Home Energy Reports and Beyond: Meeting the Moment with Behavior-Based Energy Efficiency

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Research Report

ACEEE

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.

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Executive summary

Key findings

- Home energy report (HER) programs, in which utilities provide households with personalized insights into their energy use and tips to lower their bills, are a proven, cost-effective approach to driving energy savings in the residential sector. Their primary advantage is the ability to serve many customers in a short period of time.
- HERs are the most common behavior-based energy efficiency programs. Reports have been delivered to millions of customers across the United States. Their effectiveness has remained consistent. Electricity and gas savings continue as long as reports continue to be delivered and then immediately decay over several years once the program is terminated. Reports deliver per-customer savings that add to significant aggregate impact.
- Utility regulators can revise evaluation criteria to better incentivize cross promotion of structural efficiency programs to drive higher overall efficiency savings and peak savings, support electrification, and connect low-income customers to energy support services. Currently, savings from cross-promoted programs are often entirely attributed to structural programs.
- HER programs should be part of a balanced utility portfolio of energy efficiency programs. Utilities can steadily increase investment in long-term structural energy upgrade programs alongside “quick win” behavior-based energy efficiency programs.
- Several next-generation HER programs (HER 2.0) have already been developed and deployed at scale by utilities. These new HER-type behavior programs are specifically designed to meet utilities’ expanded priorities. They include behavioral peak demand programs, high bill alerts, rate coaches, weekly energy updates, noninvasive home energy assessment tools, HERs focused on peak demand and load shaping, and disaggregated real-time feedback.

Many utilities motivate residential customers to reduce their energy use by regularly providing personalized feedback on their household energy consumption, often including how it compares to that of their peers and tips to lower their utility bills. This report examines the effectiveness of these HERs based on a review of existing research and identifies strategies for utilities, regulators, and program implementers to enhance HER programs to drive greater energy savings and meet additional priorities, such as decarbonization and affordability goals. This study did not collect new data, relying instead on

previous reports and analyses from multiple large datasets and data sources to provide a broad overview of the current landscape of behavior programs, which were also used to inform our recommendations.

Our review finds that HERs are an effective tool for driving residential energy savings. Analyses from 2016 and 2022 (as well as our review of 13 additional evaluations between 2023 and 2025) found that HERs continued to change behavior at roughly the same rate as when they were first introduced (Sussman and Chikumbo 2016; Galport 2022). As utilities, regulators, and program implementers consider the next generation of HERs, the emphasis should be on both sustaining traditional HER programs and pilot testing innovative enhancements that can expand their impact.

Key recommendations for utility regulators

Encourage customer participation in complementary programs by revising evaluation criteria and requiring channeling to low-income programs. Incentivize HER implementers to channel customers to structural efficiency programs to drive higher overall efficiency savings, support electrification, and connect low-income customers to energy support services. Revise evaluation criteria for HER programs to better assign savings attribution (to both HERs and other programs) and avoid penalizing HER programs for increased electricity consumption from home electrification or low-income energy assistance programs. These changes can be piloted (alongside traditional evaluation) before full implementation.

Encourage balanced efficiency portfolios. To meet evolving utility priorities, regulators can encourage utilities to maintain balanced portfolios that combine behavior-based "quick win" programs with deeper energy upgrade initiatives. While HERs deliver immediate savings, long-term strategies are also essential.[1] High-performing utilities invest between 3% and 53% of their residential efficiency budgets in HER programs. Performance incentives for utilities should be appropriate (not too high, not too low) for running HER programs. More research is needed to determine the optimal mix of short- and long-term programs that would best suit utilities with varying priorities and budgets.

Allow programs to continue as long as they remain cost effective. HER programs thrive when reports are consistently delivered over multiple years. Savings increase over the first two years, as customers develop energy-saving habits and behaviors, and those savings continue as long as reports are still received. We do not recommend terminating programs that deliver consistent and reliable savings as long as the cumulative lifetime savings are cost effective, but we recognize that some utilities' incentives and goals encourage short-duration programs.

Measure peak savings too. Encourage utilities to invest in behavior-based energy efficiency programs that reduce peak load by requiring the evaluation of peak savings alongside overall savings.

Pilot programs that use emerging behavior-based approaches. Regulators can encourage new behavior-based efficiency programs, both as standalone initiatives and as add-ons to HERs, by supporting pilot testing of HER 2.0-type programs and more innovative programs that go beyond HERs.

[1] The optimal balance of long- and short-term programs required to achieve utilities' varied priorities has not yet been established. We recommend a gradual and measured approach to shifting the balance of program types within a portfolio to allow observation of how savings impacts are affected and ensure that both long and short-term savings are maintained at desired levels.

Potential HER 2.0 programs

Several new programs are currently offered by program implementers that save energy through similar behavior mechanisms to HERs. These might be considered "HER 2.0" options and are ready to be deployed at scale.

- **Peak energy savings**: Using behavioral science-informed messaging with customers during peak heat events to reduce energy consumption
- **High-bill alerts**: Sending customers notifications that their bill is likely to be higher than expected at the end of the month
- **Rate coaches, weekly energy updates, and HERs focused on load shaping**: Providing customers timely information on how to save money with special rates (e.g., electric vehicle (EV) rates and time-of-use rates) and coaching them to shift their energy use to specific times of the day when the grid is "cleanest"
- **Virtual energy assessments and infrared home visualizations**: Noninvasive virtual home energy assessments and/or overhead images of homes showing heat retention relative to other homes
- **Disaggregated real-time feedback**: Phone and web apps that provide real-time granular feedback on current home energy use by every device, appliance, and system

Recommendations for program implementers to augment traditional HERs

New research in psychology and behavioral science suggests that traditional HER programs could potentially increase their impact with some minor tweaks. Program implementers may want to consider pilot testing one or more of these if they are not already doing so:

- **Describe health and environmental benefits in targeted messaging.** Test messages with some audiences that highlight the health and environmental benefits of energy savings.
- **Highlight rising trends with dynamic norm messaging.** Incorporate dynamic norms (behaviors that are not yet conducted by most others but are on the rise) to encourage adoption of less common energy-saving actions, such as heat pump installation.
- **Augment neighbor comparisons to increase their relevance.** Compare peers who share both demographic and structural characteristics (similar people, not just similar buildings), which may increase the relevance and impact of HERs.[2]

Beyond HERs: new potential behavior-based energy efficiency ideas

Regulators and utilities that want to be on the forefront of behavior-based energy efficiency innovations could consider pilot testing strategies with demonstrated potential in peer-reviewed literature. These could include:

- **School-based programs**: Educating students on energy efficiency and encouraging them to save energy at home
- **Online tools facilitating energy conservation goal setting and commitment**: Providing a platform for customers to pick their goals and choose from a menu of energy efficiency actions to achieve them

[2] Advanced analytics of customer data may be able to help create these comparisons, but data privacy regulations and customer perceptions are important to consider when using this strategy.

- **Gamification and "serious games":** Create and promote electronic games that teach energy efficiency and can be connected to actual home energy use

The role of HER programs and behavior-based efficiency

HERs have established themselves as a significant contributor to residential energy efficiency, delivering reliable savings at scale. The recommendations highlight the importance of sustaining traditional HER programs while evolving them into more sophisticated tools that leverage advanced data, behavioral science, and targeted messaging. Regulators play a critical role in enabling program longevity, portfolio balance, and innovation through flexible evaluation criteria and pilot support. Program implementers, meanwhile, are encouraged to experiment with HER 2.0 features that deepen customer engagement and align energy-saving behaviors with broader climate and equity goals.

By combining proven HER strategies with emerging approaches, utilities can maximize cost-effective savings, expand participation, and contribute meaningfully to decarbonization and energy equity. The path forward requires both continuity and innovation—maintaining the strengths of HERs while embracing new opportunities to enhance their impact in a rapidly evolving energy landscape.

Introduction

When utility-run energy efficiency programs were first introduced in the 1970s and 1980s, they were primarily concerned with reducing energy consumption, and they relied heavily on lighting measures (providing high return-on-investment) to meet that goal. Today, much progress has been made on efficient lighting and remaining opportunities for efficient lighting are decreasing. Additionally, program priorities have gone beyond saving energy and reducing ratepayer costs to also improving lives (e.g., promoting equity, electrification, healthy homes, and reducing carbon emissions). Home energy report (HER) programs save energy by providing customers with personalized information and using behavioral science-based messaging strategies to encourage them to reduce energy consumption. Customers respond by engaging in energy-efficient actions and investing in energy efficiency upgrades. The programs have demonstrated an ability to help fill the void left by the disappearance of lighting programs while addressing other emerging priorities.

The purpose of this report is to discuss the continued effectiveness of these programs to deliver benefits and address the changing priorities of utilities, customers, and state energy regulators. We critically focus on the state of HER programs and examine current discussions about them by reviewing evaluations and analyses. The report also goes beyond traditional home energy reports to examine the potential for evolution (HER 2.0) and new applications of the tools and strategies underpinning HERs. It identifies new behavior-based energy efficiency programs that utilities can pilot with program implementers to help customers save energy in the future. The report is a guide for state energy regulators and utilities that are considering (or reconsidering) the role of HER programs in energy efficiency portfolios going forward.

What is a behavior-based energy efficiency program?

Behavior-based energy efficiency programs reduce energy consumption by primarily leveraging behavioral insights derived from social science research. They typically do not rely on financial incentives, legal requirements, or mandates to change behavior, although these can be secondary or background elements of the program. For this report, we focus on residential programs that influence behavior within the home or that are based on energy demands from the home (e.g., heating ventilation and air conditioning (HVAC), and electric vehicle (EV) charging). These can include both curtailment (frequently repeated small actions such as hang-drying laundry) and efficiency (one-time large investment behaviors such as insulating the attic), and everything in between (e.g., infrequent actions that do not require an investment, such as adjusting thermostat setpoints).[3]

Most non-behavior-based residential utility-run energy efficiency programs encourage one-time investment behaviors by lowering the financial barriers to upgrading. That is, they offer rebates, incentives, or no-cost upgrades for residents to improve their homes' energy efficiency (i.e., structural measures). These are helpful and important, but behavior-based efficiency programs also help save energy through a different pathway. Behavior-based programs are the only programs that can also

[3] See Stern and Gardner (1981) for a discussion of the differences between curtailment and efficiency. This report does not examine technologies that eliminate the need for human action (e.g., sensor lights or thermostats with an "auto-away" function).

encourage customers to change their small, repeated actions to be more efficient (i.e., curtailment behavior). HER programs are the most ubiquitous type of utility-run behavior-based efficiency program, but other programs and strategies can also be used to shift curtailment behavior.

A key part of the behavioral science approach to reducing energy use is evaluation. Although not all behavior-based strategies available in peer-reviewed literature demonstrate the strongest evidence of causation (because they may be preliminary studies with observational or qualitative data), this element is critical for utility-run programs. To claim savings from behavior-based energy efficiency programs, evaluation methods must adhere to the principles of causal inference while providing statistical confidence in the evaluated results. In most cases, this means using randomized control study designs. Only then can savings be used to meet state-imposed requirements or goals and ensure that ratepayer energy efficiency funds are being deployed cost effectively to achieve the policy objectives of the program. Given our focus on utility-run programs in this report, we only include programs (and potential programs) that lend themselves toward high-quality evaluation methods.

Home energy report programs

Home energy reports (HERs) reduce household energy consumption by providing customers information about their use relative to others, alongside tips on how to save energy. Every element of the report is informed by behavioral science research. They are sent monthly, bimonthly, or quarterly to customers, separately from their utility bills. HER programs are by far the most popular type of utility-run behavior-based energy efficiency program—they are the only behavior-based energy efficiency program offered by most of the United States' largest utilities (Specian et al. 2023). Indeed, in many cases, utilities and regulators use the terms "behavior program" and "HER program" interchangeably. Some utilities run these programs themselves, but most rely on companies such as Oracle, Bidgely, Uplight, or Franklin Energy to implement them. Roughly two thirds of the 53 biggest U.S. energy utilities ran these programs between 2021 and 2023 (Specian et al. 2023). They have since reached millions of customers, and estimates from Oracle (the largest and oldest program implementer running these programs) suggest they have saved customers over $3 billion (Clifford 2022).

As shown in figure 1, HERs also frequently include additional information on historical energy consumption and programs or incentives that are available to customers in their regions. HERs emerged from research by Nolan et al. (2008) and Schultz et al. (2007) demonstrating that residents shown social norm information about their neighbors' energy use reduce their consumption to match.

Figure 1. Typical home energy report sent to customers. This one was created by Oracle/Opower.

Although HERs in those original studies were simple paper products created by psychology research teams, modern HERs that incorporate email, video, and other advances serve larger populations and are more sophisticated, requiring high-performing analytic processes for analysis, design, and production. Program implementers process large datasets to create and send reports that produce a measurable shift in behavior (Galport 2022).

Beyond the analyses required to determine which homes to group together for neighbor comparison, the newest programs use advanced analytical methods, combined with advanced metering infrastructure (AMI) and machine learning to estimate when and how energy is used in each home (Mimaroglu and Yang 2022). This, in tandem with information collected from publicly accessible data sources on home size, home age, and occupant demographics, can be used to create customized reports that present tips (and other information) that are hyper-targeted and highly useful to residents. For example, a household with a pool could get a tip about upgrading to a larger pool filter, a household with a heat pump heating system could get a tip about the temperature setpoint, and a low-income household could receive information on no-cost energy-saving strategies. Personalization can significantly influence pro-environmental behavior (e.g., Boomsma et al. 2016). The overall focus on personalization is part of the success of modern HER programs.

HER programs are broadly distributed to utility customers, regardless of housing type, location, or income level, and are thus able to serve a wide swath of the population quickly. HER programs are opt-out,[4] meaning that households are enrolled in the program by default and would need to take active steps to remove themselves, which usually only 2% or fewer do (e.g., McClaren et al. 2018). Apart from the group of households selected to serve as "controls" (that do not receive reports for evaluation purposes), reports can be rapidly delivered to nearly all utility customers. The programs generate small but reliable per-customer savings that add up to sizable savings across the full population of customers. After nearly two decades of evaluations and millions of reports sent to customers, the energy savings from these programs are well-established and predictable (Galport 2022).

Beyond traditional HERs

Behavioral science insights can be leveraged to reduce energy consumption (for a summary of many of these, see Scepanovic et al. (2020)). HERs, which rely on social norms-based strategies, are the most ubiquitous among utilities because they are inexpensive, scalable, replicable, and lend themselves to randomized control trial (RCT) evaluation. Utilities rely on this type of plug-and-play program and its strong evaluation to be able to justify their use to utility regulators. Thus, although numerous programs can leverage behavioral science to reduce energy use in creative ways (Sussman and Chikumbo 2016), we showcase in this report some of the HER and non-HER behavior programs that may be best suited to utility implementation, as well as some implementation-ready new programs that similarly influence energy use behavior using personalized information (that we term "HER 2.0"). The programs we highlight can be systematically evaluated for energy reduction impact and leverage customer data to produce energy savings.

[4] Some utilities, such as Rhode Island Energy, have sought to shift HER programs to opt in. This is likely to result in lower overall energy and carbon savings (despite likely higher per-customer savings).

Given the current policy landscape surrounding energy efficiency programs and their requirements to deliver more than just lowest-cost energy savings, we decided to conduct research on some of the conversations around these programs. In this report, we summarize the findings of this research and provide guidance on best practices and future potential evolutions of HER programs.

The benefits of home energy reports

We begin by reviewing current evidence on the effectiveness of home energy reports and whether they continue to deliver energy and financial savings, low-cost climate change mitigation, the ability to reach many customers, means to capitalize on new technology, and the ability to channel customers to other programs.

Energy and financial savings for households

Since their first implementation in 2007, HER programs have consistently helped customers reduce their energy consumption and associated energy bills. Evidence suggests that HERs continue to change behavior at roughly the same rate as when they were first introduced (Sussman and Chikumbo 2016; Galport 2022). Importantly, these benefits can be realized by nearly all utility ratepayers, including renters, those in single- and multifamily homes, and customers at all income levels.

In 2016, ACEEE reviewed dozens of HER program evaluations covering 31 HER programs up to program year 2015 (Sussman and Chikumbo 2016). That review found that electricity savings ranged from 0.5% to 5.2% per household, and gas savings ranged from 0.3% to 1.6%. The median estimate was roughly 1.6% savings for electricity and 0.8% savings for gas. Given they reach millions of customers, these small per-customer savings translate to significant aggregate reductions in energy and consequent carbon emissions.

In 2022, Illume published a meta-analysis of 111 HER evaluations spanning program years 2018–2022 and found similar results (Galport 2022): Electricity savings ranged from 0.6% to 1.7% with a weighted mean of 1.16%, and gas savings ranged from 0.3%–1.7%, with a mean of 0.87%. Supplementing these, for this report we reviewed 13 additional new evaluations published in 2023 and 2024 and found savings in similar ranges: 0.31% to 2.29% for electricity and 0.11% to 1.4% for gas.[5] Each of the program evaluations within the reviews includes thousands of customers (sometimes hundreds of thousands), lending strong evidence of consistent and predictable savings.[6] Indeed, after third-party evaluations of millions of customers' responses to HERs, the savings are remarkably consistent. In California, Opower[7] estimates this translates to about $7–$29 in bill savings per customer per year (CPUC 2024, p29). Across

[5] The lower level of savings for gas, relative to electricity, is likely because gas is generally only used for space heating, water heating, and cooking, whereas electricity is used for a variety of purposes in addition to those. Customers can also more readily address cold temperatures than hot temperatures with non-HVAC-related actions (e.g., they can add more clothing layers to stay warm, but can only remove so many layers to cool off).

[6] As sample sizes increase, the power to detect significant savings increases. A basic sample size calculation for the type of statistics used in most HER evaluations (linear multiple regression or Analysis of Variance F test with fixed effects and two groups, power = 0.95, alpha = 0.05, and effect size = 0.02), shows that a sample size of 1,000 to 1,300 should suffice for an effective evaluation. The evaluations of HER programs have more than sufficient sample size.

[7] Opower was acquired by Oracle Corporation in 2016 and the behavior-based efficiency program implementer now officially goes by the name Oracle Utilities – Opower. We use "Opower" in this report for the sake of brevity.

the country, customers saved roughly $3.3 billion between 2009 and 2022 from a 32-terawatt energy reduction (Clifford 2022).

Factors affecting savings

HER programs thrive when reports are delivered consistently over multiple years. They save energy by helping customers establish habits and plans for energy upgrades. These behaviors take time to establish and require regular reminders. This can be observed in the two-year energy savings ramp-up period for most HER programs. Savings from HERs ramp up over the first one to two years and then reach a steady state that continues as long as reports are delivered. As such, HER programs are best conceived of as multiyear investments, with costs and savings spread over multiple years.

The programs with small per-customer savings that we examined for this report (between 2023 and 2024 with participants saving less than 0.9% electricity or gas) had small savings because they were evaluated during this initial ramp-up period.[8] That is, programs evaluated within the first year or two have comparatively low savings that will ultimately increase as new energy-saving behaviors become solidified and households invest in energy upgrades. This is a consistent finding that was also reflected in ACEEE's earlier review (Sussman and Chikumbo 2016) and the Illume meta-analysis (Galport 2022).

Once aggregate savings (across all customers) stabilize, they tend to remain at the same level as long as reports continue to be delivered. Longitudinal studies of multiple programs delivering HERs for four years bear this out (Allcott and Rogers 2014; Khawaja and Stewart 2014; Galport 2022), and this was extended to five years by ACEEE in our earlier report (Sussman and Chikumbo 2016). In 2022, evaluators reanalyzed savings from a "legacy" cohort in one particularly long-running program in Puget Sound, recruited in 2008 (still including over 9,000 treatment customers), and found the electricity savings were still 1.3% lower than the randomly assigned control group. Thus, the duration of savings during active HER report years appears to be quite long (DNV 2024).

Other factors can also make HERs marginally more effective. Paper HERs are more effective than digital emailed HERs ("eHERs"; Sussman and Chikumbo 2016; Galport 2022), and savings are often higher for customers with high baseline energy use, more space (floor area), and fewer occupants (Khawaja and Stewart 2014; Ashby et al. 2012). HERs delivered monthly may result in slightly higher savings than those delivered quarterly.[9] This should occur because much of the effect of HERs comes from repeated actions and small investments[10] and households save the most energy right after receiving reports, especially in the early ramp-up period (Allcott and Rogers 2014).

Low-cost savings, fast

Utilities' and regulators' priorities for energy efficiency programs have shifted from only saving energy to also addressing equity concerns and mitigating climate change (Specian and Gold 2021). In 2020, Hibbard and colleagues found that HERs can be a cheaper way to mitigate climate-related damages than

[8] The evaluations were Cadmus, 2024a; Guidehouse, 2024; Cadmus, 2024b; Opinion Dynamics, 2024; Mississippi Power, 2024; and ADM Associates, 2024.

[9] In one evaluation, gas savings were about 1.8 times higher and electric savings were 1.5 times higher (not statistically significant) among customers receiving monthly reports, as opposed to quarterly reports (DNV GL 2016). This evidence indicates a possible difference but more research is needed.

[10] For example, turning things off, setting household temperatures in winter or summer, and replacing light bulbs (Sussman and Chikumbo 2016; Khawaja and Stewart 2014; Annika et al. 2014).

other efficiency programs (Hibbard et al. 2020). They found that home energy reports can serve many more households than other programs (e.g., programs providing incentives for insulation or HVAC upgrades), and they can do so more quickly and less expensively. There are benefits to this speed because carbon emissions avoided earlier are more impactful than the same emissions avoided later. For this reason, their analyses showed that HER programs mitigate one dollar of climate change-caused damage at less than one quarter the cost of other programs.

Home energy reports also serve a very large number of customers because they are opt-out programs and because households do not wait for a repair or replacement need before using them. HERs can be proactively sent to most utility customers immediately, whereas, for programs helping to replace a major energy-consuming appliances such as a heating or cooling system, most customers wait until the system fails before participating. Moreover, home energy reports can be served to both homeowners and renters. In the program evaluations we examined that included multiple residential programs, home energy report programs dwarfed other programs in program participation numbers, despite requiring a control group of HER non-recipients for evaluation purposes. In 2020, Hibbard and colleagues found that across three utilities in different U.S. states, HERs were able to reach 31 to 148 times as many customers as other equivalent programs. This demonstrates the ease of deploying HERs to a broad swath of customers to achieve savings relatively quickly.

The primary expenses for HER programs (processing of information, analysis of results, creation of reports, and mailing physical reports to households) are minimal compared to the costs of structural energy efficiency programs (e.g., providing rebates for energy-efficient appliances or envelope improvements). HERs are among the lowest-cost options relative to their savings (Dougherty and Van de Grift 2016).

Capitalize on new technologies

Modernizing America's aging electricity grid usually includes adding advanced metering infrastructure (AMI; sometimes called "smart meters") to residents' homes (Progressive 2024). This technology improves utilities' ability to respond to energy demand as well as monitor when parts of the grid may need attention (Progressive 2024). However, installing AMI across a service territory can be expensive. One early report estimated the cost usually ranged from $130–600 per customer (U.S. DOE 2016) and the cost has not changed much since.[11] HERs therefore leverage this existing investment by ratepayers to deliver additional benefits.

AMI technology allows granular observation of real-time energy use, usually at about 15-minute or one-hour intervals (Potter 2024). Using data from these meters, utilities and program implementers can implement nonintrusive load monitoring methods to differentiate which appliances in a home are using electricity at any given time (Verma et al. 2021). Disaggregated energy feedback derived from AMI data effectively helps households understand their energy use (Herrmann 2018) and early use of AMI data to provide disaggregated feedback on specific energy uses in the home show they can lead to significant savings (Chakravarty and Gupta 2013).

For example, households shown that specific appliances are responsible for an unusually high proportion of energy can act on that information—they can change how they use that appliance or choose to buy a more efficient one if the opportunity presents itself. They can also show when energy is

[11] For example, in 2022, Jersey Central Power & Light was approved to spend $4.3 million on 1.1 million customer smart meters (Johnson 2022).

most frequently used, and recommend shifting the use to other times, when energy is cheaper or results in fewer carbon emissions. Today, most modern HER programs are able to capitalize on AMI data to provide the deeper analysis of home energy consumption that explains how and when customers use energy, alongside the biggest opportunities for energy savings. Thus, HER programs help utilities maximize their investments in AMI and do so without raising costs for customers. Taking advantage of AMI information for programs that have not already done so is the first step in creating HER 2.0.

Increase participation in other utility-run programs

HERs include customized tips for saving energy in addition to the personalized energy use information. In most cases, utilities use this space to encourage energy efficient actions and promote their other programs. Although several program evaluations and studies show that so-called "curtailment" behavior may be the primary energy saving mechanism for HERs (see Sussman and Chikumbo (2016) for a review), a sizable proportion of savings also come from durable upgrades. One evaluation of a Sacramento-based HER program found that an estimated 40% of savings came from installing energy-efficient structural measures (Wu 2012).

HER programs help utilities maximize their utility-run structural energy efficiency programs. A quasi-randomized control field experiment demonstrated that HER programs promoting rebates for structural measures saved customers more than three times as much energy as when those rebates are offered without the HER program (5.7% with versus 1.7% without; McClaren et al. 2016). Researchers compared the energy consumption of households that only participated in rebate programs to those who received HERs and participated in rebate programs. They found that households also receiving HERs saved significantly more. Additionally, HER recipients participated in slightly more rebate programs than rebate-only participants (1.55 versus 1.46 programs, respectively).

A study looking at surveys from 6,000 HER program participants found that the action with the biggest difference in frequency between HER recipients and non-recipients was requesting a home energy audit (see table AI-1 in Allcott and Rogers 2012). Additionally, three of the 13 new evaluations we reviewed for this report described program uplift. They show that participation in energy efficiency programs was 2.5%–15% higher among HER recipients than non-HER recipients.[12]

Nevertheless, HER programs could likely do even more to promote other utility-run programs. Under the current program evaluation paradigm, HER programs are disincentivized from channeling recipients to other programs. This is because any savings resulting from customers participating in other programs are removed from the savings attributed to the HER program. For example, if a customer receives a HER that tells them about a utility program providing rebates for HVAC upgrades and then buys a new HVAC system and receives the rebates, the savings from the newly installed HVAC system will be attributed only to the HVAC program, while those savings are subtracted from the efficiency impact attributed to the HER program. So, the HER program alerted the customer to the HVAC program (via the tips section) and motivated them to participate (through neighbor comparison), but the savings are not attributed to the HER (i.e., these savings are removed from the savings generated by the HER). If, on the other hand, the HER program channels customers toward nonprogram efficiency actions, for instance the federal Home Energy Rebates programs, then it "keeps" all the savings and is viewed as more successful.

As noted in one commentary (Dougherty and Van de Grift 2016, p. 906), this need to avoid double-counting savings "… leaves program implementers hesitant to cross-promote programs or use one

[12] The evaluations were Guidehouse, 2023; Guidehouse, 2024a; Cadmus, 2024.

program's dollars to support another" and "a top-down, portfolio-level evaluation or a market-focused evaluation would inherently remove these barriers …" That is, despite HER programs already effectively channeling customers toward other programs, they could do even more if energy efficiency savings from channeling were not fully attributed to structural programs. For example, if residential programs were evaluated as a bundle, or if savings derived from channeled participants were split between HER programs and structural programs, then HERs would be incentivized to do more program channeling. Given the massive reach of HER programs and the comparatively small reach of other programs, channeling customers from one to the other would help both programs and drive more savings for the utility overall. This is a win-win for the customer, the utility, and both programs. The new evaluation method could be pilot tested to determine viability (i.e., continuing individual-level evaluation and adding bundle-level or split attribution to observe how well it works).

An alternative to bundle-level evaluation or splitting of energy efficiency savings among programs could be an expansion of program marketing budgets to help cover the channeling activities of HERs. That is, HER-specific energy savings could continue to be paid through the utility's energy efficiency budget, and channeling activities could be covered by the utility's marketing budget. This method would require a quantification of the cost of saving energy from HERs, separate from the cost of diverting customers to other programs (only the cost of diverting customers could be covered by marketing budgets). However, this approach would be complicated and may not be possible to administer in practice.

The changing landscape of HER program evaluation

For at least a decade, HERs have been deemed an acceptable program for saving energy across the United States. In nearly all states, these programs qualify as energy efficiency programs and, thus, utilities allocate a portion of their energy efficiency budgets to running them, and claim the savings generated toward their efficiency goals. Nevertheless, in some states HER programs are being reconsidered in light of changing policy priorities and in response to concerns about their efficacy.

For instance, in New York, a new regulatory framework encourages utilities to implement structural energy efficiency programs (e.g., providing incentives for building envelope or mechanical systems improvements), which they term "strategic," and discourages investment in HER programs in favor of measures with longer measure lives (New York Public Service Commission 2025). In Rhode Island (as of March 2026), regulators are considering requiring these programs only include emailed reports ("eHER") and not paper reports delivered by mail (Rhode Island Energy 2025). In North Carolina, some argue that savings are overestimated, and utilities are relying too heavily on savings from HER programs relative to other utility efficiency programs (South Carolina Public Service Commission 2018). In Florida, regulators have a long-standing policy that only permits utilities to run programs for structural measures, which exclude HER programs (Specian 2024). Below, we discuss some of the conversations happening around HER programs and their evaluations.

Current conversations about HER programs

Through discussions with program implementers, utilities, and energy efficiency advocates, as well as reviews of several state-level public filings regarding HER programs, we have identified several recurring conversations around HER programs. We discuss the research and data related to these conversations below.

How HER programs can meet new policy priorities

Energy regulators, legislators, and utilities across the United States have expanded their energy efficiency priorities from merely saving energy to encouraging electrification, reducing greenhouse gas emissions (typically prioritized with electrification), reducing low-income customers' energy burdens, and addressing inequity. Indeed, a growing number of states' Energy Efficiency Resource Standards (EERS) have included these additional goals (Mah et al. 2025).

In New York, regulators have moved to classify energy efficiency programs as "strategic," "neutral," or "non-strategic" for reducing carbon emissions and set upper limits on how much utilities can spend on each program type (New York Public Service Commission 2025). HER programs are classified as "non-strategic" because they are perceived to inadequately address carbon emissions, and some also believe they do not reduce low-income customers' energy burdens.

Indeed, the key innovation in these reports, the energy use neighbor comparison, has the effect of motivating residents to reduce energy use and traditionally were not designed to encourage fuel switching or participation in low-income programs, whereas new programs can be targeted to specific customer segments and tailored to encourage those actions. Unlike other energy efficiency programs, however, HER programs can motivate customers to engage in habitual behavior-based energy efficiency actions such as turning things off and changing thermostat set points.

Nevertheless, HERs have great potential for helping achieve other priorities. For example, to promote electrification and decarbonization, reports could provide energy-saving tips that channel customers toward electrification programs. Among customers concerned about climate change, reports could center around greenhouse gas emissions or air pollution rather than only energy consumption and saving money. A comparison to neighbors on this metric would motivate action to reduce emissions as opposed to just reducing energy.

A small study of HERs (based on billing analyses over 100 days for 118 households) suggests this approach could be effective (Asensio and Delmas 2016). Participants who received HERs comparing their energy use with their neighbors' in terms of "pounds of air pollutants" conserved more electricity than others who were randomly assigned to receive the same message phrased as "dollars saved." Those who received the environment-framed reports achieved savings of 8%–10% that were maintained until the end of the 100-day study (relative to controls).

HER-type programs can encourage households not only to perform energy saving actions, but to perform them at specific times of day. By encouraging customers to shift their loads to times when the utility grid is greenest and least constrained (i.e., electricity is generated by sources emitting the fewest greenhouse gases), HERs can maximize their climate mitigation impact. This conforms to the total system benefit (TSB) approach to efficiency, in which time of use is a factor alongside amount of use.

Figure 2, below, shows the projected marginal emission rates in Maryland as an example. HER programs can encourage customers to use energy during the green time blocks and conserve energy during the red blocks. In our 2016 review (Sussman and Chikumbo 2016), we found six Opower programs evaluated for peak demand usage reported considerable savings during peak periods.[13] As described later, in the HER 2.0 section of this report, Peak Energy Savings programs, peak-focused HERs, and load shaping

[13] These savings were either recorded as percentage savings per customer (0.43%–2.2%) or overall annual savings for the power company (e.g., 9,291 therms, or 1.45–15.4 MW).

programs are a few that have the potential to be especially impactful. For this type of program to work, utilities would need to share granular customer data with program implementers.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
12am	0.683	0.619	0.618	0.684	0.633	0.782	0.752	0.729	0.684	0.701	0.673	0.658
1am	0.698	0.592	0.625	0.694	0.584	0.750	0.729	0.726	0.681	0.775	0.654	0.665
2am	0.660	0.624	0.634	0.657	0.612	0.665	0.741	0.680	0.728	0.717	0.608	0.596
3am	0.618	0.611	0.539	0.624	0.502	0.624	0.689	0.599	0.678	0.664	0.561	0.613
4am	0.608	0.550	0.556	0.591	0.507	0.598	0.651	0.563	0.619	0.654	0.560	0.571
5am	0.573	0.577	0.561	0.566	0.529	0.537	0.591	0.576	0.565	0.551	0.601	0.532
6am	0.598	0.552	0.552	0.569	0.521	0.504	0.513	0.483	0.538	0.577	0.551	0.570
7am	0.583	0.537	0.534	0.560	0.489	0.486	0.507	0.487	0.487	0.543	0.557	0.599
8am	0.588	0.571	0.544	0.479	0.357	0.398	0.509	0.501	0.517	0.547	0.551	0.568
9am	0.611	0.568	0.530	0.268	0.250	0.280	0.495	0.411	0.506	0.447	0.576	0.592
10am	0.596	0.504	0.294	0.233	0.219	0.213	0.426	0.359	0.484	0.460	0.550	0.559
11am	0.613	0.515	0.202	0.195	0.169	0.217	0.392	0.339	0.385	0.406	0.468	0.507
12pm	0.624	0.409	0.238	0.170	0.148	0.350	0.519	0.419	0.454	0.317	0.513	0.511
1pm	0.583	0.420	0.212	0.173	0.146	0.374	0.606	0.561	0.512	0.340	0.505	0.578
2pm	0.593	0.417	0.351	0.147	0.290	0.470	0.701	0.584	0.572	0.415	0.595	0.594
3pm	0.628	0.603	0.493	0.309	0.414	0.531	0.777	0.604	0.641	0.562	0.603	0.560
4pm	0.627	0.566	0.545	0.529	0.547	0.699	0.805	0.678	0.651	0.646	0.574	0.556
5pm	0.688	0.535	0.523	0.615	0.520	0.745	0.793	0.658	0.663	0.610	0.584	0.636
6pm	0.635	0.533	0.522	0.576	0.562	0.733	0.831	0.706	0.727	0.659	0.555	0.597
7pm	0.632	0.558	0.486	0.563	0.595	0.714	0.814	0.670	0.726	0.633	0.555	0.601
8pm	0.618	0.508	0.497	0.608	0.620	0.743	0.791	0.681	0.688	0.608	0.584	0.608
9pm	0.614	0.543	0.522	0.619	0.568	0.705	0.866	0.674	0.625	0.754	0.642	0.629
10pm	0.644	0.604	0.541	0.633	0.573	0.773	0.800	0.679	0.708	0.822	0.651	0.714
11pm	0.671	0.659	0.620	0.633	0.649	0.749	0.762	0.729	0.773	0.777	0.633	0.710

Figure 2. Projected marginal CO_2 emission rates in Maryland in 2027 (tons CO_2/MWh). Columns represent months, rows represent hours, and cell values reflect the average marginal emission rate in that hour for the entire month. To maximize climate mitigation, customers can be encouraged to save electricity during the red colored blocks of time. Values derived via data provided through PJM's Data Miner 2 tool and through Maryland's statewide decarbonization plan.

HER programs make use of extensive customer data to create tailored energy tips. Similarly, HERs can be designed to alleviate energy burdens by channeling low-income or historically underserved populations toward energy assistance and no-cost weatherization programs. They can help customers save energy while encouraging behaviors that match new policy priorities, through no- and low-cost changes.

Notably, however, to achieve these new goals, regulators should consider revising the evaluation criteria for HER programs. For instance, if electricity reduction is the primary evaluation criterion, then when a customer electrifies their home heating in response to a HER recommendation, their electricity use will increase and the HER program will be penalized. Similarly, a HER program would not generate savings (and therefore not benefit) if a low-income customer alleviates their energy burden through an energy assistance program that provides emergency assistance paying energy bills. New evaluation criteria for these programs should be developed to credit programs for fuel switching and encouraging participation in low-income programs. Program implementers such as Opower are investigating methods of comparing electrified homes specifically to other electrified homes (for the purposes of creating the HERs themselves), but the question of how to account for the energy impacts of electrification and low-income programs in energy efficiency portfolios is an important one that applies to many energy efficiency/electrification programs (not just HER programs).

Moreover, as discussed earlier, the current method of calculating and removing program uplift savings from HERs disincentives HER implementers from channeling customers to other programs. If uplifted savings could be partially credited to the HER program, implementers would be incentivized and more interested in expanding efforts to channel customers to other efficiency program services. **ACEEE recommends that utility regulators consider revising program evaluation criteria to incentivize program channeling (e.g., by evaluating residential programs as a bundle or splitting energy efficiency savings between structural and HER programs).** By piloting this strategy before a full rollout, regulators can determine if/how it influences program design and whether or not it influences the quality of the programs.

HER programs provide both energy savings and marketing

HER programs can promote other energy efficiency programs while also generating savings themselves. HER programs can channel customers to other utility programs, but they are not merely marketing initiatives. Treating them as such would disincentivize program implementers from designing HERs that nudge customers to save energy (in addition to promoting other programs), leaving significant energy efficiency and peak demand savings on the table. Only behavior-based energy efficiency programs can encourage energy savings through both curtailment and efficiency. Thus, **we recommend including HER programs as energy efficiency programs rather than marketing initiatives.**

HER programs as part of a balanced energy efficiency portfolio

A balanced energy efficiency program portfolio includes offerings that reach as many customers as possible, achieve substantial overall savings, and enable motivated participants to lower their energy bills to a substantial degree. HERs' strengths are reaching many customers and achieving significant aggregate energy savings. In general, however, to achieve deep energy savings and significant energy bill reductions, individual customers need to make structural changes to their homes through equipment replacement and building shell upgrades. In addition to enabling deeper energy savings for individual participants, structural improvements also yield savings for many years (often decades), leading to increased cumulative savings over time. For this reason, utilities should develop balanced energy efficiency portfolios that include robust investment across a diverse array of structural program offerings alongside behavioral programs.

In 2023, 35 of the 53 largest U.S. energy utilities (roughly two thirds) ran a HER program or other similar behavior-based energy efficiency program (based on data gathered by ACEEE for the *Utility Energy*

Efficiency Scorecard; Specian et al. 2023). Given the relatively low startup costs for HER programs, relative to other programs, previous analyses found that utilities that emphasized first-year savings goals relied particularly heavily on HERs to generate savings (Dougherty and Van de Grift 2016). This is partly because most utilities assume HER savings have a one-year measure-life.[14]

The ACEEE *2023 Utility Energy Efficiency Scorecard* (Specian et al. 2023) found that many utilities do not report on lifetime savings or measure lives. A 2019 report also found that 25 of 27 states with Energy Efficiency Resource Standards focus on first-year or incremental annual savings (Gold and Nowak 2019) and this general lack of focus on long-term measures remains an issue (Mah et al. 2025). On the other hand, measures with higher upfront costs, but longer-term deep savings, such as envelope and HVAC upgrades, can save more energy and money per customer, improve resilience to extreme weather events, and provide a host of health and comfort benefits (Baniassadi et al. 2022).

However, first-year (quick win) savings are important as well. Atmospheric greenhouse gas emissions accumulate over time and earlier savings are more valuable than later savings (Kallbekken and Rive 2007). As time passes, the cost and effort needed to avert catastrophic climate impacts increases, meaning that reducing carbon emissions quickly is critical. According to one analysis, a 20-year delay would mean that annual emissions reductions would have to be 5 to 11 times greater than with early climate action (Kallbekken and Rive 2007).

That said, efficiency goals are also important—utilities with more long-term savings goals may wish to invest more heavily in structural programs, despite reaching fewer customers. Programs incentivizing structural measures (e.g., insulation or HVAC upgrades) produce high per-customer persistent savings among a smaller subset of customers, but these savings are critical. HER program savings begin to decay as soon as programs are terminated. Therefore, to maintain HER savings over the long term, they should be delivered for multiple years, as these programs are intended, which entail year-over-year spending to keep savings up. By contrast, once structural improvements are in place those investments produce long-lasting savings that last for many years without the need for further program spending. In the ideal scenario HER programs complement structural programs, channeling customers and increasing participation.

Traditional quick-win upgrades, such as light-emitting diode (LED) lighting have achieved sufficient market penetration that they no longer need to be incentivized (i.e., people buy them anyway) and, thus, they are no longer able to provide a bulk of the savings in utilities' energy efficiency portfolios (Sprayregen and Huessy 2019). HER programs are one of the few remaining quick-win options to fill the gap left in these portfolios.

Importantly, HER programs are also able to encourage curtailment-based savings, including savings at specific times of day or year when the grid is dirtiest and most constrained. This is different than the efficiency-based savings that other programs offering structural measures can provide. Utilities can avoid leaving savings on the table by deploying programs that capture savings from both efficiency and curtailment actions. Moreover, if climate mitigation is a priority, then regulators can impose goals of reducing peak demand, in addition to overall demand, and HER programs (and especially some HER 2.0 programs described later) are well-positioned to help achieve those goals.

HER programs are particularly helpful for producing near-term curtailment-based savings, and structural energy efficiency programs can deliver ongoing savings (as well as comfort and health benefits) through building infrastructure upgrades. As more electric load comes onto the grid, all types of programs are

[14] As one experienced evaluator we spoke to noted, "the problem is that utilities are drunk on first year savings."

needed to avoid blackouts and brownouts. An overreliance on either of these types of measures means that utilities and customers miss out on potential benefits that the other cannot provide. Fortunately, most utilities have a variety of programs already in place. The 2023 ACEEE *Utility Energy Efficiency Scorecard* research found that utilities with a behavior program also had, on average, 10 other residential energy efficiency programs (Specian et al. 2023). As noted earlier, combining programs also bolsters their successes (McClaren et al. 2016). The key to an effective portfolio is balanced funding (and consequent savings) allocated to behavior and non-behavior-based programs.

To date, no definitive analysis has been conducted to establish the optimal measure life requirements for energy efficiency programs or the percentage of portfolio savings that should optimally be derived from HER programs or other programs in a portfolio. More research is needed to determine what mix of long- and short-term programs best serve a variety of priorities and budgets. For example, if the policy priority is mitigating climate change, regulators need more research on the best mix of programs for reducing cumulative atmospheric greenhouse gases. If the primary goal is improving equity outcomes, regulators need research to determine the best mix for alleviating high energy burdens. If there is a complex mix of goals, then the research on how to balance a portfolio to achieve multiple goals is critical.

In absence of definitive research on the optimal portfolio balance, New York State proposed a new rule stating that 85% of energy efficiency program funds should be spent on programs that provide "strategic" (i.e., structural) energy efficiency measures (New York Public Service Commission 2025, p. 9). Across the rest of the United States, behavior program spending by utilities varies. Five of six utilities scoring highest on investment in long-term measure life upgrades in the 2023 ACEEE *Utility Energy Efficiency Scorecard* spent between 3% and 20% of their residential budgets on behavior-based energy efficiency programs and generated between 5% and 64% of their savings from those. The other utility offered a suite of behavior-based energy efficiency programs (as opposed to just HERs) and therefore spent a higher percentage of its residential budget on behavior-based programs (53%). It claimed over 90% of its residential savings from these programs (see table 1 below; evaluations of utilities in the *Scorecard*; Specian et al. 2023).

Balance is key. Utilities that are attempting to maximize cost-effective energy efficiency can optimize behavior-based program savings as part of that effort. However, if utility goals focus too much on first-year energy savings (as opposed to using an "all cost-effective" approach),[15] they risk overrelying on behavior-based energy efficiency programs and underinvesting in the structural energy efficiency measures that are also needed to achieve 2050 deep decarbonization objectives. **ACEEE recommends energy efficiency portfolios take a balanced approach and include both behavior-based energy efficiency (quick win) programs alongside programs that encourage structural energy upgrades and longer-term savings.**

Table 1. Savings from residential behavioral energy efficiency programs

[15] Overreliance on HER programs can result from a variety of causes. For example, some annual incremental savings requirements in EERS policies can encourage short-term goals and some cost-effectiveness test practices can result in overestimation of savings from these programs.

Utility name	Total residential portfolio budget ($)	Residential behavioral program budget ($)	% of total residential budget spent on behavioral programs	Total residential portfolio savings (kWh)	Residential behavioral program savings (kWh)	% of total residential savings from behavioral programs
ComEd[1]	$105,095,000	$6,457,000	6.14%	816,309,447	100,555,672	12.32%
Xcel CO[2]	$21,796,428	$1,708,087	7.84%	73,006,220	4,239,557	5.81%
Consumers Energy[3]	$63,565,996	$6,433,127	10.12%	167,471,000	25,577,000	15.27%
San Diego Gas & Electric (SDG&E)[4]	$20,921,101	$4,197,442	20.06%	20,750,000	13,340,000	64.29%
Xcel MN	$36,310,703	$989,940	2.73%	356,759,000	19,395,000	5.44%
Pacific Gas & Electric (PG&E)	$54,309,450	$23,404,174	52.80%[5]	260,170,000	238,920,000	91.83%

[1] Figures are from the Program year 2024 program cost-effectiveness analysis; these figures are for residential electric behavioral programs and include low-income programs. [2] Residential electric home energy insights program, Program Year 2024. [3] Residential electric behavioral programs; Program Year 2024. [4] Residential electric behavioral programs; Program Year 2023. [5] PG&E spending on behavior programs is higher than other utilities, partly because it includes a suite of behavior-based energy efficiency programs beyond HERs.

Would customers have done the behavior anyway?

After decades of deployments and millions of customers reached by HER programs, these programs have become part of the fabric of the energy efficiency landscape. Although historically deployed almost entirely by one company (Opower, owned by Oracle), they are now produced by a larger number of program implementers (e.g., Bidgely, Uplight, and Franklin Energy), and some utilities have developed in-house programs or incorporated HER-like information into utility bills. The small (hard-to-observe) per-customer savings (1%–2%), combined with the ubiquitous nature of the programs, can make it difficult to see that HER programs continue to be effective.

HER programs do differ in effectiveness among different populations. For example, HERs may influence behavior in some university dorms (Alberts et al. 2016) but not others (Myers and Souza 2020). One analysis of U.S. HER programs suggests that savings are higher in regions that are more concerned about climate change, which is where most programs were initially implemented (Allcott 2015). Another analysis further demonstrates that if more affluent customers with larger baseline usage and larger homes are targeted, then programs may have higher per-customer savings (Gerarden and Yang 2023). Thus, although savings are real, performance may vary across geographies and customer types.

Despite being effective, the aggregate impact of HER programs is only observable at the programmatic level. Some customers reduce consumption considerably while many others do not reduce at all. These individual consumers, therefore, do not personally observe much reduction in household energy use themselves, but, over time, the thousands of customers saving small amounts add up to a measurable

impact at the programmatic level. Indeed, as noted earlier, a legacy HER program cohort in Puget Sound continues to see a 1.3% savings two decades after the program was started (DNV 2024). This type of observation is only possible at the programmatic level. Nevertheless, it is easy for customers with direct experience receiving HERs for multiple years to think that the reports do not affect their behavior because they have personally ignored them for years.

In New York, regulators have publicly stated that savings generated from HERs could be from free riders—customers that would have saved energy even in absence of the program (New York Public Service Commission 2025). However, long-running studies of HER programs, in which customers are randomly assigned to receive, or not receive, HERs confirms that recipients do, in fact, save energy, even after many years of receiving reports (and eventually stop saving energy when reports are stopped). Evidence from over two decades of program evaluations suggests that they continue to be effective (Sussman and Chikumbo 2016; Galport 2022). The savings from HER programs could not be generated without the sophisticated data analysis, presentation, and delivery of HER program implementers. These programs influence customers to save energy largely through subtle and occasional curtailment behaviors, which is a form of energy savings that structural energy efficiency programs cannot provide. Therefore, **ACEEE finds that HER programs drive behaviors that would not have otherwise happened, verified by many years of rigorous evaluation**.

Effective evaluation methods continue to demonstrate impact

Given the unique nature of HER programs, and behavior-based energy efficiency programs more broadly, they require more complex methods of evaluation and statistical analyses than other energy efficiency programs. These methods are less familiar to evaluators than methods used for structural measures. Although different, they are sound and rigorous methods of demonstrating savings.

As part of this report and the 2016 examination of behavior-based energy efficiency programs (Sussman and Chikumbo 2016), ACEEE reviewed methods and statistics for many of these evaluations. We found that in nearly all cases where statistical analyses were presented, the evaluations were conducted effectively and demonstrated reliable savings estimates. Nevertheless, several best practices should be followed to ensure maximum reliability (Stewart and Todd 2020; Todd et al. 2012).

The goal of behavior program evaluation is to determine whether the behavior-based program (e.g., HER program) caused the program participants to reduce their energy consumption. To achieve this goal, all other alternative explanations (known and unknown) should be ruled out to the best of the evaluators' abilities. Employing a randomized control group and comparing the results of program participants to the control group using a so-called "difference-in-difference" analysis provides optimal evidence of this causality.[16] This method should effectively control for all known and unknown alternative explanations for results and is generally sufficient. However, evaluators can further sharpen their results by reducing the "noise" from the data. This can be done by also explicitly removing any additional known sources of variability that could influence energy use. For example, evaluators can

[16] The difference-in-difference method involves calculating the difference between baseline energy consumption and post-program energy consumption for participants and nonparticipants. If there is a difference between participants and nonparticipants in the pre-post calculation (a "difference between groups" in the "difference between pre and post") then this can be inferred to be caused by the behavior program.

reduce noise in the data by explicitly controlling for external temperature fluctuations.[17] This can reduce error terms and make results stronger.

Another key element of a credible evaluation is a sufficiently large sample size (i.e., number of customers in both the treatment and control groups). Given the small effect of HERs on any given customer (usually an average 1%–2% reduction in electricity use) a large number of customers is generally needed to observe a statistically significant impact. The appropriate minimum sample size varies by a number of factors, including the number of subgroups that are being observed and the number of data points (energy readings) reported for each customer—more subgroups and fewer data points increase the necessity for more customers. Therefore, we do not recommend splitting the customers into too many subgroups. A power analysis should be conducted to obtain the precise minimum number of customers required for each subgroup. Each case is different, but programs with over 2,000 customers per group are usually sufficiently large to enable accurate estimation of impacts.

Most programs we examined used a randomized control design and all had sufficiently large sample sizes in each subgroup. This allowed evaluators to validate the design and assess the impact of the programs. Evaluators nearly always conducted difference-in-difference analyses and controlled for outside temperatures. A few used a matched control group, which is less preferred but given the control groups were matched on a number of relevant characteristics (and effectiveness has been demonstrated in a large number of other settings using randomized control designs), these also provide sufficiently strong evidence of effectiveness.[18] Importantly, all evaluations were conducted by third-party evaluators rather than the program implementers themselves. Many programs also compared their study outcomes to other HER studies, to ensure their results were not outliers. Overall, ACEEE found the HER program evaluations to be accurate and persuasive.

Distributional equity

Unlike many residential energy efficiency programs, HER programs can serve most of a utility's customer base and, as such, support distributional equity. Given that all utility ratepayers pay for HER programs through charges on their energy bills, the fact that nearly all can receive reports (and that many energy-saving actions are no-cost) means that the benefits of the program are well-distributed to customers.

HERs help reduce energy bills by motivating customers to take curtailment and efficiency actions. Low-income customers tend to have higher energy burdens than non-low-income customers (Ayala and Dewey 2024), and HERs have the potential to help lower bills for this group. Despite low-income customers tending to have less efficient homes (Rohe et al. 2010) and less disposable income to spend on efficiency measures, five evaluations we reviewed for this report examined subgroups with low-income customers and found that savings were generally similar to those of non-low-income

[17] In a properly randomized trial, the treatment and control groups will have the same exogenous temperature experience. Although temperature will impact energy use for both groups, the difference between the groups in an RCT remains causally attributable to the treatment. Controlling for temperature is, therefore, generally optional and not required.

[18] Although evaluations typically include a measure statistical significance (i.e., establishing significance based on whether *p*-values are below 0.05) this statistical approach can be less effective in large datasets with large numbers of comparisons. However, the consistent finding of positive effect sizes as a result of HERs programs implementation suggests that the energy-saving impacts of HER programs are unlikely to be just a statistical artifact.

customers.[19] Thus, HER programs have the potential to lower bills for low-income and non-low-income customers alike.

However, in our conversation with ACEEE's low-income utility working group, this group expressed reservations about utilities using only this tool to achieve savings. Although the information provided in HERs is helpful to low-income customers, they would like to see utilities also invest in structural measures that lead to health and safety improvements for customers and provide information on bill assistance and weatherization programs. They strongly agreed that HER program evaluation criteria be reconsidered to allow them to be incentivized to channel customers toward other programs (especially low-income utility energy efficiency and assistance programs). Thus, **ACEEE recommends that low-income customers receive tailored HERs that help channel them toward structural and assistance programs.**

Measure life and cost-effectiveness accounting practices

A HER program's savings measure life, persistence of savings, and years of active HER delivery have a complex interdependent relationship. Although HER programs could be run for as little as one year, they are meant to be delivered for multiple years. Some evaluation experts argue that HERs have short measure lives because customers' savings begin to decay immediately after the program is terminated, and they do not remain at maximum levels unless the program is run every year. However, this may not be the appropriate lens by which to view measure life for these programs. As noted earlier, habits and energy efficiency upgrade planning take time for customers to develop, and, as a result, savings from these programs take up to two years to reach maximum levels. Once these savings levels are reached, they are maintained as long as HERs continue to be delivered. HERs should therefore be approached with the intention of being delivered for multiple years, considering the cumulative costs and savings over that time, as opposed to the costs and savings for any one year.

A complicating factor for the evaluation of HER program savings is that post-termination, customer energy savings from HER programs decline over several years, rather than dissolving immediately. Based on the handful of programs that continued to observe energy consumption after HERs were no longer delivered, it seems energy savings persist for several years after the intervention ends, with various rates of decay in savings behavior (Illinois Energy Efficiency Stakeholder Advisory Group 2024; Khawaja and Stewart 2014). The 2025 Illinois Technical Reference Manual effectively summarizes these decay rates in reference tables (Illinois Energy Efficiency Stakeholder Advisory Group 2024, p. 18), noting that a cohort in Puget Sound continued to see savings eight years following termination (18% of the original electric savings and 62% of the original gas savings, relative to the termination year). In another example, a study of experimental cohorts in Pennsylvania identified that savings following the cessation of HERs declined around 0.05% per month, persisting in total from 20–34 months before returning to baseline (Ciccone and Smith 2018).

Given the decay in savings over time, some evaluation experts argue that after the first year of the program, evaluators should only credit utilities for incremental savings beyond what customers would achieve if the program were terminated. That is, they posit that HER programs should be treated as having a multiyear measure life, and therefore, from the second year onward, only incremental savings should be counted toward energy savings goals.

[19] The evaluations were Cadmus, 2024; Guidehouse, 2024; ADM Associates and Tetra Tech, 2018; Navigant Consulting, 2015; Freeman, Sullivan & Company, 2013.

Measure life accounting methods also have important implications for utilities that receive incentive payments based on a percentage of net benefits (dollar savings to the utility system, minus the costs of running programs). A "percentage of net benefits" arrangement incentivizes utilities to invest in energy efficiency programs that have the highest return on investment each year. Programs that deliver the most annual benefits relative to their annual costs are, therefore, most likely to be implemented and continued. This could lead to an overreliance on HER programs (especially if the utilities assume a one-year measure life) and, therefore, also incentivize an unbalanced energy efficiency portfolio. Utility regulators may want to consider how HER-based performance payments are assessed to ensure that they are neither too high nor too low, and to encourage a balanced portfolio.

Nevertheless, treating HER programs as having multiyear measure lives increases the complexity and cost of evaluation, and is generally less favored by utility regulators. States that treat HER programs as a multiyear measure must calculate incremental annual savings while accounting for persistent savings from previous years. The combination of persistent—albeit decaying—savings over multiple years and the multiyear "ramp up" in savings in the initial few years of receiving reports complicate cost-effectiveness testing for a HER program if it is treated as a multiyear measure. There are also high levels of interannual variation in savings levels and between study cohorts, which makes it more difficult to determine the appropriate decay rate and to accurately forecast expected savings for a specific utility. As a result, over the past six years, three states (Pennsylvania, Illinois, Minnesota) have adopted a multiyear measure life assumption, while others (Maryland, Nebraska, Nevada, Washington, New Jersey, New Hampshire) have considered and declined it.

A single-year measure life assumption reduces complexity and provides a good basis for program evaluation as long as utilities are not overreliant on behavior-based energy efficiency programs in their overall program portfolio. For utilities that rely on behavior-based programs for the majority of their portfolio savings, using a one-year measure life could lead to overestimated program savings. In those cases, utilities and regulators may wish to examine the potential impact that their measure life assumptions could be having on savings estimates. They could also consider prioritizing reaching new customers over reaching the same cohort for multiple years (although rotating customers who receive reports can lead to reduced customer satisfaction).

ACEEE recommends delivering HERs for multiple years, allowing sufficient time to reach maximum savings levels and continuing the program as long as cumulative savings outweigh the costs.

Regulatory recommendations for traditional HER programs

HER programs can serve nearly all a utility's customers and deliver consistent and reliable savings quickly. However, HER programs and their evaluation methods can also be modified to better meet utilities' evolving priorities. For traditional HER programs, ACEEE recommends that utility regulators:

- Incentivize HER implementers to channel customers to structural efficiency programs to drive higher overall efficiency savings, support electrification, and connect low-income customers to energy support services. Revise evaluation criteria for HER programs to better assign savings attribution and avoid penalizing HER programs for increased electricity consumption from home electrification or low-income energy assistance programs.
- Run HER programs for as long as they remain cost effective. HER programs thrive when they are delivered for multiple years. This allows them to foster and maintain behavior changes and energy efficiency upgrading. Current evidence suggests that after the initial two-year ramp-up period, HER program savings tend to remain at the same level as long as reports continue to be

delivered. We do not recommend terminating programs that deliver consistent and reliable savings as long as the cumulative lifetime savings are cost effective.

- Assess overarching energy regulatory requirements to ensure performance payments tied to HER programs are appropriate (neither too high nor too low) and utilities are incentivized to deliver a balanced portfolio, including both large-scale behavior-based energy efficiency programs (far reaching/quick win) alongside structural programs that deliver deeper, longer-duration savings that accumulate over time. More research is needed to determine the optimal mix of short- and long-term programs that would best suit utilities with varying priorities and budgets.
- Require the evaluation of peak savings alongside overall savings. This may encourage utilities to invest in behavior-based energy efficiency programs that reduce peak load. Shifting usage to times when the grid is cleanest and least constrained is a step toward mitigating climate change.
- Encourage pilot implementation of promising new potential behavior-based energy efficiency programs (both as standalone programs or add-ons to existing HER offerings). These are described next.

HER 2.0 and beyond

Several new programs are currently offered by program implementers that save energy, meet climate priorities, and increase affordability through similar behavior mechanisms to HERs. These might be considered “HER 2.0” options and are ready to be deployed at scale now. Additionally, new research from psychology and social sciences identifies potential tweaks to traditional HERs that could make them more impactful, as well as potential out-of-the-box innovations that go beyond HERs entirely. In this section, we first highlight potential HER 2.0 programs (that can be combined with HER programs or run independently), then describe suggested modifications that might improve traditional HERs, and finally present a few potential new innovative programs that show promise but need additional pilot testing in the field.

HER 2.0

HER 2.0 programs are those that, like traditional HERs, deliver personalized information to customers to encourage them to save energy. They rely on big data and advanced analytics, and they are already available from one or more program implementers to be deployed at scale. In most cases, these programs are opt-out, meaning that customers receive communications by default but can choose not to receive them. This aspect of the programs allows program implementers to reach many more customers than programs that require customers to actively choose to participate. Importantly, HER 2.0 programs include features that can help utilities meet their priorities of mitigating climate change, improving equity outcomes, and promoting electrification.

Peak energy savings (also called Behavioral Demand Response, opt-out)

Reducing energy use during peak heat events helps mitigate climate change and reduce customer bills. Behavioral Demand Response is a behavior-based energy efficiency program that discourages energy use during peak heat/cool days. One typical program run by Opower is like a HER focused just on a few hours during a peak event. It involves (1) an email introducing the program at the start of the season, (2) an email and/or automated phone call the day before the peak event, and (3) a post-event email and/or

automated phone call a day or two after the event. The pre-event communication announcement also includes a peak event normative comparison of each customer's peak usage to their neighbors' for the most recent event and suggests actionable tips for reducing peak usage. The post-event communication has personalized rankings for each participant on how they did during the event, compared to their neighbors, plus additional energy saving tips. Importantly, other than the inherent savings that come from energy upgrades, no financial incentives are provided to participants (this is part of what defines it as behavior based), and the program can be run as opt-out (i.e., enrolling customers by default), making it a behavior program that lends itself to rigorous evaluation. Naturally, adding an incentive is likely to help further promote behavior change, but the fact it does not rely primarily on financial incentives is what qualifies it as "behavioral." A large-scale evaluation of this program with summer PG&E customers found that, when combined with a HER program, it helped customers reduce their electricity consumption by 2.4% on peak days (as compared to 1.8% for the HER group alone; Cook et al. 2016). This type of approach could also be modified to encourage load shifting away from times on specific days when the grid produces the highest emissions. A recent ruling by the Federal Communications Commission (FCC) allows utilities to text customers about peak demand events (Walton 2025). This has the potential to increase the impact of peak demand programs, as the messages encouraging action can be sent closer to the opportunity to act and therefore be more effective.

High-bill alerts (opt-out)

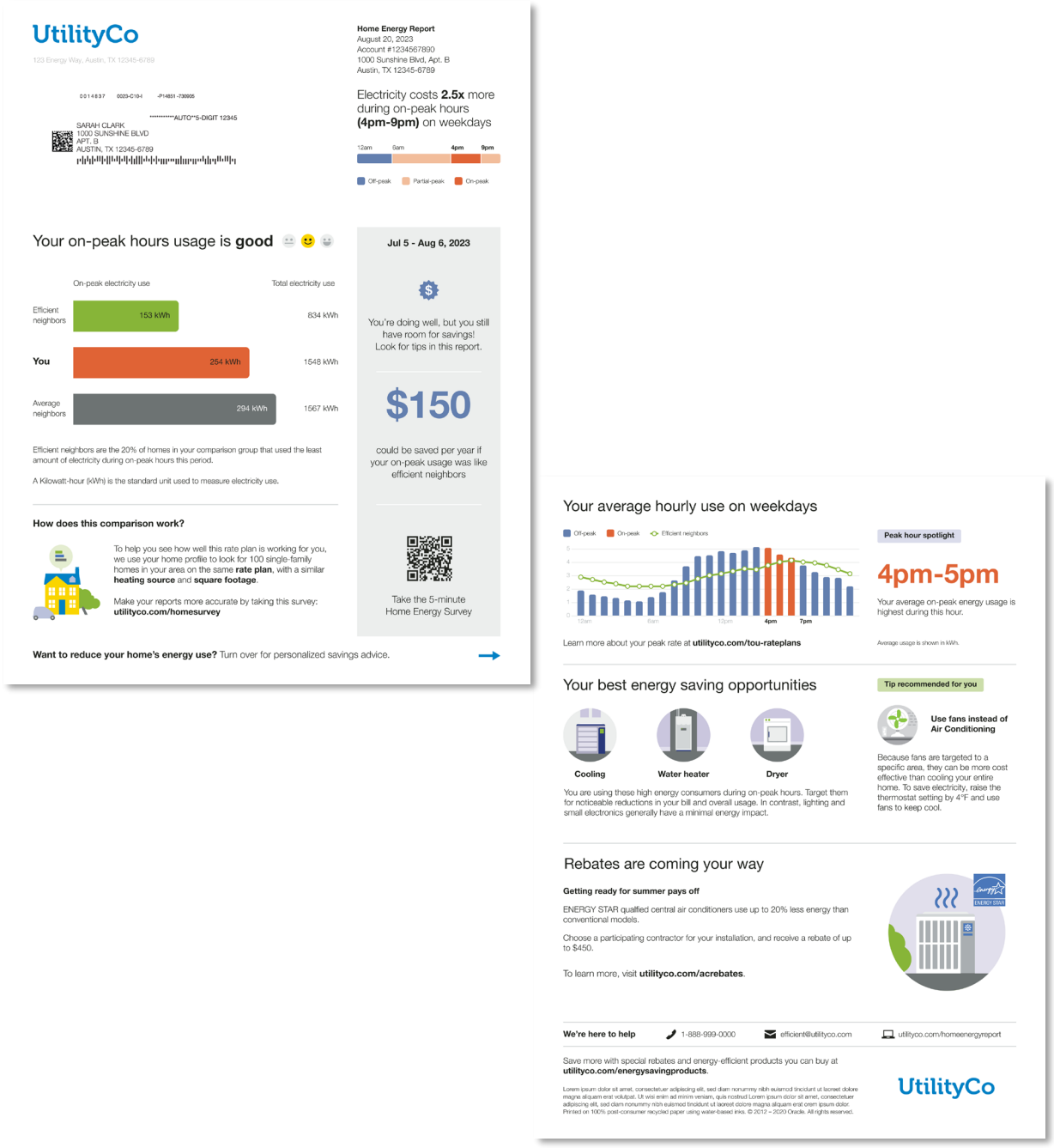
High-bill alert programs can also help save customers energy and money, thus meeting utility climate and affordability goals. These programs only send messages to customers whose patterns of energy suggest they will experience unusually high bills unless their use is curtailed. This program has the potential to be effective because alerts are only provided when bills will be high and, as such, customers are less likely to habituate to (i.e., "tune out") the message. It can reduce energy consumption but also addresses utilities' and regulators' growing concerns with utility bill affordability (allowing customers to plan and change their energy use *before* they get their bills). Once again, this program does not include any financial incentive for saving (thereby qualifying it as a behavior-based program), and it can be implemented as opt-out, meaning that it saves energy through curtailment and lends itself to rigorous evaluation (although the evaluation is slightly more complicated than for HERs because not everyone receives alerts).[20] In an evaluation of this type of program with 50,000 Midwestern households (plus 25,000 controls) in 2015/2016, those in the high-bill alert group reduced their electricity consumption by 0.5% and their gas consumption by 0.5% (Jacobsen and Stewart 2025). All HER 2.0 programs can be run alongside traditional HER programs, but it is particularly common for high-bill alert programs to complement HER programs.

Rate coaches, weekly energy updates, and HERs focused on load shaping (opt-in)

Shifting customer energy use to off-peak times and encouraging participation in climate-forward electricity rates (e.g., time-of-use rates, or rates specific for EVs and heat pumps) helps mitigate climate change. A few program implementers have developed programs that encourage customers to shift their energy use to different times of the day. As described earlier, this can be used to decrease peak energy consumption and reduce greenhouse gas emissions.

[20] High-bill alerts are deployed as randomized control trials with the treatment group enabled for high-bill alerts (and only some percentage of them trigger an alert over the duration). The entirety of the treatment group is then compared to the entirety of the control group. This is sometimes called a randomized encouragement design because one group is encouraged or allowed to participate and the other is not.

Rate coach programs provide customers tailored information about which special rates might be best for them, and how to get the most of their special electricity rates in regular emails and/or letters. Oracle offers a version of their traditional HER that focuses customers on shifting their use to off-peak times (as shown in figure 3, below).



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**********AUTO**5-DIGIT 12345

SARAH CLARK
1000 SUNSHINE BLVD
APT. B
AUSTIN, TX 12345-6789

Home Energy Report
August 20, 2023
Account #1234567890
1000 Sunshine Blvd, Apt. B
Austin, TX 12345-6789

Electricity costs **2.5x** more during on-peak hours **(4pm-9pm)** on weekdays

12am 6am 4pm 9pm

Off-peak Partial-peak On-peak

Your on-peak hours usage is **good**

	On-peak electricity use	Total electricity use
Efficient neighbors	153 kWh	834 kWh
You	254 kWh	1548 kWh
Average neighbors	294 kWh	1567 kWh

Efficient neighbors are the 20% of homes in your comparison group that used the least amount of electricity during on-peak hours this period.

A Kilowatt-hour (kWh) is the standard unit used to measure electricity use.

How does this comparison work?

To help you see how well this rate plan is working for you, we use your home profile to look for 100 single-family homes in your area on the same **rate plan**, with a similar **heating source** and **square footage**.

Make your reports more accurate by taking this survey: **utilityco.com/homesurvey**

Jul 5 - Aug 6, 2023

You're doing well, but you still have room for savings! Look for tips in this report.

$150

could be saved per year if your on-peak usage was like efficient neighbors

Take the 5-minute Home Energy Survey

Want to reduce your home's energy use? Turn over for personalized savings advice.

Your average hourly use on weekdays

Off-peak On-peak Efficient neighbors

12am 6am 12pm 4pm 7pm

Learn more about your peak rate at **utilityco.com/tou-rateplans**

Peak hour spotlight

4pm-5pm

Your average on-peak energy usage is highest during this hour.

Average usage is shown in kWh.

Your best energy saving opportunities

Cooling **Water heater** **Dryer**

You are using these high energy consumers during on-peak hours. Target them for noticeable reductions in your bill and overall usage. In contrast, lighting and small electronics generally have a minimal energy impact.

Tip recommended for you

Use fans instead of Air Conditioning

Because fans are targeted to a specific area, they can be more cost effective than cooling your entire home. To save electricity, raise the thermostat setting by 4°F and use fans to keep cool.

Rebates are coming your way

Getting ready for summer pays off

ENERGY STAR qualified central air conditioners use up to 20% less energy than conventional models.

Choose a participating contractor for your installation, and receive a rebate of up to $450.

To learn more, visit **utilityco.com/acrebates**.

We're here to help 1-888-999-0000 efficient@utilityco.com utilityco.com/homeenergyreport

Save more with special rebates and energy-efficient products you can buy at **utilityco.com/energysavingproducts**.

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Figure 3. An example of a "peak forward" HER that is specifically designed to shift electricity use to off-peak times

Puget Sound Energy published an evaluation of Year 1 of their rate coach pilot program (named Time Varying Rate Pilot, implemented by Uplight) in August 2025 (Ladd et al. 2025). It included over 7,000 customers spread across six treatment groups, each opting to enroll in different types of time of use rates. Targeted participants were encouraged to enroll in a special rate first by receiving Rate Education Reports via email and mail and then by being pointed toward a Rate Advisor Web Tool that provided "shadow billing" and "what-if" analysis (94% of enrollees indicated using this tool prior to enrolling).[21]

Once enrolled, participants received weekly Rate Coach Emails and Time of Use Alerts to help customers shift their energy use and maximize the benefits of their new rates. Ninety-four percent of customers reported taking action to shift their energy use times. Participants in each of the time-of-use rates achieved significant demand reduction (and bill savings) during rate-specific on-peak periods across both the summer and winter.[22] The program was particularly effective at shifting electricity use among customers on the EV-specific rate plan. Given all participants enrolled in a special rate received these behavioral add-on programs, we cannot distinguish the effect of the rate itself from the effect of the communications on customer behavior. Nevertheless, customer surveys indicated appreciation of the communications and attributed an importance to them in spurring the choice to switch rates and take action to shift their energy use times.

Weekly energy updates inform customers of their energy consumption regularly and therefore help them avoid high bills, while limiting their energy consumption and consequent climate impacts. Thus, it helps utilities meet their climate and affordability priorities. These weekly messages are only sent electronically and tend to focus on a household's energy use alongside one or two historical or neighbor comparisons (as shown in figure 4, below). This type of program helps foster energy-saving habits and build trust with the utility. A weekly energy updates program is currently undergoing pilot testing with over one million PG&E customers and outcomes should be forthcoming soon.

[21] Customers also received a $25 bill credit for enrolling in a special rate.

[22] On average, each participant reduced winter on-peak use by 0.06 kW to 0.42 kW (5% to 21.6%) and summer on-peak use from 0.11 kW to 0.33 kW (8.8% to 21.4%), relative to control customers.

Figure 4. An example of a weekly energy report email from Oracle

AMI integration, as well as the availability customer data, is crucial to these programs. Although AMI is becoming more prevalent across the United States, many utilities are uninterested in, or unable to,

connect the data to their behavior programs. Data privacy issues are one obstacle, but solutions exist to protect customers while delivering these useful energy-saving programs.

Virtual energy assessments and infrared visualization (opt-out)

Encouraging customers to upgrade their homes helps utilities achieve their climate and electrification goals. The broad deployment of AMI, combined with nonintrusive load monitoring (NILM) and other analysis strategies allows for disaggregation of home energy use (i.e., learning how various household appliances use energy and at what times they are used). In addition to this allowing for augmented HERs, program implementers can create noninvasive virtual home energy assessment tools. A number of groups have used public data, alongside utility energy use information, to conduct preliminary home energy assessments at scale.

In 2015, researchers at Carnegie Mellon University used the Princeton Scorekeeping Method (PRISM) to model residential building characteristics of over 7,000 homes in Gainesville, Florida, using publicly available information (Hoşgör and Fischbeck 2015). These types of models can be developed into virtual or paper reports to send to customers as an opt-out program. Although evaluations to date have not examined whether these types of reports might generate energy savings or increase program participation, strong evaluation methods can be readily applied. This type of program can encourage the next steps of an in-person home energy assessment, a virtual walk-through assessment (with live assessor over smartphone), or direct homeowner-driven installation of energy upgrades. The virtual assessment would be opt-out but the follow-up in-depth assessment would require opting in.

As discussed by Sussman and Chikumbo (2016) and Cooper et al. (2021), home energy assessments (in-person or virtual walk-through with remote assistance) in themselves can be considered behavior-based energy efficiency programs. They encourage upgrading through reducing informational, transactional, and decision-making barriers, alongside direct installation of some free measures and some rebates and incentives for future work. Some homeowners conduct assessments because they are required to receive energy upgrade rebates or tax credits, but some conduct them proactively.

For curious homeowners interested in learning more about their homes, a low- or no-cost home energy assessment can be the gateway to further home energy upgrade investment. Two ACEEE reports (Cooper et al. 2021; Sussman and Chikumbo 2016) and one Lawrence Berkeley National Lab study (Billingsley et al. 2016) offer recommendations for maximizing the virtual and in-person assessments as behavior-based efficiency tools to encourage upgrades. However, these types of in-depth assessments require homeowner participation and, as such, cannot be run as opt-out programs the way computer-modeled noninvasive assessments can. Moreover, to incentivize the use of these tools as behavior-based efficiency programs, regulators would have to devise methods of attributing savings from them to both the rebate programs (if homeowners participate) and the assessments themselves.

Energy efficiency reports for homeowners are key elements of home energy assessments. Personalization, including visualizations of the home, are required to make those reports effective (Sussman and Chikumbo 2017; Sussman et al. 2019). Infrared images (showing heat loss) offer a rare opportunity to make energy loss visible. Homeowners find these to be a persuasive component of home energy assessments (Ingle et al. 2014). Moreover, relative to people who see generic thermal images of homes (or no thermal images), those who see tailored infrared images of their specific home recall energy assessment information more and engage more with the assessment report (Boomsma et al. 2016). Homeowners who received a thermal image of their home in addition to a carbon footprint audit were significantly more likely to install draft proofing and reduce their energy use one year later than were homeowners who received an audit without the photo (Goodhew et al. 2015).

MyHeat is a company that has leveraged the power of tailored thermal images of homes to deploy, at scale, an innovative behavior-based efficiency program that is opt-out. MyHeat uses high-resolution fly-over infrared images to identify homes that lose excessive heat from their roofs. These infrared images provide a personal and engaging message to homeowners to upgrade (i.e., they see heat escaping from their homes and energy being wasted, as shown in figure 5, below). In a large, randomized control experiment, HERs augmented with these overhead images increased household energy savings statistically significantly, above what was achieved with HERs alone (Papineau and Rivers 2022).

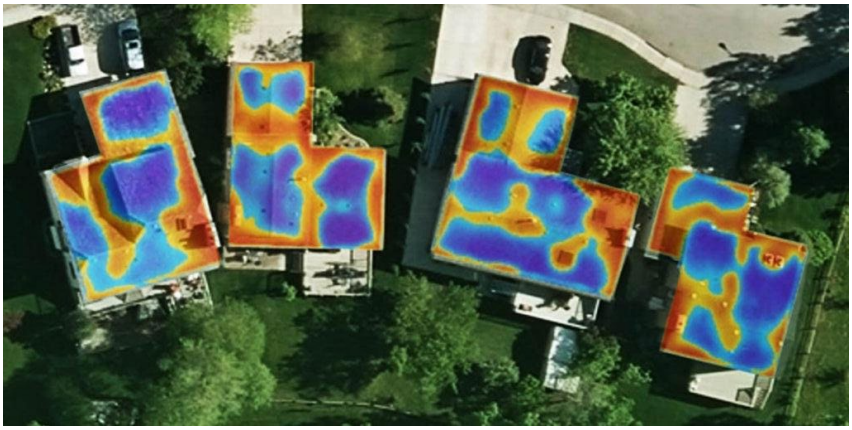

Figure 5. MyHeat adds overhead thermal images of homes to HERs to increase impact. Image reprinted from University of Calgary Geovation Group ("MyHEAT–The Geovation Group" n.d.).

Disaggregated real-time feedback (opt-in)

Reducing customer energy use limits their climate impact and reduces their bills, thus addressing utilities' climate and affordability goals. An important tenet of behavioral science is that a behavior change strategy is most effective when it targets a specific behavior and the intervention happens in close proximity (time and place) to the opportunity to act (Russell et al. 1999). Therefore, feedback that specifies to residents exactly what appliances are using energy, at the time that the energy is being used, can provide actionable information at a timely moment that should reduce energy consumption. Several companies have developed tools that can provide disaggregated (i.e., appliance-level) real-time electricity-use feedback to customers (e.g., Sense, Emporia Vue, and Bidgely). An initial small-sample study with 328 California homes (163 in treatment group and 165 in control group) and 150 international homes found customers with the Bidgely feedback device reduced electricity consumption by an average of 14% (Gupta and Chakravarty 2013). Another early review (before phone apps were the norm for these programs) reviewed 10 such programs (plus two that provided non-disaggregated real-time feedback) and found average savings of 4.5% (Kelly and Knottenbelt 2016).

Unfortunately, the apps providing the most detailed (and actionable) appliance-level energy use information require a hardware installation in a home's electric panel (often with the help of an electrician), because most AMI meters do not provide sufficiently granular energy use information. New "smart" electrical panels can come pre-fitted with these devices (e.g., "SPAN® | Smart Electrical Panels" n.d.). In some regions, such as New York and California, where new electrical panels are required to be solar and EV-ready, smart panels are becoming the norm. However, generally these programs must be distributed as an opt-in offering and, as such, cannot reach as large a population. They also require a slightly more complex evaluation methods, such as the "recruit and deny" method (see Sussman and Chikumbo (2016) for an example of such an evaluation from DTE Energy). Nevertheless, they provide the basis for a new type of behavior-based energy efficiency program.

Targeted and segmented reports (opt-out)

Providing tailored reports to specific customers has the potential to alleviate energy burdens and improve equity outcomes while maximizing the reports' impacts. Most new HER providers are able to use machine learning to combine data consumption patterns from AMI meters with customer data and publicly available data. This combined information allows them to provide tailored reports that can, among other things, channel low-income customers toward low-income programs and no-cost energy savings tips. The ability to tailor reports to specific customers is not new, but not all utilities have been able to furnish implementers with the required data. Connecting HERs to AMI data, for example, could greatly facilitate the development of this type of high-impact HER.

Social science insights to potentially improve traditional HERs

Over the past several years, social scientists have conducted HER research that could suggest potential improvements to the reports themselves that could result in higher savings. For example, changing how benefits of energy savings are framed could help promote behavior change. Among customers that are environmentally concerned, a message capitalizing on their environmental self-identity can also boost the effect of social information programs (Bonan et al. 2021).

New research on so-called injunctive norms and dynamic norms could also help boost savings. A positive injunctive norm about energy savings, a message that saving energy is generally perceived as "good" and "approved of" (when not widely practiced) can be enhanced in current HERs. Although some injunctive norm messages are already used, a tag, in the form of up to three thumbs-up emojis for high-savings homes, can slightly boost energy savings (Bonan et al. 2020). A dynamic norm message—one that shows that others are increasingly saving energy or investing in energy upgrades—can also help boost HER effectiveness. Research on waste reduction shows that when customers are shown dynamic norm messages about waste behavior, they may reduce household waste by 7%–10% (Ek and Söderberg 2024). This could be particularly effective for actions that are still conducted by a relatively small percentage of households, but for which the number is increasing year-over-year, such as installing a heat pump.

The referent group for social comparisons is also important. The typical HER compares a household's energy use to their neighbor's use, with no regard to how closely the recipient identifies with that group of neighbors. HERs would be more effective if they were able to compare energy usage to the usage of others with whom they strongly identify (Xiao et al. 2023). Also, comparing customers with similar baseline energy usages can increase savings (i.e., comparing efficient customers to other efficient customers, and less efficient customers to other less efficient customers; Callery et al. 2021). Some HER program implementers already use this type of comparison.

These advancements are promising but require more field testing. They are good evidence-based ideas for augmenting and improving traditional HERs and can be added to current HER rollouts to potentially increase savings slightly. ACEEE recommends program implementers field test a few potential changes to HER messaging:

- Test messages that focus more heavily on health or environmental benefits of energy savings. In the case of environmental benefits, this should only be tested with audiences that are likely to be concerned about environmental sustainability or climate change. When possible, use advanced data analytics to identify customers that could be most responsive to these messages.

- Provide an additional injunctive norm message to what is already being presented. Research suggests that adding more thumbs-up emojis could be one way to achieve this effect, but more (or larger) smiley faces and other similar icons would likely have similar impacts.
- Add dynamic norm messages to encourage home energy upgrades. That is, show graphs and messages on low-frequency behaviors, such as heat pump installations, demonstrating that these behaviors are on the rise (even if they are currently not widely practiced).[23]
- If possible, use advanced analytics to do augmented neighbor comparisons. Identify not just similar buildings, but similar *people* in similar buildings. Describe this comparison group of similar people to HER recipients in their reports to maximize impact.

Beyond HERs: new behavior-based energy efficiency programs

For decades, social scientists have studied human behavior and developed nonfinancial, non-mandate-based strategies for reducing energy use. Although HERs are the most ubiquitous application of a social science-based strategy, they are by no means the only potential application of social or behavioral science-based approach.

A broad range of potential behavior-based strategies

Behavior-based energy efficiency programs can be (and have been) developed using behavioral insights and experimental research strategies. These insights have led to a wide variety of behavior-change strategies, some of which could be adapted to influence residential energy consumption. Scepanovic et al. (2020) summarize 23 of these in a meta-analysis and provide suggestions for which strategies may be suitable in a number of settings. Many of these, such as community discussion, are not easily scalable and others, such as eco-labels, are not easily utility-deployable energy efficiency solutions. Nonetheless, many of these ideas (e.g., social energy apps, reward and competition, and continuous feedback) can provide a basis for the development of new behavior-based energy efficiency programs that can be deployed at scale (see Scepanovic et al. (2020) for a review and summary).

Although a myriad of creative behavior-based strategies exists to encourage residents to curtail their energy use, only a minority lend themselves to the type of rigorous evaluation utilities need to demonstrate savings at scale (Sussman and Chikumbo 2016). Of those, only a fraction can be designed to use the type of opt-out approach that HERs can employ, and which allow the program to reach many customers.

Combining strategies can help

Combining several strategies may prove most effective. A meta-analysis of combinations of interventions (Osbaldiston and Schott 2012) found six combinations to be particularly effective: rewards and goals, instructions and goals, commitment and goals, prompts and making it easy, prompts and justifications, and dissonance and justifications. These are general strategy combinations, but combining strategies for energy efficiency, in particular, also appears to be effective (McAndrew et al. 2021).[24] For

[23] As with all behavior-based initiatives, effective messaging alone is unlikely to be sufficient to encourage major investments in energy upgrades. Dynamic norm messages, for example, have the highest likelihood of being effective if they are targeted to customers who are most likely to be receptive to them (e.g., they have old systems and are already thinking about replacing them). Pairing the message with information about a rebate program could also further increase uptake.

[24] Information and education, pricing mechanisms such as tariffs and rewards, smart meters and in-home displays, home retrofits focused on making a home more energy efficient, home audits, digital technology (web or app), community workshops and training, and policy changes.

HERs, research from large-scale pilot programs with utility customers shows that combination of HERs with a peak energy savings program (involving a call before and after a peak heat/cool event to discourage energy use, as described below) or a program that showed customers overhead infrared visualizations of their homes, both increased savings statistically significantly (Cook et al. 2016).

Innovative out-of-the-box ideas

The following programs have shown promise in peer-reviewed journal articles and reports but would benefit from additional pilot testing by utilities. They are presented here because they are deployable at scale and have a demonstrated ability to be rigorously evaluated. Utilities and regulators seeking to push the envelope of potential behavior-based energy efficiency programs could consider these options.

School-based behavior programs (opt-out)

School-based residential efficiency programs use behavioral strategies to reduce energy consumption rather than relying on traditional incentives and mandates. They operate on the premise that students taught about energy efficiency in school could take those lessons home, and parents would then act on the students' suggestions. These types of programs have existed in various forms for years, but they could not be readily used by utilities as energy efficiency programs because of the challenges around evaluation and demonstrated savings.

Two studies of school-based programs include evaluation methods that potentially show a path for inclusion of these programs as utility-run behavior-based efficiency. In 2015, Schultz and colleagues (2015) published a report on a school-based fundraiser in Vermont that led to increased energy-efficient lightbulb sales and reduced electricity consumption (5.6%). There was some evidence that participants at the fundraiser were also more likely to subsequently participate in additional programs. This initiative involved a complex evaluation, examining lightbulb sales in stores in the region of the schools (compared to sales prior to the event), surveying light bulb purchasers, and gathering energy data from light bulb purchasers (and comparing it to random households who lived close to them). This quasi-experimental method is not perfect for establishing causality, but provides enough preliminary evidence to develop a pilot program for further investigation.

A somewhat simpler evaluation method (and one that may be more scalable) for a school-based program was implemented by a group of Singapore researchers (Agarwal et al. 2017). This group evaluated the impact of "Project Carbon Zero"—a school-based competition to reduce residential energy consumption among students and their neighbors. To determine savings, the group examined the electricity consumption of blocks of homes within two kilometers of the school and compared it to those just outside the two-kilometer boundary. They found that, during the contest, blocks of homes within the boundary reduced their consumption by 1.8%, relative to those outside the boundary. This quasi-experimental method is effective enough to justify developing new pilot programs, despite not being as strong an evaluation method as a randomized-control trial.

Goal setting and commitment (opt-in)

Encouraging customers to set their own energy savings goals, and then make a public commitment to achieving those goals, can be a powerful tool to encourage energy reductions. In one early example of the commitment effect (Pallak and Cummings 1976), households who made a public commitment to save energy, believing their energy use would be published broadly in newspapers and other media, used significantly less energy than those who did not make a commitment, or who made a private commitment.

One company (C3) created a tool to use this strategy at scale to reduce energy consumption. C3 ran a field study with 2,487 ComEd customers in which customers signed up to make an energy efficiency commitment through an online portal (Harding and Hsiaw 2014). Customers logged in and selected actions to do from one of three lists of energy savings recommendations (each with different levels of estimated savings). This permitted households to select their own savings goal on a continuous range. Customers were then awarded points for completing actions that could be redeemed for goods and services. Those who selected a goal of 0% or over 50% (about a quarter of all participants) did not significantly reduce their energy consumption, and those who selected a goal between 15% and 50% (41% of all participants) stopped reducing their energy consumption after several months, but those who selected realistic goals of above 0% but below 15% reduced their consumption (about a third of participants) by 11% and maintained the savings over 18 months. Impressively, despite a large proportion of customers choosing unrealistic goals or choosing not to set a goal, the overall savings from all program participants was still 4.4%.

The demonstrated savings of this program across a large population of actual utility customers shows that it could be viable as a behavior-based energy efficiency program that encourages both curtailment and efficiency behavior. That said, given it requires active engagement from the customer, it cannot be rolled out as an opt-out program (thus reducing the number of customers it serves) and it is more difficult to evaluate because of how to create a control group.[25] For the C3-run program, the control group was effective despite not being randomly assigned. Instead, the researchers created a matched control group of 9,964 households in the same region. The control households were not offered the program but, based on psychosocial and financial characteristics, were predicted to be likely to sign up if they were offered it. This evaluation method can provide sufficient evidence of success, if executed correctly and reviewed by external experts to ensure appropriateness.[26]

Gamification and serious games (opt-in)

Electronic games can provide deep understanding of energy efficiency, shift attitudes toward conserving energy, and motivate players to reduce their energy consumption (Johnson et al. 2017). People can often learn better with games than other media (Squire 2008). Games can simulate home energy scenarios and challenge players to save energy under various constraints. Some games can be integrated with players' personal home energy information.

Although these so-called "serious" games or energy conservation "gamification" can be made broadly accessible, customers must opt-in to play them in order to benefit from them and, thus, only a subset of customers will be nudged to act. Historically, most of these games are not especially highly rated, receiving average ratings of 3.2 out of 5 in Apple Store reviews (Beck et al. 2019). A review of 57 of these

[25] The opt-in requirement could significantly reduce the number of participants if not sufficiently marketed and promoted. For example, Opower used to have a "My Goal" savings reduction feature that was not strongly promoted. They eliminated the option because of the lack of participation. A utility we spoke with also indicated that they tried rolling out a similar program and later withdrew it because it was not effective. Marketing and promotion are important but opt-out programs will almost always have more participants.

[26] Matched control groups are likely sufficient in this case, and they are the only type of control group that makes sense in this context. That said, the savings percentages estimated by comparison to a matched control group could be slightly inaccurate. This is because the treatment group members all opted in and the control group likely would not *all* have opted in if given the opportunity (although the matching procedure is used to ensure that most probably would). The groups are very similar, but likely not as similar as would be the case for a randomized control design.

games found that most games only include one "gamification component"[27] and that ratings were best predicted by including more of these components (Beck et al. 2019). Moreover, the authors found that these games were generally difficult to find in the U.S. Apple Store and suggested cross-promotion by utilities as a potential solution to increasing uptake.

Games are also challenging to evaluate because control groups are difficult to formulate. One review of 25 serious games (electronic and "live" games) to reduce energy consumption found that although the tool shows promise, the quality of the evaluations was generally low (Johnson et al. 2017). Games such as homeRUN (Agusdinata et al. 2024), Energy Cat (Casals et al. 2020; shown in figure 6, below), and Power House (Reeves et al. 2015) simulate a home's energy in a "sim-city" type of environment to allow players to make decisions with varying trade-offs and consequences to build an optimal home energy system. ECOISLAND (Takayama and Lehdonvirta 2009) is a game for environmentally minded households to be played on a tablet mounted in a public place within the house, tracking each household member's estimated carbon emissions (through home sensors and self-reported data). Power Explorer uses a monster avatar in various environments to teach energy savings. It is directed toward teenagers and comes with home sensors providing instant feedback on energy decisions in the game (Gustafsson et al. 2009).

[27] Gamification components include points, leaderboards, badges/achievements, levels, stories/themes, clear goals, feedback, rewards, progress, and challenges.

Figure 6. Energy Cat gamifies energy conservation at home, increasing knowledge about energy and reducing electricity and gas use. Reprinted from Casals et al. (2020).

ECOISLAND was evaluated through a monitor attached to participating household's air conditioning unit, examining use before and during the game (Takayama and Lehdonvirta 2009). Power House was evaluated with a similar pre-post method, but using utility (PG&E) AMI data (Reeves et al. 2015). Power Agent was also evaluated using energy sensors inside the home, but rather than a pre-post evaluation, energy savings were compared to similar nearby homes with similar characteristics and household members (Gustafsson et al. 2009). Energy Cat evaluation (Casals et al. 2020) found that electricity and gas use went down by 4% and 8%, respectively, during the study period, but that these were not statistically significant because of a small sample size (statistical significance would likely be reached if

the researchers had more participating households). These all used small sample sizes, and energy savings over longer periods either went down or could not be ascertained.

Nevertheless, if a video game could be developed that was exciting and enjoyable to play (and that also happened to help save energy at home), this could be a promising approach to encouraging energy savings from younger family members who are less often considered when designing behavior-based energy efficiency programs. This could thus tap a new source of energy savings not previously considered. Given this would be an opt-out program, savings would have to be evaluated using a matched control group or using a randomized recruit-and-delay (i.e., waitlist control) group.

Conclusions

HER and other behavior-based energy efficiency programs deliver energy savings to large numbers of customers quickly, ensuring nearly all customers who paid into the programs have an opportunity to benefit from them. With lighting no longer being available as a "quick win" energy efficiency program option for utilities, HER programs play an important role in reducing energy consumption and mitigating climate change. Nevertheless, a balanced energy efficiency portfolio is necessary, such that behavior-based programs complement programs delivering longer-term structural efficiency measures. Unlike most energy efficiency programs, behavior-based energy efficiency programs (and HERs in particular) save energy through both curtailment and efficiency actions (not just efficiency upgrades). HER programs already help save energy and channel customers to other programs, but this can be augmented through changes in evaluation. Moreover, regulators could encourage utilities to run pilot studies to learn if new programs (already showing promise in smaller studies) could be implemented for additional behavior-based savings. Indeed, action from utilities, regulators, and relevant program implementers will all help ensure that behavior-based energy efficiency programs meet their maximum potential and effectively achieve multiple policy priorities.

Recommendations

Based on the available literature, ACEEE recommends several actions for regulators, utilities, and program implementers:

- Incentivize HER implementers to channel customers to structural efficiency programs to drive higher overall efficiency savings, support electrification, and connect low-income customers to energy support services. Revise evaluation criteria for HER programs to better assign savings attribution and avoid penalizing HER programs for increased electricity consumption from home electrification or low-income energy assistance programs.
- Run HER programs for as long as they remain cost effective. HER programs thrive when they are delivered for multiple years. This allows them to foster and maintain behavior changes and energy efficiency upgrading. Current evidence suggests that after the initial two-year ramp-up period, HER program savings tend to be maintained at the same level as long as reports continue to be delivered. We do not recommend terminating programs that deliver consistent and reliable savings as long as the cumulative lifetime savings are cost effective.
- Assess overarching energy regulatory requirements to ensure performance payments tied to HER programs are appropriate (neither too high nor too low) and utilities are incentivized to deliver a balanced portfolio, including both large-scale behavior-based energy efficiency programs (far reaching/quick win) alongside structural programs that deliver deeper, longer-duration savings that accumulate over time. More research is needed to determine the optimal

mix of short- and long-term programs that would best suit utilities with varying priorities and budgets.

- Require the evaluation of peak savings alongside overall savings. This could encourage utilities to invest in behavior-based energy efficiency programs that reduce peak load. Shifting usage to times when the grid is cleanest and least constrained is a step toward mitigating climate change.
- Encourage pilot implementation of promising new potential behavior-based energy efficiency programs (both as standalone programs or add-ons to existing HER offerings). These can include HER 2.0 programs such as:
    - Peak energy savings
    - High-bill alerts
    - Rate coaches, weekly energy updates, and peak-focused HERs
    - Virtual energy assessments and infrared visualizations
    - Disaggregated real-time feedback
    - Targeted and segmented reports
- Utilities and regulators seeking to push the envelope of potential behavior-based energy efficiency programs could also consider these out-of-the-box options:
    - School-based programs
    - A goal setting and commitment online platform
    - Gamification and serious games for saving energy at home
- Program implementers can field-test a few tweaks to traditional HERs (developed in social science labs and presented in peer-reviewed literature) to learn if they augment HER effectiveness. These include:
    - Testing messages that focus more heavily on health or environmental benefits of energy savings than financial and energy impacts
    - Highlighting rising trends with dynamic norm messaging (behaviors that are not yet conducted by most others but are on the rise) to encourage adoption of less common energy-saving actions, such as heat pump installation
    - Augmenting neighbor comparisons to increase their relevance. Comparisons to peers who share both demographic and structural characteristics (similar people, not just similar buildings) may increase the relevance and impact of HERs.[28]

[28] Advanced analytics of customer data may be able to help create these comparisons, but data privacy regulations and customer perceptions are important to consider when using this strategy.

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Evaluations reviewed for this report

In addition to assessing the large-scale reviews conducted in prior research of HER program utility evaluations, we independently examined the following newer evaluations for savings levels and program elements.

1. Cadmus. 2024. “Home Energy Reports 2023 Energy Waste Reduction Product Research & Evaluation Report.” Prepared for Consumers Energy.

2. Guidehouse. 2024. "CT R2255 Avangrid Behavioral Programs Impact Evaluation." Prepared for Eversource CT.

3. ADM Associates, Cadmus, Brightline. 2023. "Program Year 1: July 1, 2021–June 30, 2022." Prepared for South Jersey Industries Utility: Elizabethtown Gas.

4. Cadmus. 2024. "Public Service Electric & Gas Clean Energy Future Program Year 2022/2023 Evaluation Report." Prepared for Public Service Electric & Gas (PSE&G).

5. ADM Associates. 2023. "EM&V Report Program Year 1: July 1, 2021–June 30, 2022." Prepared for South Jersey Industries Utility: South Jersey Gas.

6. DNV. 2024. "Home Energy Reports 2022 Impact Evaluation and 2022–2023 Process Evaluation Report." Prepared for Puget Sound Energy.

7. Opinion Dynamics. 2024. "Dominion Energy South Carolina, Inc. EnergyWise Program Year 13." Prepared for Dominion Energy.

8. Mississippi Power. 2024. "Mississippi Power Company 2024 Annual Energy Delivery Plan." Prepared for Mississippi Public Utilities Commission.

9. Southern California Gas Company. 2025. "Southern California Gas Company (U 904 G) Energy Efficiency Programs 2024 Annual Report." Submitted to the California Public Utilities Commission. Rulemaking 25-04-010.

10. Guidehouse. 2023. "Home Energy Reports Impact Evaluation Report: Energy Efficiency Plan: Program Year 2022 (1/1/2022–12/31/2022)." Prepared for Nicor Gas Company.

11. Guidehouse. 2024a. "Home Energy Reports Impact Evaluation Report: Energy Efficiency Plan: Program Year 2023 (1/1/2023–12/31/2023)." Prepared for Nicor Gas Company.

12. ADM Associates. 2024. "Evaluation, Verification & Measurement Report Home Energy Reports Program Washington." Prepared for Pacific Power.

We also reviewed the following evaluations for their inclusion of low-income cohorts:

1. ADM Associates and Tetra Tech. November 2018. *Final Annual Report to the Pennsylvania Public Utility Commission Phase III of Act 129 Program Year 9 (June 1, 2017–May 31, 2018).* For Pennsylvania Act 129 of 2008 Energy Efficiency and Conservation Plan.

2. Navigant Consulting, May 2015. *Home Energy Reports Program: 2014 Evaluation Report*. Prepared for AEP Ohio.

3. Freeman, Sullivan & Company, April 2013. "Evaluation of Pacific Gas and Electric Company's Home Energy Report Initiative for the 2010–2012 Program." Prepared for Pacific Gas and Electric Company.