How Efficient is Your Efficiency Portfolio? Lessons from the United States on DSM Portfolio Optimization

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Abstract

Most of the energy efficiency efforts in the Unites States are coordinated by electric and gas utilities. Energy efficiency resource standards (EERS) encourage utilities to reduce their customers' energy use. The budget for energy efficiency programs is raised in the form of tariff riders, or small additional charges on each kWh or therm used by the customers. Because customer dollars are being used to fund energy efficiency, utility energy efficiency managers want to optimize how the money is being spent. Each state has unique regulatory requirements to ensure that customer dollars are being spent wisely. But with over $7 billion spent annually on energy efficiency, these funds can be further optimized to maximize efficiency gains.

This study cites three metrics that utilities and regulators should keep close track of to ensure that Demand Side Management dollars save energy in the most efficient manner, as well as optimize additional benefits of these funds: benefit-cost tests, acquisition costs, and customer reach. The benefit-cost test compares the benefits and costs of an energy efficiency program or portfolio of programs with the supply-side alternative. Acquisition costs measure the budget it takes to achieve savings during a given time period. While many energy efficiency programs install equipment that will last for years, utilities are beholden to shorter-term filing savings targets. These targets typically prescribe the budgets and savings that a utility must spend and achieve in the next 1-3 years. With customer reach, while many energy efficiency programs enact deep savings within a household, such programs are expensive on a per household basis, and only fractions of the customer base are going to opt in. There are several benefits to having energy efficiency benefits spread across the entire footprint, which we will examine in turn below. Cross-utility data from programs throughout the US are used to analyze how US utilities are doing on each of these metrics, with clear implications for European energy efficiency.

Introduction

The United States has a long history of delivering utility demand-side management (DSM) programs and can provide a reference for future energy efficiency strategy, both in the country and across other counties leading energy conservation efforts.

Spurred by the oil shocks of 1973, the country enacted a series of public policies to encourage increased energy productivity. The Energy Policy and Conservation Act (EPCA) 1975, Energy Conservation and Production Act (ECPA) 1976, National Energy

Conservation Policy Act (NECPA) 1978, and Public Utility Regulatory Policies Act (PURPA) 1978 set the foundation for utility conservation and load management that led to the growth of utility DSM programs (Alliance 2013).

By the 1980s, rebate programs grew in popularity and demand-side management was included as an energy resource option in utility planning, referred to as least-cost (or integrated-resource) planning. At the same time, states began to include a surcharge on utility bills (tariff riders) that established public benefits funds for uses such as energy efficiency programs. Other key state-level policy drivers for energy efficiency spending and savings were increasingly adopted, including Energy Efficiency Resource Standards (EERS), systems benefit charges, integrated resource planning, and Demand Side Management plans (Barbose et al. 2013).

By 2013, the annual spend on utility ratepayer funded electric energy efficiency budgets grew to $7.2 billion (CEE April 2013). As of April 2014, 25 states in the US have implemented Energy Efficiency Resource Standards, which are binding energy savings targets delivered over the long-term by utilities to help their customers reduce energy use (ACEEE 2013). With 40 years of utility DSM programs, the US has extensive experience planning, implementing, and evaluating efficiency portfolios and can serve as a benchmark for assessing the effectiveness of energy efficiency programs.

The Need for Efficient Energy Efficiency

The growing energy efficiency budgets in the US are funded by ratepayer-supported energy efficiency funds, state treasury funds, state bonding authorities, and funds from environmental fines (Brown 2008). However, ratepayer money constitutes the vast majority of these budgets. Of the $7.2 billion spent by US administrators on gas and electric DSM programs in 2012, ratepayers funded $7 billion which translates to over 97% (CEE March 2014).

These funds are collected from ratepayers through two mechanisms: tariff rates and public benefit charges. These funding mechanisms have several benefits. First, they directly tie the energy efficiency funding source to the level of end-use energy consumption by placing a fee on energy ratepayers (Brown 2008). Furthermore, because they do not have to be repaid to the funding source, they provide greater flexibility than other funding sources (Brown 2008). As such, ratepayer funding mechanisms are a logical source of energy efficiency program resources and require the responsible implementation of programs.

The predominantly ratepayer-funded US DSM expenditures grew 80% from $4 billion to $7.2 billion between 2008 and 2012 (CEE 2014). As such, the economic investment into energy efficiency is growing rapidly. With 25 states now employing Energy Efficiency Resource Standards (EERS) and the EPA's Clean Air Act Section 111(d) that is the first ever national legislation to offer energy efficiency as a viable means to achieve required carbon emissions reductions, the need for and focus on energy efficiency will likely continue to increase in the future.

Given the increasing investments in energy efficiency and their dependence on ratepayer funding, it is imperative that programs be run efficiently and produce the greatest public benefit. Utilities and energy providers are held accountable for responsibly serving their customers by regulators (in regulated markets) or ratepayers themselves (in competitive markets). As part of their role of protecting the customer, regulators – often state commissioning bodies in the US – protect and advocate for the customer by overseeing the utility in various capacities, such as determining rate structures and resource planning. In addition, they often require energy savings to be delivered by the utility and subsequently, incentivize utilities according to the performance of their energy efficiency portfolio.

While the mechanism may be different, the same principle holds in competitive markets. Since customers can choose their energy service provider, a utility must run its business efficiently to manage costs and to deliver superior service, such as offering energy efficiency programs, in order to acquire and retain customers.

Because ratepayers fund energy efficiency and the utility is held responsible for best serving ratepayers in both regulated and competitive markets, it is important to have efficient energy efficiency portfolios. This, in turn, requires a method to assess the performance of programs and portfolios.

Utilities, State Commissions, and regulatory bodies in the US often adopt a series of metrics and goals for energy efficiency portfolios and programs. Energy efficiency stakeholders have developed various metrics to help determine whether energy efficiency measures are a worthwhile investment. Often, portfolios must meet cost-effectiveness standards that include a benefit-cost test. These can be assessed at the measure, program, or portfolio level.[1] Other common metrics of program success are based on program participation and cost of savings delivered.

Application to Europe

As the EU member states respond to new energy efficiency requirements, it is important to establish metrics that can assess portfolio plans and the effectiveness of implemented programs. The Energy Efficiency Directive 2012/27/EU establishes a common framework of measures to enable the achievement of the Union's 2020 20% savings target, and a recently proposed 2030 framework would increase this target to 30%.

The Directive legally requires member states to achieve state-specific savings targets and develop energy efficiency plans to implement a variety of new measures. Member states are required to submit National Energy Efficiency Action Plans (NEEAPs) that provide specifics on measures adopted or plans to implement the main elements of the Directive. The Energy Efficiency Obligation (EEO) scheme is the Directive's recommended policy measure in which energy distributors and retail energy companies achieve energy savings targets. These end-use savings schemes are most similar to demand side management portfolios and plans in the US, as savings are delivered to the customer by the utility.

As of August 2014, five countries have existing EEOs and eleven countries are developing new EEOs in the future. While Europe has different funding mechanisms

[1] Energy efficiency measures are the activities implemented at the end-user that directly reduce energy or demand use while maintaining or improving the energy service. Energy efficiency programs are collections of coordinated activities to install one or more measures that are intended to motivate customers in a specific market segment to realize more energy efficiency. Energy efficiency portfolios are multiple program indicatives that are offered to specific market segments (Slote, Sherman & Crossley 2014).

from the US, the energy efficiency funding is still predominantly sourced from ratepayers in many countries, including Denmark, Italy, the United Kingdom, and Poland. Other countries rely on government financing, such as France and Ireland, which is still paid for by the taxpayer. As such, it is similarly important to deliver efficient savings. While countries are developing and planning their EEOs, they should subsequently be determining the best method and metrics for planning and prioritizing consumer energy efficiency programs. Since the US has a considerable history of consumer-facing energy efficiency, the Union can learn from their experience, particularly with determining portfolio success and establishing benchmarks of an efficient portfolio.

The focus of this paper is to understand how to best evaluate efficiency programs using a combination of metrics and subsequently benchmark US portfolio effectiveness. It may be tempting to assign a single metric as the absolute measurement for a program or portfolio's efficiency, under the assumption that one metric should clearly represent the chief goal of delivering energy efficiency. However, as outlined here, a single metric cannot wholly characterize the efficiency of a given program. Instead, it is necessary to assess metrics that examine multiple aspects of an energy efficiency program. The following analysis examines three categories of efficiency metrics – benefit-cost tests, acquisition costs, and customer reach – and current trends across residential efficiency portfolios in the US.

Portfolio Efficiency Metrics

When assessing the efficiency of a program, it is essential to assign metrics that enable replicable and reliable evaluation. Furthermore, those metrics should reveal a comprehensive evaluation of the program's success in delivering efficient savings. Utilities and energy service providers can have different energy efficiency goals that they're working towards – but most commonly, they revolve around energy savings and customer participation. As established in the previous sections, because energy efficiency programs are predominantly funded by rate- and tax-payers, utilities and energy service providers are responsible for delivering energy efficiency programs as efficiently as possible. Furthermore, since funding is sourced territory-wide, programs should also deliver benefits across the territory. A set of metrics is necessary to comprehensively assess the efficiency and success of a program. This paper outlines three classes of metrics that when considered together, offer a holistic assessment of energy efficiency programs.

All of these metrics can be assessed at the program and portfolio level. However, the balance between metrics and programs should be considered at the portfolio level. Some programs may be relatively less cost-effective but deliver savings to the majority of ratepayers, while others may offer the opposite benefit. Similarly, there may be contradictions between benefit-cost tests and acquisition costs because the former considers the savings over the lifetime of a program but the later only considers savings in a given year. An efficient and effective portfolio finds a balance between energy efficiency programs to achieve strong, portfolio-level metrics.

Benefit-Cost Tests

The cost-efficiency of energy efficiency is essential to determine how much of the potential for energy efficiency can be captured when competing with other energy resource options (National Action Plan 2008). At a high level, cost-effectiveness tests consider the benefits of an investment and the corresponding costs. When applied to energy efficiency, cost-effectiveness tests compare the costs of delivering the program to the benefits delivered by the program. Program planners and evaluators in the US have used five key cost-effectiveness tests over the passed 20 years (National Action Plan 2008). Each of these tests evaluates cost-effectiveness from various stakeholder perspectives, considering different costs and benefits accordingly. The stakeholder perspectives covered by the five tests include an energy efficiency program participant, the organization offering the program, a non-participating ratepayer, and society in general. Table 1 provides a brief introduction to each of these commonly used tests. Each is assessed using the net present value (NPV) of the lifetime costs and benefits of a program. As such, benefit-cost tests consider future savings. This is appropriate given the comparison to the cost of alternate energy resources.

Table 1. Cost-effectiveness tests commonly used in the United States (National Action Plan 2006)[2]

Cost-Effectiveness Test	Overview
Participant cost test (PCT)	Compares costs and benefits of the customer participating in program
Program administrator cost test (PACT)	Compares costs and benefits of the program administrator
Ratepayer impact measure test (RIM)	Assesses the effect of changes in revenues and operating costs caused by a program on customers' bills and rates
Total resource cost test (TRC)	Compares the total costs and benefits of a program, including participant and utility costs and the avoided cost of saved energy
Societal cost test (SCT)	Similar to the TRC but includes societal costs and benefits

The National Action Plan for Energy Efficiency recommends considering various tests to ensure that an energy efficiency portfolio balances the costs and benefits between stakeholders (2008). While running all five tests is the most comprehensive method, a subset of tests is often used for simplification. The mix of tests considered should match the program goals and important stakeholders. This paper recommends the Total Resource Cost Test (TRC) as one of the tests considered and provides analysis on this test. TRC is the preferred cost-effectiveness test in the majority of states in the US (National Action Plan 2008).

Cost-effectiveness tests establish a threshold that programs must meet in order to be considered cost-effective. A test threshold of greater than 1.0 requires the benefits to outweigh the costs. Depending on a program's goals, this threshold can be set higher or

[2] See the National Action Plan for Energy Efficiency for the costs and benefits included in each test.

lower. For example, some low income programs in the US have lower cost-effectiveness requirements given the larger goal of serving a resource-strapped customer segment.[3] If a program meets the designated threshold, it can be considered a cost-effective energy resource.

Acquisition Costs

In addition to considering a program's cost-effectiveness as an energy resource compared to alternate generation options, the actual monetary spend for delivered energy savings should be assessed. The cost of acquiring energy efficiency savings, referred to here as acquisition costs, is the money spent on the program divided by the energy savings created by the program. In the US, this is most commonly represented as dollars per kilowatt-hour (US$/kWh) or dollars per therm (US$/therm). For this analysis, acquisition costs are considered to be the cost of savings that are claimed by a utility and therefore, counted towards utility energy efficiency goals. Depending on the savings accounting established by the regulatory body, this could cover incremental savings, life-cycle savings, or another metric of savings accounting.[4] Therefore, acquisition costs determine how efficiently a program or portfolio achieves its savings targets. This is similar to the First-Year Cost of Saved Energy (CSE), or the cost of acquiring a single year of annualized incremental energy savings from a program or portfolio (Billingsley et al. 2013).

While benefit-cost tests are important to establish a baseline of eligible energy efficiency programs, an additional measure of cost-effectiveness is necessary to optimize the impacts of energy efficiency spending. Acquisition costs are helpful when comparing relative costs between programs and resources. However, they are not a direct cost-effectiveness test as they do not capture the monetized value of energy efficiency to stakeholders (Billingsley et al. 2013). The acquisition costs associated with a demand side management portfolio should be minimized so that energy savings are delivered at the lowest cost compared with alternatives. This metric is valuable for gauging the relative impact of energy efficiency programs and prioritizing among them.

Customer Reach

Beyond cost-effectiveness, an efficient portfolio is one that also delivers benefits to the majority of ratepayers. Because ratepayers fund the majority of energy efficiency programs, they should also reap the benefits of the delivered savings. A portfolio that only benefits a small portion of the population should not be considered effective as it distributes the benefits and costs inequitably. Instead, an effective portfolio reaches and delivers savings to as many ratepayers as possible. Customer reach is defined here as the

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[3] California, for example, requires low income efficiency programs to meet a reduced Modified Participant Cost Test and Utility cost Rest threshold of 0.25 (California Public Utilities Commission 2012).

[4] Incremental savings are defined as the additional, new savings achieved by an energy efficiency program or measure in a given year. Life-cycle savings include the expected trajectory of savings from an energy efficiency program or measure over the life of the measure (Navigant 2014). However, savings accounting metrics and definitions are not always consistent between regulators and regions. Other metrics can include first-year savings and cumulative savings.

percent of the service territory that participates in a given program. This metric provides a straightforward assessment of the customers directly benefitting from energy efficiency programs. Maximizing customer reach ensures a more equitable distribution of ratepayer funds.

An efficient portfolio and program will be successful in engaging a broad population. In contrast, if a portfolio only reaches a small group of customers, its programs can be considered unbalanced and inefficient.

US DSM Portfolio Trends

The analysis presented here is meant to reveal broad trends in the DSM sector. Due to data availability, this study assesses portfolio-level metrics. However, it is not recommended that a program administrator evaluate the metric only at the portfolio level. Assessing program-level metrics enables the administrator to differentiate between programs and build efficient portfolios.

Benefit-Cost Tests

This study analyzed TRC values from 36 program administrators, covering 58 residential electric and dual-fuel energy efficiency portfolios and 974 programs from across the US. These portfolios exhibited a mean TRC of 2.6 and median of 2.3. The majority of programs were well above the benefit-cost test threshold, demonstrating lifetime savings that outweigh program costs. Data spanning four years reveals a recent decrease in portfolio TRC with the most recent year, 2013, exhibiting the lowest TRC value of 1.8.

TRC data points were recorded from utility annual reports and filings. Because these contain self-reported data and findings, annual reports and filings may include some biases. However, they offer the most complete picture of portfolio success and are assumed to be reasonable estimates.

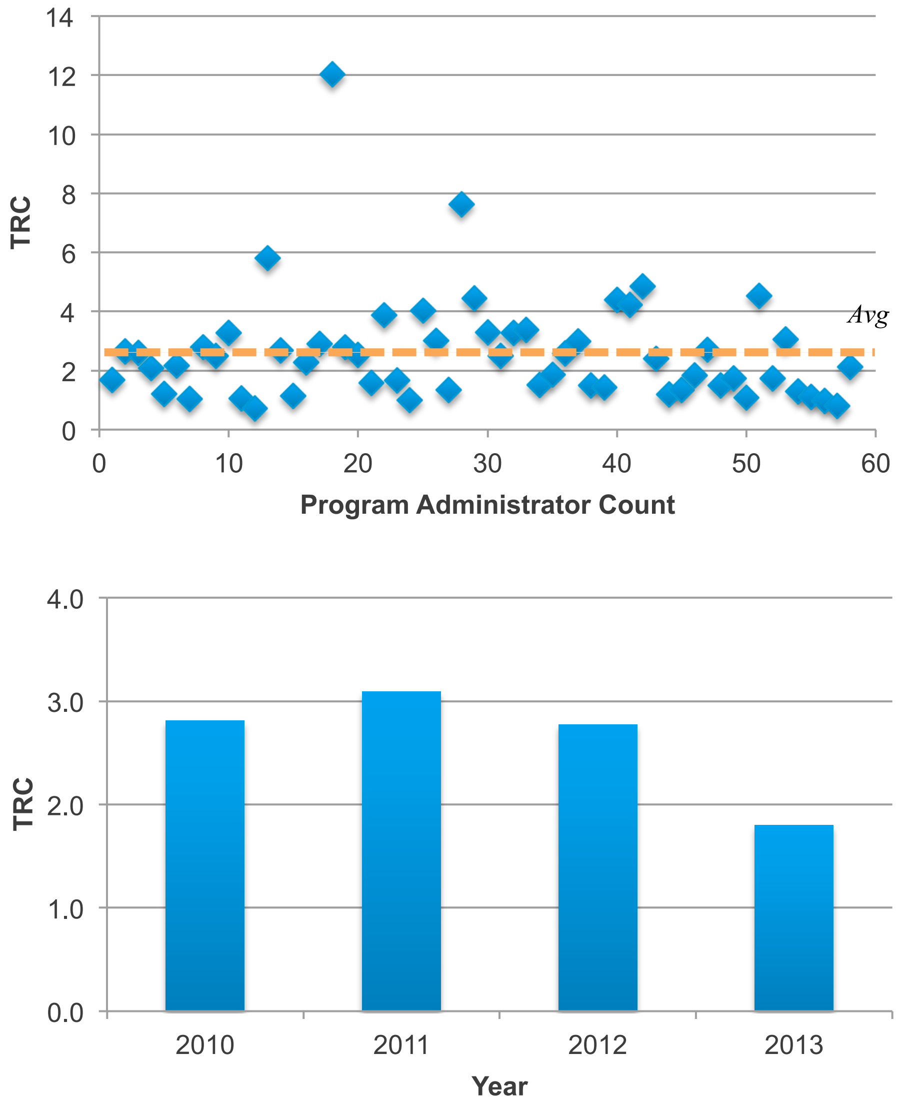


Figure 1. TRC values across electric and dual-fuel utility portfolios and mean portfolio TRC by year

Acquisition Costs

Acquisition costs were assessed across 75 electric program administrators, including 203 portfolios and calculated using observed net savings and program costs. The portfolio mean across all years is US$0.29 per kWh and median is US$0.23 per kWh. This is higher than the 2009-2011 First-Year CSE for residential programs of US$0.116, calculated according to the Lawrence Berkeley National Laboratory DSM Program Impacts Database (Billingsley et al. 2013). This is possibly due to the inclusion of low income programs in the analysis presented here, as low income programs tend to have higher acquisition costs as demonstrated by Brown et al.'s finding that First-Year CSE for low income programs are on average US$0.57. Over time, this study reveals a slight increase in the acquisition cost of electric portfolios over time, demonstrating that electric energy efficiency savings are slowly becoming more expensive to deliver. This trend is likely to continue due to increasing stringency of lighting efficiency standards mandated by the Energy Independence and Security Act of 2007. Program managers have relied on lighting, specifically compact fluorescent lights (CFLs), for low cost energy savings. Increased standards force program administrators to consider more expensive savings in their place.

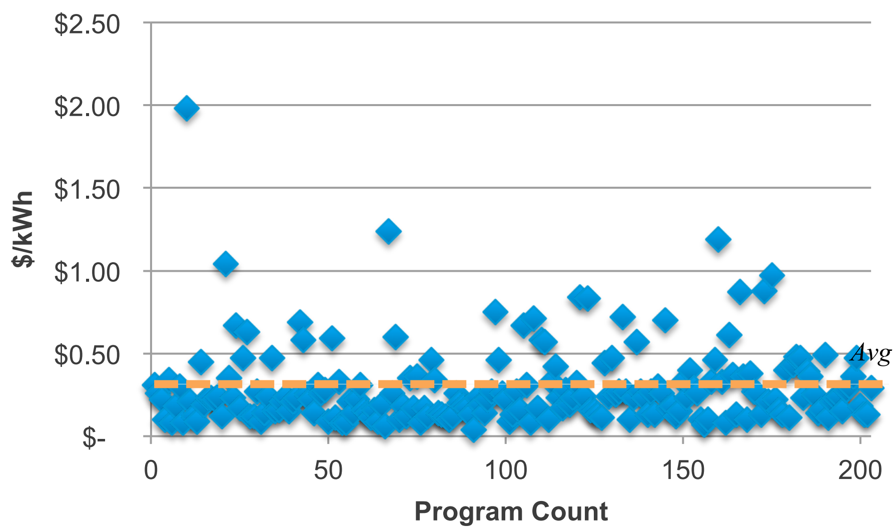


Figure 2. Acquisition costs across electric utility portfolios and mean acquisition cost by year

Acquisition costs of gas programs were determined for 36 program administrators running 101 programs and calculated with observed net savings and actual program spending. As seen in Figure 3, gas programs exhibit a greater variability and spread across acquisition costs. The mean portfolio acquisition cost is US$4.55 per therm and median is US$4.19 per therm. Acquisition costs of gas savings steadily increased over the four years of analysis. In 2015, new federal gas furnace efficiency standards will increase the efficiency of manufactured gas furnaces and therefore, diminish the opportunity for claimable energy efficiency savings from utility furnace measures.

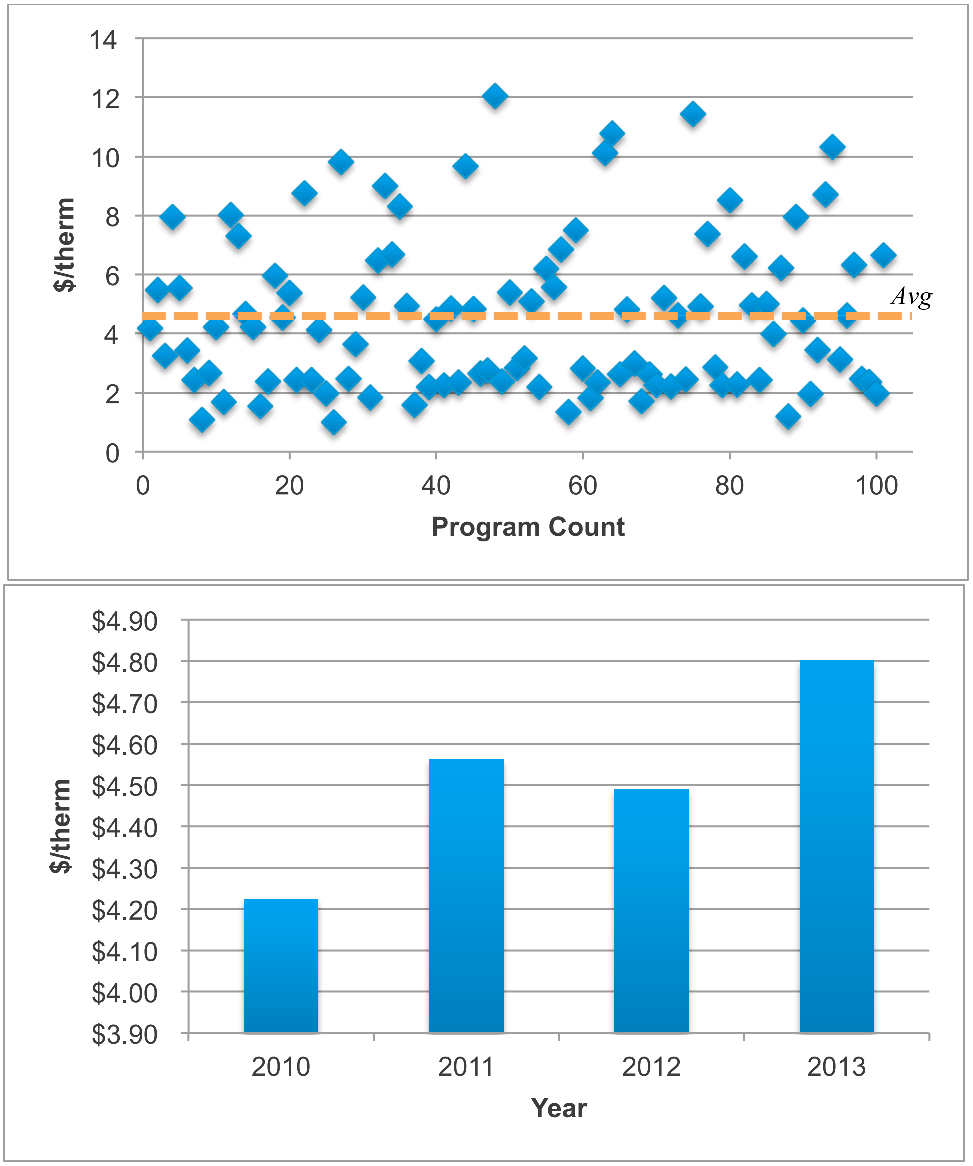


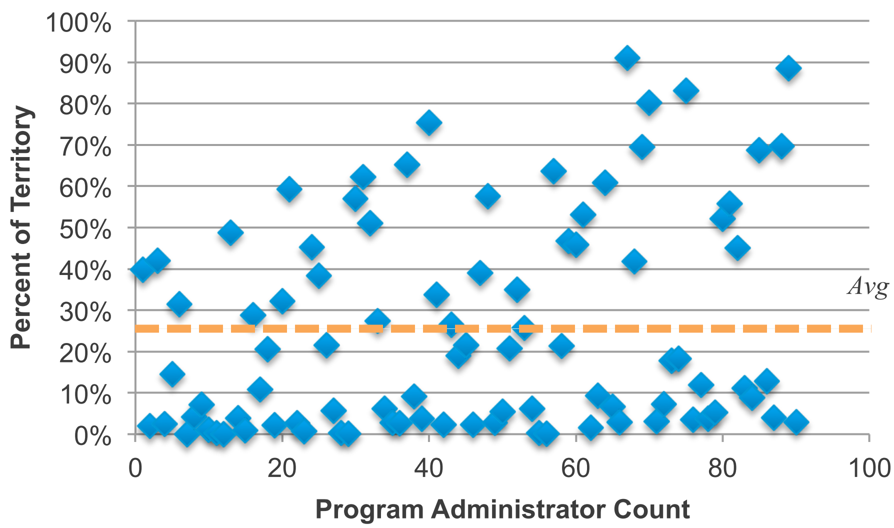
Figure 3. Acquisition costs across gas utility portfolios and mean acquisition cost by year

Acquisition cost data was collected using DSM Insights, a benchmarking tool created by E Source that extracts and aggregates information on electric and gas utility demand side management programs. Source data to DSM Insights is gathered from utility annual reports and filings.

Customer Reach

Data on customer reach was acquired for 33 residential electric and gas program administrators and 91 programs. Participation was calculated as the percentage of a program administrator's residential customers that are participants in an energy efficiency program. As seen in Figure 4, participation in energy efficiency programs is shown to increase steadily across service territories in recent years. The mean across all years studied is 25% and the median is 16% customer reach. While the majority of portfolios exhibit customer reach below 20%, there is a large range and variability exhibited by all analyzed portfolios.

Participant data was also collected using DSM Insights and supplemented with utility customer data to calculate customer reach.



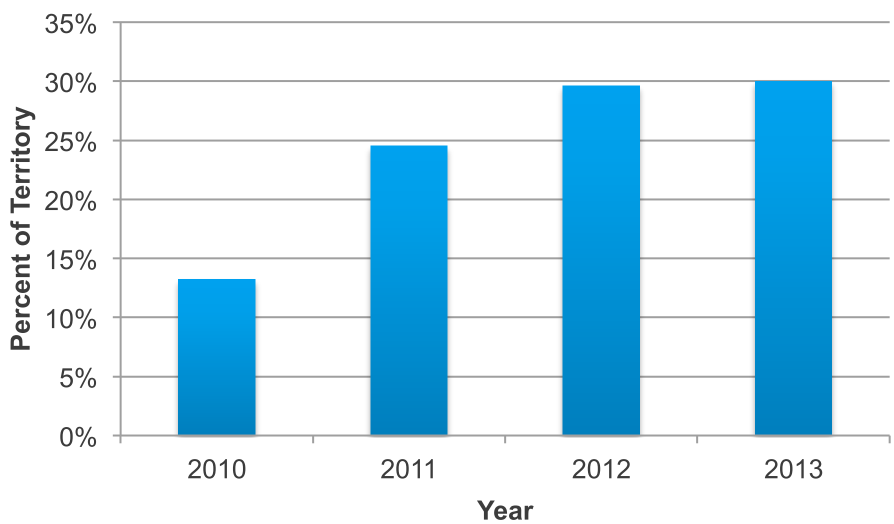


Figure 4. Acquisition costs across gas utility portfolios and mean acquisition cost by year

Conclusions

It is widely accepted that a range of cost-effectiveness tests be used to achieve a comprehensive assessment of a program or portfolio's cost-effectiveness (National

Action Plan 2008). However, this study suggests that metrics beyond cost-effectiveness tests that balance stakeholder costs and benefits should also be considered to offer a holistic assessment of a program's success. Similarly, this set of metrics – benefit-cost tests, acquisition costs, and customer reach – should be considered when planning a portfolio in order to optimize the benefits of energy efficiency programs.

This analysis of US program and portfolio utility metrics is consistent with trends observed in the industry – portfolios are becoming more expensive and less efficient. While declining TRCs have remained well above a benefit-cost ratio of 1.0, acquisition costs have steadily increased for residential energy efficiency programs. Residential energy efficiency programs missed their average 2012 target of US$0.23 per kWh with average costs reaching US$0.26 per kWh (Brown, Junders & Stout 2014). Aggregate costs are only expected to increase given industry trends and factors such as increased federal lighting efficiency standards. Along with the shrinking of claimable and broad-reaching savings from lighting measures, program administrators are facing increasing pressure on portfolio performance with slowing budget growth and increasing savings targets. Program administrators tracked in an E Source study found the proportion of program administrators exceeding their energy efficiency budgets more than doubled within two years (Brown, Junders & Stout 2014). This suggests that residential energy efficiency is becoming more expensive. With low cost savings receding, it is increasingly important to thoroughly assess the effectiveness of available programs and plan a portfolio that balances its success across metrics.

In Europe, the entire customer base contributes directly and indirectly to energy efficiency budgets through distribution tariffs and government-sponsored funding for energy efficiency programs. Therefore, program administrators have a similar responsibility to those in the US to deliver an equitable and cost-effective energy efficiency offering. As countries are developing their EEOs and later determining the success of their efficiency efforts, the three metrics addressed here allow for a comprehensive assessment of efficiency programs.

References

American Council for an Energy-Efficient Economy (ACEEE). 2013. "State Energy Efficiency Resource Standards (EERS): EERS Policy Approached by State."

Alliance Commission on National Energy Efficiency Policy. 2013. *The History of Energy Productivity*. Alliance to Save Energy.

Barbose, G., M. Billingsley, C. Goldman, and I. Hoffman. 2013. *Future of U.S. Utility Customer-Funded Energy Efficiency Programs: Spending & Savings through 2025.* Lawrence Berkeley National Laboratories.

Billingsley, M., C. Goldman, I. Hoffman, K. LaCommare, S. Schiller, and E. Stuart. 2013. *The Program Administrator Cost of Saved Energy for Utility Customer-Funded Energy Efficiency Programs*. Lawrence Berkeley National Laboratory. Prepared for the US Department of Energy.

Brown, M. and InterEnergy Solutions. 2008. “State Energy Efficiency Policies Options and Lessons Learned: Brief #1 Funding Mechanisms for Energy Efficiency.” Alliance to Save Energy. https://www.ase.org/resources/brief-1-funding-mechanisms-energy-efficiency

Brown, M., B. Jungers, and T. Stout. 2014. *Apples and Oranges: Aggregating Data from Energy Conservation Programs*. E Source.

California Public Utility Commission. 2012. “Decision on Large Investor-Owned Utilities’ 2012-12 Energy Savings Assistance (ESA) and California Alternative Rates for Energy (CARE) Applications.” Decision D.12-08-044, Ordering Paragraph 38, p. 381.

Consortium for Energy Efficiency (CEE). 2014. *2013 State of the Efficiency Program Industry: Budgets, Expenditures, and Impacts*.

Consortium for Energy Efficiency (CEE). 2014. *Efficiency Program Industry by State and Region Appendices, 2013*.

National Action Plan for Energy Efficiency (National Action Plan). 2006. *A Plan Developed by More Than 50 Leading Organizations in Puruit of Energy Savings and Environmental Benefits Through Electric and Natural Gas Energy Efficiency*. US Department of Energy and Environmental Protection Agency.

National Action Plan for Energy Efficiency (National Action Plan). 2008. *Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy Makers*. Energy and Environmental Economics, Inc. and Regulatory Assistance Program.

Navigant. *2013 California Energy Efficiency Potential and Goals Study*. Prepared for California Public Utilities Commission.

Slote, S., M. Sherman, and D. Crossley. *Energy Efficiency Evaluation, Measurement, and Verification: A Regional Review of Practices in China, the European Union, India, and the United States.* Regulatory Assistance Program.