The Need for Climate-Forward Efficiency:

Early Experience and Principles for Evolution

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ACEEE REPORT

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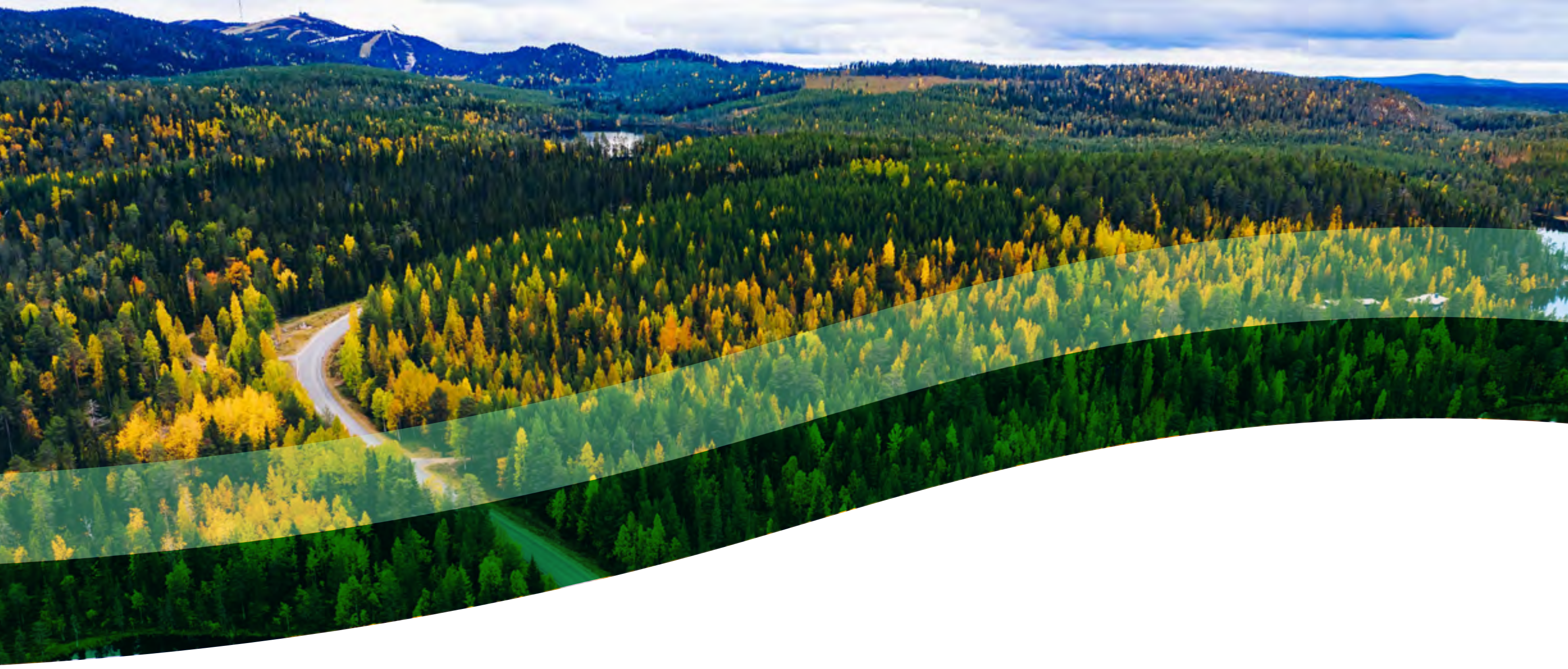
Contents



About ACEEE

The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

ACEEE
American Council for an Energy-Efficient Economy

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Executive Summary

KEY TAKEAWAYS

The purpose of utility energy efficiency programs is evolving as modern policy expectations—such as environmental protection, equity, and economic development—have begun rising to the forefront in many states.

States and utilities need to align their energy efficiency portfolios with decarbonization goals if they intend to meet their climate commitments.

A *climate-forward efficiency* approach that elevates equitable greenhouse gas (GHG) mitigation and adaptation as drivers is needed to align energy savings with periods of high carbon intensity on the grid; unlock the benefits of electrification; better integrate with demand flexibility; maintain a reliable, secure, and low-cost electricity system; expand equity and reach; and animate local markets.

A transition to climate-forward efficiency will encounter challenges related to misaligned utility incentives, heightened data requirements, the potential for stranded assets and cost shifts between sectors and fuels, and political opposition.

Leading states are taking a variety of policy and programmatic approaches to equitably align energy efficiency with GHG reductions, including the adoption of “next-generation” energy efficiency resource standards and metrics, utility business model reforms, modifications to demand-side resources’ eligibility for public funding, changes to cost-effectiveness testing, and new approaches to resource planning and procurement.

Emerging approaches generally fall into two categories: those that redefine the range of offerings that could qualify as energy efficiency, and those that modify how we measure the success of those offerings.

We identified four general approaches (avoided carbon, multiple goals, Total System Benefit, and proxy metrics) that have been taken to measure the progress energy efficiency portfolios are making towards GHG goals.

We propose nine principles that should guide the selection of greenhouse gas metrics for climate-forward efficiency, but find that no metric fully satisfies all principles of climate-forward efficiency.

BACKGROUND

The Intergovernmental Panel on Climate Change (IPCC) confirmed in August 2021 that greenhouse gas (GHG) emissions from human activity have accelerated climate change, and that achieving net zero emissions within the next few decades would be necessary to stabilize the climate (United Nations 2021). This demands ambitious actions across multiple sectors, especially the power sector. One of the most useful approaches on the demand-side is utility energy efficiency programs, which have been primarily designed to conserve energy and reduce utility and customer costs. Historically, environmental protection, equity, and economic development only registered as secondary objectives, if at all.

State policymakers, investors, advocates, and some utilities have committed to decarbonization, recognizing the critical role of the electric sector in aiding emissions reductions. Cost declines for renewable energy have changed grid dynamics, put a premium on demand flexibility, and unlocked vehicle and building electrification as core climate solutions. Meanwhile, continued inequality, pandemic-induced recession, and historic disinvestment in communities of color demand that our attention be focused on ensuring equitable decarbonization.

CLIMATE-FORWARD EFFICIENCY

This report establishes a new *climate-forward efficiency* framework for equitably aligning energy efficiency (EE) and decarbonization goals within state and utility EE portfolios.

We define climate-forward efforts as those that

- Treat EE as an intentional driver of GHG eduction
- Scale to meet the magnitude of the decarbonization goals in policy and utility corporate commitments
- Leverage EE as a tool to mitigate and adapt to the impacts of climate change on customers by advancing equity, enhancing resilience, and improving health outcomes
- Prioritize EE investments based on their time, seasonal, and geographic impacts
- Enable prioritization of investments across fuels, systems, and sectors, particularly from electrification

THE NEED FOR CLIMATE-FORWARD EFFICIENCY

Over 50 U.S. utilities have announced carbon-free or net-zero targets, yet few are on the path to meet them. Even fewer have energy efficiency program goals based on these climate commitments. Because the carbon intensity of electricity generation varies hourly, seasonally, and year over year, energy efficiency is becoming a more time-sensitive resource with respect to GHG emissions. Efficiency portfolio administrators will need to tailor their EE measures to capture savings when the grid's carbon output is highest. They can generally unleash even greater savings by electrifying technologies like space heating, water heating, and transportation that are conventionally powered by natural gas and delivered fossil fuels like propane, fuel oil, gasoline, and diesel.

Utilities must unlock more integrated and cost-effective whole-building solutions as well. This can be done by better utilizing demand flexibility enabled by grid-interactive efficient building (GEB) technologies and breaking down conventional siloes between utility EE, electrification, demand flexibility, and renewable energy efforts. Utilities must continue to expand the reach of their energy efficiency programs, especially to energy-burdened and frontline communities most at risk from climate change. These efforts must help animate local markets for EE technologies and services to achieve results at scale.

Responding to these needs will be challenging. Accounting for the GHG benefits of EE across multiple fuel categories and on more granular time scales will be more difficult than the status quo. Legacy utility business models and regulatory incentives that prioritize short-term savings (e.g., commercial lighting upgrades) over longer-term measures (e.g., weatherization of the building envelope) will need to be revised. Guardrails will be needed to ensure that crucial investments in electrification complement those in traditional energy efficiency. Policymakers and regulators must optimize utility support to achieve the scale of reductions needed without significantly displacing private sector competition and investment. Changes like these are likely to encounter political opposition—both at the macro-level (i.e., whether to address climate change at all) and in the details (e.g., quantifying avoided costs of GHG in cost-effectiveness tests).

THE EMERGING STATE OF CLIMATE-FORWARD EFFICIENCY

States are currently taking a variety of policy actions to better align energy, decarbonization, affordability, and equity goals. Some have built upon annual resource-specific goals that specify how much electricity, natural gas, or peak savings utilities must achieve. They have done this through the establishment of multiple goals that reflect expanded policy objectives and/or fuel-neutral goals that establish primary energy (Btu) or GHG reduction targets. This empowers a program administrator to prioritize the highest-potential GHG mitigation measures across fuels and eligible sectors.

Utility business model reforms are also unlocking the potential for emissions reductions. In some states with performance incentives for utilities or program administrators, we see an evolution in metrics to align with climate-forward efficiency. Revenue decoupling mechanisms, which make utilities indifferent to sales volume, become more important to ensure that customers benefit from the extra revenue utilities receive from electrification and disincentivize inefficient electrification (e.g., electric resistance space heating).

Some states are reviewing and updating policies to enable EE and demand response resources (e.g., grid-interactive electric heat pump water heaters) to participate in integrated programs that deliver both services. Others have lifted fuel-switching restrictions, which prohibit ratepayer funding from supporting electrification that passes environmental and consumer economic screens. Some states have taken steps to align cost-effectiveness testing with local policy goals, including those motivated by climate change.

REDEFINING ENERGY EFFICIENCY TO SUPPORT DECARBONIZATION

The emerging policies and practices for climate-forward efficiency in states and utilities largely fall into two categories: those that redefine the range of offerings that could qualify as energy efficiency, and those that modify how we measure and hold utilities accountable for the success of those offerings.

We identify four categories of resources that ought to be eligible for ratepayer funding under a climate-forward efficiency framework, but which are not included in many current definitions of energy efficiency:

- Efficient fuel switching (e.g., electrification)
- Passive demand reduction (e.g., peak-saving efficiency)
- Demand flexibility programs (e.g., managed electric vehicle charging)
- Non-energy resources (e.g., refrigerant savings for GHG abatement, tree planting)

Key mechanisms for expanding the definition of energy efficiency to subsume these resources include removing existing barriers on investment in equipment that lower emissions through fuel switching from fossil fuel to electricity, updating criteria and definitions regarding resource eligibility for ratepayer-funding, and reducing programmatic silos within utilities (e.g., separate EE and demand response programs).

Table ES1 summarizes the approaches taken by leading states to hold utilities accountable for the success of their climate-forward efficiency offerings. These metrics are not mutually exclusive and may be combined together within a single "metric framework." For example, the Sacramento Municipal Utility District (SMUD) has a single overarching goal of avoided GHG emissions; Massachusetts has established multiple goals (e.g., all fuel savings, electricity savings, natural gas savings, peak reduction, GHG, etc.) that must be met in parallel; and California investor-owned utilities (IOUs) must segment their EE programs into separate portfolios based on their primary purpose (resource acquisition, market support, and equity).

Table ES1. Approaches taken by leading states to quantify the progress toward GHG goals through energy efficiency

Approach	Description	Locations
Avoided GHG	Sets common metric of avoided GHG emissions (e.g., carbon dioxide equivalent) for efficiency and electrification programs	SMUD, VT; DC and MD (under consideration)
All fuel savings	Annual or lifetime energy saved across all fuel categories, usually measured in Btu	MA, NY; MD (under consideration)
Total System Benefit	Uses the total economic benefits of energy efficiency to set resource efficiency goals	CA IOUs
Proxy metrics	Goals are set using proxy metrics that do not involve measures of energy, power, or emissions (e.g., number of heat pumps installed, EVs purchased)	VT

Metrics should capture progress towards both decarbonization goals and other benefits associated with energy efficiency, including equity and market transformation.

We offer the following set of principles for states and utilities to consider when establishing climate-forward energy efficiency metrics, but note that no single metric fully satisfies all principles, and each brings its own set of advantages and drawbacks:

- *State/corporate alignment*. Metrics should facilitate direct comparisons to state and utility climate policy commitments.
- *Cumulative emissions*. Metrics should capture full lifecycle impact of climate-forward efficiency measures on carbon emissions.
- *Accuracy*. Metrics should match the level of detail required by policy goals.
- *Inclusivity*. Metrics should capture emissions reductions that result from all types of climate-forward efficiency activities.
- *Market transformation.* Metrics should capture progress towards market transformation activities that will drive long-term emissions reductions beyond those that maximize direct reductions in the immediate program cycle.
- *Equity*. Metrics should capture progress towards equity goals established in state policy.
- *Robust development*. Metrics should be developed in a transparent manner with participation from all stakeholders, especially those who are traditionally underrepresented.
- *Data pipeline*. Metrics should be supported by access to sufficient data to calculate metrics for the duration of the programs.
- *Avoid perverse incentives*. Metrics should not incentivize sub-optimal resource acquisition or unwanted activities (e.g., importing electricity with high carbon content).

MOVING FORWARD

Climate-forward efficiency will require expanding eligible resources in utility energy efficiency offerings to include energy savings and emissions reductions measures that are often overlooked, if not prohibited, such as efficient fuel switching and demand flexibility. We recommend that major stakeholders take stock of their current practices and assess the extent to which their work is supportive of climate-forward efficiency.

In a companion report, *A Roadmap for Climate-Forward Efficiency*, we will expand upon the vision of climate-forward efficiency and detail a strategy roadmap that policymakers, regulators, utilities, program administrators and implementors, advocates, trade allies, and others can adapt for their own particular circumstances to ensure that they are realizing the potential of energy efficiency as a critical climate change mitigation tool.

Why Climate-Forward Efficiency?

Climate change is one of the defining global challenges of our time. In the United States alone, drought, heat waves, wildfires, flooding, and other extreme weather events have become more common due to the rise in global temperature. These events endanger human lives, degrade ecosystems, damage infrastructure, and disrupt economic activity (USGCRP 2018).

Global concern about climate change led to the 2015 Paris Agreement, as more than 130 countries pledged to limit global warming to “well below” 2°C (Schiermeier 2016). Three years later, the IPCC published a report that urged the international community to aim for a 1.5°C goal due to the dangers of a 2°C temperature increase. To achieve the 1.5°C goal, GHG emissions would need to fall by 45% below 2010 levels by 2030 and reach net zero by 2050 (IPCC 2018).

The United States is responsible for about 14.5% of annual global emissions, the second highest percentage in the world (Ritchie and Roser 2020). Matching the global goal of 1.5°C will require the U.S. to decarbonize across all sectors of the economy including power generation, buildings, transportation, industry, and agriculture. ACEEE modeled the impact of energy efficiency opportunities and found they could cut expected 2050 U.S. carbon dioxide emissions by half, as shown in figure 1.

However, substantial expansion of energy efficiency efforts is still required to deliver the scale of emissions reductions needed. There are a multitude of opportunities for energy efficiency to facilitate the transition to a low-carbon electric grid, but the focus of most utility energy efficiency programs has been a reduction in annual energy sales rather than GHG reductions. Utility energy efficiency portfolios that treat emissions reductions as a byproduct rather than a driver of energy savings will encounter challenges in optimizing their offerings for decarbonization goals and will struggle to measure their success against climate pledges made by their state or even their own companies.

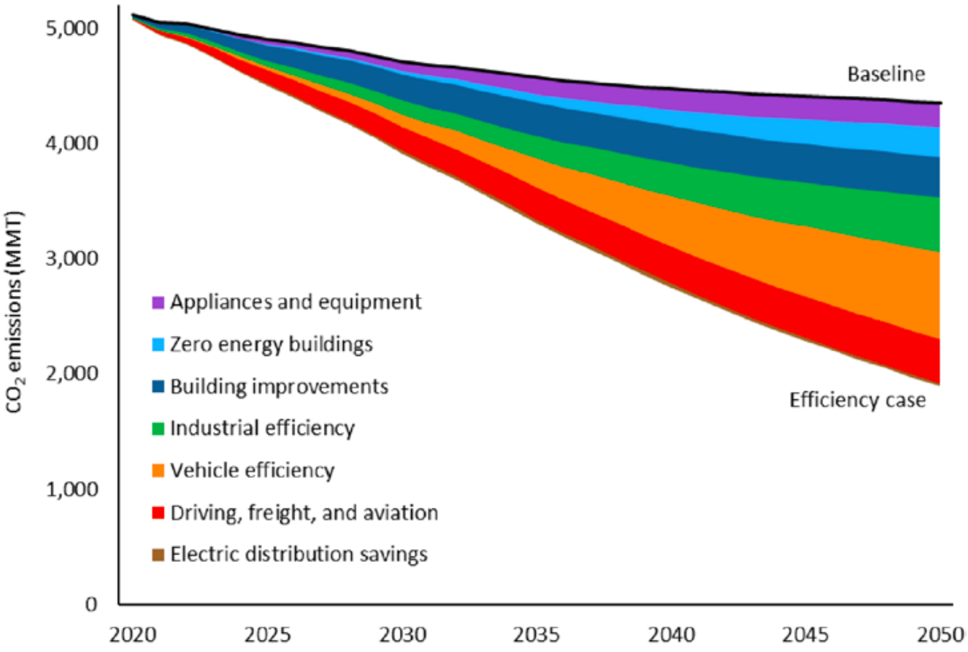

Figure 1. Carbon dioxide emissions reductions from combined opportunities across sectors. ***Source: Halfway There*** **(Nadel and Ungar 2019).**

NOT ALL SAVINGS OFFER EQUAL VALUE FOR CLIMATE

The growth of renewable energy is a key pillar of decarbonization of the electricity system and is indispensable for averting the worst impacts of climate change. Regional grid operators are integrating ever larger amounts of solar and wind capacity onto their grids, even issuing public announcements when renewable energy hits record levels.[1] In some instances, surpluses of renewable generation have led to significant curtailments and driven the wholesale price of electricity negative (Burgess, Schlegel, and Zuckerman 2018). Utilities in the southwestern United States and California have experienced significant increases in the penetration of renewable resources—particularly solar PV. This has had a major effect on the operation and pricing of electricity in the wholesale markets in these regions. For example, the frequency of negative

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[1] For example, the Southwest Power Pool tweeted that they had achieved 87.5% renewable penetration during the morning of May 8, 2021, and CAISO issued a press release to announce records it set in renewable energy integration (SPP 2021; CAISO 2021).

prices in the California Independent System Operator (ISO) energy markets has increased in recent years, particularly during midday hours with low to moderate load moderate load (e.g. in April).[2] As renewable energy prices continue to drop, occurrences like these will only become more commonplace.

However, utility energy efficiency portfolios, which have delivered customer and grid savings for over four decades, have not yet evolved to match these supply-side changes. Energy savings realized during periods of high-renewable generation offer fewer GHG reductions. In the absence of a robust energy storage market, poorly designed EE offerings that deliver savings when the price of electricity is negative could both cost consumers money during those periods and hinder the growth of renewables, though this phenomenon is currently rare.

While there are multiple reasons for the lack of alignment between energy efficiency and GHG reduction, one key driver is that many current utility energy efficiency policies measure success in terms of site energy consumption reduction at customers' electricity and natural gas meters. Whether that energy is measured in terms of kilowatt hours (electricity), therms (natural gas), or rarely Btu (fuel agnostic), measures of site energy savings inherently ignore everything happening "in front of the meter" to produce and deliver energy to the home, including the carbon intensity of delivered electricity and natural gas.[3] Failure to account for GHG emitted during the conversion of fuel to useful energy renders utilities and program administrators (PAs) unable to determine, for example, whether an electric heat pump would deliver more GHG reductions than an efficient natural gas furnace or gas-fired heat pump, let alone make programming decisions optimized for decarbonization.

EQUITY AND RESILIENCE

An evolution of utility energy efficiency programs must ensure that the intended benefits are delivered in a manner that is fair and just. The impacts of climate change are disproportionately borne by low-income communities and communities of color, and are expected to worsen (EPA 2021). These impacts include traditional utility reliability issues, like more intense precipitation events that contribute to power outages, as well as extreme heat and cold (e.g., insufficient weatherization creating inability to safely shelter-in-place). Utilities that align energy efficiency and GHG mitigation while considering the social determinants of health will enhance their customers' resilience to climate change, helping them adapt in a way that also supports health and equity.[4] These actions will also go a long way towards ensuring that economically disadvantaged customers are not left behind in the clean energy transition.

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[2] Energy efficiency lowers total system demand, which could increase the risk of renewable energy curtailments during periods of high solar and wind generation. Robust energy storage options (e.g., grid-scale electrochemical batteries) will offset the concern during these periods, converting avoided energy to stored energy that can be deployed at more favorable times.

[3] A more complete picture is provided through source energy, which accounts for all energy consumed during the conversion of fuel to electricity and includes factors like the heat rate of generating stations and line losses on the transmission and distribution systems that site energy ignores.

[4] Social determinants of health are the conditions in the environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks.

TOWARD CLIMATE-FORWARD EFFICIENCY

Despite a growing number of states adopting goals to decarbonize their electric power sectors, most are not on track to meet the targets.[5] The current reality is that energy efficiency funds are limited, and investment decisions are being made using frameworks that do not prioritize greenhouse gas reductions.

Utility energy efficiency has largely been designed to conserve energy and reduce costs for utilities and their customers. In overseeing these efforts, regulators have typically viewed environmental protection, equity, and economic development as secondary objectives. However, those secondary objectives are rising to the forefront for many reasons:

- Climate change is threatening grid reliability and resilience, which endangers the health and safety of customers.
- Recognizing the critical role of the electric sector in reducing GHG emissions to mitigate the effects of climate change, state policymakers, investors, advocates, and some utilities have committed to net zero emissions targets and are seeking to provide programs and services that reduce climate-related risks for vulnerable customers.
- Cost declines for renewables have changed grid dynamics, putting a premium on demand flexibility, and unlocking vehicle and building electrification as core climate solutions.
- Energy efficiency investments are being recognized and deployed as a form of economic stimulus (e.g., American Recovery and Reinvestment Act, Illinois Climate and Equitable Jobs Act).
- Continued inequality, pandemic-induced recession, and historic disinvestment in communities of color demand that our attention focus on ensuring equitable decarbonization.

Yet the current structure, operation, and evaluation of utility energy efficiency programs limits their ability to help achieve an affordable, equitable, clean energy future. Transformative strategies can unlock EE's full potential to work towards net zero emissions, act as a grid resource, foster equity, and preserve health and safety.

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[5] Berg et al. 2021. *Meeting State Climate Goals: Energy Efficiency Will Be Critical*. ACEEE. https://www.aceee.org/research-report/u2104.

We present this report as part of the foundation of ACEEE's Climate-Forward Efficiency Initiative and define climate-forward efforts:

- Treat energy efficiency as an intentional driver of GHG reductions.
- Scale to meet the magnitude of the decarbonization goals in policy and utility corporate commitments.
- Leverage energy efficiency as a tool to mitigate and adapt to the impacts of climate change on customers by advancing equity, enhancing resilience, and improving health outcomes.
- Prioritize energy efficiency investments based on their time, seasonal, and geographic impacts.
- Enable prioritization of investments across fuels, systems, and sectors, particularly from electrification.

In these ways, climate-forward efficiency balances and aligns our needs for net-zero emissions with other benefits that customers and communities seek from energy efficiency.[6]

REPORT STRUCTURE

The remainder of this report is structured as follows. In Section 2, *The Need for Climate-Forward Efficiency*, we establish the reasons energy efficiency needs to be aligned with net zero targets, as well as the challenges anticipated in doing so. In Section 3, *The Emerging State of Climate-Forward Efficiency,* we highlight state and utility policy approaches—both taken and under consideration—to elevate GHG reductions within their energy efficiency portfolios. In Section 4, *Redefining Energy Efficiency to Support Decarbonization,* we propose redefining energy efficiency to (1) expand the range of activities that should qualify as energy efficiency under a decarbonization framework and (2) identify potential metrics that could measure progress under those new definitions.

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[6] Throughout this report, references to decarbonization in the context of climate-forward efficiency should be assumed to also include equity, health, resilience, and the other goals listed in this framework, unless stated otherwise.

The Need for Climate-Forward Efficiency

In this section, we expand upon these ideas and outline why it is necessary for utility EE practices to evolve in order to unleash their full potential in a way that decarbonizes our economy, values system benefits, preserves health, and supports equity. After explaining the opportunities associated with realigning energy efficiency and GHG reductions, we will also present some potential alignment-related challenges that policymakers, regulators, utilities, and other stakeholders should be aware of and prepare for.

MATCHING COMMITMENTS WITH ACTIONS

Since Xcel Energy's announcement in 2018 committing to 80% carbon reduction by 2030 and 100% carbon-free electricity by 2050, 51 additional U.S. utilities have subsequently announced ambitious climate commitments for net-zero or carbon-free emissions by 2050 (as of June 2021) (SEPA 2021; Xcel Energy 2018). Only four have interim targets on pace with the decarbonization needed to meet Paris climate targets, or 80% of 2005 emissions by 2030 (Romankiewicz, Bottorff, and Stokes 2020). Over one-third of Americans live in a city or state with a commitment to a carbon-free grid (Trumbull et al. 2019). Despite this ambition, few utilities are currently on the path to meet these goals. A 2020 analysis found that most companies are not yet incorporating their climate commitments into their integrated resource planning (IRP) and/or making resource planning decisions, including for energy efficiency, based on their commitments.

Even fewer have goals for their energy efficiency programs based on climate commitments; as of this writing only the Sacramento Municipal Utility District (SMUD) has set such a target (SMUD 2020b). Instead of measuring the success of customer programs based on lifecycle GHG emissions, most utilities with ambitious efficiency goals are striving to meet targets based on annual electricity or therms savings. Such targets, tied to the idea of least-cost procurement, have successfully driven most of the utility-sector energy efficiency savings of the last few decades, including 80% of nationwide utility program electricity savings in 2017 (Gold, Gilleo, and Berg 2019). However, these narrowly drawn targets miss the necessary scale for decarbonization goals, disregard the time- and locational-value of energy efficiency resources, ignore the potential from efficient fuel switching, and overlook the value of savings over the life of a measure. While cost-effectiveness can examine the full stream of benefits and costs over time, and may capture greenhouse gas reduction benefits, it primarily serves as a threshold "yes/no" decision rather than the ultimate objective that utilities optimize their portfolios around.[7] As a result, shifting metrics of success for GHG can elevate the options utilities have to deliver greenhouse gas reductions to and on behalf of their customers.

In general, when climate commitments, goals, and policy objectives are aligned, program administrators and the ecosystem of implementors, local governments, and other actors can better understand what different program objectives are and how progress will be measured. They can then improve the deployment and quality of offerings to align with those goals (NRDC 2020). Such alignment may instigate, motivate, and necessitate shifts in prioritizing technologies and the ways that a utility values, measures, and compensates customers for adopting them. Without the clarity that comes from goals that match the objectives, we see even fewer utilities investing in the set of customer clean energy offerings that are aligned with and scaled to those commitments.

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[7] "In its simplest form, energy efficiency cost-effectiveness is measured by comparing the benefits of an investment with the costs." (National Action Plan for Energy Efficiency 2008b).

RECOGNIZING THE TIME VALUE OF ALIGNMENT

For about four decades, states have been measuring the success of efficiency programs based predominantly on the amount of energy they saved at customers' electric and natural gas meters. However, the carbon intensity of electricity generation varies both temporally and spatially. A saved kWh of electricity can offset about 2.21 pounds of CO_2 when a grid is exclusively powered by coal, 0.91 pounds of CO_2 when a grid is exclusively powered by natural gas, but no CO_2 when a grid is fully powered by renewable energy (EIA 2020).[8] Because the set of generating power plants that produce electricity at any given moment regularly changes, so too will the avoided emissions achieved through energy efficiency.

As such, energy efficiency is becoming a more time-sensitive resource with respect to GHG. Utilities interested in achieving net zero emissions must do more than just meet an annual energy savings target. Their energy efficiency offerings should be targeted to the times when carbon emissions on the grid are largest.

Low-carbon sources of electricity like solar, wind, and nuclear can offer power to the grid at lower costs than carbon-intensive fuels like natural gas and coal, and as a result are often among the first sources of generation to be dispatched in electricity markets. It is for this reason that the highest demand hours of the year, which require the greatest number of fossil generators running, are typically the most carbon intensive.[9]

To illustrate these points, consider the monthly emissions intensity of the California grid presented in figure 2. The average hourly carbon intensity of generated electricity is indicated for each month of the year. In 2019, the lowest hours for carbon intensity (depicted in green) occur during midday in the spring. This is a period when renewable energy (i.e., solar) production is high and system load (particularly for space heating and cooling) is low. A MWh saved during these hours will result in roughly half the emissions savings of a MWh saved at night in summer or winter (depicted in red), when those conditions are reversed.

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[8] In different units, a saved MWh of electricity can offset 1.00, 0.42, and 0 metric tons of CO_2 on grids powered exclusively by coal, natural gas, and renewable energy, respectively.

[9] These high-carbon periods are highly correlated with periods of high net load. Net load is the total system demand minus energy provided by non-dispatchable (i.e., renewable) sources. Because net load is predominantly met with fossil-based resources, it is a better indicator of the grid's instantaneous carbon emissions rate than total system load.

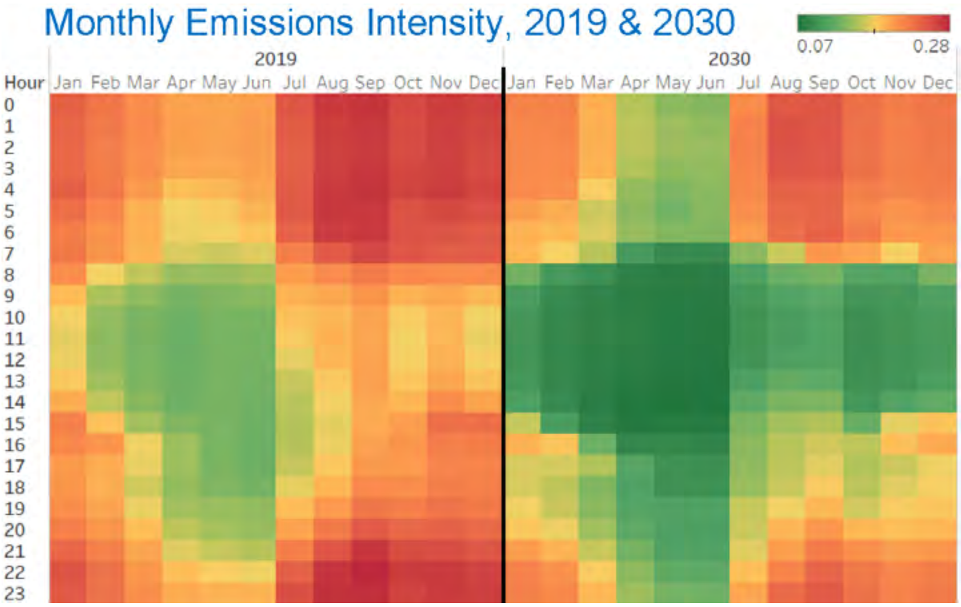

Figure 2. This figure, produced by the California Energy Commission (CEC), compares the forecasted average CO_2 intensity of electricity (tons of CO_2 emitted per MWh) per hour for each month of the year in 2019 (left) and 2030 (right) (Brook 2018). Electricity produced during hours represented by red blocks are more carbon intensive, while those represented by green blocks are less carbon intensive.

In addition to diurnal and seasonal changes to the generation mix, electric grids throughout the country will continue to decarbonize year-over-year by virtue of a combination of factors including state renewable portfolio standards and the declining price of renewable energy. To capture future emissions savings, utilities should project and plan around what will be high-carbon hours in years to come (e.g., the red and orange hours on the right side of figure 2). This is a crucial consideration for long-lived measures that reduce energy consumption for many years like variable speed fans, motors, and pumps as well as advanced building controls, but is especially important for passive demand reduction measures like weatherization and shading, which "permanently" shed peak load but will be unable to respond to time-based GHG emissions profiles after their installation.[10]

In addition, there is a "time value of avoided emissions" that is similar in nature to the time value of money: emissions reductions (and thus avoided climate impacts) today are worth more than equivalent emissions reductions in the future. This should place additional emphasis on short-term energy efficiency programs (e.g., behavioral programs) that can be deployed quickly and potentially at lower cost than programs that address building fabric or appliances (Hibbard et al. 2020).

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[10] However, these passive measures enable active demand response measures. For example, a well-insulated and shaded house allows a smart thermostat to temporarily turn off the air conditioner during the peak time with little discomfort and customer dissatisfaction.

UNLEASHING ELECTRIFICATION

Reaching climate targets requires unlocking the emissions reductions that electrification can provide. The combustion of fossil fuels like natural gas and fuel oil for space heating, water heating, and cooking in U.S. buildings accounted for about 546 million metric tons (MMT) of carbon dioxide emissions in 2020, which is almost 12% of all U.S. energy-related emissions. Direct combustion of coal, natural gas, and petroleum in the industrial sector contributed 949 MMT (21% of total) while fossil fuel consumption for transportation was responsible for 1627 MMT (35% of total) (EIA 2021).[11]

Electrifying those end uses holds the potential to reduce carbon dioxide emissions by about 850 MMT per year by 2050.[12] About 14% of those reductions come from electrification of building technologies, primarily the conversion of fossil-based heating equipment (like gas furnaces) to more efficient electric heat pumps. [13] Another 14% comes from the industrial sector (Nadel and Ungar 2019).

The remaining 72% of the CO_2 reductions will come from the electrification of light-, medium-, and heavy-duty electric vehicles. Yet we cannot electrify vehicles at the pace needed without active utility participation alongside the actions of local, state, and federal governments. Utilities are in a prime position to address some of the primary barriers to transportation electrification, which include upfront vehicle costs, availability of charging infrastructure, and customer and dealer incentives and awareness (Singer 2017). Utilities can also optimize EVs to take advantage of low-carbon electricity through managed charging and time-of-use rates. This includes shifting to off-peak EV charging and avoiding the dispatch of highly polluting and carbon-intensive plants to meet peak demand. As regulated entities, their efforts can be directed at those contexts and communities that are currently or have historically been disadvantaged, such as multiunit dwellings in communities with a history of redlining (Huether 2021). Further, the proliferation of electrification may lead to downward pressure on electricity rates for all utility customers—even for those who do not own an EV or heat pump (Frost, Whited, and Allison 2019).

The level of GHG reduction will depend on the carbon intensity of the local electric grid. But even today, switching from a gas furnace to a heat pump will reduce carbon emissions in 99% of U.S. households, while switching from a fuel oil furnace will reduce emissions in essentially all households (McKenna, Shah, and Silberg 2020). Because electric heat pumps will operate for about 15 years after original installation, cumulative emissions savings will grow faster as the grid decarbonizes. These national findings have been corroborated by regional analyses as well. For example, a study of homes in Sacramento, California finds that electrification of single family residences can reduce emissions by 30–60% today and by 80–90% by 2050, relative to natural gas–fueled homes (Mahone et al. 2019).

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[11] The remaining 32% of energy-related emissions came from the electric power sector.

[12] This value only accounts for carbon reductions from electrifying end uses after first reducing load through traditional energy efficiency measures.

[13] Heat pump efficiency decreases with outside temperature. During very cold periods, units typically default to an inefficient backup electric resistance heating mode. However, in recent years cold climate heat pump models have been developed that allow the units to heat buildings efficiently even when outdoor temperatures are below 0°F.

INTEGRATING WITH DEMAND FLEXIBILITY

A growing number of buildings have demand flexibility, which is the capability to adjust their load profiles across different timescales using distributed energy resources.[14] Technologies that enable the shaping, shedding, and shifting of their electricity consumption include dimmable LEDs, electric vehicles, smart controls, variable frequency drives (VFD), and variable refrigerant flow (VRF) HVAC systems. They offer a class of grid-interactive efficient buildings (GEBs) the ability to utilize "smart technologies and on-site distributed energy resources to provide demand flexibility while co-optimizing for energy cost, grid services, and occupant needs and preferences in a continuous and integrated way" (Neukomm, Nubbe, and Fares 2019).[15]

Although integrated programs that combine efficiency and demand response or flexibility provide many benefits, few such utility programs exist (York, Relf, and Waters 2019). Aligning utility portfolios around decarbonization goals presents an opportunity to better coordinate the services that GEB technologies can provide to both customers and the grid. Decarbonization can serve as a driver for regulatory incentives for utilities to more fully consider the combined options offered by GEBs, thereby maximizing opportunities for them to provide these services.

The U.S. Department of Energy's national GEB roadmap finds that by 2030, GEB measures have the potential to reduce national CO_2 emissions by 80 million tons (or about 6% of total power sector emissions), with the largest portion of reductions coming from lower overall electricity demand. These savings are projected to be even greater in a future with high levels of electrification of building heating and transportation technologies, though the exact values will depend on geography and the penetration of renewable energy, as shown in figure 3 (Satchwell et al. 2021).

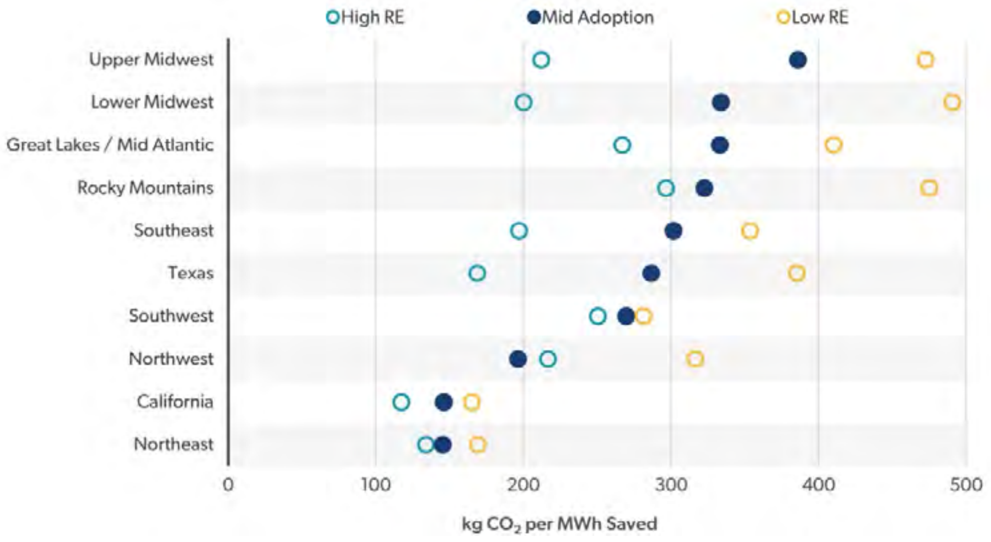

Figure 3. The rate of avoided CO_2 will vary geographically due to differences in the emission rates of the local generating units, and changes in the generation fleet over time. Opportunities for emissions reductions are greatest in areas like the Midwest where the percentage of fossil-based generation is higher than average. Figure from *A National Roadmap for Grid-Interactive Efficient Buildings* (Satchwell et al. 2021).

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[14] *Distributed energy resources* are customer-sited energy technologies that can reduce or shift power demand (kilowatts), reduce energy use (kilowatt-hours), or supply power to the grid. Distributed energy resources include energy efficiency, load management (demand response), renewable energy (such as solar photovoltaic systems), and storage (batteries).

[15] For more insight into what qualifies as a GEB technology, see these resources from the U.S. Department of Energy: www.energy.gov/eere/buildings/grid-interactive-efficient-buildings.

Breaking Down Silos

States and utilities pursuing separate energy efficiency and net zero emissions goals often encounter technology and program silos that do not effectively allow for integrated, whole-building solutions. Customers have a variety of energy needs that may need to be serviced by different fuels (e.g., electricity, delivered fuels) at different times (e.g., on-peak, off-peak) and under their own individual cost constraints. Aligning energy efficiency with GHG goals forces program designers to confront these interactions and address them within a common framework. The ability to work across siloes expands utilities' options and invites new, optimized, cost-effective solutions.

As an example, consider a utility with an electricity savings target (supported with customer incentives) and a GHG commitment, but no fuel-neutral target (e.g., Btu or GHG).[16] Weatherization of a propane-heated home in that service territory could yield space heating energy and emissions reductions of between 10–50%, depending on the level of the retrofit. The utility, however, could only incentivize a relatively small portion of this project: the electricity savings resulting from reduced furnace fan time and central air conditioning reductions. Moreover, the utility could offer no incentive to switch from the propane furnace to a cleaner, more efficient electric heat pump, since that would increase the home's electric load.

If the household opted instead to install the heat pump first, establish a new baseline level of electricity consumption over several months, then weatherize, it would be able to claim those electricity savings and receive higher utility incentives. The customer would, however, be left with an oversized (and therefore more expensive and often less efficient) heating system that was originally selected to meet the needs of a less efficient home. Placing the focus of savings squarely on GHG reductions properly aligns these incentives and, in this case, would encourage the customer to both weatherize and switch to a more efficient heat pump. This avoids these sorts of perverse interactions that arise simply because climate-forward measures were not part of the program. This type of whole-building approach will be needed to right-size equipment and reduce overall project first costs.

In addition, rather than administer electric efficiency, gas efficiency, net-zero, and related programs separately, alignment can bring multiple goals under a single umbrella. This can result in more cost-effective procurement through design and evaluation on a holistic, fuel-neutral basis (NYSERDA 2018).

Maintaining Reliable, Secure, Low-Cost Systems Amid a Changing Landscape

Decarbonization goals will require continued electrification of the building stock, including conversion of fossil-based heating systems to electric heat pumps. The combination of heat pumps' more efficient cooling, their introduction of additional winter electric load, and the relative dearth of solar energy resources during winter months will contribute to many regions of the country becoming winter peaking. Extreme or extended periods of winter cold can more than double winter electric load, introducing a significant challenge to meeting demand without having to build out potentially expensive and fossil-powered supply-side resources. The most

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[16] Fuel-neutral goals create an overarching goal for a portfolio of programs and may not specify the resources from which utilities must derive energy savings. It may be an energy goal, measured in British thermal units (Btus), or it may be a GHG reduction goal, measured in carbon-dioxide equivalents.

effective solutions will be a combination of weatherization and higher-efficiency heat pumps, with an acknowledgement that limited use of back-up fuel-based systems could be a cost-effective approach to handling the very coldest winter days (Specian, Cohn, and York 2021).[17]

Resource-specific efficiency standards are not equipped to handle the interactions between these various systems that will emerge on the path toward electrification. In some cases, these standards may undermine electrification efforts by counting against savings targets or performance incentive mechanism thresholds.[18] An all fuels savings construct could more deftly account for potential geographic fuel delivery constraints (e.g., service load at the end of a natural gas delivery pipeline), providing an additional pathway to cost effectively maintain reliability while also approaching GHG mitigation goals.

Energy efficiency can reduce costs associated with the integration of renewable energy. When combined in clean energy portfolios (CEP) including wind, solar, and demand flexibility, energy efficiency can not only help provide the same grid services as natural gas power plants, but can do so at lower cost in about 90% of cases. Energy efficiency plays a key role here, accelerating the time frame in which a CEP becomes cost effective by eight years, on average (Teplin et al. 2019). By lowering peak demand, energy efficiency can also accelerate the retirement of expensive peaker plants, which also tend to be among the most carbon-intensive sources of generation (Gold, Ungar, and Berg 2021).

Moreover, climate change affects reliability and resilience in ways that are tightly integrated with energy efficiency. The number of billion-dollar disaster events attributed to extreme weather has trended upward, and climate change is projected to increase the frequency and magnitude of those events (NCEI 2021; Silverstein, Gramlich, and Goggin 2018). A climate-forward efficiency framework can more effectively leverage the reliability benefits that accrue from mitigating emissions through energy efficiency (by avoiding the worst impacts of climate change) while simultaneously enhancing the resilience of residential and commercial buildings that would have to ride through such events (see for example Specian et al. 2020).

EXPANDING EQUITY AND REACH

There is a growing need to expand the reach of utility efficiency programs to increase benefits to customers, the grid, and the climate. To meet "net zero by 2050" targets, the International Energy Agency (IEA) projects the need to increase energy efficiency improvements globally to a rate of 4% per year through 2030, which is about three times the recent average. That rate of achievement will require a push beyond typical business-as-usual participation rates for utility programs. For example, home retrofits are a crucial component of the narrow path to 1.5°C, but these programs currently reach only a very limited number of eligible customers in the service territories where they are offered: less than 2% on average (York et al. 2015).

Beyond the need to ramp up participation broadly, climate-forward efficiency demands a focus on reaching and adequately serving energy-burdened customers and those frontline customers most at risk from climate change. The impacts of climate change have been and continue to be disproportionately borne by members of environmental justice and other disadvantaged communities. These communities pay an outsized share of energy and transportation costs: utility cost burdens are 3.5 times higher for low-income customers than non-low-income customers

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[17] Weatherization in this case is assumed to lift a home's thermal performance from a 2006 baseline to IECC 2015 levels, and a commercial building's performance from an ASHRAE 2007 baseline to the 2019 standard. Additional savings are achievable through deep energy retrofits involving more comprehensive envelope upgrades.

[18] This issue arises where baselines are set using a rolling basis and resource-specific goals become more difficult to attain with higher levels of electrification. Such an issue is not present in states with fixed (e.g., based on a specific year) or absolute (e.g., based on a specified quantity of MWh savings) baselines. Nine states have such targets in their EERS goal design, although more may have this issue in performance incentive mechanism design (Gold, Gilleo, and Berg 2019).

and gasoline cost burdens for low-income households are more than 3 times larger than burdens for higher-income households, with greater impacts on Black, Hispanic, and American Indian households (Vaidyanathan, Huether, and Jennings 2021; Drehobl, Ross, and Ayala 2020).

Addressing decarbonization with business-as-usual strategies that focus on "early adopters" risks reinforcing economic and racial inequities. Transportation electrification offers one example: EV infrastructure deployment may not reach disadvantaged neighborhoods or residents of multiunit dwellings without clear policy direction and emphasis in utility program design. Further, existing tax credits and purchase incentives may not benefit households without a tax burden or the capital to address remaining price differences for EVs (Howard et al. 2021). To avoid exacerbating these inequities, climate-forward efficiency must include policy and program designs targeted at these communities and new partnerships with those communities to ensure that their needs are prioritized in the transition.

Animating Local Markets

Utility-sector energy efficiency programs are funded by captive ratepayers through utility rates and statewide public benefits funds. Total efficiency program spending in 2019 was approximately $8.4 billion, of which $6.8 billion was for electric efficiency and $1.5 billion for natural gas energy efficiency (Berg et al. 2020). While significant, such funds are insufficient to scale efficiency to the climate challenge. An estimate of the cost to conduct deep retrofits on most U.S. homes and buildings, a crucial step in meeting 1.5°C Paris Agreement climate commitments, found that it would cost over $3.6 trillion in total (Goldstein, Turnbull, and Higgins 2018; Golden, Scheer, and Best 2019). Utilities will need to address the growing load shape challenges driven by the variability of many renewable resources. Behind-the-meter solutions, such as energy efficiency, demand response, electrification and storage, will play an important role in grid stability, but only if they can deliver changes in demand that meet the time and locational needs of the grid. This article will discuss how smart meter interval data, combined with open source methods and software, provide transparent measurement of savings load shapes (resource curves).[19]

Currently, most energy efficiency programs use a single implementor and business model, limiting savings to the portion of the market that responds to a particular program design and approach. Pay-for-performance models may be able to bring more ratepayer funding to bear to support energy efficiency by enabling private market investment (e.g., through project finance) in the implementors and aggregators that deliver programs to customers. If utilities solicit bids for clearly defined resource needs and set up reliable *offtaker* (energy purchase) contracts, aggregators can enter into the energy savings equivalent of a solar power purchase agreement (PPA) with the utility. Other models may also support treatment of energy efficiency like a long-term power purchase agreement or like a utility-owned generation or leased property, such as the MEETs model.[20]

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[19] This estimate assumes 120 million housing units, $20,000–$40,000 cost per deep retrofit ($20K for multiunit and $40K for single family) for a total of $3.6 trillion.

[20] Metered EE Transaction Structure (MEETS) is a financing arrangement in which the yield from metered EE, that is, the difference between a dynamic baseline and actual consumption, is delivered to the utility, enabling EE to be treated like a long-term power purchase agreement or a utility-owned generation or leased property (Gold et al. 2020).

CHALLENGES

While the need for climate-forward efficiency is clear, adopting this as a new framework is likely to encounter some challenges. These include misaligned utility incentives, heightened data needs and modeling complexity, the potential for stranded assets and cost shifts between fuel sectors, and potential political opposition and regulatory challenges.

UTILITY INCENTIVES

Utility business models that reward increased volumetric sales and capital expenditures provide strong incentives for some climate-forward efficiency resources over others, and those incentives may not align with available equitable decarbonization pathways.[21] Absent business model reforms through performance-based regulation (including decoupling and performance incentive mechanisms), utilities face strong incentives to take actions that increase sales and drive the need for additional infrastructure to support those sales (York et al. 2014).

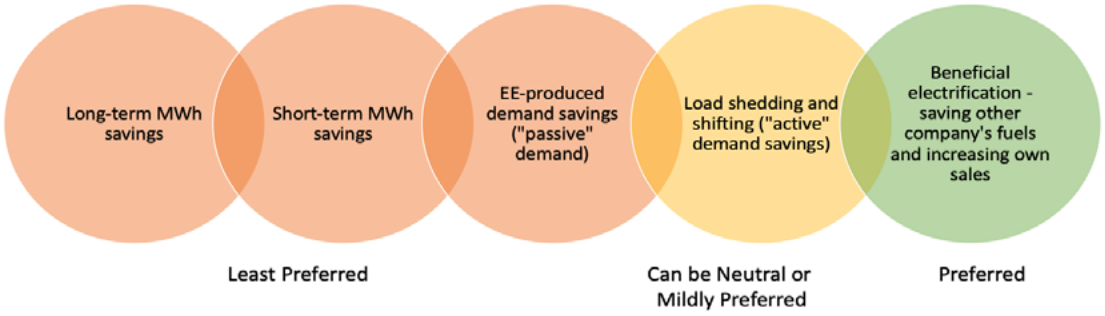

Figure 4. Typical electric utility order of preference for procuring demand-side options. All of these categories may provide societal benefits, but utilities will likely need more regulatory incentives to the left (Gold, Gilleo, and Berg 2019; Lazar and Colburn 2013).

As illustrated in figure 4, those resources that reduce both sales and investment, such as energy efficiency and rooftop solar, are least favored. Because peak demand affects investment much more than sales, utilities may prefer peak demand savings over long-term electricity savings like those associated with insulation or new construction. Electric utilities with fuel-neutral energy savings or GHG goals may be compelled to prioritize investments in beneficial electrification.[22] Policymakers will be challenged to ensure that new utility investments in electrification are in addition to and not at the expense of utility investments in buildings and industrial energy efficiency (Howard et al. 2021). Similarly, gas utilities may naturally favor gas appliance efficiency over envelope efficiency or electrification solutions, so policymakers will need to consider reforms that encourage them to offer and prioritize the lowest-carbon options.

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[21] Capex bias is conventional cost-based accounting that incentivizes capital expenditures. Throughput bias/incentive is an incentive to grow energy sales and disincentive to reduce sales (Cross-Call et al. 2018).

[22] Most organizations define electrification as beneficial when it provides net societal and participant benefits. For example, the Regulatory Assistance Project states that electrification must meet one or more of the following conditions without adversely affecting the other two: (1) saves consumers money over the long run, (2) enables better grid management, (3) reduces negative environmental impacts (Shipley et al. 2021).

Related challenges exist for incorporating EVs into climate-forward efficiency strategies. Many states have created a role for utilities in supporting both make-ready upgrades and EV charging infrastructure itself.[23] Approval of the latter is most common for underserved communities and locations where the economics for EV infrastructure are particularly challenging (e.g., multiunit dwellings, medium- and heavy-duty fleet charging) and unlikely to be served by the private market without government intervention. Policymakers and regulators will have to take into account both economic theory and political reality to discover the optimal level of utility support that is warranted in such cases: large enough to achieve the scale of change needed, but not so large as to displace private sector competition and investment.

These incentives may manifest differently depending upon a utility's market structure. For example, vertically integrated utilities will be more resistant to efforts to procure demand-side resources to offset the need for new power plants while both distribution-only utilities and vertically integrated utilities will seek to sell more power that increases sales and justifies new spending on poles and wires (Gold et al. 2020).

DATA AVAILABILITY AND MODELING COMPLEXITY

It is more difficult for stakeholders to model and account for impacts across multiple fuel categories, such as the electric and natural gas systems. Moreover, obtaining the data needed to realize climate-forward efficiency also introduces challenges. Unlike relatively simple annual energy savings calculations, climate-forward programs must also take into consideration the emission rate of generators that produce that electricity, possibly on an hourly or sub-hourly basis. This creates a need for granular energy savings load profiles, which do not currently exist at the scale needed. Because carbon dioxide's impact on climate change is cumulative, the emission rate of the grid will need to be forecasted for the lifetime of the measures, which (though measure lifetimes are generally poorly quantified at present) can span decades. Where the data are available, these additional considerations will likely introduce additional administrative complexity for stakeholders, particularly if energy efficiency, demand flexibility, renewable energy, and other related silos are integrated.

NATURAL GAS AFFORDABILITY AND BUSINESS MODEL CHALLENGES

Electrification and the resulting drop in natural gas sales revenue may present a significant challenge to gas utilities' ability to maintain a safe, reliable, and equitable distribution network. Reduced gas sales can make it harder to invest in urgent safety upgrades in some parts of the country, especially those focused on decarbonization (e.g., California). The lack of policies to prioritize low-income and disadvantaged communities for building envelope and HVAC upgrades could leave these communities stranded on the gas system facing higher rates, disconnections, and greater health risks (Gridworks 2019; Bilich, Colvin, and O'Connor 2019). Such a scenario could limit public support for an energy transition unless these issues are addressed in a way that transforms the gas utility business model or supports a managed and deliberate transition. For example, utility efforts to promote electrification may be first taken advantage of by customers with the ability to afford the upfront costs of HVAC conversions. This exodus of natural gas customers could leave existing, lower-income customers to bear a larger share of fixed infrastructure costs. Utilities may also encounter resistance with customers for whom climate-alignment, on its own, does not make sense, or who are incentivized to stick with fossil-based heating for other reasons (e.g., cost, resilience, preference).

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[23] Make-ready—a utility-led program that prepares a site for installation of electric vehicle supply equipment through upgrades to electrical equipment on the customer side of the meter (Howard et al. 2021).

POLITICS

Politicization around climate change makes climate-forward efficiency more likely to encounter political headwinds than traditional efficiency. Adopting a GHG focus may create political obstacles for affected programs, and potentially threaten efficiency programs overall if government support for climate action erodes. In addition, the process of shifting efficiency portfolios' metrics of success has the potential to create disagreements. It may be impossible to obtain and make publicly available consensus hourly savings load profiles across end uses and sectors. Even if the importance of the climate crisis is not in dispute, certain actors (e.g., large commercial and industrial customers) may object to being asked to pay for additional, non-energy goals that they believe they can meet through alternative means (e.g., corporate renewable energy procurement). Trade allies who implement energy efficiency programs may bristle at being pressured into supporting electrification if they are less familiar with those technologies or if they feel doing so could compromise customer comfort.[24] Even in states with GHG policies, many utility regulators may feel limited to their traditional focus on economic regulation and unable to create environmental or social policy through ratemaking; in response, some legislatures are explicitly expanding the purview of agencies to these issues.

Furthermore, quantifying the avoided costs of GHG emissions (for both compliance and environmental purposes) has the potential to be more politically fraught than quantifying avoided electric system impacts on their own. Reductions across multiple fuel categories will introduce additional interactions (e.g., electric/natural gas systems) that may be more difficult to model and account for. This difficulty is compounded if the resource being saved is outside the locus of control of the entity assigned to manage the goal. Moreover, outside of select regions (e.g., New England and California), most avoided cost data needed to quantify the benefits of climate-forward efficiency actions are often redacted or available only to a limited group of actors, inhibiting the ability of non-utility stakeholders to encourage utilities or regulators to fully value efficiency.

We set aside these challenges for now and will revisit them in an associated follow-on report, *A Roadmap for Climate-Forward Efficiency*. In the next section, we report on how leading states are bringing energy efficiency and GHG into alignment, thus advancing climate-forward efficiency.

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[24] This could be the case, for example, in cold climates where customers might prefer the high-temperature air delivered by natural gas furnaces over the more gradual heating delivered by heat pumps.

The Emerging State of Climate-Forward Efficiency

APPROACHES TAKEN OR CONSIDERED BY STATES AND UTILITIES

As regulated entities, utilities invest in the energy efficiency offerings that are built on a foundation of state and occasionally federal or local policies, each of which may require changes to maximize GHG reductions from customer programs. A comprehensive strategy—getting the utility business model right and setting efficiency targets in energy efficiency resource standards (EERS)—is most correlated with achieving large savings (Sergici and Irwin 2019; Molina and Kushler 2015). Requirements to include energy efficiency as a part of robust integrated resource planning and conduct all-cost-effective energy efficiency procurement (as a part of "all-source procurement"[25]) can also support additional progress.

Both mandates and procurement requirements rely on cost-effectiveness testing rules that determine which costs and benefits of investments are calculated as well as how they are calculated; they also rely on authorizing legislation or rules defining what types of investments are eligible as energy efficiency. These policies, rules, and definitions are evolving as some states invest ratepayer, taxpayer, or carbon market revenues in low-carbon, energy-saving technologies that may not have met the criteria for energy efficiency in the past. Further, some states are taking action to adjust the mandates of Public Utility Commission (PUCs), empowering or requiring them to explicitly consider GHG reductions and equity in decisions. Below, we examine each of these policy areas, describing the variety of actions states are taking to shift to climate-forward efficiency portfolios.

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[25] All-source procurement selects portfolios of optimal utility-scale and distributed energy resources and captures the value of interaction between resources to meet system needs. This contrasts with business-as-usual procurement, which often defines system need by describing a generation technology to meet the need (e.g., gas-fired generators) (Shwisberg et al. 2021).

"NEXT-GENERATION EERS"

EERS are policy requirements for utilities or statewide administrators to hit long-term (three or more years) cumulative energy savings targets, with sufficient funding to fully implement the energy efficiency programs for homes and businesses. Twenty-seven states have enacted such goals, achieving savings levels varying from 0.19% to 2.51% of sales for electricity and 0.25% to 1.05% for natural gas (Berg et al. 2020).[26] Such targets are structured in absolute terms (e.g., as a specified annual number of MWh or therms saved) or in relative terms[27] (e.g., as an established percentage of electricity or natural gas consumption) (Gold, Gilleo, and Berg 2019).

The policy framework most commonly used is an annual resource-specific goal; these include targets for electricity, natural gas, and peak savings measured in incremental annual or, less frequently, lifetime savings.[28] While such targets are relatively simple with clearly obligated entities responsible for delivering savings, they may miss opportunities for higher GHG reductions by saving fuel oil, propane, and other unregulated fuels; switching from fossil fuel to electric end uses; and using whole-building solutions outside of resource-siloed offerings (Gold, Gilleo, and Berg 2019). They also may emphasize measures with low first-year costs that may not align with a long-term perspective, especially for integrated resource planning and climate planning (Gold and Nowak 2019). Further, annual goals fail to reflect differences in GHG reductions in different seasons, times of day, and locations.

Next-Generation EERS (2019) profiles states evolving their EERS design to better align with state policy goals, including decarbonization, affordability, and equity. That paper describes two primary approaches (Gold, Gilleo, and Berg 2019). *Multiple goals* enable states to meet multiple policy objectives, reflecting the variety of policy priorities energy efficiency can support.[29] *Fuel-neutral goals* establish an overall goal in primary energy or GHG emissions, enabling a program administrator to prioritize the highest-potential GHG mitigation measures across fuels and eligible sectors. Leading states typically combine these approaches.

Such "next-generation" EERS are increasingly common. Seven of the top eight states in ACEEE's *2020 State Energy Efficiency Scorecard* have either made such changes (as in Massachusetts, Vermont, Minnesota, New York, and California) or are considering such policies (as in Maryland and Connecticut) (Berg et al. 2020; CPUC 2021a; O. Tully, policy strategist, Acadia Center, pers. comm., May 28, 2021). In addition, one utility, Sacramento Municipal Utility District, has set goals for their customer energy efficiency programs based on avoided CO_2 emissions.

In most cases, policymakers have maintained resource-specific goals as part of a portfolio of multiple goals (as in Massachusetts) or sub-targets (as in New York), especially for electricity savings. Policymakers have kept such goals either for tracking purposes or to ensure that electric

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[26] Savings are defined as 2019 net incremental savings in MWh/2018 retail sales, or % of 2018 retail sales, detailed in tables 8 and 9 of Berg et al. (2020). Included savings for states with EERS implemented in 2018 are defined by table 16.

[27] For those states expressing targets in relative terms, regulators specify either a fixed basis (total retail sales from a specific year) or a rolling basis (a moving year or average among years that changes with each compliance year) for determining savings levels.

[28] Incremental annual savings represent annual energy savings from equipment installed or activities conducted in a specific year. They are the difference between the energy use of the measure in that year and the energy use of the measure they are replacing (i.e., the baseline). Lifetime savings are a measure of the savings produced over the duration of a measure or activity. They are captured in two primary types of goals: (1) total annual savings goals, which measure the savings in a particular year from measures installed in that year plus the savings persisting from measures installed in prior years, and (2) projected savings goals, which include the savings from measures installed in a program year as well as the savings from those measures projected throughout their lifetime. Projected savings look forward, so they do not include savings from measures installed in earlier years that are still in place (Gold and Nowak 2019).

[29] *Multiple goals* are an approach to set a variety of distinct goals or portfolios. We distinguish multiple goals from resource-specific goals in that they include some additional elements beyond energy savings goals; for example, GHG emissions reductions, low-income savings, or net benefits. Multiple goals may combine resource-specific and fuel-neutral goal strategies.

energy efficiency measures are not de-emphasized by electric or dual-fuel utilities who may prefer electrification or demand savings over long-term electricity savings in MWh (Gold, Gilleo, and Berg 2019).

UTILITY BUSINESS MODEL REFORM

Under the conventional utility business model, shareholders earn returns on utilities' capital investments. This reduces the financial incentive to support many of the customer-sited, low-carbon resources needed to meet climate commitments (Cross-Call et al. 2018). To address this bias toward capital expenditures, states have created a variety of shareholder incentive mechanisms (some of them performance based) to offer a financial incentive for developing these resources.

Most of the states with next-generation EERS also have some form of performance incentives for utilities or program administrators. In some cases, policymakers have made changes to performance incentives to ensure that utilities' financial remuneration for efficiency matches their climate-focused policy objectives, such as increasing the availability of demand flexibility resources to support renewables integration. For example, an increasing number of states are creating incentives for peak demand savings, including "passive" demand reduction (long-term adaptation of customer demand in response to prices and efficiency measures, or "shape" services) and "active" demand reduction (traditional utility and wholesale market demand response programs, or "shed" services) (Gold et al. 2020; Alstone et al. 2017).

Utilities still just scratch the surface of strategic demand reduction's (SDR's) potential in system planning and investment strategies. Currently, most utilities face financial disincentives to pursue SDRs, which is one barrier to widespread deployment of SDR resources. One solution is performance incentive mechanisms (PIMs). Nine states plus Washington, DC have multifactor performance incentive frameworks, where program administrators are rewarded for performance on multiple dimensions (Relf and Nowak 2018).[30]

In addition, some states that still have resource-specific EERS use performance incentives designed around multiple goals to direct policy outcomes; for example, Michigan utilities have annual electricity (kWh) and gas (therms) targets, but performance incentives are based on lifetime kWh and therms and low-income lifetime kWh and therms (Gold and Nowak 2019). Consumers Energy also has performance incentives to reduce peak demand (Gold et al. 2020). While these metrics do not include fuel-neutral Btu or GHG metrics, they do represent important steps to unlock additional efficiency and demand response.

Some resources, such as energy efficiency and customer-owned solar, also decrease utility sales, which under traditional regulation reduces revenues, disincentivizing investment in these resources due to the "throughput incentive." Full or partial revenue decoupling mechanisms make utilities indifferent to sales by ensuring revenues at the level approved by the regulator regardless of how much they sell. Decoupling policies are therefore a critical policy driver of GHG-aligned energy efficiency. Eighteen states have such decoupling policies for electric utilities and 26 states have them for gas utilities (Sullivan and De Costanzo 2018).

Decoupling also supports the broader set of climate-forward efficiency resources by disincentivizing inefficient electrification (e.g., electric resistance space heating) and ensuring that customers benefit from the extra revenue utilities receive from electrification, thus making

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[30] Note that we distinguish between energy savings goals and outcomes driven by performance incentives, although the two strategies are often paired. Performance incentives are the mechanisms that offer financial rewards or earnings opportunities for energy efficiency outcomes.

consumer and advocate support for electrification more likely.[31] However, a risk is that some utilities may see decoupling as disincentivizing efficient electrification, especially those that do not have full revenue decoupling in place and see electrification as a growth opportunity. This concern is partially offset by the fact that some utilities will see beneficial electrification as a stimulant for investment (e.g., in new distribution infrastructure to support such electrification), with utilities earning a rate of return on these investments.

Policy Changes to Expand the Definition of Energy Efficiency

Changing the energy savings goals will be insufficient to achieve net zero emissions if some low-carbon measures are not eligible for public (ratepayer, taxpayer, etc.) funding. The definition of energy efficiency varies from state to state, but typically focuses on kWh or therms savings and does not include savings from fuel switching or load management. This is consistent with the design of most EERS and the fact that electricity and natural gas are individually regulated.[32]

As already noted, in many states fuel-switching programs are expressly prohibited by state rules even if they save total site or source energy across fuels, or there is uncertainty or lack of state guidance on whether efficient fuel switching should be eligible. Given the opportunities to reduce emissions from fuel switching and demand flexibility, some states are reviewing and updating policies to enable these resources as part of efficiency and demand-side management programs. In some states, we see changes to fuel-switching restrictions to allow for electrification, typically where it meets some definition of "beneficial" or "strategic." For example, California updated its "Fuel Substitution Test" for energy efficiency programs to realign testing criteria with current cost-effectiveness approaches and environmental goals. Now ratepayer funding can support customers who want to switch from gas to electric technologies when those criteria are met (CPUC 2019). Such policies to enable and support savings from efficient fuel switching are nascent but receiving increasing attention across the states. However, as shown in figure 5, at least 10 states explicitly prohibit fuel-switching measures, and more than half may implicitly prevent fuel switching because they have no clear policy in place (ACEEE 2020).

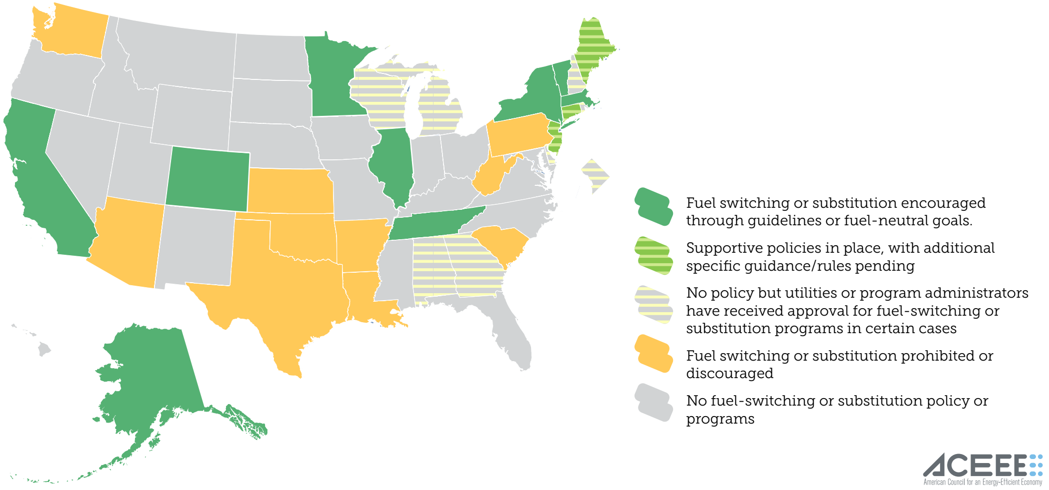

Figure 5. Fuel-switching or substitution policies by state. ***Source:*** **ACEEE 2020.**

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[31] Without decoupling, the additional revenue utilities earn through electrification does not materialize as customer benefits until the next rate case. With decoupling, additional sales from electrification can result in benefits to ratepayers as excess revenues are refunded on customer bills.

[32] Electricity and natural gas are separately regulated even for combined utilities that offer both.

States are also expanding the set of resources eligible to be included in a ratepayer-funded demand-side management portfolio. In Massachusetts, An Act to Advance Clean Energy, H. 4587 (2018), made energy storage, renewable energy, and strategic electrification eligible to participate in the portfolio. These resources may result in an ultimate increase in electricity consumption but must deliver cost-effective reductions in GHG emissions. In Minnesota, the Energy Conservation and Optimization (ECO) Act expanded the scope of measures to be funded by the ratepayer-funded efficiency offerings administered by energy utilities, to include cost-effective load management and fuel-switching measures under certain conditions (Minnesota House of Representatives 2021). For more detail on shifting requirements for what resources are eligible for energy efficiency ratepayer funding, see *Expanding the Set of Resources Available for Climate-Forward Efficiency* below.

COST-EFFECTIVENESS TESTING AND VALUATION

Investments using public dollars, including ratepayer investments, require analysis to ensure that funds are spent prudently. Cost-effectiveness testing, or benefit-cost analysis, compares the benefits and costs of individual or multiple types of distributed energy resources with each other and with alternative energy resources. Benefit-cost analysis practices should align with local policy goals and objectives, including decarbonization policies (NESP 2021).

Cost-effectiveness testing may undervalue or be misaligned with climate-forward efficiency in a few ways. Some cost tests may miss key relevant impacts, including avoided health and environmental impacts, even in states with clear climate policy goals. Others may be applied asymmetrically across costs and benefits, typically capturing costs, which tend to be easier to calculate. Still others may have a fuel-switching restriction embedded within their cost-effectiveness testing criteria, setting constraints on electrification that may not reflect current grid conditions. California, Massachusetts, and New York all modified inputs or assumptions around electrification in their cost-effectiveness testing in the last three years, with the effect of expanding which resources are deemed cost effective (Veilleux, Khawaja, and Singh 2020).

A number of states have taken action to realign their benefit-cost analysis with local policy goals, motivated by climate change and other priorities. As of June 2020, 10 states have applied the National Standard Practice Manual's process of creating a jurisdiction-specific test to align cost-effectiveness testing with their state's policy priorities. Of those, seven states (Colorado, Connecticut, Maryland, Michigan, Minnesota, Rhode Island, and Washington) and Washington, DC have ambitious utility-sector or economy-wide climate policy commitments in place (NESP 2021).

Some climate alignment efforts are running headlong into the scope of an economic regulator's mandate, with regulators hamstrung by their core mandate, typically defined in the context of just and reasonable rates and safety, reliability, and affordability. In response, state legislatures in states including Maine, Massachusetts, Washington, and Colorado have passed bills that adjust the mandates of PUCs or consumer advocates, empowering or requiring them to explicitly consider GHG reductions and equity (Maine House of Representatives 2021; Colorado General Assembly 2021d; Massachusetts State Senate 2021; Maryland General Assembly 2021; Washington State Legislature 2021). The Maine Legislature enacted LD 1682—An Act To Require Consideration of Climate Impacts by the Public Utilities Commission and To Incorporate Equity Considerations in Decision Making by State Agencies, empowering the Maine Public Utilities Commission (PUC).

In addition, some states may not have fully aligned benefit-cost analysis with local goals, but have taken steps to value the environmental and health benefits associated with reduced GHG pollution. Ten states include the impacts of avoided utility environmental compliance costs for carbon dioxide or general GHG emissions in cost-effectiveness testing. Twelve states plus Washington, DC capture societal environmental benefits above and beyond impacts to the utility system, such as contributions to climate change or the societal health impacts associated with air pollution.[33] Finally, eight states plus Washington, DC capture health benefits for participants in energy efficiency and other customer programs (ACEEE 2018).

Figure 6 shows the states that incorporate health and environmental benefits into their cost-effectiveness tests; most but not all include impacts from CO_2, as some states include NOx, SO_2, and CO_2 impacts together. As shown, some states monetize the value based on local estimates or other studies; others use proxies for monetized values.

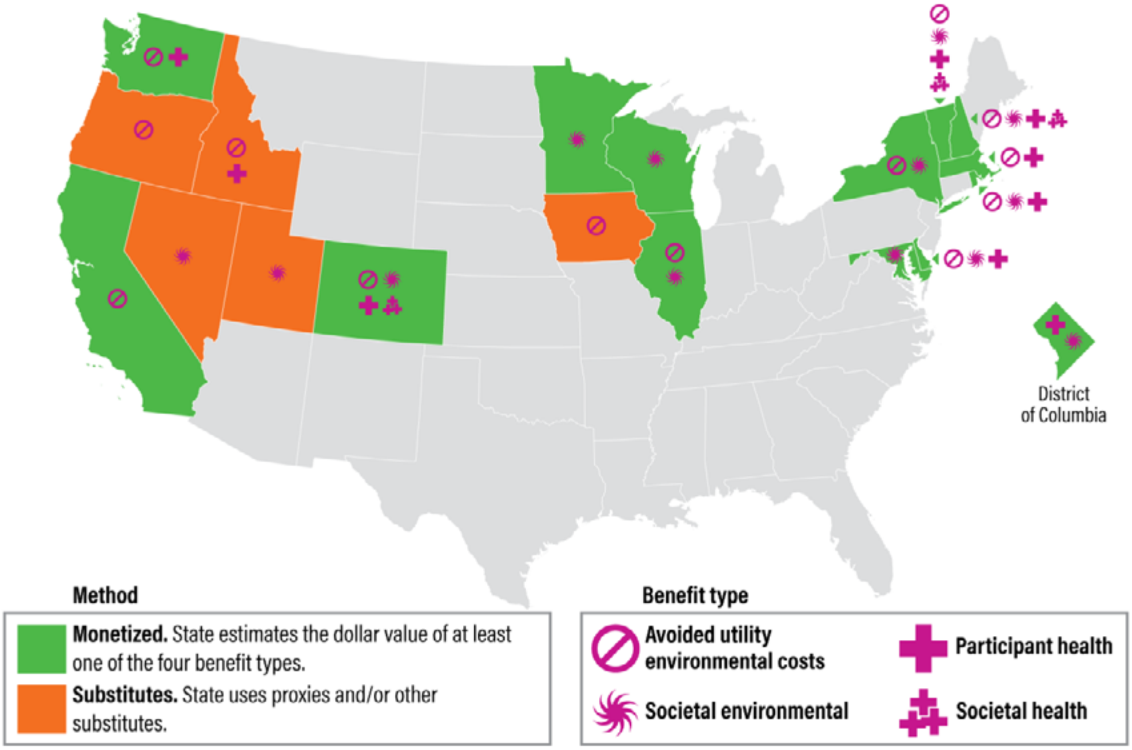

Figure 6. State approaches to accounting for health and environmental impacts in cost-effectiveness tests. *Source:* ACEEE 2018.

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[33] Reducing power plant emissions can reduce emissions of mercury, particulates (PM10 and PM2.5), CO_2, and ground-level ozone, thereby reducing hospital admissions and premature deaths, among other public health benefits.

Resource Planning and Procurement

Utilities engage in multiple planning processes to ensure reliable service at all levels of the system, and may include energy efficiency as part of integrated resource planning (IRP) or distribution system planning (DSP). In some states, such planning processes are used in lieu of energy efficiency resource standards to guide utility investment in demand-side resources; in others, planning is complementary to EERS. Aligning and scaling efficiency to climate as a part of the planning process requires changes to how IRPs incorporate climate into projections of new needs and how energy efficiency is treated as a resource.

To meet climate policy commitments, states must set resource plans based on the state and utilities' climate commitments, including shifts to supply and demand to enable increasingly carbon-free grids, and growth in infrastructure to accommodate electrification of vehicles, buildings, and industry. A few states are beginning to change practices to incorporate a climate perspective, initially as "scenarios" adjacent to primary cases, but increasingly as the primary case for analysis of system needs. In Michigan, a 2020 Executive Directive compelled the state Office of Climate and Energy to evaluate whether IRPs are consistent with the state's emission reduction goals, including consideration of environmental justice and health impacts (Michigan Office of the Governor 2020).

Alongside a climate-aligned articulation of system needs, states and utilities will need to reform how energy efficiency is treated in planning and procurement. Right now, most utilities treat energy efficiency as a decrement to load (Frick and Relf 2020). To fully value efficiency, utilities will need to consider energy efficiency on par with other resources in the planning process, recognizing its operational and cost characteristics, to allow for selection of the optimal quantity of efficiency. This requires quality cost-benefit analysis and symmetry in how resources are acquired in procurement decisions (Frick et al. 2021). Parallel changes are needed in ISO/RTO capacity markets and load forecasting; in some markets, energy efficiency and demand response can participate in forward capacity markets. Such changes will require advances in data availability and modeling capability in most jurisdictions. There are some limited examples of all-source or clean energy procurement that include energy efficiency, for example, at Portland General Electric in Oregon and at Glendale Water & Power, a municipal utility in California (Shwisberg et al. 2021).

Redefining Energy Efficiency to Support Decarbonization

The emerging policies and practices summarized in the previous section largely fall into two categories: those that redefine the range of offerings that could qualify as energy efficiency (such as cost-effectiveness and valuation, and changes to definitions in legislation and rules) and those that modify how we measure and hold utilities accountable for the success of those offerings (such as EERS design and utility business model reform). In this section, we explore options for a redefinition of energy efficiency (including the eligibility of different activities under a decarbonization framework) and potential metrics to measure progress under those new definitions.

EXPANDING THE SET OF RESOURCES AVAILABLE FOR CLIMATE-FORWARD EFFICIENCY

The definition of energy efficiency in regulation will determine which measures and technologies are eligible for public (typically ratepayer) funding. Historically, energy efficiency has been defined to include measures, behaviors, or practices that reduce the demand for electricity or natural gas on an absolute or per-unit-of-consumption basis. In some states, the definition is included as a part of broader demand-side management programs that include load shedding (demand response) or load shifting (demand flexibility) measures. Yet even in those cases, efficiency is typically separately defined in statute or relevant regulations, enabling separate treatment for policies such as performance incentives. In many states, fuel-switching programs for buildings and industry are expressly prohibited by state rules. Such restrictions and definitional boundaries have typically arisen because of inherent biases in the utility business model against energy efficiency that saves the fuel a utility sells (e.g., electricity savings for an electric utility) and reduces capex requirements. These biases create a need to set separate goals for least- or low-cost resources, such as energy efficiency, that otherwise might not be procured.

However, states and utilities are choosing to consider a broader range of customer decarbonization options as eligible measures in utility energy efficiency portfolios, given the opportunities from electrification and demand flexibility, cost pressures on traditional energy efficiency, and need for holistic decarbonization aligned with 1.5°C Paris Agreement targets.

As described in *The Need for Realignment* section, doing so may help to unleash beneficial electrification, integrate demand flexibility into programs, and create incentives to treat customer opportunities for decarbonization holistically. In practical terms, there are three mechanisms for expanding the definition of energy efficiency to be climate forward:

- Remove existing bans on low-carbon resources, as when the Minnesota legislature removed an earlier ban and enabled efficient fuel switching (Minnesota House of Representatives 2021).
- Update criteria regarding resource eligibility for ratepayer funding, as the California Public Utilities Commission did when it created the Fuel Substitution Test and enabled ratepayer funding for a broader set of gas-to-electric fuel-switching use cases.
- Change definitions of eligible resources to be more expansive and reduce programmatic silos, as Massachusetts did in the 2018 law expanding eligibility to active demand management, storage, and strategic electrification (Massachusetts House of Representatives 2018).

These mechanisms do not preclude states and utilities from keeping a separate definition for “resource-specific” or “traditional” energy efficiency while broadening the set of resources eligible for energy efficiency funding. They may choose to do so for tracking purposes, to ensure consistency in benchmarking progress against other jurisdictions, or to ensure a minimum level of support for those resources that meet the traditional definition of energy efficiency. For example, the ECO legislation in Minnesota expanded eligibility for energy savings goals to include energy efficiency and efficient fuel switching, but retained the definition of energy efficiency (Minnesota House of Representatives 2021).

A key question facing states and utilities is which resources with the potential to cost effectively decarbonize energy should be included in an energy efficiency portfolio. Table 1 outlines the definitions of which resources are eligible for ratepayer funding in states or for utilities that have a climate commitment.

We identify four primary categories which might be considered as eligible resources in a ratepayer-funded program for customer decarbonization offerings, but which are not currently included in many definitions of energy efficiency around the country:

- Efficient fuel switching: These measures replace a technology or appliance with one driven by a different energy source, thus increasing usage and/or demand of the new energy source, most commonly from direct fossil end use to electric use. This includes both those that replace one regulated fuel with another regulated fuel, and those in which a regulated fuel (electricity or natural gas) replaces an unregulated fuel like propane or gasoline.[34] These often must meet specific criteria for GHG or energy reduction and cost-effectiveness.
- Passive demand reduction programs: These reductions in demand (kW) do not involve active control of measures, which may be achieved through energy efficiency (e.g., envelope measures), dynamic pricing, or other distributed energy resources. Such resources are also called “shape” demand response resources (Alstone et al. 2017) as well as, distributed energy resources (DERs).
- Active demand reduction programs: These reductions in demand (kW) involve active control of measures and may be achieved through load flexibility measures such as direct load control programs. These resources are also called load “shedding” or “shifting” measures.
- Non-energy resources: These GHG abatement programs are related to a utility’s programs or business areas but the benefits are largely non-energy based (e.g., refrigerant savings, tree planting).

In addition, some states are beginning to consider how natural gas efficiency measures can best support their decarbonization goals. These measures provide immediate GHG reductions and may be the most cost-effective option available relative to electrification in many retrofit contexts (Kushler and Witte 2020; Nadel 2018). Envelope, behavioral, and operational measures delivered by natural gas utilities are not controversial; such investments are a clear “no regrets” step because they provide immediate reductions and can help reduce the cost of future investments in efficient HVAC equipment, through either electrification or efficient gas appliances using low-carbon fuels. However, with policy-mandated declines in the carbon intensity of the grid, natural gas appliance and equipment efficiency measures may not be the lowest-carbon option over the full lifetime of measures. Further, absent changes to decarbonize the fuel supply of natural gas through biogas or hydrogen, these investments may prevent a customer from reaching zero emissions for the lifetime of that equipment (Nadel 2018). As a result, some states are considering whether to restrict investment in natural gas appliance efficiency for long-lived measures.

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[34] While many states refer to these different types of measures broadly as fuel switching, in California regulators refer to fuel replacements involving two fuels both regulated by the CPUC as “fuel substitution” and refer to replacement of non-utility fuels as “fuel switching.”

Table 1. Eligible resources in ratepayer-funded energy efficiency programs in leading states

State	Definition in legislation or rulemaking
California	A 2019 order allows fuel substitution of regulated fuels when it does not (1) increase total source consumption or (2) adversely impact the environment when compared with the baseline measure using the original fuel (Decision 19-08-009). A 2021 CPUC order combines energy and peak demand targets into one fuel-agnostic "Total System Benefit" metric, which encourages targeting the load reduction and longer-duration energy savings that deliver most value. However, demand response, demand flexibility and storage, and vehicle electrification are still treated separately (Decision 21-05-031).
Colorado	Gas utilities are subject to Clean Heat Plan requirements: they must reduce GHG 4% by 2025, 22% by 2030, and 90% by 2050 from a 2015 baseline. Eligible measures include energy efficiency, biomethane, hydrogen, recovered methane (limited to 1% of 2025 and 5% of 2030 goals), beneficial electrification, and cost-effective distribution system leak reduction (beyond federal/state requirements) (Colorado General Assembly 2021c). In addition, the PUC must set savings targets for gas utilities based on all cost-effective achievable demand-side management (DSM) savings, defined to include energy efficiency (including weatherization and insulation), conservation, load management, beneficial electrification, and demand response programs (Colorado General Assembly 2021a). In addition to existing DSM plans, the PUC must set separate targets for electric utilities to promote beneficial electrification, which must (1) reduce net lifetime GHG emissions and (2) reduce societal costs or provide for more efficient utilization of grid resources (Colorado General Assembly 2021b).
District of Columbia	A pending contract for FY2022–FY2026 for the DC Sustainable Energy Utility will include four new cumulative performance metrics measured over the five-year performance period *(% of total $5M incentive opportunity in parenthesis)*: • fuel-neutral energy savings benchmark, measured in source MMBtu *(40%)* • GHG goal derived based on a percentage of 2006 emissions, using a marginal emissions rate *(20%)* • a renewable energy capacity goal, set at 5 MW, with a requirement to achieve energy efficiency savings for those projects *(15%)* • deep energy retrofits, measured using savings from each of the projects that achieve 30% or greater savings *(5%)* The contract includes two existing metrics, measured annually: • green jobs for DC residents *(10%)* • spending requirement to ensure low-income customers (80% of area median income) receive 30% of total budget *(10%)* In addition, the contract includes language that creates a procedural barrier for natural gas or fuel oil appliance efficiency, requiring approval from the District Department of Energy and Environment (DOEE) for "any expenditure/financial incentives for new or existing natural gas or fuel oil appliances and equipment, battery storage, electric vehicles/charging infrastructure, combined heat and power, and power purchase agreements."

State	Definition in legislation or rulemaking
Massachusetts	A 2018 law expands the definition of “efficiency and load management programs” to include energy storage and other active demand management technologies, and strategic electrification, which it defines as cost-effective measures that reduce GHG and minimize ratepayer costs. In 2021 MA program administrators (PAs) proposed to eliminate residential incentives for oil-fired boilers and phase out incentives for central air-conditioning systems that are not heat pumps by Year 3 of the current PA Energy Efficiency plan. They also proposed eliminating incentives for replacing condensing natural gas and propane heating systems with new condensing systems in the 2022–24 term. However, they plan to continue to offer residential incentives for non-condensing and efficient condensing oil furnaces (while baseline data still show there are material cost-effective savings and benefits to be realized).
Maryland (as currently proposed in working group; subject to iteration)	A draft consensus proposal from the ongoing Future Programming Work Group proposes to expand eligible EmPOWER (ratepayer funded) resources to include the resources listed below (approval is subject to Commission and/or legislative approval). It sets a minimum threshold for behind-the-meter energy efficiency and LMI spending, and a maximum threshold for non-energy resources or front-of-meter energy resources. Behind-the-meter resources • Energy efficiency programs: improve the efficiency of the end use or building shell regardless of fuel • Electrification: measures that increase electric usage and/or demand by switching from direct fossil end use to electric use • Passive demand reduction programs: reductions in demand (kW) that do not involve active control of measures; may be achieved through energy efficiency, dynamic pricing, or other distributed energy resources • Active demand reduction programs: reductions in demand (kW) that involve active control of measures; may be achieved through distributed energy resources or other load flexibility measures Front-of-meter community resources • Programs or resources that can be shown to directly benefit a set of customers; these are separate from utility resources that broadly benefit customers (e.g., a program that benefits an identifiable set of consumers that opt in as compared to improvements in transformer efficiency that benefit all customers) Front-of-meter utility resources • Programs or resources that broadly benefit customers (e.g., line losses) Non-energy resources • GHG abatement programs that are related to a utility’s programs or business areas but whose benefits are largely non-energy based (e.g., refrigerant savings)

State	Definition in legislation or rulemaking
Minnesota	The Energy Conservation Optimization Act of 2021 encourages utilities to offer load management programs that enable customer economic benefits and utility system optimization, including renewable energy integration. It also broadens the definition of eligible measures for electricity and natural gas savings goals to include efficient fuel switching, defined to include those measures that decrease source energy consumption on a fuel-neutral basis, do not increase annual GHG emissions, are cost effective, and are installed and operated in a manner that improves the utility's system load factor. However, the law maintains separate definitions for energy efficiency, efficient fuel switching, and load management, and notes that efficient fuel switching and load management can count toward net benefits (for the purpose of calculating shareholder incentives) only when the Department of Commerce determines that "the primary purpose and effect of the program is energy efficiency."
New York	The 2018 *New Efficiency: New York* report and subsequent DPS order expanded the definition of energy efficiency to include savings from all fuel sources in buildings (electricity, natural gas, heating oil, and propane), thus including building electrification as eligible resources for utility and NYSERDA efficiency programs.
Vermont	Act 151, passed by the legislature in 2020, allows the use of a portion of the state's energy efficiency system benefits charge for programs that reduce greenhouse gas emissions in the thermal energy or transportation sectors, capped at $2M/year. Such measures must have a nexus with electricity usage and must be additive to electric utility programs, be proposed after coordination with State agencies, and be delivered statewide. In 2021, the Vermont PUC approved Efficiency Vermont's 2021–23 Demand Resource Plan, which includes new flexible load management, refrigerant management, and electric vehicle deployment programs.

Sources: CA: (CPUC 2021a; 2019), DC: (L. Loncke, senior economist, DC DOEE pers. comm., August 18, 2021); MA: (Massachusetts House of Representatives 2018); MD: (MEA and OPC, MEEA, the Joint Utilities of Maryland 2021); MN: (Minnesota House of Representatives 2021); NY: (NYSERDA 2018); VT (VEIC 2021).

ELIGIBLE RESOURCES DISCUSSION

Scaling each of the resources described above (efficient fuel switching, passive and active demand reduction, and non-energy resources) is a crucial part of successfully delivering on the promise of climate-forward efficiency. Nonetheless, fully shifting eligibility for energy efficiency to include all these resources will face business model, motivation, market design, and jurisdictional authority challenges.

For efficient fuel switching (typically focused on electrification), there are two major considerations for eligibility: the appropriate criteria and the appropriate funding mechanisms. For eligibility, we generally see definitions based on cost-effectiveness, site or source energy savings, and lifetime greenhouse gas reductions; some states such as Minnesota also include load management requirements. Those factors will vary by geography, end use, building type, and building envelope efficiency (Nadel and Perry 2020; Nadel 2018, 2016). Since 2018 we have seen state efforts to include efficient fuel switching of building and industrial loads; however, we have not seen examples of utilities including efficient fuel switching from vehicles in these portfolios. Some state commissions have found that ratepayer funds are not an appropriate funding source for electrification, citing concerns about competitive markets (especially for EVs), and concerns that such measures are only cost effective as a means of delivering GHG reductions but are not, at their core, a least-cost procurement option.[35]

The case of passive demand reduction programs is generally less complicated, as energy efficiency is the primary source of "shape" savings and is already included as an eligible resource. However, few utilities fully value energy efficiency on par with other resources, so while eligibility is not a challenge, data availability and incorporation into metrics (discussed below) are (Frick et al. 2021). Active demand reduction programs that deliver load shedding or shifting services (sometimes called load management or demand flexibility) are often included as a part of broad DSM portfolios, but there are often separate budgets. Recent efforts such as in Minnesota, Massachusetts, and Maryland (proposed) integrate these resources into the same portfolio while still maintaining minimum standards or separate definitions for energy efficiency, likely because the utility faces stronger incentives to pursue demand response/flexibility than energy efficiency (Gold et al. 2020).

Natural gas energy efficiency has served an important role in lowering system costs, supporting customer affordability, and addressing gas price volatility. In the context of net-zero economy-wide carbon targets and faster progress on decarbonizing electricity supply relative to fuels, there is a concern that investments to make fossil-fuel-based appliances more efficient may hinder the adoption of transformative technology and "lock-in" GHG emissions, potentially missing limited windows for replacement. At a minimum, maintaining funding for gas efficiency programs and focusing efforts on building shell and operational improvements is a win-win; such improvements can pave the way for electrification, reducing heating loads and supporting customer resilience. For natural gas appliance efficiency, climate-forward efforts will need to balance the near-term GHG reductions from more efficient appliances with the risk of foreclosing an opportunity for deeper savings. Massachusetts considered these issues in the most recent 2022–24 proposed plan, attempting to balance both cost-effectiveness and GHG concerns. They propose to phase out incentives for some measures, such as central air-conditioning systems that are not heat pumps and incentives for replacing condensing natural gas and propane heating systems with new condensing systems, but kept others, such as replacing residential non-condensing equipment and supporting efficient condensing oil furnaces (Massachusetts Utility Energy Efficiency Program Administrators 2021).

For any decision to grow or shift eligibility, it will be essential for states and utilities to take steps to bake those new resources into potential studies, integrated resource planning, and goal design, and to enable commensurate increases in funding through appropriate sources. Otherwise, inclusion of new resources may undermine achievement of overall equitable decarbonization goals where business model misalignments remain.

Expanding eligibility to include a broader set of low-carbon efficiency resources can remove barriers to participation, but may not drive change at the scale and speed required without addressing the metrics used to define compliance with mandates and performance under outcome-oriented business models. The next section discusses changes to how we measure the success of energy efficiency offerings.

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[35] See various orders in Docket No. 4770—The Narragansett Electric Co. d/b/a National Grid—Application for Approval of a Change in Electric and Gas Base Distribution Rates www.ripuc.ri.gov/eventsactions/docket/4770page.html.

SHIFTING METRICS FOR SUCCESS

In the previous section, we explored which resources might be eligible as energy efficiency measures when focusing efforts on decarbonization. Operationalizing those changes also requires establishing metrics of success and a framework for how those goals interact. In this section, we provide examples and additional details of emerging options measuring success in aligned energy efficiency and decarbonization programs and policies. We also discuss changes to regulatory policies and utility practices needed to make metrics like these feasible.

CLIMATE-FORWARD EFFICIENCY METRIC CRITERIA

States and utilities require metrics to assess how well their offerings are delivering climate-forward efficiency. These metrics should capture progress towards both decarbonization goals and other benefits associated with energy efficiency, including equity and market transformation (MT).[36] Building on the early experiences of leading states, our literature review, expert interviews, and workshop feedback, we offer the following set of principles for states and utilities to consider when establishing climate-forward energy efficiency metrics.

- *State/corporate alignment*. The utility programs' metrics of success should be capable of measuring progress against the state's mandated climate policy commitments and/or the utility's own corporate commitments. In cases where those targets differ, metrics should try to be inclusive of both. If this is not possible, aligning metrics with the more ambitious set of goals is recommended.
- *Cumulative emissions*. The climate impact of GHG emissions is cumulative, so metrics should capture the full, lifecycle impact of energy efficiency measures on carbon emissions.
- *Accuracy*. Different methods of calculating GHG impacts will have different levels of uncertainty. Choosing metrics that are too granular can result in unnecessary complexity, while choosing metrics that are too simple can compromise informed decision making. Select metrics that match the level of detail required by policy goals.
- *Inclusivity*. Metrics should capture emissions reductions that result from all types of energy savings activities including "traditional" fuel-specific energy savings, beneficial electrification, and demand flexibility.
- *Market transformation*. Metrics should capture progress towards market transformation activities that will drive long-term emissions reductions beyond those realized directly through proximate portfolio measures.
- *Equity*. Metrics should capture progress towards equity goals (e.g., investments made or benefits delivered) for low-income, environmental justice, or otherwise underserved communities as established in state policy.
- *Robust development*. Metrics should be developed in a transparent manner with participation from all stakeholders, especially those who are traditionally underrepresented.

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[36] Market transformation, as defined by the Northwest Energy Efficiency Alliance (NEEA), "is the strategic process of intervening in a market to create lasting change in market behavior by removing identified barriers or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice" (NEEA 2020).

- *Data pipeline*. Ensure there will be access to sufficient data to calculate metrics for the duration of the programs. These data—which include customer energy consumption, load savings shapes, GHG baselines, marginal emissions rates, and avoided costs—should be high quality, transparent, and capable of enabling robust oversight and market feedback.[37]
- *Avoid perverse incentives*. Do not use metrics that are "gameable" by utilities or that otherwise incentivize suboptimal resource acquisition (e.g., de-emphasizing long-term electricity savings opportunities) or unwanted activities (e.g., importing electricity with high carbon content).

METRICS APPROACHES

Table 2 contains a summary of emerging approaches that states and utilities have taken or are considering taking to establish metrics for the GHG-aligned energy efficiency programs. Each approach has benefits and drawbacks, which we explore in table 4. One or more approaches listed in table 2 may be combined into a "metrics framework." We illustrate several metrics framework options later in this section.

Table 2. Approaches taken by leading states to quantify the progress toward GHG goals through energy efficiency. This list does not include supportive policies that are not specifically associated with metric design (e.g., including the value of emissions reductions in cost-effectiveness testing).

Approach	Description	Example locations
Avoided GHG	Sets common metric of avoided GHG emissions (e.g., carbon dioxide equivalent) for efficiency and electrification programs	SMUD, VT; DC and MD (under consideration)
All fuel savings	Annual or lifetime energy saved across all fuel categories, usually measured in Btu	MA, NY; MD (under consideration)
Total System Benefit	Uses the total economic benefits of energy efficiency to set resource efficiency goals	CA IOUs
Proxy metrics	Goals are set using proxy metrics that do not involve measures of energy, power, or emissions (e.g., number of heat pumps installed, EVs purchased)	VT

Avoided GHG: Among the most conceptually simple metrics for measuring the success of a climate-aligned energy efficiency portfolio is the amount of GHG emissions it avoids. In January 2020, Sacramento Municipal Utility District (SMUD) became the first utility in the U.S. to update its energy efficiency goal to a GHG-based metric (SMUD 2020a).[38] This shift was enabled by a tool SMUD developed with E3 to calculate the hourly carbon emissions of each efficiency measure they incentivize by multiplying its energy savings shape by the grid's carbon profile over the lifetime of the equipment (up to 2060).

SMUD's program leadership noted that before the change, the utility's efficiency program was approaching a point of diminishing returns. After the change opened the door to electrification measures, the maximum incentive they offered ($2,000 for residential air-conditioning and

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[37] All else being equal, metrics that are simple to calculate are preferable. However, we are not prepared to elevate "simplicity" as part of this principle without accounting for the tradeoffs it brings.

[38] SMUD is a municipal, electric-only utility in California.

envelope) increased to $13,000. This shift in metric rejuvenated utility programs that contractors had been losing interest in, and put the utility on a pathway to triple the carbon savings it would have achieved through traditional energy efficiency alone (SMUD 2021; O. Bartholomy, Distributed Energy Strategy Manager, and S. Blunk, Strategic Planner: Building Electrification and Energy Efficiency, SMUD, pers. comm., April 22, 2021).

All fuel savings: This approach sets an overarching energy savings goal that applies across fuel types including electricity, natural gas, propane, and fuel oil. The target is typically set in a common energy unit of Btu. In 2018 New York State adopted a statewide site energy reduction target of 185 TBtu relative to forecast energy consumption in 2025. The Mass Save energy efficiency goals for the 2019–21 program cycle included for the first time a net adjusted lifetime all fuel statewide goal of approximately 262 TBtu.[39] Wisconsin's statewide Focus on Energy program administrator has an overall MMBtu goal in the 2019–22 cycle with "minimum" thresholds for electricity (kWh) and natural gas (therms) savings, which together represent 90% of the goal, leaving 10% that can be met with any form of energy savings (Wisconsin PSC 2018).

Total System Benefit: The California Public Utilities Commission (CPUC) recently approved a new metric called Total System Benefit (TSB) that bases goals on a requirement for each investor-owned utility to capture all cost-effective energy efficiency.[40] The TSB, which is measured in dollars, reflects "the sum of the benefit that a measure provides to the electric and natural gas systems" (CPUC 2021b). These benefits include lifecycle energy, capacity, and GHG reductions. Such a metric facilitates the combination and optimization of resource efficiency measures and considers their cost-effectiveness jointly. Being fuel agnostic, the TSB can accommodate the benefits of fuel switching. A strength of this metric lies in its comprehensiveness. However, a TSB with an incomplete or asymmetric accounting of benefits would be of significantly lower utility for climate-forward efficiency.

Proxy metrics: Another approach is to measure success using a metric that is strongly correlated with GHG reductions, but which does not explicitly consider energy, peak, or emissions: for instance, the number of heat pumps sold or the number of new electric vehicles registered. Some proxies can be converted into deemed savings estimates, while others cannot. An example of this approach can be seen in Vermont, where through Act 151 state utilities are allowed to use energy efficiency charge funds on programs, measures, and services that reduce GHG in the transportation sector. One of the state's program administrators, Efficiency Vermont, developed metrics around market transformation (see figure 7), since it recognized that increasing the market share of EVs would be needed to realize long-term change. However, these activities, which include strengthening the EV supply chain and consumer outreach and education, do not neatly translate into avoided GHG. Proxy metrics can also focus on resources beyond electrification; for example, residential market transformation (percentage of homes above code) and business market transformation (number of partners) metrics were included in Efficiency Vermont's 2015–17 program cycle (Vermont Public Utility Commission 2017).

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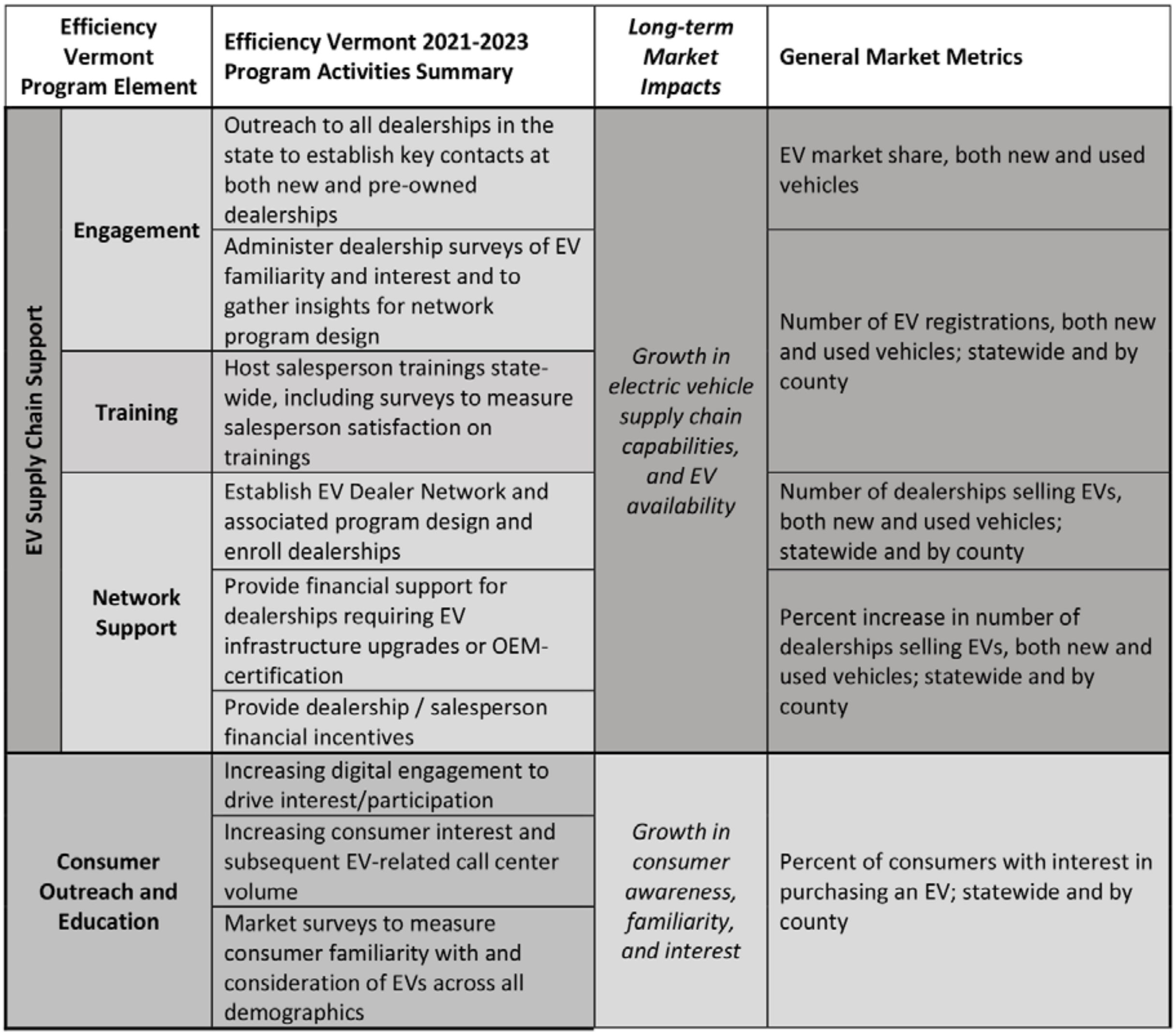
[39] This target excludes active demand reduction.

[40] At present, "all cost-effective" is defined as a Total Resource Cost test with a benefit-cost ratio greater than 1.0 (CPUC 2021a).



Efficiency Vermont Program Element		Efficiency Vermont 2021-2023 Program Activities Summary	*Long-term Market Impacts*	General Market Metrics
EV Supply Chain Support	Engagement	Outreach to all dealerships in the state to establish key contacts at both new and pre-owned dealerships	*Growth in electric vehicle supply chain capabilities, and EV availability*	EV market share, both new and used vehicles
		Administer dealership surveys of EV familiarity and interest and to gather insights for network program design		Number of EV registrations, both new and used vehicles; statewide and by county
	Training	Host salesperson trainings state-wide, including surveys to measure salesperson satisfaction on trainings		
	Network Support	Establish EV Dealer Network and associated program design and enroll dealerships		Number of dealerships selling EVs, both new and used vehicles; statewide and by county
		Provide financial support for dealerships requiring EV infrastructure upgrades or OEM-certification		Percent increase in number of dealerships selling EVs, both new and used vehicles; statewide and by county
		Provide dealership / salesperson financial incentives		
Consumer Outreach and Education		Increasing digital engagement to drive interest/participation	*Growth in consumer awareness, familiarity, and interest*	Percent of consumers with interest in purchasing an EV; statewide and by county
		Increasing consumer interest and subsequent EV-related call center volume		
		Market surveys to measure consumer familiarity with and consideration of EVs across all demographics		

Figure 7. Summary of Efficiency Vermont's EV Market Transformation program activities from 2021–23 under Act 151 (Efficiency Vermont 2021).

METRIC FRAMEWORKS

There are a few options for structuring the types of climate-forward efficiency metrics listed in table 2. These include having multiple goals, an overarching goal (with the potential of subtargets), and separate portfolios. These metric framework options are summarized in table 3 and projected against climate-forward efficiency principles in table 5.

Table 3. Approaches taken by leading states to organize goals and metrics toward climate-forward efficiency

Metrics framework	Description	Example locations
Overarching goal (may have subtargets)	Evaluates success of a portfolio based exclusively or predominantly on one metric, either avoided emissions (e.g., SMUD) or energy savings (e.g., NY)	SMUD; NY overarching TBtu goals + subtargets; WI
Multiple goals	Portfolio of related goals (e.g., GHG, net lifetime all fuel Btu, annual electric MWh, net economic benefits) that must be met in parallel, or with one overarching goal	MA; NY specific EAMs; Efficiency Vermont, DC, NJ
Separate portfolios	EE goals are separated into distinct portfolios—resource, market transformation, and equity	CA IOUs

Overarching goal: The utility measures the success of its energy efficiency portfolios in terms of one overarching target, such as avoided GHG emissions (e.g., SMUD) or energy savings. Additional metrics such as resource-specific energy savings, peak demand reductions, and equity targets may be included as subtargets, denominated in the same units as the primary target.

Multiple goals: The multiple goals approach establishes multiple targets utilities must meet in different categories in order to match the variety of desired resources (e.g., types of energy or GHG savings) or policy objectives (e.g., distribution of benefits). This may include the continuation of resource-specific energy efficiency goals measured in terms of annual energy (kWh, therms) or power (kW) reductions, plus the inclusion of additional targets such as fuel-neutral energy savings, lifetime energy savings, GHG, or sector-specific (e.g., low-income customers, renters, etc.) targets. One prominent example of this multiple goals framework is found in Massachusetts, where the state has established a net adjusted lifetime Btu reduction target across all fuels. Massachusetts has also maintained separate targets for net annual and lifetime electricity and natural gas savings, and summer and winter peak demand reductions. Their performance framework also includes targets for net benefits and GHG reduction targets (Gold, Gilleo, and Berg 2019).

Multiple goals can also be established by multifactor incentives rather than EERS.[41] For example, in New York State, ConEd can increase its earnings through approved earnings adjustment mechanisms (EAMs).[42] Of the seven EAMs that ConEd can receive, at least two serve to realign efficiency to achieve greater GHG reductions. The first EAM, "Deeper EE Lifetime Savings," incentivizes energy efficiency investments that are "typically more technically challenging, require more lead time, have longer EULs [expected useful lives], and/or are more expensive for customers to undertake and for utilities to implement, but have longer and greater payback, thus defined as 'deeper'" (ConEd 2019). These measures, which could include deep energy retrofits and upgrades to more efficient heating and cooling equipment, are crucial drivers of long-term building decarbonization and also help to mitigate load growth and growth in peak expected to result from electrification (Specian, Cohn, and York 2021). A second EAM encourages the adoption of electric heat pumps and electric vehicles that lead to a decrease in the lifetime CO_2e emissions (in metric tons) associated with incremental electrification investments (ConEd 2019).

Separate portfolios: States can meet their various climate-forward efficiency goals by segmenting their energy efficiency portfolios. For example, in California the CPUC has directed program administrators to "segment their portfolios based on the primary program purpose" (CPUC 2021a). The three directed purposes are resource acquisition (i.e., delivering cost-effective, avoided-cost benefits to the electricity system), market support (i.e., market transformation), and equity. The portfolios need not be mutually exclusive, but the exercise of segmentation helps balance the multiple benefits of climate-forward efficiency while separately maintaining the cost-effectiveness of individual portfolios.

Metrics Discussion

The value of a climate-forward efficiency metric depends upon perspective and policy goals. Consider the example of a customer replacing a natural gas furnace with an electric heat pump. From the perspective of a conventional natural gas efficiency program, the switch is highly efficient since it eliminates a large natural gas load. From the perspective of a conventional electricity efficiency program, the move is counterproductive since it adds new electric load. From a fuel-neutral perspective, the move is likely a net positive since it generally requires fewer on-site Btus to transfer heat into a home via a heat pump than it does to generate the same amount of heat through natural gas combustion. But from a GHG perspective, the impact on emissions is less clear. It will depend upon the marginal emissions rate of the electricity that powers the heat pump, a value that itself varies minute to minute and year over year.[43]

Some states may wish to account for the impact of their efficiency portfolio on electricity, natural gas, and carbon savings. Even those concerned only with accounting for carbon would need to conduct more calculations than would be required for annual estimates. Regardless of the precise approach, designing, managing, and evaluating an energy efficiency portfolio aligned with a net-zero pathway is likely to be more data intensive than the status quo.

In table 4 we project the principles outlined above onto each of the metric approaches in table 2 and share potential benefits and drawbacks. For this analysis we draw a distinction between the quantity being measured and how it is being measured. For example, two otherwise identical states may establish a lifetime carbon emissions metric, but arrive at different end results

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[41] Multifactor incentives are a type of performance incentive mechanism in which utilities earn rewards for meeting pre-established goals based on multiple metrics (for more, see Relf and Nowak 2018).

[42] "Earnings adjustment mechanisms" are the New York State–branded version of performance incentive mechanisms. They are incremental earnings utilities can receive for achieving NY REV objectives.

[43] As illustrated in figure 2, these rates can be reasonably projected, and therefore provide a way to map energy savings to GHG reductions.

because those metrics are calculated in different ways. Reasons for those differences could include states using different EE measure lifetimes or different rules for what qualifies as an avoided emissions (e.g., the embodied carbon of an avoided substation), and the resolution used to map energy reductions to avoided carbon (e.g., using unique power plant emissions rates for all 8,760 hours per year versus using the same emissions rate for each hour in a month, as in figure 2). In short, the calculation methodology matters in ways that can be independent of the metrics themselves.

Table 4. Intersection of climate-forward efficiency metrics approaches and principles

Principle	Avoided GHG	All fuel savings	Total System Benefit	Proxy metrics
State/ corporate alignment	This provides the most direct linkage to a state or utility's climate commitments, setting a metric for exactly what is intended to be captured. However, by doing so it removes the ability to set goals based on other criteria, such as peak load reduction.	This approach allows a direct comparison with a state or utility's energy reduction commitments but does not yield a direct comparison to climate commitments measured in avoided GHG.	By quantifying the full stack of benefits within the Total System Benefit, this metric is the most flexible when it comes to changing or accounting for multiple policy goals.	Like energy itself, these metrics can be correlated to GHG reductions, but they will be far enough removed that it can be difficult to determine whether emissions reductions targets are actually being met.
Cumulative emissions	This metric will directly report the cumulative emissions reductions achieved by the EE portfolio, but different values are possible depending on the calculation methodology (i.e., algorithm) used to quantify those lifetime benefits.	Lifetime all fuels savings can serve as a proxy for avoided emissions, but average marginal emissions factors would be needed to translate to avoided GHG.	This metric allows emissions reductions to be fully valued, but it is up to the calculation methodology itself to ensure full lifetime benefits are considered.	The relationship between a proxy metric and its associated GHG reductions can change with time, making it difficult to account for cumulative emissions reductions without careful accounting.

Principle	Avoided GHG	All fuel savings	Total System Benefit	Proxy metrics
Accuracy	This can vary based on the calculation methodology. Multiplying energy consumption by an annual average emission factor, for example, will generate less accurate results than 15-minute accounting. The methodology would need to address short-term versus long-term marginal emissions factors to account for the grid getting cleaner over time.[44]	Avoided energy use requires less data and is easier to calculate than avoided emissions and is therefore likely to be more accurate than avoided carbon. However, this accuracy may not be particularly valuable if GHG reduction remains the core goal.	Having to account for the valuation of multiple benefits effectively requires a higher resolution (e.g., hourly) analysis of avoided costs. If such analysis is high quality, the TSB is likely the most inherently accurate metric.	This is by far the least accurate option of the four for assessing GHG impacts, especially if the proxies cannot be clearly linked to energy consumption.
Inclusivity	This metric requires that avoided GHG be measured, but it does not specify all the sources from which savings must be counted.	By accounting for savings from all fuel types and measures (including electrification), this approach is very inclusive, but will miss non-energy resources.	The metric can incorporate the value of GHG reductions, but it does not specify all the sources from which savings must be counted.	By focusing on things other than energy, peak, or emissions, this metric is likely to miss measurements that would be key to accounting for all sources of GHG reduced.
Data pipeline	Focusing on a single metric could conceivably simplify the data requirements, but intermediate values like load savings shapes and marginal emission rates will still be needed to calculate savings.	Without the need to explicitly convert kWh, therms, and Btu to carbon, data requirements (e.g., from marginal emissions factors) should be lessened, and required quantities should be easier to obtain.	This is the most data intensive of the four approaches and requires publicly available avoided-cost data in addition to hourly load savings shapes, marginal emission factors, etc.	Because of its simplicity, this could be the easiest metric to track (e.g., number of heat pumps purchased). However, the data might originate from a source outside the utility, which could complicate data acquisition.

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[44] For example, a region with renewable energy penetration may initially be well-served by an emission factor averaged over the entire year. But as renewable energy grows and becomes more variable, multiple emissions factors may be needed throughout the year to accurately map MWh reductions to GHG reductions.

In table 5 we provide some benefits and drawbacks of these metric framework options as projected onto our climate-forward efficiency principles. We note that there may be a moderate degree of overlap between a multiple goals framework and overarching goal framework with subtargets.

Table 5. Intersection of climate-forward efficiency metric frameworks and principles

Principle	Overarching goal	Multiple goals	Separate portfolios
Inclusivity	The level of inclusivity depends on what reductions are eligible to be counted under the overarching goal. If the overarching goal has subtargets, regulators may be able to direct reductions from specific sources.	The multiple goals framework allows for measurement and management of the different types of activities that could lead to emissions reductions, though the level of inclusivity will ultimately depend on the reductions eligible to be counted within those goals.	The level of inclusivity depends on the reductions eligible to be counted under the portfolio that contains GHG reductions.
Market transformation (MT)	Avoided GHG/Btu can be a proxy for MT but does not reflect market indicators directly. Absent MT-specific subtargets, this can make it more challenging to determine how much MT was facilitated by the EE program itself.	Multiple goals framework allows for the inclusion of MT metrics.	Separating MT into its own portfolio removes any compromises that might have to be made in service of overall portfolio cost-effectiveness. Separation of portfolios also provides a discrete set of measures that can be evaluated specifically for their MT impact.
Equity	Subtargets are required to quantify the benefits that are delivered to disadvantaged communities.	This metric admits targets and goals that can quantify progress made toward equity.	By separating equity into its own portfolio, this framework removes any compromises that might have to be made in service of overall portfolio cost-effectiveness.
Avoid perverse incentives	If the overarching goal is in terms of GHG, reductions quantified through marginal avoided emissions may not take into consideration relevant utility-scale activities like self-scheduling of fossil resources or importing electricity with high carbon content.	Multiple goals that require specified percentages of reductions to come from specified sources may be established independent of an analytic framework justifying those breakdowns. Interactive effects between overlapping goals (e.g., requiring both Btu and therms savings) may not maximize GHG reductions in practice.	Using separate portfolios risks inattention to the connections between them, especially if there are not clear guidelines for resources that serve multiple functions.

No metric or metrics framework fully satisfies all principles, most have limited track records, and each brings its own set of advantages and drawbacks. An EE portfolio based solely on avoided emissions focuses squarely on GHG, but may miss out on achieving other goals valuable to the energy system including equity, health, and market transformation. The introduction of electric and natural gas savings subtargets, or including lifetime Btu savings, improves the chances of long-lived, climate-friendly measures like weatherization being properly valued over time, and reduces the likelihood that utilities will pursue electrification while bypassing these energy efficiency measures. However, basing an avoided GHG metric on anything other than avoided marginal emissions can provide a skewed picture of EE's decarbonization impact, and even make EE programs appear less attractive in a region with increasing shares of renewable energy.

Avoided cost calculators that can report the value of energy efficiency savings on an 8,760-hour basis can naturally accommodate a Total System Benefit approach. This also offers policy flexibility, since changing policy goals can be reflected through an updated valuation of benefits (e.g., increasing the value of avoided emissions to achieve more GHG reductions). However, if load saving shapes are unavailable or the grid's projected carbon emissions (for the lifetime of the measure) are not well known, the Total System Benefit becomes less useful. Such an approach also values transparency of calculations. In regions where avoided costs are not made public, the Total System Benefit will be more difficult to execute.

Like the Total System Benefit , the multiple goals framework offers additional flexibility if the scope of GHG emissions evolves. For example, ambitious states and utilities may wish to account for leakage of chlorofluorocarbons (CFCs) from refrigerants inside covered efficiency technologies. The lifecycle emissions associated with the creation of different types of insulation, for example, could be relevant: if energy efficiency delivers enough capacity to offset the need for a new power plant, the embodied carbon that would have gone into its creation could be counted, as well as the carbon needed to extract, transport, refine, and deliver that fuel to the plants prior to consumption.

The use of proxy metrics, such as the number of dealerships selling EVs or heat pumps sold in a region, has the benefit of being far simpler to measure. However, it does not directly quantify the emissions a state or utility actually intends to minimize. Proxy metrics may have value when the GHG reductions associated with measures are difficult (or impossible) to quantify or to attribute to a program administrator, but as the grid decarbonizes, the benefits of those proxies may no longer map to GHG reductions in a uniform way.

Conclusion

In this report we explained how utility energy efficiency efforts, which have historically been designed largely to conserve energy regardless of time or location, and reduce costs for customers, have seen formerly secondary goals related to the environment, equity, and economic development rise to become leading motivators for action. We observed that the scale of decarbonization goals set by states and utilities has in many cases not been met with utility actions commensurate with that ambition. We illustrated how siloed utility programs impede holistic, integrated solutions that combine traditional efficiency, electrification, and demand flexibility in ways that are needed to realize a low-carbon energy system. We further reflected on how carbon reductions through energy efficiency are a time-sensitive resource, although modern utility programs often fail to treat them as such.

We introduced the concept of climate-forward efficiency as a framework that recognizes the time, seasonal, and geographic value of energy efficiency; achieves savings and emissions reductions across fuels; can scale to meet the magnitude of decarbonization goals; and balances the alignment we need for climate with other benefits that customers and communities seek from energy efficiency including equity, health, and market transformation.

We conclude that to transition to climate-forward efficiency we will need to expand the definition of energy efficiency to include energy savings and emissions reductions measures that are often overlooked, if not outright prohibited. We provided examples of leading states and utilities that are taking actions to revolutionize their energy efficiency portfolios, and we recognized four approaches taken by states and utilities to measure their progress within this climate-forward efficiency framework. We nominated a set of criteria that should be used to select those metrics, then provided benefits and drawbacks of each approach.

We recommend that every major stakeholder take stock of their current practices and assess the extent to which the work they are doing now is supportive of climate-forward efficiency. In the second report in the series, we will expand upon the vision of climate-forward efficiency and include a strategy roadmap that policymakers, regulators, utilities, program administrators and implementors, advocates, trade allies, and others can adapt for their own particular circumstances to ensure that they are realizing the potential of energy efficiency as a critical climate change mitigation tool.

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Appendix A. Research Objectives and Methodology

RESEARCH OBJECTIVES

This report was prepared in parallel with a follow-on companion report *A Roadmap for Climate-Forward Efficiency*. These two reports serve as a foundation for ACEEE's larger Climate-Forward Efficiency initiative. While this report was intended to establish why climate-forward efficiency is needed and how it is currently being realized, *A Roadmap for Climate-Forward Efficiency* identifies how to define EE to maximize emissions reductions, then develops strategies that state policymakers, regulators, utilities, trade allies, and others can take to realize it in practice.

METHODOLOGY

LITERATURE REVIEW

Our research included a literature review to develop preliminary answers to the following questions:

- What approaches are emerging to re-envision utility efficiency programs, planning, and policies to maximize GHG reductions?
- How do we define energy efficiency to maximize emission reductions achieved by utility policies and programs?
- How can we restructure energy efficiency policies, pricing, programs, and procurement so that success is measured by the avoided GHG needed to meet policy goals?

We consulted internally to collect a set of relevant reference materials that could speak to these core questions. Using ACEEE's *Next-Generation Energy Efficiency Resource Standards* report as a foundation, we identified examples of states that had taken steps to incorporate GHG reductions into their metrics of success. We reviewed utility filings, conference proceedings, reports, and similar materials to improve our understanding of utilities that have begun to align efficiency with greenhouse gas reductions and states with fuel-neutral resource standards.

EXPERT INTERVIEWS

We supplemented our literature review and email survey with more than 15 in-depth interviews of experts with insight into the efficiency/climate alignment issue. Experts were selected based on internal discussion and external recommendation. They were drawn from state government, utilities, program administrators, and nonprofit organizations. Interviews typically lasted between 30–75 minutes and covered a similar range of topics.

We asked those interviewed to share examples from the utility sector where energy efficiency was being considered or used intentionally as a tool to maximize GHG reductions. Where applicable, we asked about the steps they had taken in their own work to advance climate-forward efficiency. We solicited their opinions on the benefits and drawbacks of incorporating GHG into an energy efficiency-based framework. We discussed what metrics they would recommend to measure the progress of a GHG-aligned efficiency portfolio, and the associated data requirements. Each interview set aside time to think through the equity impacts associated with this transition.

PRELIMINARY ANSWERS AND STAKEHOLDER FEEDBACK

Drawing from our desktop research and stakeholder interviews, we drafted preliminary answers to the core questions above. This includes potential benefits and drawbacks of EE/GHG alignment, principles of alignment, and candidate alignment pathways.

On June 25, 2021, ACEEE hosted a virtual 2-hour workshop featuring over 30 participants from around the country. Participants were selected based upon expressed interest and knowledge surrounding climate-forward efficiency or by virtue of professional recommendations. They were drawn from a range of organizations that included public utility commissions, electric and gas utilities, program administrators, program implementors, federal government agencies, and NGOs. Feedback was collected in the form of a breakout session during which facilitated discussions drew out answers to the following questions related to the need for and challenges surrounding climate-forward efficiency:

- Is your motivation for climate-forward efficiency included in our working draft? How does this look from your perspective on the industry? What is missing? What might you characterize differently?
- What challenges do you see that we'll need to solve to advance climate-forward efficiency? Do you agree with the concerns we highlighted?

Participants were granted access to a cloud-based document and invited to leave their input in real time (through a notetaker) during the breakout sessions. They were provided a link to this document immediately following the workshop and were invited to insert any clarifications or additions. Feedback from the workshops was used to improve initial answers and produce this final report.

Climate-Forward Efficiency

In parallel with the production of this research report, ACEEE launched the Climate-Forward Efficiency initiative. This initiative is a platform to engage stakeholders as they bring EE/GHG into alignment in their own work. This and the associated *A Roadmap for Climate-Forward Efficiency* report will serve as the foundation of this effort, explaining why EE/GHG alignment is needed and identifying what pathways are available to do so. Climate-Forward Efficiency will support policymakers, utilities, advocates, and others with the research, tools, and technical assistance needed to make these changes happen.