

Reimagining Energy Efficiency: Building on a Legacy of Success for Higher Impacts and Value

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ABSTRACT

This paper draws out key lessons for the structure and delivery of customer energy efficiency programs from their earliest days to the present as can be applied moving forward to embrace advances in technologies, products, and energy markets. Program goals also are changing, with increased focus on decarbonization, energy equity, health impacts, and workforce development, among others. Each generation of customer energy efficiency programs has brought new perspectives, approaches, and lessons for improving their performance and increasing their value. This paper looks both back to this experience and ahead to reimagine energy efficiency programs to meet a broader set of ever-more-critical goals.

Introduction: Lessons from the Legacy of Customer Energy Efficiency Programs

Energy efficiency programs for utility customers have grown and matured since their origins in the 1970s. Despite their advancements, many such programs have recently encountered challenges due to changes in funding, policies, and practices. In some cases, pushbacks have reduced funding or restricted the types of energy efficiency programs offered and customers eligible for them. At the same time, the need for much greater energy savings from energy efficiency has become more critical as a core strategy to address climate change. The potential for high savings remains great, and those savings would yield numerous additional benefits. The foundations and approaches of today's customer energy efficiency programs are largely based on technologies, markets, and policies that are undergoing rapid change. Program designs have evolved and become more sophisticated as they have embraced and incorporated improved approaches for reaching and serving customers.

The roots of energy efficiency programs serving utility customers are deep. The first such programs emerged over 50 years ago in response to upheavals in energy markets and growing awareness of negative environmental impacts associated with the production and use of energy (York, Nowak, and Kushler 2012). Each era of programs embraced a central guiding philosophy and yielded important lessons for program administrators and implementers. Below I offer my condensed and simplistic view on this history that captures the essence of each energy efficiency (EE) era:

- EE 1.0 (70s-early 80s): EE as an engineering problem: “Let’s make a better mousetrap!” Just use better technology.
- EE 2.0 (80s-90s): EE as bribery: “Let’s make a deal!” We’ll pay you to do the right thing!
- EE 3.0 (90s-2000s): EE discovers the invisible hand: “Let’s transform markets!” Change is complex!
- EE 4.0 (2000s-2010s): EE finds a human face: “Let’s just behave!” — the rise of behavior-change approaches.

- EE 5.0 (present): EE and low-carbon, connected, distributed, and interactive energy systems. “Let’s boldly go to a smart, sustainable future!” Everything is connected and communicates. Net-zero is possible and practical. Renewables rise rapidly and displace the dirty stuff. Big data and advanced analytics simplify the complexity of energy use. Beneficial electrification becomes a key program goal.
- EE 6.0 (emerging and the future). All of the above, EE is good for everyone. “Let’s do right for all.” The rise of energy justice and equity. EE rebalances to serve all types of customers justly.

Each of these eras of EE programs yielded key lessons that added to the body of knowledge for present and future program design, delivery, and evaluation. The result is a more mature, nuanced, and effective industry that continues to evolve. This paper explains the evolution and rationale of EE 5.0 and EE 6.0 — “reimagined energy efficiency.”

Changes Affecting Today’s Customer Energy Efficiency Programs

Energy markets and technologies are undergoing rapid, dramatic changes. The utility industry itself is in the midst of perhaps the biggest transformation in its history with the rapid rise of utility-scale and consumer-sited renewable resources, along with storage and smart, interactive technologies. A large and growing number of utilities are phasing out large, centralized fossil-fuel generation plants to meet decarbonization targets established to combat climate change (Specian and Gold 2021).

Technological Transformations

The industry transformations underway are driven by the vast array of technological changes occurring throughout the economy, which affect the production, delivery, and use of energy in homes, businesses, institutions, and industries. These include:

- Much greater availability and affordability of high-efficiency products. Advances in a wide range of technologies growing from a variety of causes, including standards and market forces, mean that many high-efficiency products are commonplace and reasonably affordable; examples include LED lighting products and high-efficiency appliances (e.g., refrigerators, washing machines, air conditioners, and smart thermostats)
- Rapid rise of smart, interactive (capable) technologies. Connected, learning technologies and automation, combined with grid-interactive capabilities, can both optimize and economize energy use (improving efficiency) and as provide demand-response capabilities to support and improve grid reliability. Such behind-the-meter solutions for integrated packages of distributed energy resources (energy efficiency, demand response, renewables, and storage) can play a valuable role in grid stability, especially as the temporal and locational needs of the grid are increasingly variable (Golden, Scheer, and Best 2019). Smart, connected thermostats, a prime example, have become very popular and widely available. Incorporating comprehensive packages of distributed energy resources (including high energy efficiency) creates grid-interactive efficient buildings (GEBs), an emerging model for buildings that provide flexible demand to grid operators and low energy costs for owners (Bastian and York 2019).

- Emphasis on system efficiency improvements. While not a new concept, there is growing recognition among building operators and engineers that the opportunities to achieve the highest energy savings are for improving the energy efficiency of systems in buildings or industrial applications (e.g., HVAC, pumping, lighting) rather than individual components. Advanced controls can often help optimize operation and increase energy efficiency of entire systems.
- Beneficial electrification. The evidence is rapidly growing for the pressing need to reduce carbon emissions by transitioning away from fossil fuel technologies for uses such as space heating (in homes and commercial/industrial buildings), water heating, cooking, and industrial processes. Advances in efficient electric technologies, notably cold climate air-source heat pumps, induction stoves, and heat pump water heaters offer viable, attractive alternatives to their fossil-fuel counterparts. In many cases, they will also reduce customer energy costs, although this depends on prices of alternate fuels, electricity rates, and climate.
- Rapid growth and opportunity for distributed generation. The dramatic decreases in the cost of customer-sited solar generation that make such systems affordable and practical for many homeowners as well as businesses, institutions, and industries have brought about perhaps the largest single change facing electric utilities. Combined with storage options and grid-interactive technologies, integrated packages of distributed energy resources (DERs) — including energy efficiency measures — may provide more flexible loads on grid systems. This can yield high value to both grid operators and individual customers if rate and performance structures are supportive of such flexibility and provide sufficient incentives. Microgrids are a related advance that could become more commonplace, especially for customers that require extra-high reliability.
- Net-zero energy buildings. Net-zero buildings have quickly moved from a futuristic, but impractical and costly concept to a realistic, economical option for homeowners and other building owners. While net-zero energy is typically easiest to achieve in new construction, there are means to achieve it in existing buildings, generally through a combination of deep energy efficiency retrofits to reduce building energy loads and addition of on-site electricity generation from photovoltaic panels and battery storage. There also has been pioneering work with “energiesprong” retrofits (use of customized exterior insulating wall panels) to more easily retrofit entire multifamily buildings to achieve near- or net-zero energy using production technologies that could readily achieve scale (Energiesprong 2021). “Passive house” is a related design model for achieving high energy efficiency for homes and other buildings (Passive House US 2022)
- Big data/advanced analytics. Advances in metering, computing, networking/connectivity, analytics, and machine learning/artificial intelligence make it possible to gather granular data for whole buildings as well as individual devices and equipment, which customers and utilities can use for near-real time monitoring, diagnostics, and optimized control. The outputs can readily be reported with user-friendly graphics as dashboards on desktop and mobile devices. It can also enable third parties to provide market-based energy efficiency services for customers. Such capability enables customers to check on energy

use and detect problems, and many of these functions can be automated so customers get desired performance without manual programming, historically seen as a hindrance for even such simple devices as programmable home thermostats (Meier et al. 2010)

New Goals and Priorities for Energy Efficiency

Along with technological transformations, the goals and priorities of customer energy efficiency programs are changing. The goals of such programs have historically been based primarily on the rationale of energy efficiency as a lower-cost energy resource, with the objective of reducing energy use through cost-effective energy efficiency measures. New goals have emerged to address a wide variety of prominent concerns.

Addressing climate change has rapidly become a primary goal for energy policies and programs. Research by ACEEE (Ungar and Nadel 2019) and others clearly shows the critical role that energy efficiency plays in achieving the large carbon reductions needed to meet climate change targets. “Climate-forward efficiency” (a term coined by ACEEE) is necessary to meet this challenge (Specian and Gold 2021).

Energy equity and environmental justice have also become top priorities for customer energy efficiency and related clean energy programs and policies. Of all income groups, low- and moderate-income households have the most to gain from decarbonization’s health benefits and energy savings, reducing their energy burdens and improving their indoor environments (Drehobl and Ayala 2020; Adamkiewicz et al. 2011). Emerging approaches for more-comprehensive approaches for decarbonization — combining high energy efficiency with electrification — are needed to ensure that the clean energy transformation underway is equitable, reaching all households, regardless of income (Baker 2021).

The recent increase in the number and intensity of various weather and climate-related natural disasters, such as wildfires, floods, heat waves, cold snaps, severe storms, and hurricanes, has increased threats to the reliability and resilience of our electricity grid and other energy systems and supplies. Energy efficiency is a key distributed energy resource that can improve reliability and resilience, as shown by analysis of the extreme winter weather event in Texas in 2021 (Nadel and Amann 2021). However, electric system planning, decision making, and cost-effectiveness analysis typically excludes these benefits of customer energy efficiency programs (Relf, York, and Kushler 2018). Such undervaluation can result in under-investment in energy efficiency.

Among these many changes, the value of saved energy, particularly electricity, is itself changing. Historically, most programs used a fixed value for a saved kilowatt-hour for screening and evaluation purposes. With the rapid growth of variable generation sources on the grid, such as solar and wind, the value of saving electricity can vary widely by time and location. This can change the economics and cost-effectiveness of energy efficiency investments. At the same time, some energy efficiency technologies can support and enable greater load flexibility, which could be of high value to grid operators (Mims Frick 2020).

More than saving energy: increased value of other benefits of energy efficiency

A large and growing number of corporations, utilities, institutions, state and local governments, small and large businesses, and industries of all sizes have established sustainability goals, most of which are focused on reducing carbon emissions. Many of these plans set net-zero targets to be achieved in the next decade or two. Reaching these goals will take

comprehensive solutions that include both energy efficiency and low/no-carbon energy production and use.

There is growing recognition and interest in the broad set of benefits of energy efficiency, including:

- Relieving energy burdens among most vulnerable populations, energy equity and environmental justice more generally (Drehobl and Ayala 2020)
- Health and safety (Hayes and Denson 2019)
- Improved competitiveness and productivity (Ungar et al. 2020)
- Reducing greenhouse gas emissions to address climate change (Specian and Gold 2021)
- Economic development and workforce development (Shoemaker, Ayala, and York 2020)
- Reliability and resilience (Relf, York, and Kushler 2018)

The tools and techniques used to screen, select, and evaluate energy efficiency measures reflect the broadening of program objectives. For example, the National Standard Practice Manual now presents methods for valuing and including non-energy benefits of energy efficiency and other distributed energy resources (NESP 2020). In a national survey of state evaluation practices, ACEEE (York, Cohn, and Kushler 2020) found that 20 of 44 states responding include a value of carbon reduction in their benefit/cost analysis of energy efficiency measures and programs. With increasing emphasis on decarbonization, this number is likely to increase. Utility regulators need to support such expanded valuation of energy efficiency's contributions to decarbonization.

Signs of Reimagined Energy Efficiency: Recent and Emerging Advances

Today's energy efficiency programs reflect their history and embrace innovation. A close look at their design and delivery reveals features that reflect changing goals, technological changes, and utility industry transformation.

One important change affecting programs is the emergence of more dynamic energy markets that can enable customers to be more active and engaged in their energy choices and use. Advances in technologies can automate such engagement as evidenced by the development of grid-interactive efficiency buildings (GEB) (Bastian and York 2019) and the rapid growth of residential smart thermostats, which learn and respond to customer preferences and behavior. When combined with dynamic rates (time-of-use rates) and flexible loads, the demand-response capabilities can yield high value to both customers and the grid. Managed charging for electric vehicles is another example of flexible loads that supports optimization of grid resources, especially given increasing variability in the value and availability of distributed generation (Myers 2019).

Residential customers are increasingly choosing green and clean energy technologies and related services to reduce their carbon footprint. Program providers are leveraging this interest in green technologies by applying behavioral insights to reach and motivate more customers, whether to invest in clean energy technologies and/or change behaviors affecting their use of energy. Such clean energy choices include energy-efficient products and equipment along with customer-sited renewable energy (Hertz-Shargel 2022).

Corporate sustainability goals and plans have become common, another clear sign of the growing value assigned to reducing negative environmental impacts from company operations and practices.

Leading examples of new and updated models of existing and emerging energy efficiency programs include:

- Active Efficiency. The Alliance to Save Energy created the Active Efficiency Collaborative in 2020. It defines “active efficiency” as “the rigorous deployment of technologies, practices, and policies that enable the most productive use of energy at a given place and time. The concept combines traditional and emerging efficiency tools (such as robust building envelopes and efficient devices and lighting) and non-traditional tools (such as digital technologies) (Vidangos 2020).”¹
- Energy efficiency as a service (EEaaS). The rapid rise of “as-a-service” models for various customer services is slowly emerging in energy markets. Rather than owning a technology, customers pay for services provided, illustrated well by Uber. EEaaS applies this model for providing energy services to customers, typically structured so that providers pay the upfront costs of energy efficiency upgrades and recoup their investment under long-term contracts that yield cost savings to customers while earning profits for the providers out of energy savings realized from the upgrades. A few utilities have introduced this type of program, which is a promising way to achieve deep retrofits (Henner and Howard 2022). Related to EEaaS are various financing solutions, such as “pay-as-you-save” (PAYS) and “property assessed clean energy” (PACE). These approaches can enable customers to overcome the large upfront costs of deep energy retrofits, which can yield not only large energy savings, but also large carbon emission reductions.
- Online markets. Many utilities have responded to the rapid growth of online shopping by offering online markets for a wide variety of energy-efficient products, such as smart thermostats, LED lightbulbs, and smart power strips. These markets typically include options for customers to enroll in demand-response programs. Customers enjoy the convenience of online shopping with the benefit of their utility’s endorsement of the energy-efficient performance of the products. This builds on earlier lessons from market transformation (York, Bastian, and Amann 2017).
- Decarbonization programs for affordable housing. The affordable housing community has much to gain from building decarbonization, including reduced energy burdens, improved health, safety, and resilience, and reduced greenhouse gas emissions. Efforts to achieve decarbonization of affordable housing are at early stages of development and implementation, but there are many positive signs for growth of such programs (York et al. 2022). Despite the challenges of retrofitting for decarbonization (comprehensive energy efficiency and electrification), doing so will be necessary to meet climate targets and ensure that the benefits of decarbonization accrue to all customers, including the affordable housing community.

¹ ACEEE earlier termed this concept “intelligent efficiency” (Rogers and Elliott 2013).

Call to Action: Time for an Energy Efficiency Make-over

Part of the legacy of energy efficiency is an image problem. For many customers, energy efficiency is viewed only as actions you can take requiring some additional costs that may pay back in the long run. The messages can be as enticing as “eat your vegetables, they’re good for you.” A dominant image is doing such mundane things as insulating your attic, caulking your windows, or purchasing energy-efficient home goods, such as lightbulbs or air conditioners. Once the action is taken, the primary benefit is largely invisible — that of reduced energy costs. There is no glitz, glamour, or curb appeal to a well-weatherized and -insulated home compared to one with a prominent solar panel on the roof and a Tesla parked in the driveway.

Consumer research has long revealed the simple truth that customers will spend money on the things they value. Homeowners invest in features and improvement to their homes based on the value of such investments to them. And what any customer (homeowner or renter) values is individual and personal, whether appealing to aesthetics, comfort, or functionality. No one talks about the payback for granite countertops or new kitchen cabinets.

Customer energy efficiency programs have become much savvier in recognizing that messaging and communication have strong impacts on customer choices and actions (Shelton 2018, Leblanc 2022). Effective program marketing must appeal to customer values and priorities, which differ greatly across customer segments. Figuring this out requires effective market research. What are customers most interested in? What do they value? What appeals to them? For example, many affluent customers are not driven by cost savings potential for energy efficiency. Matching marketing messages to different customer segments in targeted campaigns can drive increased interest and participation in programs (York et al. 2015). Anecdotal “person-on-the-street” interviews well illustrate the wide chasm between customer perceptions of energy efficiency and those of program practitioners, particularly regarding language and services provided (LeBlanc 2022).

The legacy of energy efficiency language itself can be a stumbling block for effective messaging and marketing. Below is a selected set of terms used by many in the industry that are deeply rooted in programs, but that largely do not resonate and appeal to average customers:

- Energy audit (or more common now, energy assessment)
- Retrofit
- Pay-back
- Cost-effectiveness
- Weatherized
- Demand-response
- Time-of-use

Such terms largely connote accounting, engineering, and economic analysis. They express practicality but are jargon. They sound geeky and ill-defined, not readily understood by most customers. What about creating and using language that appeals to customer values? For example: Green remodeling? Low-carbon makeover? Smart comfort homes? Eco-friendly home goods? Eco-equity (home value)? Concrete examples are Sealed’s “Home Comfort Plan and

“Climate Control Plan”² and Google/Nest’s “Rush Hour Rewards.”³ Surely creative marketing and messaging can drive greater customer interest in and actions for advancing energy efficiency in their homes, businesses, and industries. Clear signs indicate that such changes are happening in markets; “net-zero” is a prime example. Such a term is clear in concept and aspirational to customers concerned about carbon emissions.

As part of reimagined energy efficiency, programs and marketing can sharpen their focus on reaching and influencing customer choices at decision points for purchasing products or making larger investments for home improvements. The energy efficiency industry has long recognized lost opportunities — long-lived changes and decisions resulting in energy inefficiency, such as purchasing and installing low-efficiency furnaces or water heaters. Wherever and whenever consumers make such choices, energy-efficient options should be mainstream, readily available, appealing to customers, and affordable.

Characteristics of Reimagined Energy Efficiency

Reimagined energy efficiency is the embodiment of the lessons learned over many years of customer programs combined with advances in technology and understanding consumer behavior and motivation, all in the context of broader utility industry transformations and rapidly changing markets. By reimagining energy efficiency, we can better use it as an effective tool to meet new objectives and changed priorities for our production and use of energy.

An overarching characteristic of reimagined energy efficiency is that it rests on a solid foundation of traditional energy efficiency, such tried and true, proven measures as improving the thermal performance of building envelopes with insulation, air sealing, and high-performance windows. Such “passive efficiency” is entirely complementary to “active efficiency.” Together they can achieve significant energy savings and carbon reductions, minimizing and optimizing energy use in homes, other buildings, and industry.

Reimagined energy efficiency is multi-dimensional. While not all the following characteristics are applicable to every type of energy efficiency measure or technology, today’s markets and programs offer prominent examples of each:

- **Active, smart, connected, and integrated:** Grid-interactive efficient buildings are the model for highly efficient buildings that can communicate with and respond to the grid with a full array of distributed energy technologies: on-site renewable generation, storage, and demand response.
- **Innovative:** Reimagined energy efficiency can be rethinking conventional technologies to perform common functions in new ways or add features to make them more attractive and valuable to customers. Smart thermostats are prime examples. The developers rethought and re-engineered the common household thermostat to make it attractive to homeowners.
- **Equitable:** Energy efficiency products, technologies, and services can be used by and can benefit all types of customers, and they can be obtained affordably.

² <https://sealed.com/comfort/> and <https://sealed.com/climate-control/>

³ <https://support.google.com/googlenest/answer/9244031?hl=en&co=GENIE.Platform%3DAndroid#:~:text=What%20Rush%20Hour%20Rewards%20does,use%20and%20lower%20grid%20costs.>

- Visionary: Products and services meet high customer aspirations and offer value. They align with customer priorities. A prime example is “net-zero homes,” which offers a clear, readily understandable vision of a home with a low carbon footprint.
- Appealing: Products and services appeal to customer value, not the idea of payback. They go beyond simple economics. People invest in many things that aren’t cost-effective. They may solve high-priority problems and/or yield other high-value benefits. They are both motivating and rewarding. High visibility and feedback that clearly demonstrates value to customers can increase customer uptake.
- Planned: Products and services anticipate replacement needs and are ready with high-efficiency options.
- Affordable: Financing for products and services is creative, not relying solely on utility customer incentives. Customer programs to advance energy efficiency, whether offered by utilities, non-utility organizations, state agencies, local government, or federal government, are readily available and designed for all customer sectors, particularly those that are resource disadvantaged.
- Data rich, analytically complex: Technologies and devices take advantage of big data and analytics. They use advanced metering, controls, and analytics. Customers, utility program staff, and building operators can use the outputs and results of advanced analytics to diagnose performance of components and systems to identify problems and inefficiencies. This information can help optimize performance and improve energy efficiency.
- Customer focused and user friendly: Programs and services, as well as devices and technologies, are customer focused — developed with the customer experience as a guiding principle. This can take many forms, such as apps for mobile devices (click it and forget it — automated functions based on customer data and preferences) or one-stop shops for integrated packages of products and services. Some programs and services may be high touch, with program processes behind the curtain.
- Market driven: The scale needed for meeting carbon reduction targets cannot be met solely through utility and related customer programs. Private markets for energy efficiency products and services need to grow and thrive, which requires developing and growing workable business models in the private sector.

Conclusions

Achieving the large carbon reductions needed to address climate change requires rapid, fundamental changes in our use and production of energy. Energy efficiency is a proven, low-cost means to reduce energy use and associated carbon emissions. As programs evolve to prioritize carbon reductions, they will need to accelerate the uptake of climate-forward efficiency across the full spectrum of the ways we use energy in our daily lives and throughout the entire economy.

To reach the scale necessary to achieve energy efficiency’s potential will require increased investment in energy efficiency programs through all channels — government programs, utility programs, and private markets. Historically, utility-funded programs have been a primary vehicle to provide incentives and services to advance energy efficiency. Local, state, and federal programs have also played prominent and important roles. These efforts need to be increased. Policy makers, program administrators, and businesses must catalyze and expand

private markets for energy efficiency products, technologies, and services. Reimagined energy efficiency is important on both program-based and market-based front to help increase participation in available programs and grow markets outside of programs. Administrators of utility customer programs need to expand their efforts to transform markets, better leveraging and engaging with private investments and markets. Customer programs should identify opportunities to catalyze markets to achieve large impacts. Reimagined energy efficiency also needs stronger supportive policies for energy efficiency, such as building codes and appliance/equipment standards. Research and development are fundamental for reimagined energy efficiency to develop new technologies and improve performance of existing technologies. Both private and government research and development are important and can be complementary.

There are many positive signs of such reimagination already on the energy efficiency landscape, whether emerging or well-established. In rising to meet the tremendous challenges to address climate change, energy equity, and sustainability, we need to foster and accelerate these changes in how we envision and advance energy efficiency throughout our economy. This requires a “big tent” approach, engaging the full spectrum of stakeholders and actors to work collaboratively to advance energy efficiency and the broader clean energy transformation underway.

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