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Best Practices in Energy Efficiency Program Screening:

How to Ensure that the Value of Energy Efficiency is Properly Accounted For

Prepared for:

National Home Performance Council

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Preface

In 2011, a group of energy efficiency industry stakeholders convened to address concerns that the current practice of cost-effectiveness testing is inhibiting the development of effective, high-quality energy efficiency programs. Convened by the National Home Performance Council this stakeholder coalition includes representatives from state and local governments, utilities, program administrators and implementers, professional evaluators and researchers, contractors, and labor.

NHPC's white paper, *Measure it Right*, was released for comment in November 2011 and again June 2012 to recommend a framework of best practices for implementation of cost-effectiveness tests. While the paper outlined stakeholder positions, concrete research was identified to further the understanding of the complex interaction between cost effectiveness tests and energy efficiency programs.

This paper by Synapse Energy Economics was commissioned by NHPC to address this need. The paper provides a comprehensive review of a wide range of problems and inconsistencies in current cost-effectiveness test practices, and recommends a range of best practices to address them. These best practices (a) align test implementation with the underlying objectives of the tests as originally designed;(b) ensure that energy resources are developed at the lowest cost; and (c) support public policy goals such as promoting customer equity, serving a broad range of customers, encouraging comprehensive whole-house improvements, and avoiding lost opportunities.

We anticipate that these recommendations will provide guidance to commissions, commission staff and program evaluators well into the future. However, we also expect and hope that this report will launch a robust conversation about best practices for cost-effectiveness testing, and we invite comments and critique of the paper and its recommendations. NHPC welcomes these comments and aims to address these issues with further studies, stakeholder convening, and policymaker communication.

NHPC is grateful to the Energy Foundation and Energy Federation Incorporated (EFI) for the financial support for the on-going stakeholder process, the white paper, and this research paper. NHPC also thanks both its board of directors for making this tricky issue an organization priority and the diverse group of stakeholders who shared their knowledge and expertise on cost-effectiveness testing to advance solutions. Finally, NHPC thanks the team at Synapse that authored this excellent and path-breaking paper.

The National Home Performance Council is a national non-profit organization created to support whole-house energy efficiency programs through research and stakeholder engagement. NHPC's board of directors includes a wide range of energy efficiency stakeholders including: state energy offices, non-profit organizations, contractors, program implementers, real estate representatives, utilities, and manufacturers. NHPC's mission is to address challenges that prevent the growth and expansion of the whole-house energy efficiency sector and communicate these solutions.

Table of Contents

Executive Summary

Accounting for the Full Value of Energy Efficiency

Energy efficiency is widely recognized as a low-cost, readily-available resource that offers a variety of benefits to utility customers and to society as a whole. Many states have established efficiency savings targets, some states require that energy efficiency be the first choice among resource options, and an increasing number of states require energy efficiency program administrators to pursue all cost-effective energy efficiency. As states continue to advance energy efficiency initiatives and establish increasingly aggressive savings goals, it is vitally important that best practices be used in screening energy efficiency resources for cost-effectiveness.

There is a great amount of variation across the states in the ways that energy efficiency programs are screened for cost-effectiveness. Many states are applying methodologies and assumptions that do not capture the full value of efficiency resources, leading to under-investment in this low-cost resource, and thus higher costs to utility customers and society.

> Many states are applying methodologies and assumptions that do not capture the full value of energy efficiency, leading to underinvestment in this low-cost resource…It is vitally important that states properly apply the cost-effectiveness tests.

The purpose of this report is to identify the best practices available for screening energy efficiency resources, in order to capture and assess the full value of those resources. Many of these best practices are based on economic theory, while others are a matter of public policy and should be based on thoughtful decisions by legislators and regulators. Our goal is to help inform those decisions.

As discussed below, five standard tests are used to determine the cost-effectiveness of energy efficiency programs. Of these, the Program Administrator Cost (PAC) test, the Total Resource Cost (TRC) test, and the Societal Cost test are predominately used by states as the primary test for screening efficiency programs. Ever since ratepayer-funded energy efficiency programs have been in place, there has been considerable debate about which test is best to use for screening energy efficiency. That debate continues to this day. We address this issue below and in Section 2.

However, we note that – while the choice of test is important – it is even more important to ensure that states are *properly applying* the cost-effectiveness tests. That is, to ensure that each test is being applied in a way that achieves its underlying objectives, is internally consistent, accounts for the full value of energy efficiency resources, and uses appropriate planning methodologies and assumptions. Many states are not properly applying the cost-effectiveness tests, and thus are understating the value of energy efficiency resources.

In the following sub-sections we provide an overview of the best practices to use in applying the cost-effectiveness tests when screening energy efficiency resources.

These include: fully accounting for other program impacts (OPIs)[1] where appropriate; properly estimating avoided costs; using the most appropriate discount rate; capturing spillover effects; fully accounting for the risk benefits of energy efficiency; and more. All of the best practices we recommend are being applied today in at least one state, and sometimes in many states. However, there are few states, if any, that apply all of the best practices recommended here. In the final section of this Executive Summary we discuss the key issues to consider in deciding which test to use in screening energy efficiency programs.

We note at the outset that one of the chief considerations in screening energy efficiency programs is to ensure that the programs will reduce energy costs to customers. Energy efficiency offers a variety of benefits to customers and to society as a whole, some of which have important public policy implications. However, in screening energy efficiency resources it is critical to acknowledge that for many key stakeholders – e.g., legislators, regulators, and consumer advocates – the benefit of reducing energy costs and reducing customers' bills is paramount.

Treatment of Other Program Impacts

Other program impacts are those costs and benefits that are not part of the cost, or the avoided cost, of energy. OPIs fall into three categories:

- *Utility-perspective* OPIs include, for example, reduced customer arrearages and reduced bad debt write-offs.
- *Participant-perspective* OPIs include, for example, improved health, increased safety, other fuel savings, reduced maintenance costs, and increased comfort. Many of these participant-perspective OPIs are especially significant for low-income customers.
- *Societal-perspective* OPIs include, for example, reduced environmental impacts and reduced costs of providing health care.

These OPIs should be included in cost-effectiveness tests for which the relevant costs and benefits are applicable. The primary rationale for including OPIs is to ensure that the tests are internally consistent. This is especially important in the application of the TRC test. By definition, this test includes the participant cost of the energy efficiency measures, which can be quite large in many cases. In order for the TRC test to be internally consistent, it must also include the participant benefits from the energy efficiency measures, including OPIs. Excluding the participant-perspective OPIs from the TRC test results in cost-effectiveness outcomes that are skewed against energy efficiency, under-investment in energy efficiency programs, and higher costs for utility customers on average.

The primary rationale for including other program impacts is to ensure that the tests are internally consistent. Since the TRC test includes the program participants' costs, it must also include the program participants' benefits.

[1] We use the term "other program impacts" to describe what are commonly referred to as non-energy impacts (NEIs) or non-energy benefits (NEBs). OPIs are those costs and benefits that are not part of the costs, or the avoided cost, of the energy provided by the utility that funds the efficiency program. In addition to non-energy impacts, OPIs also include "other fuel savings," which are the savings of fuels that are not provided by the utility that funds the efficiency program.

Unfortunately, OPIs are often not accounted for in a comprehensive manner and are frequently ignored altogether. A recent survey found that most states use the TRC test as the primary test for screening energy efficiency programs; however, only 12 states quantify participant OPIs, and not all OPIs are accounted for among those 12 states. As a result, many states are applying the TRC test in a way that is skewed and understates the true value of energy efficiency. This may be the most significant problem with energy efficiency program screening methods in the US today.

> The PAC test can be applied at the portfolio level to give regulators and other stakeholders confidence that utility customer funds spent on energy efficiency will reduce costs for those utility customers.

There are two types of participant-perspective OPIs that deserve particular attention: low-income benefits, and other fuel savings. These impacts tend to be of significant magnitude and will help justify low-income programs, residential retrofit programs, and new construction programs. All of these programs offer significant public policy benefits by serving a broad range of customer types; achieving comprehensive, whole-house savings; promoting customer equity; and reducing lost opportunities.

It is important to recognize that including OPIs in the TRC test may require utility customers to pay higher energy efficiency costs than otherwise. These higher costs can be justified because (a) accounting for OPIs is necessary in order to maintain internal consistency in the TRC test; and (b) accounting for OPIs helps to achieve important public policy benefits. Nonetheless, regulators and other stakeholders need to have confidence that utility-customer funds spent on energy efficiency programs will reduce energy costs for those utility customers. This concern can be addressed by applying the Program Administrator Cost test to the entire portfolio of energy efficiency programs. (This recommendation is described in more detail below under the subheading "The Best Test(s) to Use for Screening Energy Efficiency Programs.")

Choice of Discount Rate

The choice of discount rate to use for calculating the present values of costs and benefits has significant implications for the cost-effectiveness of energy efficiency programs. This is because program costs are typically incurred in the early years, while program benefits are enjoyed over the life of the energy efficiency measure. States use a variety of discount rates when screening energy efficiency programs, indicating a diversity of views on this important issue.

The different cost-effectiveness tests require the use of different discount rates because they represent the perspectives of different decision-makers. The Societal Cost test requires the use of a societal discount rate, which is typically very low due to society's (i.e., government's) tolerance for waiting for future benefits, and its ability to access funds at relatively low borrowing costs.

> The discount rate applied to the PAC and TRC tests should reflect the lower financial risk of energy efficiency investments.

Many states use the utility's weighted average cost of capital (WACC) when applying the TRC and PAC tests, based on the notion that energy efficiency investments are comparable to investments in supply-side resources that are financed at the WACC. However, investments in energy efficiency resources are different from investments in supply-side resources, especially in the way that costs are recovered by the utility.

Utilities typically have to raise capital (mostly with debt and equity) to invest in supply-side resources, and then they are later allowed to recover the investment plus the cost of capital through rates over the life of the asset. For energy efficiency investments, utilities are typically allowed to recover the investment immediately through system benefit charges, or in a very short amount of time through balancing accounts in rates. Because of this different approach to cost recovery, efficiency investments are a much lower financial risk to utilities than supply-side resources.

The discount rate applied to the TRC test and the PAC test should reflect this lower financial risk of energy efficiency investments. We recommend that states use a generic market indicator of a low-risk investment, such as the interest rate on long-term US Treasury bills, when applying the TRC or the PAC test. This rate is widely accepted as representing low-risk investments, and is straightforward, transparent, and readily available.

Calculation of Avoided Costs

All of the relevant avoided costs should be accounted for, and each of them should be calculated correctly.

Energy efficiency programs result in several types of avoided costs, and each of them should be included in the screening analysis and calculated correctly. First and foremost, avoided energy and capacity costs should be based on long-term forecasts that properly capture the energy and capacity impacts of energy efficiency resources, account for the structure of the market in which the relevant utility operates, and capture differences between peak and off-peak periods.

It is also important to account for the cost of transmission and distribution that is avoided by energy efficiency. In estimating these costs, program administrators should distinguish between those transmission and distribution costs that can be deferred or avoided through energy efficiency and those that cannot. Avoided distribution costs tend to be higher than avoided transmission costs, but avoided transmission costs are increasing, particularly in regions of the country that are expecting significant growth in new transmission investments.

The avoided costs of compliance with environmental regulations should be explicitly accounted for in the Societal Cost test, the TRC test and the PAC test. The costs of environmental compliance will eventually be passed on to ratepayers, and those that can be avoided should be included as part of the avoided costs of energy efficiency. Recent environmental regulations from the US Environmental Protection Agency are likely to increase the costs of environmental compliance, and may require the retirement of many fossil-fired generation units, which will have significant implications for energy efficiency avoided costs.

Similarly, there are several existing and anticipated initiatives at the federal, regional and state levels to curtail the emissions of greenhouse gases (GHG). Energy efficiency is by far the lowest-cost and most plentiful option for meeting these initiatives. In order to meet climate change regulations at the lowest cost, the full avoided cost of complying with current and future GHG initiatives should be accounted for in screening energy efficiency programs. In sum, energy efficiency should be evaluated on an equivalent basis with other options for

In those states and regions with climate change requirements, energy efficiency should be evaluated on an equivalent basis with other options for mitigating greenhouse gases.

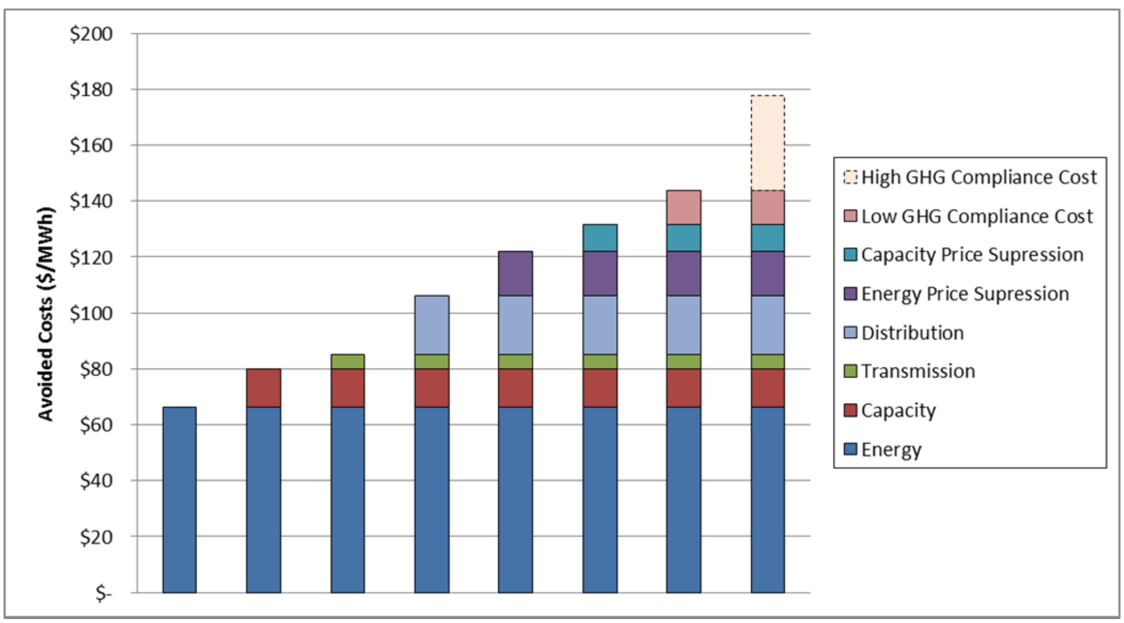
mitigating GHG emissions.

In regions of the country with organized wholesale energy and capacity markets, energy efficiency resources will reduce energy and capacity demands, which can lead to reduced wholesale energy and capacity prices. Because wholesale energy and capacity markets provide a single clearing price to all wholesale customers, the reductions in wholesale energy and capacity clearing prices are experienced by all customers of those markets. This price suppression effect should be included as one of the benefits of energy efficiency in those regions with competitive wholesale electric markets.

Analyses of energy efficiency cost-effectiveness should take account of the transmission and distribution losses that are avoided by transmitting less power from the generator to the end-use customer. In doing so, program administrators should account for the marginal losses, as opposed to the average losses, because these are the losses that are avoided by energy efficiency measures. Marginal losses tend to be significantly higher than average.

These components of avoided costs, especially when combined, will have a significant impact in determining the cost-effectiveness of energy efficiency resources. Figure ES.1 presents a summary of the avoided costs mentioned above, with the different components broken out separately. The avoided costs presented in Figure ES.1 are used by an actual electric utility in New England that we reference throughout this study as an example, as further discussed below. The details behind each of these avoided costs are presented in Appendix A.

Figure ES.1. Example of Avoided Costs, Broken Out by Component ($/MWh)



Source: Synapse 2011, as discussed in Appendix A.

Additional Screening and Methodological Issues

In order to fully capture the actual effect of energy efficiency programs, it is important to properly account for free-riders, spillover effects, and market transformation. These effects should be estimated and accounted for in a manner that is timely, consistent, and

Energy efficiency screening practices should properly account for spillover effects, market transformation, risk benefits, the full useful life of efficiency measures, and be screened at the program level.

comprehensive. Programs that are expected to have significant market transformation impacts should be provided with greater flexibility in the screening process, for example by allowing market transformation programs to be implemented even if they do not pass the TRC test, but including their costs and benefits in the PAC test applied at the portfolio level.

It is also important to recognize that energy efficiency can mitigate various risks associated with energy planning and the construction and operation of large, conventional power plants. These risks include fuel price risk, construction cost risk, planning risk, reliability risk, and risks associated with new regulations. These risk benefits should be accounted for when screening energy efficiency programs, either through system modeling or through risk adjustments to the energy efficiency benefits.

Energy efficiency measures produce savings over the course of their useful lives. Depending on the measure, the useful life can be as long as 20 years or more. Energy efficiency screening practices should use study periods that include the full life of the measures. Artificial caps on study periods or useful measure lives will skew the cost-effectiveness analysis, and result in an under-investment in energy efficiency.

Cost-effectiveness tests should be applied at the appropriate level in the planning process. Some states require that each energy efficiency measure be screened for cost-effectiveness, while others require screening at the program level, and others require screening at the portfolio level. We recommend that states do not require energy efficiency to be screened at the measure level, because this is overly restrictive and ignores the important interactions between measures. In particular, it ignores the fact that some measures have benefits in terms of encouraging customers to adopt other efficiency measures. As noted below, we recommend that energy efficiency programs be screened at the program level using the Societal Cost test or the TRC test, and that the entire portfolio of programs be screened using the PAC test.

Furthermore, when energy efficiency measures are screened in the field (i.e., at the customer's premises), they should be screened using the Participant's Cost test, to provide the customer with relevant information regarding which measures to adopt. The TRC test should not be used for field screening energy efficiency measures, because it is overly restrictive, can exclude measures that are cost-effective to customers, increases the transaction costs of contractors and customers, creates lost opportunities, and hinders the goal of achieving comprehensive, whole-house efficiency savings.

The Best Test(s) to Use for Screening Energy Efficiency Programs

Five standard tests are used to evaluate energy efficiency programs, three of which are predominately used by states as the primary test for screening efficiency programs: the PAC test, the TRC test, and the Societal Cost test. The choice of which test to use will have a significant impact on the amount of energy efficiency resources that are identified as being cost-effective.

Choosing the most appropriate test requires consideration of several factors. One key factor is the question of scope. If a state wishes to limit the scope of the cost-effectiveness analysis to utility revenue requirements, then the PAC test is most appropriate. If a state wishes the scope of the analysis to include the total incremental impacts of the efficiency measure on all utility customers, then the TRC test is most appropriate. If a state wishes the scope of the analysis to include all impacts to society, then the Societal Cost test is most appropriate.

We recommend that the Societal Cost test to be used to screen energy efficiency programs…. States that choose not to rely upon the Societal Cost test should use the TRC test….States that choose to use the TRC test must account for the participants' other program impacts.

We recommend that the Societal Cost test be used to screen energy efficiency programs. This test includes the broadest range of energy efficiency costs and benefits, and provides the best measure of public policy benefits that are of great importance to legislators and regulators, such as low-income benefits, other fuel savings, and environmental benefits. If a state chooses to use the Societal Cost test, the test should account for these public policy benefits to the greatest extent possible.

We recommend that all states that choose not to rely on the Societal Cost test use the TRC test to screen energy efficiency programs. If a state chooses the TRC test, the test should account for OPIs to the greatest extent possible, as further discussed in this report. If regulators are unwilling to account for OPIs, the TRC test should not be used for screening energy efficiency programs, because this approach will provide misleading results that are skewed against energy efficiency.

If regulators choose to not account for OPIs, the PAC test is the best test to use in screening energy efficiency programs. This test is relatively transparent, is limited to the impacts on revenue requirements, and ensures that utility customers on average will experience lower utility costs as a result of the efficiency programs. If the PAC test is used, regulators must recognize that important benefits are being ignored, particularly low-income benefits and other fuel savings.

We recommend that the PAC test be applied at the portfolio level, regardless of which test is used at the program level, to ensure that the entire set of programs will result in a net reduction of utility revenue requirements.

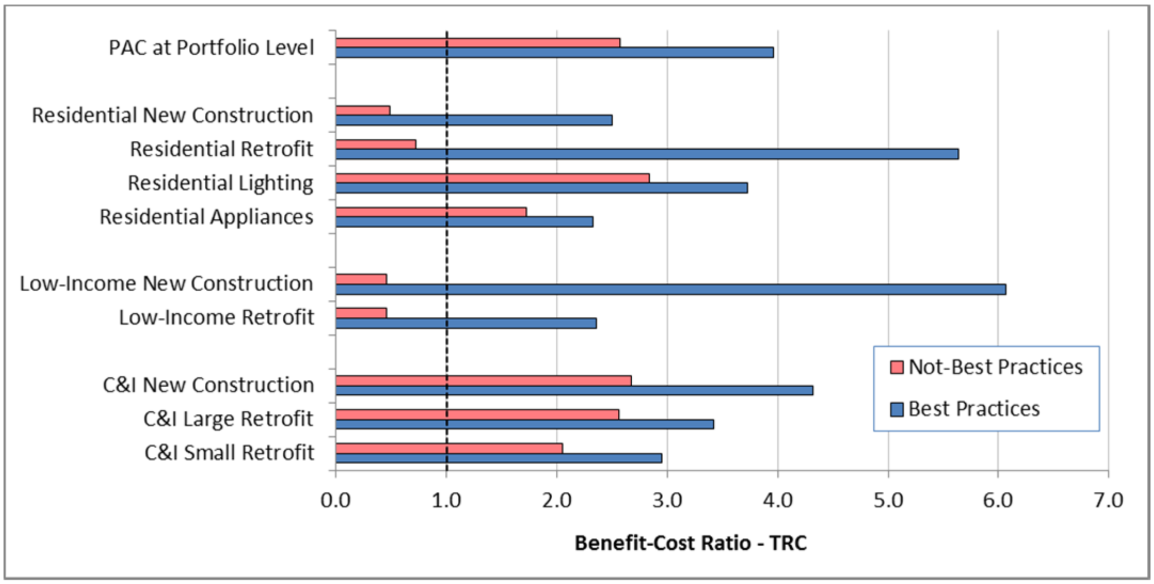
However, there is an important concern with applying either the Societal Cost test or the TRC test, because of the potential impact on costs to utility customers. Some stakeholders may be concerned that accounting for OPIs and the associated public policy benefits will unnecessarily increase energy efficiency program costs, and burden utility customers with costs for achieving benefits that are not related to utility services. This is a critical consideration, particularly for states that are pursuing aggressive levels of energy efficiency savings or pursuing all cost-effective energy efficiency.

To address this concern, we recommend that the PAC test be applied to the entire portfolio of efficiency programs. This will ensure that the entire set of programs will result in a net reduction in utility revenue requirements, i.e., a net reduction in costs to utility customers. This combined program/portfolio screening approach should be simple to apply because it relies upon a single, primary test (either the Societal Cost test or the TRC test) for all of the detailed cost-effectiveness assessments, and a secondary test (the PAC test) that would be applied only once at the end of the assessment as a check on behalf of utility customers. Applying the tests in this manner allows states to balance the goal of achieving key public policy objectives with the goal of ensuring a net reduction in costs to utility customers.

Illustrative Example of the Impacts of Best Practices

Figure ES.2 provides an illustration of how different methodologies and assumptions can affect the cost-effectiveness of energy efficiency programs. The screening results presented below for the best practices are for an actual utility in New England that we use throughout this study to illustrate the potential impact of different screening approaches and assumptions. The data presented in Figure ES.2 result from applying the TRC test.

Figure ES.2. Cost-Effectiveness Under Best Practices and Not-Best Practices



The best practices case (blue bars) includes all the avoided costs described above, the OPIs that are currently used in Massachusetts, a risk-adjusted discount rate of 3.2 percent, and a study period of 30 years to capture all or most of the efficiency measure lives. In contrast, the not-best practices case (red bars) includes all the same assumptions except that the discount rate is based on a utility weighted average cost of capital (8.5 percent), the study period is limited to 15 years, and all OPIs are excluded.

As the figure illustrates, cost-effectiveness is reduced significantly when the not-best screening practices are applied. The low-income programs are most affected, primarily because the OPIs are excluded. The residential new construction and retrofit programs are also heavily affected, primarily because the other fuel savings are not accounted for in the not-best practices case. The impacts on the commercial and industrial sector are primarily due to the change in discount rate.

In the sections below we provide similar illustrative examples, wherein we indicate the separate effects of different approaches and assumptions.

1. Introduction

Background

Despite many years of experience with screening energy efficiency programs in the US, states use a wide variety of practices when screening energy efficiency programs. Different methodologies for identifying and modeling the costs and benefits of energy efficiency programs significantly influence which programs are considered cost-effective.

The purpose of this report is to provide energy efficiency program administrators, regulators, and other efficiency stakeholders with a reference document containing best practices for screening energy efficiency programs.[2] The report is focused on several topics that are currently posing challenges for energy efficiency program administrators in today's planning climate.

One of the premises underlying our analysis is that energy efficiency program administrators should be implementing all cost-effective energy efficiency, and therefore it is critical that the cost-effectiveness tests be properly designed and implemented. Another premise underlying our analysis is that consumer advocates and regulatory commissioners are key stakeholders in the review and approval of energy efficiency plans and therefore need to have confidence that the design and application of the energy efficiency cost-effectiveness screening is in the best interest of utility customers.

Issues with Current Screening Practices

The variety of practices around the states for energy efficiency screening has not only led to inconsistency, but also to many cases where the cost-effectiveness tests are not being applied properly. Some of the topics that are currently posing challenges for energy efficiency program administrators include the following:

Other Program Impacts: Other program impacts should be included in the appropriate energy efficiency cost-effectiveness tests, in order to ensure that the tests are internally consistent. However, in practice these important impacts are rarely accounted for in a comprehensive manner and are frequently ignored altogether. This leads to energy efficiency screening results that are incomplete, misleading, inconsistent with the underlying rationale of the cost-effectiveness tests, and typically skewed against energy efficiency.

Application of Avoided Costs: Avoided costs are a significant component of efficiency program benefits. Therefore, all avoided costs should be included in program screening and calculated correctly. Unfortunately this is not the case in every state. For example, some states undervalue avoided capacity costs, some do not account for avoided T&D costs, some in regions with competitive wholesale markets do not account for the price suppression effect, and some do not fully account for avoided environmental compliance costs.

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[2] For our purposes here we define "best practices" as those policies and practices that: (a) are most likely to support key goals of utility regulators, such as ensuring low-cost, reliable, safe energy services; and (b) are most likely to support additional public policy goals of legislatures and regulators.

Discount Rate: The discount rate used to calculate present values of costs and benefits has significant implications for the cost-effectiveness of energy efficiency programs. Many states use the utility weighted average cost of capital for a discount rate. However, the energy efficiency activities are a low-risk investment for most energy efficiency program administrators, and thus a lower discount rate would be appropriate.

Cost-Effectiveness Screening Level: Cost effectiveness can be determined at either the measure level, program level, or at the portfolio or plan-wide level. Of these options, measure level screening is the strictest application for determining cost-effectiveness, and often leads to limited programs and savings. We are aware of at least one state that screens for cost effectiveness at the measure level and is experiencing difficulty justifying certain measures, including insulation in home energy retrofits. While such measures provide significant levels of savings, especially when combined with other measures or efficiency efforts, the program administrators cannot include uneconomic measures in their efficiency plans, and are therefore compelled to reduce their program offerings and overall savings.

Measure Life: Implementing energy efficiency programs requires upfront spending, while the measures installed through the programs produce savings over the course of their useful lives. Depending on the measure, the useful life can be as long as 20 years or more. Some states artificially truncate the years of benefits that can be included in cost-effectiveness screening (e.g., only 15 years of savings can be accounted for). Such an approach skews the cost-benefit analysis because it limits the full amount of benefits resulting from efficiency efforts.

This report addresses these and other issues, and recommends best practices that regulators, program administrators, and other efficiency stakeholders can adopt for appropriate efficiency program screening.

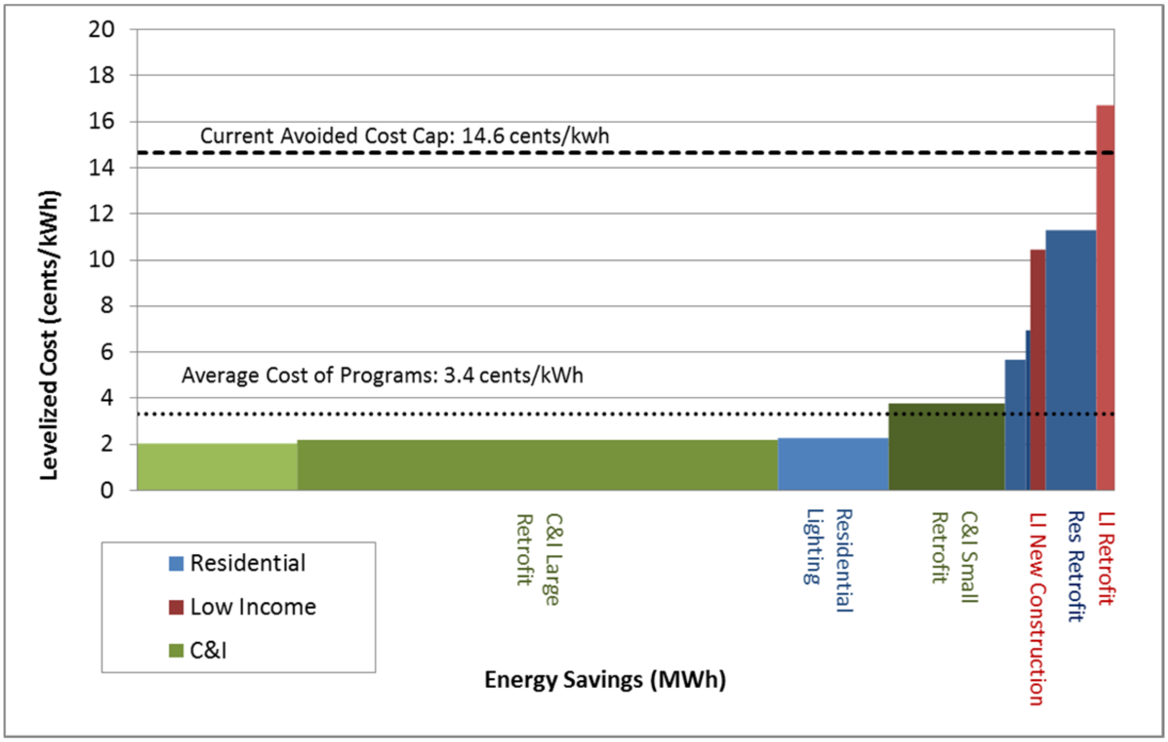
Illustrative Examples

For many of the topics discussed below, we provide an illustrative example that demonstrates the issue and highlights the effect of applying the recommended best practice. The illustrative examples are based on an actual efficiency portfolio provided by an electric utility in New England, including the utility's efficiency budget, savings, measure life, avoided costs, and other factors. We reference the same utility in each example for consistency.

Appendix A includes a description of the programs that are offered by this example utility. Figure 1.1 below provides a summary of the actual levelized cost of saved energy for each of these programs, relative to the avoided cost cap that is currently being used by this utility. Each program's energy savings are presented in the width of the program's bar, and each program's levelized cost is demonstrated by the bar's height. (The costs and avoided costs presented in this figure are limited to those that are included in the Program Administrator Cost test, i.e., just the electricity-related costs and benefits.)

As indicated in Figure 1.1, these programs are all well below the avoided cost of electricity, with the exception of one of the low-income programs. (This low-income program is cost-effective under the Total Resource Cost test, because of the low-income other program benefits. We will address this issue in Section 4.1.) The average cost of the energy efficiency portfolio as a whole is well below the avoided costs, with an average levelized cost of 3.4 cents per kWh.

Figure 1.1. Levelized Costs by Program Energy Savings (cents/kWh)



Source: The program costs are the actual 2010 program costs of our example New England utility.

In the following sections we will return to this example utility, and provide illustrative calculations for how different energy efficiency screening assumptions will affect the cost-effectiveness results.

2. Tests for Screening Energy Efficiency Programs

2.1 Description of the Cost-Effectiveness Tests

The costs and benefits of energy efficiency are qualitatively different from those of supply-side resources in that they can have different implications for different parties. As a result, five cost-effectiveness tests have been developed to consider efficiency costs and benefits from different perspectives.[3] Each of these tests combines the various costs and benefits of energy efficiency programs in different ways, depending upon which costs and which benefits pertain to the different parties. These tests are described below and summarized in Table 2.1.[4]

- The Societal Cost Test.[5] This test includes the costs and benefits experienced by all members of society. The costs include all of the costs incurred by any member of society: the program administrator, the customer, and anyone else. Similarly, the benefits include all of the benefits experienced by any member of society. The costs and benefits are the same as for the TRC Test, except that they also include externalities, such as environmental costs and reduced costs for government services.
- The Total Resource Cost (TRC) Test. This test includes the costs and benefits experienced by all utility customers, including both program participants and non-participants. The costs include all the costs incurred by the program administrator and participating customer, including the full incremental cost of the efficiency measure, regardless of whether it was incurred by the program administrator or the participating customers.[6] The benefits include all the avoided utility costs, plus any other program benefits experienced by the customers, such as avoided water costs, reduced operations and maintenance costs, improved comfort levels, health and safety benefits, and more.
- The Program Administrator Cost (PAC) Test.[7] This test includes the energy costs and benefits that are experienced by the energy efficiency program administrator. This test is most consistent with the way that supply-side resources are evaluated by vertically integrated utilities. The costs include all expenditures by the program administrator to design, plan, administer, deliver, monitor and evaluate efficiency programs offset by any revenue from the sale of freed up energy supply. The benefits include all the avoided utility costs, including avoided energy costs, avoided capacity costs, avoided transmission and distribution costs, and any other costs incurred by the utility to provide electric services (or gas services in the case of gas energy efficiency programs).

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3 For additional information on these tests, see CA PUC 2001 and NAPEE 2008.

4 These tests are sometimes defined slightly differently by different Public Utilities Commissions. Some states have created additional tests (e.g., ODC 2012; MEA 2011).

5 The California Standard Practice Manual (SPM) considers the Societal Cost Test a variant on the TRC test (CA PUC 2001, p 18). Many states and studies depart from the SPM by drawing a more complete distinction between these two tests.

6 The incremental measure cost is the difference between the cost of the efficiency measure and the cost of the most relevant baseline equipment that would have been installed in the absence of the program.

7 This is sometimes referred to as the Utility Cost test or the Energy System test.

- The Participant Test. This test includes the costs and benefits experienced by the customer who participates in the efficiency program. The costs include all the direct expenses incurred by the customer to purchase, install, and operate an efficiency measure. The benefits include the reduction in the customer's electricity bills, as well as any financial incentive paid by the program administrator.[8]
- The Ratepayer Impact Measure (RIM) Test.[9] This test provides an indication of the impact of energy efficiency programs on utility rates. The results of this test provide an indication of the impact of energy efficiency on those customers that do not participate in the energy efficiency programs. The costs include all the expenditures by the program administrator, plus the "lost revenues" to the utility as a result of the inability to recover fixed costs over fewer sales. The benefits include the avoided utility costs.

Table 2.1. Components of the Energy Efficiency Cost-Effectiveness Tests

	Participant Test	RIM Test	PAC Test	TRC Test	Societal Cost Test
Energy Efficiency Program Benefits:					
Customer Bill Savings	Yes	---	---	---	---
Avoided Generation Costs	---	Yes	Yes	Yes	Yes
Avoided Transmission and Distribution Costs	---	Yes	Yes	Yes	Yes
Avoided Cost of Environmental Compliance	---	Yes	Yes	Yes	Yes
Other Program Benefits (utility perspective)	---	---	Yes	Yes	Yes
Other Program Benefits (participant perspective)	Yes	---	---	Yes	Yes
Other Program Benefits (societal perspective)	---	---	---	---	Yes
Energy Efficiency Program Costs:					
Program Administrator Costs	---	Yes	Yes	Yes	Yes
EE Measure Cost: Rebate to Participant	---	Yes	Yes	Yes	Yes
EE Measure Cost: Participant Contribution	Yes	---	---	Yes	Yes
Other Program Costs	Yes	---	Yes	Yes	Yes
Lost Revenues to the Utility	---	Yes	---	---	---

How the Cost-Effectiveness Tests Are Being Used Today

A recent survey by ACEEE provides a useful summary of how the cost-effectiveness tests are used across the states.[10] Nationwide, a total of 45 jurisdictions have some level of formally approved ratepayer-funded energy efficiency programs in operation. All of these jurisdictions use some type of benefit-cost test in connection with their ratepayer-

8 Throughout this analysis we use the term program administrator to refer to the entity that implements energy efficiency programs, whether it be a vertically integrated utility, a distribution utility or a third party administrator.

9 This has previously been referred to as the Non-Participant test and the No-Losers test.

10 The ACEEE report provides the results of a comprehensive survey and assessment of the current "state of the practice" of utility-sector energy efficiency program evaluations across the 50 states and the District of Columbia. The study examined many aspects relating to how states conduct their evaluations and the key assumptions employed, including the use of cost-effectiveness tests (ACEEE 2012).

funded energy efficiency programs. Most states have some type of legal requirement for the use of such tests, either by legislation or regulatory order (ACEEE 2012, p.30).

Many states examine more than one benefit-cost test. The ACEEE survey found that 36 states (85 percent) apply the TRC test; 28 states (63 percent) apply the PAC test; 23 states (53 percent) apply the Participant Test; 22 states (51 percent) apply the RIM test, and 17 states (40 percent) apply the Societal Cost Test (ACEEE 2012, p.12).

However, regulators tend to adopt one of these tests as the primary guideline for screening energy efficiency programs. The ACEEE survey found that 95 percent of states rely on a single, primary screening test:

- The TRC is used by 29 states (71 percent) as the primary methodology for defining energy efficiency cost-effectiveness.
- The Societal Cost test is used by six states (15 percent) as the primary methodology for defining energy efficiency cost-effectiveness.
- The PAC test is used by five states (12 percent), as the primary methodology for defining energy efficiency cost-effectiveness
- The RIM test is used by one state (2 percent), as the primary methodology for defining energy efficiency cost-effectiveness (ACEEE 2012, p.13).

2.2 Implications of the Cost-Effectiveness Tests

In theory, all of the above cost-effectiveness tests should be considered in the evaluation of ratepayer-funded energy efficiency resources, to provide the most complete picture of the impacts on different parties. However, most states rely upon one or two tests as the *primary* standard for screening energy efficiency programs, due to the challenges of working with multiple tests that provide different results.

Also, it is important to recognize that the different tests provide different types of information and should be used for different purposes. The RIM test and the Participant test provide "distributional" information, i.e., information regarding how the impacts of energy efficiency are distributed across customers. In particular, the RIM test provides an indication of the primary impacts of energy efficiency on those customers who do not participate in the energy efficiency programs, because the main impacts on these customers are the adjustments in rates resulting from energy efficiency. The Participant test, on the other hand provides an indication of the primary impact of energy efficiency on the program participants. These two tests together provide a rough indication of how the benefits are distributed between program participants and non-participants.

In the paragraphs below we summarize some of the key implications of each of the five cost-effectiveness tests. Table 2.2 summarizes some of the key points.

The Societal Cost test is the most comprehensive standard for evaluating the cost-effectiveness of efficiency, because this is the only test that includes all benefits and costs to all members of society. Ideally, the Societal Cost test should include all costs and benefits, including externalities, regardless of who experiences them.

The TRC test is the next most comprehensive standard for evaluating the cost-effectiveness of energy efficiency, by including all the impacts to the program administrator and its customers.[11] It offers the advantage of including the full incremental cost of the efficiency measure, regardless of which portion of that cost is paid for by the utility and which portion is paid for by the customer. In practice, however, the TRC is frequently misapplied. Many states that use the TRC test do not include all of the costs and benefits to customers, in particular the other program costs and benefits. Applying the TRC test in this way skews cost-effectiveness results, typically skewed against energy efficiency. This issue is discussed in detail in Section 4.1.

Table 2.2. The Five Principal Cost-Effectiveness Tests[12]

Test	Key Question Answered	Summary Approach	Implications
Societal Cost	Will total costs to society decrease?	Includes the costs and benefits experienced by all members of society.	Most comprehensive comparison, including the impact to all of society.
Total Resource Cost	Will utility costs and program participants' costs decrease?	Includes the costs and benefits experienced by all utility customers, including energy efficiency program participants and non-participants	Includes the full incremental cost of the efficiency measure, including participant cost and utility cost.
Program Administrator Cost	Will utility costs decrease?	Includes the costs and benefits that are experienced by the energy efficiency program administrator.	Limited to impacts on utility revenue requirements. Most consistent with supply-side cost-effectiveness methodologies.
Participant Cost	Will program participants' costs decrease?	Includes the costs and benefits that are experienced by the customer who participates in the efficiency program	Provides distributional information. Useful in program design to improve participation. Of limited use for cost-effectiveness screening.
Rate Impact Measure	Will utility rates decrease?	Includes the costs and benefits that will affect utility rates, including program administrator costs and benefits and lost revenues.	Provides distributional information. Useful in program design to find opportunities for broadening programs Should not be used for cost-effectiveness screening.

The PAC test is more restrictive than the TRC test, in that it only compares the program administrator costs to the costs of avoided supply-side resources. One way to think of this test is that it is limited to the impacts that would eventually be charged to all customers through the revenue requirements; the costs being those costs passed on to ratepayers for implementing the efficiency programs, and the benefits being the supply-side costs that are avoided and not passed on to ratepayers as a result of the efficiency programs.[13] This test is most consistent with the way that utilities typically evaluate the cost-effectiveness of supply-side resources. However, the PAC does not include several

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[11] The name of this test is misleading, because it does not include "total" costs of an energy efficiency resource. A more accurate and descriptive name for this test would be the All Customers test, because it includes the total costs and benefits to all utility customers.

[12] Adapted from NAPEE 2008, p.2-2, with modifications.

[13] The name of this test is a little misleading, because it does not include the costs and benefits to the program administrator itself (e.g., utility profits). A more descriptive name for this test would be the Revenue Requirements test.

significant impacts that have important public policy implications, and are important in planning energy efficiency programs, most notably the benefits to low-income customers and the savings associated with alternative fuels.

The Participants test is fundamentally different from the other tests, in that it limits benefits to customer bill savings as the primary benefit of the programs. Customer rates are typically higher than the marginal avoided costs of the energy system, leading to higher energy efficiency benefits per unit of energy saved. Also, the only costs in this test are the customer costs, which in many cases are lower than the costs incurred by the program administrator to plan, design, and deliver the energy efficiency programs. Consequently, this test is typically the least restrictive of all the other cost-effectiveness tests. As noted above, it provides an indication of the distributional effects of the energy efficiency program, along with the RIM test, and may useful in optimizing program design for participation.

The Rate Impact Measure test tends to be the most restrictive of all the efficiency tests, because the utility lost revenues can make very large contributions to the energy efficiency program costs. Most, if not all, states have ruled that the RIM test should not be used as the primary test for evaluating energy efficiency cost-effectiveness. There are several reasons for this.

- Applying the RIM test to screen efficiency programs will not result in the lowest cost to society or the lowest cost to customers on average. Instead, it will lead to the lowest rates (all else being equal). However, achieving the lowest rates is not the primary goal of utility planning and regulation, especially if lower rates lead to higher costs to customers on average.
- The RIM test is heavily influenced by the lost revenues to the utility. However, lost revenues are not a true cost to society. Lost revenues represent a "transfer payment" between efficiency program participants and non-participants; the bill savings to the program participants result in the lost revenues that are collected from all customers, including non-participants.14 In this way, lost revenues are not a new or an incremental cost in the same way that the program administration costs are a new and incremental cost of implementing energy efficiency programs, and they should not be applied as such in screening a new energy efficiency resource.
- A strict application of the RIM test can result in the rejection of large amounts of energy savings and the opportunity for large reductions in many customers' bills in order to avoid what are often small impacts on non-participants' bills. From a public policy perspective, such a trade-off is illogical and inappropriate.
- The RIM test does not provide useful information about what happens to rates as a result of program implementation. A RIM test benefit-cost ratio of less than one indicates that rates will increase (all else being equal), but says little to nothing about the magnitude of the rate impact. And it says nothing at all about the amount of cost savings associated with the energy efficiency.

[14] Note that in those jurisdictions where utilities are not allowed to collect lost revenues and do not have decoupling, for those years in between rate cases this transfer payment is actually between the utility shareholders and program participants.

- Screening efficiency programs with the RIM test is inconsistent with the way that supply-side resources are screened, and creates an uneven playing field for the consideration of supply- and demand-side resources. There are many instances where utilities invest in new power plants or transmission and distribution facilities in order to meet the needs of a subset of customers, (e.g., new residential divisions, an expanding industrial base, geographically-based upgrades). These supply-side resources are not evaluated on the basis of their equity effects, nor are the "non-participants" seen as cross-subsidizing the "participants."

Nonetheless, efficiency programs can lead to increased rates, and rate impacts are an important consideration for regulators and other efficiency stakeholders. However, it is important to recognize that the rate impacts of energy efficiency programs are not a matter of cost-effectiveness. (As noted above, the lost revenues are simply a transfer payment and do not represent an incremental cost.) Instead, they are a matter of customer equity between program participants that experience reduced bills and non-participants that experience increased rates and therefore increased bills.[15]

Therefore, the RIM test should not be used in screening energy efficiency programs for cost-effectiveness. Instead, efficiency program administrators should take steps to (a) analyze rate and bill impacts in a fashion that provides much more information than what is available from the RIM test; (b) design programs in a way that mitigates rate impacts without sacrificing energy efficiency savings; and (c) work to increase the number of program participants so as to mitigate the equity concerns between participants and non-participants.[16]

2.3 Deciding Whether to Apply the PAC, TRC or Societal Test

The decision of which cost-effectiveness test to use for screening efficiency programs has been a matter of debate since the introduction of energy efficiency programs, and continues to be a subject of debate today (Neme and Kushler 2010; CA PUC 2012b). This decision requires consideration of several factors, including economic factors and public policy issues. Below we describe the key issues to consider in making this decision.

First is the question of scope. While the cost-effectiveness tests are frequently described as pertaining to different perspectives, another way to distinguish them is that they vary by the scope of the impacts to be accounted for. If the scope of the test is to be limited to revenue requirements, then the PAC test is most appropriate. If the scope of the test is to include the total incremental impacts of the efficiency measure on all customers, then the TRC test is most appropriate. If the scope of the test is to include all impacts to society, then the Societal Cost test is most appropriate. The decision of which scope to use is a policy decision, which will need to balance several public policy considerations, discussed below.

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[15] It is important to note that all customers benefit from energy efficiency programs in certain ways, regardless of whether they participate in the programs. For example, all customers will experience reduced risk, improved reliability, reduced transmission and distribution costs, reduced costs of environmental compliance, reduced environmental impacts, and the benefits of price suppression effects in wholesale electric markets.

[16] For additional information regarding the management of rate and bill impacts, see US DOE 2011.

The Societal Cost test is the most comprehensive test, and is most appropriate for those states that wish to give consideration to the societal benefits of energy efficiency programs, particularly the environmental and health benefits. The disadvantages of this test are that some stakeholders may view the scope as outside the interests and jurisdiction of regulatory commissions; some of the societal impacts are uncertain and difficult to forecast; and this test might lead to undesirable cost impacts on utility customers.

The TRC test is the next most comprehensive test, and is the most widely used test. Regulators and legislators are apparently drawn to this test because it includes the total incremental impacts of efficiency measures. However, the TRC test creates a dilemma for policymakers. In order to be internally consistent the test must include other program impacts on the program participants, but regulators are often wary of doing so because some of the costs are uncertain and difficult to quantify. In addition, some stakeholders are concerned that including OPIs in the assessment of energy efficiency could lead to utility customers paying higher costs for efficiency programs in order to pay for other program benefits that are not in their interest and should not be paid for through utility rates.

The PAC test is most appropriate for those states that want to limit the energy efficiency cost-effectiveness analysis to the impacts on revenue requirements. There are many advantages to this test: it is consistent with the way that supply-side investments are evaluated; it includes costs that are relatively easy to identify and quantify; and it includes the energy costs and energy benefits that are most important to utility regulators. Probably the most important benefit of the PAC test is that it provides legislators, regulators, consumer advocates and others with confidence that the energy efficiency programs will result in lower costs to utility customers. This is an extremely important consideration, particularly for those states that seek to implement all cost-effectiveness energy efficiency resources.

However, relying on the PAC test has one significant disadvantage in that the costs and benefits to energy efficiency program participants are not taken into consideration. There are two implications of this. First, by not including the participant's cost the PAC test does not include the full incremental cost of efficiency measures, which may be important to policymakers. Second, the PAC test does not include the other program benefits of efficiency measure, some of which are clearly important to policy makers. The other program benefits that are typically most important to regulators are (a) those benefits that pertain to low-income customers, because of the significant public policy implications of this sector; and (b) the other fuel savings, because these savings are important to promote comprehensive, whole-house, one-stop-shopping residential retrofit programs as well as new construction programs where customers tend to use multiple fuels. In Section 4.1 we provide an illustration of how these two types of benefits can have a significant impact on program cost-effectiveness.

Once the scope is established, it is important to ensure that the test being applied includes all the appropriate costs and benefits in a way that is internally consistent. For example, when applying the PAC test it is important to include all the costs and all the benefits that are expected to affect utility revenue requirements. Similarly, when applying the TRC test it is important to include all the participant benefits as well as the participant costs in order to maintain internal consistency. Otherwise, the test results will be skewed and misleading. These issues are discussed in more detail in Section 4.1. In addition, it is important to ensure that there is no double-counting of costs or benefits in the test being applied. Finally, it is important to ensure that transfer payments are properly accounted for when deciding which costs and benefits to include in each test.

To summarize, in choosing the appropriate test to use, policymakers must consider and balance several key questions. How important is it to include all societal impacts, including environmental and health impacts? How important is it to include the full incremental cost of the efficiency measures? How important is it to include other program impacts and the associated public policy benefits (e.g., low-income benefits, other fuel savings)? How important is it to ensure that utility revenue requirements are minimized?

2.4 Recommendations for Which Tests to Apply

With all of these considerations in mind, we offer the following recommendations. First, we note that ideally the three key tests – the PAC, TRC and Societal tests – should all be considered when assessing energy efficiency cost-effectiveness. However, we recognize that this still leaves the ultimate question of which program to implement, and that in practice it is more common and straightforward to use a single, primary test to answer this ultimate question. Our recommendations below include a primary test applied at the program level, but a secondary test applied at the portfolio level. This approach offers the benefits of both breadth and simplicity.

We recommend that the Societal Cost test be used to screen energy efficiency programs, for all those states that have the authority to account for the societal impacts of efficiency program. This test includes the broadest range of energy efficiency costs and benefits, and provides the best measure of the public policy benefits that are of great importance to legislators and regulators, such as low-income benefits, other fuel savings, and environmental benefits. Many of the concerns about quantifying the societal impacts can be addressed through rigorous analysis or sound public policy decision-making. Concerns about excessive increases to utility costs can be addressed by applying the PAC test at the portfolio level, as described below.

We recommend that all states that do not use the Societal Cost test use the TRC test to screen energy efficiency programs at the program level, and that this test should include OPIs to the greatest extent possible. At a minimum, the TRC test should include the OPIs associated with low-income programs and with other fuel savings. If regulators choose not to account for OPIs, then the TRC test should not be used for screening energy efficiency programs.

If regulators choose to not account for OPIs, the PAC test is the best test to use in screening energy efficiency programs. This test is relatively transparent, is limited to the impacts on revenue requirements, and ensures that utility customers on average will experience lower utility costs as a result of the efficiency programs. If the PAC test is used, regulators must recognize that important benefits are being ignored, particularly the low-income benefits and the other fuel savings.

The remaining concern with applying either the Societal Cost test or the TRC test relates to the potential impact on revenue requirements and costs to utility customers. This is a critical consideration, particularly for those states that are implementing aggressive levels of energy efficiency savings or pursuing all cost-effective energy efficiency.

To address this concern, we recommend that the PAC test be applied to the portfolio of efficiency programs, to ensure that the entire package of programs will result in a net reduction in revenue requirements and a net reduction in costs to utility customers. Under this approach, either the Societal Cost test or the TRC test would be the primary test for screening each energy efficiency program. Programs that do not pass the primary test would not be considered cost-effective. Then the PAC test would be applied to the portfolio of programs that do pass the primary test. If the portfolio of programs does not pass the PAC test, then one or more of the programs would need to be modified in such a way that the entire portfolio eventually passes the PAC test.

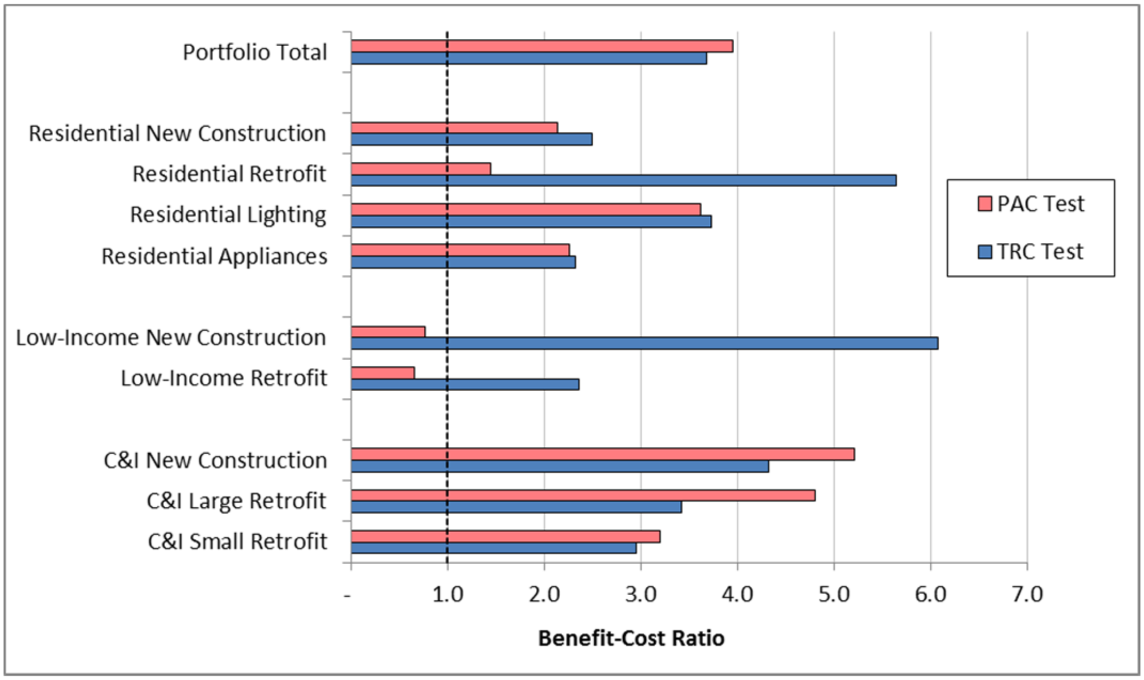
This combined program/portfolio screening approach should be simple to apply because it relies upon a single, primary test (either the TRC test or the Societal test) for all of the detailed cost-effectiveness assessments, and the secondary test (the PAC test) is applied only once at the end of the assessment as a check on behalf of utility customers. Applying the tests this way allows for a balancing of the goal of achieving key public policy objectives, such as accounting for the full incremental cost of the efficiency measure, accounting for other program impacts, and accounting for societal benefits, with the goal of ensuring a net reduction in costs to customers. The application of the PAC test at the portfolio level also provides a clear indication of the overall benefits to utility customers in terms of millions of dollars in net benefits.

Illustrative Example

Figure 2.1 illustrates program cost-effectiveness under the TRC the PAC tests, at the program and portfolio levels for our example New England utility. The TRC results below include the effect of OPIs.

While the programs and portfolio exhibits strong cost-effectiveness, the figure demonstrates the principles described above. Specifically, the TRC can be applied at the program level to ensure that public policy goals are achieved, while the PAC can be applied at the portfolio to provide confidence that the overall energy efficiency initiative will result in lower revenue requirements and lower bills on average for utility customers.

Figure 2.1. Cost-Effectiveness Results; TRC and PAC; Portfolio and Program Level



Source: The 2012 energy efficiency plan for our example utility.

3. Calculation of Avoided Costs

Energy efficiency programs result in several types of avoided costs, and it is important that all of them are included in the screening analysis and that each of them is calculated correctly. This section provides an overview of the proper techniques for estimating avoided costs. Proper estimation of avoided costs requires many important analytical techniques that are beyond the scope of this study. Readers are encouraged to refer to the reference documents for more details.

3.1 Introduction

The typical approach for quantifying the benefits of energy efficiency is to forecast long-term avoided costs, defined as costs that would have been spent if the energy efficiency savings measure had not been put in place. In addition, the utility may not have to purchase as much system capacity, make as many upgrades to distribution or transmission systems, buy as many emissions offsets, or incur as many other costs. All such cost savings resulting from efficiency are directly counted as avoided cost benefits. (NAPEE 2007, Section 3).

There are two main categories of avoided costs: energy-related and capacity-related avoided costs. Energy-related avoided costs involve market prices of energy, losses, natural gas commodity prices, and other benefits associated with energy production such as reduced air emissions and water usage. Capacity-related avoided costs involve infrastructure investments such as power plants, transmission and distribution lines, pipelines, and liquefied natural gas (LNG) terminals (NAPEE 2007, Section 3).

Nationwide, states use different methodological approaches as the basis for their avoided costs. Twelve states use essentially fixed values based on an assumed "next power plan," eleven states based them on a more sophisticated modeling of average or marginal system costs, twelve states used some market price based methodology, and three states used some other methodology (ACEEE 2012, p.32).

3.2 Avoided Energy Costs

When estimating avoided energy costs it is important to consider the relevant market structure. For those utilities that participate in competitive wholesale markets, a forecast of market prices should be used to estimate avoided costs. For vertically integrated utilities that do not participate in competitive wholesale markets, integrated resource planning approaches should be used to estimate avoided costs.

If energy market prices are used to estimate avoided energy costs, then these market prices must be forecast for as many years into the future as necessary to cover the entire study period. (See Section 5.2 for a discussion of the appropriate study period to use.) In a wholesale electricity market context, the market price is equal to the marginal cost of operating enough generation units to meet demand in each hour of the year. This marginal energy cost can vary significantly between peak and off-peak hours and seasons, and is likely to change over time in response to changing demands, changing fuel prices, plant retirements and plant additions.

Integrated resource planning approaches typically require developing two long-term, optimized electricity scenarios, one without energy efficiency programs and one with, and compare the difference in present value revenue requirements between the two scenarios. It is important that each of the scenarios modeled include an optimized set of resources; otherwise the avoided costs could be artificially inflated. Ideally, the costs of each scenario would be estimated using an hourly production cost model in order to get an accurate indication of the hourly operational costs of the electricity system.

Regardless of whether a market price forecast is used or IRP practices are used, it is important to reflect the different avoided energy costs that occur at different times of the day and different times of the year. This is because different types of energy efficiency resources can reduce demand at different times when prices may be significantly different. Those resources that reduce demand during primarily peak periods will result in higher avoided energy costs than those that reduce demand primarily during off-peak periods.

3.3 Avoided Capacity Costs

As with avoided energy costs, those utilities that participate in competitive wholesale capacity markets should use a capacity market price forecast, while those that do not should use integrated resource planning approaches.

Forecasts of avoided capacity costs typically include both a short-run and a long-run component. The transition point between the two occurs in the resource balance year, i.e., the first year in which new capacity resources may be needed to meet reliability requirements and the growth of peak loads.

Over the short-run, while there is sufficient existing capacity resources on the system, wholesale capacity market prices would be driven by the mix of existing capacity resources needed to meet the capacity requirement in each year. Over the long run, when new capacity is needed to meet demand, the capacity market prices would be driven by new entrants to the wholesale capacity market.

While the new entrant to the capacity market could be any type of generator (baseload, cycling, peaking), with any type of fuel (gas, coal, oil, wind, solar, nuclear), the new entrant's capacity-only cost is likely to be consistent with the cost of a new gas-fired combustion turbine facility, which is built primarily for the purpose of providing peaking capacity. For this reason, forecasts of wholesale market capacity prices typically assume that those prices will trend toward the cost of a new gas-fired combustion turbine by the resource balance year (Synapse 2011c). The long-run capacity value would be equal to the combustion turbine's annualized fixed cost less the net revenues it would earn through participation in the energy and ancillary services markets, i.e., the residual capacity value.

When using integrated resource planning methods to estimate avoided capacity costs it is important to properly identify the year in which new capacity is needed, both in the scenario with energy efficiency and the scenario without. It is also important to recognize that there are avoided capacity benefits from energy efficiency resources prior to the resource balance year.

Regardless of whether a market price forecast is used or IRP practices are used, it is important to estimate the avoided capacity costs separately from the avoided energy costs to ensure that there is no double-counting or under-counting of one or the other.

Some program administrators use the costs associated with a new power plant, e.g., a new peaking combustion turbine, to forecast avoided capacity costs. If this approach is used it is important to separate the capacity costs associated with the peaking unit from the energy costs.

3.4 Avoided Transmission and Distribution Costs

Introduction

The US utility sector has invested on the order of $35 to $40 billion per year in the T&D system over the past decade and is forecast to invest nearly $50 billion per year over the next two decades (RAP 2012). Energy efficiency has the potential to defer forecasted T&D investments. While not all forecast T&D investments will be deferrable due to time-related deterioration of equipment or other factors, a significant portion of T&D investment is likely to be associated with load growth. The potential benefits of deferring even a modest portion of such investments could be substantial. Most states include some value for avoided T&D in their calculation of avoided costs (ACEEE 2012, p.32).

There are two types of categories of avoided T&D costs, based on whether energy efficiency programs target at specific areas to alleviate congestions of specific T&D facilities. One type of avoided cost is called "passive deferral," which occurs from typical energy efficiency programs when the growth in load or stress on of the T&D system is reduced as a result of broad-based (e.g., statewide or utility service territory-wide) efficiency programs. Another type of deferral is called "active deferral," which occurs when a conscious decision is made to invest in energy efficiency measures or programs in targeted geographic locations for the specific purpose of lowering loads on local T&D system elements. (RAP 2012, pp. 3 – 4).[17]

T&D Avoided Cost Methodologies

T&D avoided cost values can be constructed by estimating historical annual marginal T&D investment, or by evaluating planned, future T&D investment at specific sites. One common method for estimating avoided T&D costs is called "projected embedded analysis." In this method, utilities use long-term historical trends (more than 10 years) and sometimes planned T&D costs to estimate future avoided T&D costs. (NARUC 1992) This approach often looks at load-related investment (as opposed to customer-related) and estimates system-wide (e.g., utility service territory) average avoided T&D costs. It has been mainly applied to the evaluation of the benefits of energy efficiency programs (as opposed to other resources such as distributed generation and demand response).

This approach is relatively inexpensive and less time consuming than the system planning approach as it does not require an engineering study of the electric system, nor does it require obtaining site specific load and investment data. As a weak point, it does

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[17] In recent years, aggressive geographically targeted energy efficiency programs have been implemented in several jurisdictions in an attempt to defer specific T&D projects. Examples include Pacific Gas and Electric's Delta Project, Portland General Electric's Downtown Portland Pilot, Consolidated Edison programs, Efficiency Vermont Geo-Targeted DSM, and National Grid projects in Rhode Island (RAP 2012).

not provide an accurate picture of avoided costs for specific T&D projects. It fails to capture the highest value projects that energy efficiency might defer. However, an average value estimated using the projected embedded analysis does provide an indicator of T&D avoided costs sufficient for evaluating energy efficiency for an energy future scenario that assumes significant amount of energy efficiency deployment statewide. The value would provide a rough estimate of long-term T&D avoided cost values for efficiency projects that could reliably operate to support the grid system.

The "system planning approach" examines relevant components of specific planned T&D projects. This approach is suitable for evaluating the benefits of "active deferral" of targeted energy efficiency programs and other demand side resources. This analysis incorporates projected investment costs, system performance data, forecasted area load growth and on this basis estimates avoided T&D costs for specific locations (NARUC1992). This approach could provide price or value signals that might induce locating cost-effective energy efficiency projects in the area of need.

Recently this approach has been taken to evaluate the value of distributed generation and energy efficiency by a number of entities including ConEdision in New York, Efficiency Vermont, Detroit Edison, Southern California Edison, Bonneville Power Authority and the DG Collaborative in Massachusetts that included pilot projects by National Grid and NSTAR. (Pace and Synapse 2006; Jakubiak 2003; Kingston 2005; E3 and BPA 2004; RMI et al, 2008; RAP 2012). While this approach provides a detailed local area view of T&D avoided costs, it is more costly and time consuming to conduct than the alternative that uses historical annual marginal T&D investment. The site-specific method requires a rigorous engineering study of the electric system to identify local system upgrade needs and incorporates small area investment and load data.

In some regions of the country future transmission costs are expected to increase significantly relative to historic transmission costs. In these cases, it is important that the estimate of avoided transmission costs account for this trend and not rely entirely upon historic transmission costs.

We recommend that all energy efficiency program administrators develop reasonable estimates of avoided T&D costs, using methodologies that are best able to capture the expected future costs of transmission and distribution in their system and their region. These avoided costs can be significant and will have important implications for energy efficiency cost-effectiveness screening.

Illustrative Estimates of Avoided Transmission and Distribution Costs

Below we present a summary of several T&D avoided cost estimates being used for evaluating energy efficiency programs mainly from Western and Northeastern states. (Synapse 2011c; NWPCC 2010). As indicated, the avoided distribution costs tend to be higher than the estimated avoided transmission costs, in those cases where they are both estimated. Avoided T&D costs of this magnitude can have a significant impact on the cost-effectiveness of energy efficiency programs, particularly those that have relatively high capacity savings.

Table 3.1. Select T&D Avoided Cost Estimates (2011$/kW-year)

Utility	Avoided Transmission	Avoided Distribution	Total
SDG&E, CA	20.5	n/a	n/a
SCE, CA	56.4	n/a	n/a
PG&E, CA	14.7	23.7	38.4
PacifiCorp	31.9	83.2	115.1
PGE, OR	10.8	22.4	33.2
NSTAR, MA	15.0	89.0	104.1
WMECo, MA	20.7	62.2	82.9
National Grid, MA	20.4	111.6	132.0
National Grid, RI	20.4	89.0	109.4
CL&P, CT	1.3	29.7	31.0
UI, CT	2.5	46.0	48.5

3.5 Avoided Environmental Compliance Costs

Introduction

In theory, the Societal Cost test, the TRC test and the PAC test should all explicitly account for the avoided costs of compliance with environmental regulations. It is now common practice to account for the cost of complying with *current* environmental regulations, such as the costs of purchasing SO2 and NOX allowances. However, it is much less common to fully account for the costs of complying with *forthcoming or future* environmental regulations. Failing to do so skews the cost-effectiveness evaluations against energy efficiency, can lead to significantly less energy efficiency than is cost-effective, and can result in customers paying for alternative environmental compliance options that are much more expensive than energy efficiency resources.

These avoided costs of environmental compliance should not be confused with avoided environmental externalities. Instead, these costs represent the anticipated costs that will be incurred by utilities in the future to comply with environmental requirements; costs that will eventually be passed on to ratepayers, and thus are clearly within the definitions of the TRC test and the PAC test, as well as the Societal Cost test.

Summary of Current and Anticipated EPA Regulations

The US Environmental Protection Agency (US EPA) has proposed and promulgated a number of environmental rulemakings that affect the operation of existing and new power plants under the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act.

The Clean Air Act is a comprehensive federal law that regulates air emissions from stationary sources such as chemical plants, steel mills, and electrical generators as well as mobile sources. Under this act, EPA sets emission standards for both stationary and mobile sources, and air quality standards that must be obtained by regions, states, and municipalities.

Emission standards directly affecting stationary sources, including power plants, issued under the CAA include: the mercury/air toxics standards; the cross-state air pollution rule; and new source performance standards.

At the state level, EPA has established and periodically revised National Ambient Air Quality Standards for criteria pollutants. In 2010, the EPA strengthened standards for NO_2 and SO_2, and is currently considering more stringent standards for ozone.

EPA has also proposed a few other environmental standards under the Clean Water Act and the Resource Conservator and Recovery Act that will have direct impact on the operation of existing power plants and factories, including the 316(b) cooling water rule; the waste water rule; and the coal combustion residuals rule.

The combined effect of these EPA regulations has led to some utilities announcing the retirement of several older, less-efficient fossil-fired power plants, and many more plant retirements are expected over the next five to seven years. Many fossil plants that do not retire will have to install expensive pollution abatement equipment and are likely to experience higher operating costs and reduced heat rates (RAP 2011c). These changes are likely to have significant effects on the avoided costs of energy efficiency programs (Synapse 2012).

Current and Anticipated Climate Change Initiatives

There are a variety of initiatives to curtail the emissions of greenhouse gas gases, at the federal, regional, state and local levels. These initiatives have important implications for the avoided cost of electricity, in the short-term and mid-term as well as the long-term.

At the federal level, despite a lack of action from the US Congress, the US EPA has been pursuing several approaches to address greenhouse gas emissions. On August 12, 2010, EPA proposed two rules to ensure that businesses planning to build new, large facilities or make major expansions to existing ones obtain New Source Review Prevention of Significant Deterioration (PSD) permits that address greenhouse gases. These rules became effective in early January 2011. On December 2011, US EPA announced that it will issue the New Source Performance Standards (NSPS) for new and modified electric power plants under section 111(b) of the Clean Air Act, and for existing electric power plants under section 111(d). On March 27, 2012, US EPA proposed the NSPS for new and modified power plants. This proposal essentially requires any new power plant to limit emissions to no more than 1,000 pounds of CO_2 per MWh, which is slightly more than the emissions from typical natural gas combined cycle power plants and far below the average emissions from coal power plants (Synapse 2012).

At the regional level, several states and provinces in North America have developed or have been developing multi-state climate initiatives including greenhouse gas caps and allowance trading to reduce greenhouse gas emissions. These regional efforts include North America 2050, which is a collaboration among several regional initiatives; the Regional Greenhouse Gas Initiative, which includes ten Northeast states; the Western Climate Initiative, which includes seven Western states and four Canadian provinces; and the Midwest Greenhouse Gas Reduction Accord, which includes six Midwest states and one Canadian province (Synapse 2012).

At the state level, many states are taking action to address climate change and reduce greenhouse gas emissions within their own borders. For several years states have been the innovative laboratories for climate change policies, and they are adopting a wide variety of policies across the nation. To date 43 states have adopted a greenhouse gas inventory and/or registry; 36 states adopted and two states are currently developing a state climate change action plan; and 22 states have established greenhouse gas emissions targets. Some states have adopted policies with significant limits on greenhouse gases, e.g., requiring reduction of CO_2 emissions to 80 percent of 1990 levels by 2050 (Synapse 2012).

Recommendations

<u>Accounting for EPA Regulations</u>

All states should recognize that the costs of compliance with current and anticipated EPA regulations must be included in the PAC, TRC, and Societal Tests in order for them to include all relevant impacts. These are costs that will be incurred by utilities and passed on to ratepayers, and therefore should be included in all of these tests.

Energy efficiency opportunities should be screened on a frequent, periodic basis, because energy efficiency resources may take several years to ramp up to the levels needed to economically respond to evolving EPA regulations or to replace or partially replace a retiring coal plant.

Program administrators should properly account for all current and anticipated future EPA regulations over time on a comprehensive manner, because this is likely to provide the most accurate reflection of the future and will lead to more efficient economic decisions than piecemeal analyses (RAP 2011c).

Those states that use some form of integrated resource planning for evaluating energy efficiency resources should properly address the issues related to the EPA regulations, including (a) fully accounting for energy efficiency in all coal plant retirement and refurbishment analyses; (b) properly accounting for the risk associated with EPA regulations, as well as coal plant retirements; and (c) properly accounting for the interactive effect of plant retirements.

Those states that use a more simplified avoided cost methodology for screening energy efficiency resources should properly address the issues related to the EPA regulations, including (a) ensuring that avoided costs properly consider the cost implications of all potential coal plant refurbishments and retirements; and (b) ensuring that avoided costs properly consider increased fuel, operation and maintenance costs associated with compliance with EPA regulations.

<u>Accounting for Climate Change Requirements</u>

All states should recognize that the costs of compliance with current and anticipated climate change regulations should be included in the PAC, TRC, and Societal Cost tests. These are costs that will be incurred by utilities and passed on to ratepayers through utility rates.

All states should recognize the importance of accounting for climate change compliance costs now. Uncertainty regarding the timing and size of those costs is not a good reason for inaction. Many energy efficiency resources have measure lives of 15 years, 20 years, or more. Supply-side resources have operating lives that are even longer. Resource decisions made in the near-term should be based on the best assumptions available about the conditions that will exist over these long time periods.

All states should establish energy efficiency screening methodologies that account for the cost of complying with federal climate change initiatives. If a state does not have its own forecast of federal CO_2 allowance prices, then it should rely upon publicly available forecasts.[18]

All states that have state-specific climate change requirements should account for the costs of complying with those requirements in screening energy efficiency programs. Ideally, states should use state-specific marginal greenhouse gas (GHG) abatement costs. In the absence of these, they should use reasonable proxies for the marginal GHG abatement costs.

Energy efficiency program administrators should account for all likely environmental compliance costs (e.g., climate change, EPA regulations, and others), as they can have significant cumulative effects. Furthermore, because energy efficiency may take several years to ramp up to desired levels, it is important to screen for energy efficiency opportunities on a frequent, periodic basis.

3.6 Price Suppression Effects in Wholesale Electricity Markets

In regions of the country with organized wholesale energy and capacity markets, energy efficiency resources will reduce energy and capacity demands, which then can lead to reduced wholesale energy and capacity prices. Because wholesale energy and capacity markets provide a single clearing price to all wholesale customers purchasing power in the relevant time period, the reductions in wholesale energy and capacity clearing prices are experienced by all customers of those markets. Thus, even a small reduction in a market clearing price can result in significant cost reductions across the entire market. This effect is referred to as the market price suppression effect (Synapse 2011c).

The market price suppression effect is expected to primarily occur over the short-term period after the demand response resource is called to operate. Over the long-term, when new physical capacity is needed to maintain the reliability of the system, the capacity price is likely to be set by the long-run marginal cost of new capacity and will hence be less sensitive to small reductions in demand. Even then, capacity prices could be lower with demand response than without because the long-run capacity supply curve is likely to have a lower slope. One of the challenges in estimating the impact of demand response on market prices is distinguishing between the short- and long-term market price impacts.

Note that the market price suppression effect should be considered a benefit in the RIM, PAC and TRC tests because it represents a reduction in costs to wholesale electric customers, which are passed on to retail electric customers. However, this effect should not be considered a benefit in the Societal Cost test because it represents a transfer payment from the generators that are displaced to the wholesale market customers.

[18] See, for example, forecasts prepared by the Edison Electric Institute and by Synapse Energy Economics (Synapse 2012).

3.7 Line Losses

Generating facilities are often located at great distances from customers and require step-up transformers to get the power onto the transmission system, long transmission lines, transmission substations, step-down transformers to distribution voltages, distribution lines, and distribution line transformers. Losses occur at each of these steps of the transmission and distribution system. Typical utility-wide average annual losses from generating plants to meters ranges from 6 percent to 11 percent, depending on the transmission distances, system density, distribution voltages, and the characteristics of the transmission and distribution system components (RAP 2011b, p.3).

Energy efficiency reduces loads at the customer premises, which removes the utility's requirement to supply these avoided demands with generating facilities, thereby reducing line losses. When regulators and utilities value efficiency investments in cost-effectiveness analyses, they often credit energy efficiency with avoiding the *average* losses, usually because they are a measured and published figure (RAP 2011b, pp. 1-3).

However, losses on utility transmission and distribution systems are not uniform throughout the day or the year. Additionally, efficiency measures generally contribute more to the reduction of peak demands than they do on average. Consequently, using average line losses understates the line losses avoided by energy efficiency (RAP 2011b, pp. 1 – 3).

Marginal line losses are the losses actually avoided when energy efficiency measures are installed, and are usually significantly larger than average line losses. Depending on the load shape of the utility, the percentage of generation that is lost before it reaches loads are typically at least twice as high as the average annual losses on the system. Further, line losses increase significantly during periods of peak demand on the electricity system; the time when energy efficiency measures typically provide significant levels of savings. During the highest critical peak hours (perhaps 5 to 25 hours per year) when the system is under stress, the losses may be four to six times as high as the average (RAP 2011b, pp. 1 – 4).

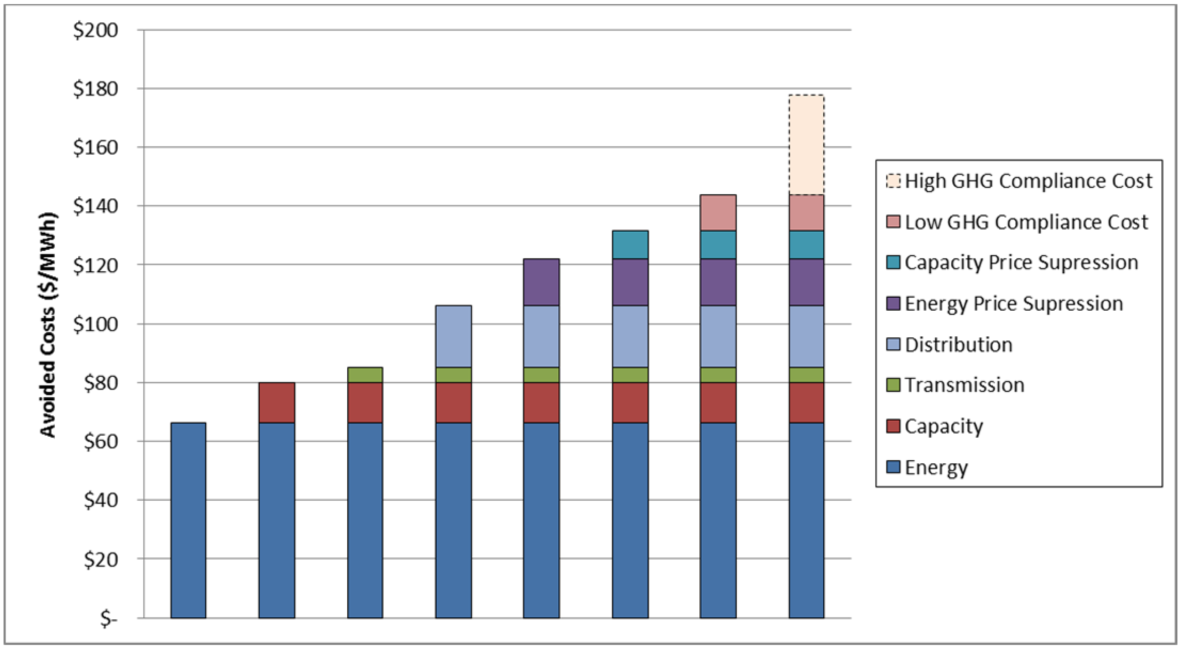
Marginal line losses require more information and more detailed calculations to measure than average losses, and few utilities or regulators have studied the marginal losses that can be avoided with incremental investments in efficiency measures that provide savings at the time of extreme peak demands. However, very significant benefits can result from measures that reduce peak demand, including energy efficiency, demand response, and use of emergency generators located at customer premises (RAP 2011b, pp. 1-5).

The bottom line is that energy efficiency measures typically provide significant savings at the time of the system peak demand, and that time occurs when the line losses are highest. Therefore, program administrators should use marginal line losses in efficiency cost-effectiveness screenings instead of average line losses. As a rule of thumb, utilities and regulators can assume that marginal losses are about 1.5 times average losses (RAP 2011b, p.5).

3.8 Illustrative Example

Figure 3.1 below provides an example of the cumulative effect of avoided costs, by presenting the costs broken out by type. These costs are levelized over 20 year for consistent comparison purposes. The right-most bar provides the total impact of avoided costs. These are the actual avoided costs that are used by our example electric utility (with the exception of the high GHG compliance cost). Additional information on these costs is presented in Appendix A.

Figure 3.1. Example of Avoided Costs, Broken Out by Component ($/MWh)



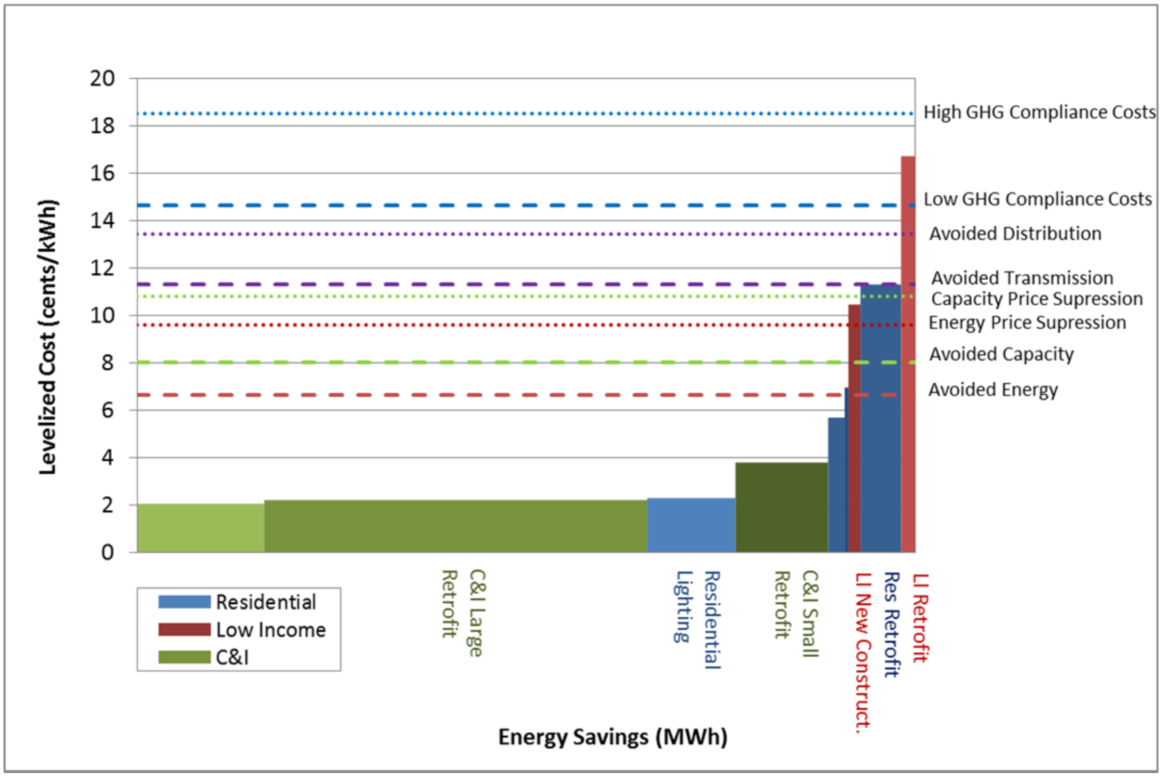
Source: Synapse 2011, as discussed in Appendix A.

For our purposes here, we present two versions of GHG compliance costs. The low GHG compliance cost is based on a forecast of CO_2 allowance prices under the current Regional Greenhouse Gas Initiative (in the short-term), as well as a forecast of CO_2 allowance prices under a future federal cap-and-trade requirement (over the long-term). This is the GHG compliance cost that is actually used by our example electric utility.

The high GHG compliance cost would be applicable to a state that has climate change regulations that are stricter than what is currently expected from current regional and future federal regulations. In particular, if a state has a requirement to reduce CO_2 emissions to 80 percent of 1990 levels by 2050, then it could expect to incur costs similar to those presented in Figure 3.1 for the high GHG compliance cost case. These estimates of GHG compliance costs are discussed in more detail in Appendix A.

Figure 3.2 provides the breakout of avoided costs superimposed over the 20-year levelized cost of saved energy for each program. (Refer to Figure 1.1.) The low GHG compliance cost line indicates the avoided cost cap that is currently being used by our example utility. As indicated, the programs are all well below this avoided cost cap, except for the low-income retrofit program which is cost-effective once the OPIs are factored in. Indeed, most programs are cost-effective relative to just the avoided energy and capacity costs. However, the additional avoided costs are necessary to support the economics of the residential retrofit and the low-income programs; two program types with important public policy implications.

Figure 3.2. Avoided Costs Relative to the Levelized Cost of Saved Energy (cents/kWh)



Sources: The avoided costs are discussed in Appendix A. The levelized program costs are actual 2010 program costs from our example New England electric utility.

4. Capturing All the Impacts of Energy Efficiency

4.1 Other Program Impacts

Description of Other Program Impacts

Other program impacts are those costs and benefits that are not part of the cost, or the avoided cost, of energy.[19] There is a wide range of other program impacts associated with energy efficiency programs. OPIs are categorized by the perspective of the party that experiences the OPI: the utility, the participant, or society at large.

Below we present a summary of the OPIs that have been identified for inclusion in cost-effectiveness tests. This list is not intended to be all-inclusive; instead it presents those OPIs that are most frequently cited in the literature and are expected to have a significant impact on energy efficiency program cost-effectiveness.

Utility-Perspective OPIs

Utility-perspective OPIs are indirect costs or savings to the utility and its ratepayers. These OPIs can be further divided into the following subcategories.

- Financial and accounting OPIs: From the utility perspective, a number of OPIs are realized from efficiency program implementation in the form of financial savings, nearly all of which arise from programs targeted to low-income customers. Energy-efficient technologies often result in reduced energy bills for participants, which can decrease the likelihood that customers experience difficulties with paying their utility bills. In turn, utilities realize financial savings through reduced costs associated with events such as arrearages and late payments (NMR 2011, p.4-1). These OPIs are often separately identified as the following: reduced arrearages, reduced carrying costs on arrearages (interest), reduced bad debt written off, and rate discounts (NMR 2011; Hall 2002).
- Customer service OPIs: Timely customer bill payments can result in fewer customer calls, late payment notices, shut-off notices, terminations, reconnections, and other collection activities. The utility realizes savings in staff time and material (NMR 2011, p.4-11).
- Safety Related OPIs: Utilities may realize savings from their efficiency programs due to a reduction in safety-related emergency calls and insurance costs due to reduced fires and other emergencies (NMR 2011, pp. 4-1, 4-15).

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[19] We use the term "other program impacts" to describe what are commonly referred to as non-energy impacts (NEIs) or non-energy benefits (NEBs). OPIs are those costs and benefits that are not part of the costs, or the avoided cost, of energy provided by the utility funding the efficiency program. In addition to non-energy impacts, OPIs also include "other fuel savings," which are the savings of fuels that are not provided by the utility that funds the efficiency program. For efficiency programs that are funded by electric utilities, the other fuels would primarily include gas, oil, propane and wood. For efficiency programs that are funded by gas utilities, the other fuels would primarily include electricity, oil, propane and wood. These other fuel savings are typically considered part of non-energy impacts, even though they actually involve energy savings. We have retitled NEBs and NEIs to OPIs to better represent the full range of impacts from efficiency programs.

Participant-Perspective OPIs

Participants in both low-income and non-low-income programs can realize a variety of OPIs from energy efficiency programs (NMR 2011, pp. 2-6, 5-1). These OPIs can be further divided into the following subcategories.

- Resource OPIs: energy efficiency can result in reduced water and/or sewage costs. Resource OPIs can also include heat (or lack thereof) generated by efficient equipment, as well as other fuel savings or costs (NMR 2011; SERA 2010).
- Equipment OPIs: participants often experience efficient equipment performing better than previous or inefficient equipment, resulting in reduced (or increased) maintenance costs, improved lighting quality, etc. (NMR 2011, pp. 5-13 – 5-15; SERA 2010).
- Property value: increased property value is frequently recognized as an OPI associated with program participation. The benefit of increased property value has been estimated through the value of anticipated ease of selling or renting, or in some cases, increased resale or rental value. The improved durability and reduced maintenance for the home is also taken into consideration (NMR 2011, p.5-16; SERA 2010).[20]
- Comfort: participants in energy efficiency programs commonly experience greater perceived comfort, either due to fewer drafts and more steady temperatures with HVAC equipment, or reduced noise from better equipment. Improved (or worsened) aesthetics can also be considered comfort OPI (NMR 2011, p.5-9; SERA 2010).
- Health and safety: energy efficiency programs may have direct impacts on health through improved home environments, reduced exposure to hypothermia or hyperthermia – particularly during heat waves and cold spells – improved indoor air quality, and potential reductions in moisture and mold, leading to amelioration of asthma triggers and other respiratory ailments. Reduced incidence of fire and carbon monoxide exposure are also commonly identified as safety-related benefits resulting from weatherization. Safety is also improved from better, more durable lighting equipment (NMR 2011, pp.5-30 – 5-34; SERA 2010; NZ EEAC 2012).
- OPIs for owners of low-income rental housing:[21] OPIs can accrue to owners of low-income rental properties, including marketability/ease of finding renters, reduced tenant turnover, increase in property value, equipment maintenance for heating and cooling systems, reduced maintenance for lighting, durability of property, and reduced tenant complaints (NMR 2011, pp.1-8, 7-1).

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[20] While increased property value is frequently cited as a significant benefit of home energy retrofit programs, some parties argue that the increased property value is primarily a function of the reduced utility bills and that to include both would be double-counting. We include this item in our list in order to be comprehensive, but caution that the property value NEI should only include those changes in property value that are not accounted for in the other categories of energy efficiency benefits.

[21] It is important to ensure that any impacts included in this category are not double-counting the impacts in other categories listed here (e.g., reduced maintenance, increased property value).

- Utility related OPIs: just as the utilities incur costs associated with making bill-related calls to payment-troubled participants or service terminations and reconnections, participants also incur opportunity costs of time spent addressing utility billing issues. Participants are impacted through reduced bill-related calls to utilities, greater control over their utility bills, reduced termination and reconnections, reduced transaction costs, and buffers against energy price increases (NMR 2011, p.5-45; SERA 2010; Hall 2002).
- Economic stability: low-income households spend a disproportionate amount of their income on energy costs, when compared to the population at large. Reducing energy costs decreases rates of mobility among low-income households, and allows income to be made available for other uses, such as healthcare (NMR 2011, p.5-19; SERA 2010).

Societal-Perspective OPIs

Societal-Perspective OPIs are indirect program effects beyond those realized by utilities, their ratepayers, or program participants, but accrue to society at large (SERA 2010, p.2). These OPIs can be further divided into the following subcategories.

- Environmental impacts: Electricity generation can have a variety of environmental impacts, including emissions of greenhouse gases, SO2, NOX, particulates, and air toxics; emissions of solid wastes; consumption of water; land use; mining impacts; aesthetic impacts and more. By reducing the need to generate, transmit and distribute electricity, energy efficiency can result in a variety of significant environmental benefits that will accrue to society as a whole (NMR 2011, p.6-1; SERA 2010).
- Economic development: efficiency programs can impact economic conditions such as employment, tax revenues, earnings, and economic output (NMR 2011, pp.6-1 – 6-4; SERA 2010).
- National security: a benefit of efficiency comes from reducing the need for energy imports, thereby enhancing national security (NMR 2011, p.6-6; SERA 2010).
- Healthcare: to the extent that energy efficiency programs can improve health and reduce health care costs, they provide a benefit to society. Examples include reduced hospitalization and visits to doctors due to reduced incidences of illness or reduced incidence rates of chronic conditions (NMR 2011, pp.6-3, 6-4; SERA 2010; NZ EEAC 2012).
- Recycling benefits: efficiency programs that include the recycling of old appliances can create benefits from waste reduction and reduced use of landfills (NMR 2011).

It is important to note that some OPIs can have benefits to more than one perspective. For example, reduced bill related calls save time and money for the utility and the participant, or improved health can affect a participant and reduce the societal costs of healthcare.

The Rationale for Accounting for Other Program Impacts

The decision of whether and how to include OPIs has significant implications for the cost-effectiveness of energy efficiency programs. As indicated in our example below, the inclusion of OPIs can sometimes make the difference between a program being cost-effective or not.

In theory, the different categories of OPIs should be included in those tests where the relevant costs and benefits are applicable. In other words, the Societal Cost test should include the utility-, participant- and societal-perspective OPIs because this test accounts for the impacts from all these perspectives; the TRC test should include the utility- and participant-perspective OPIs because this test accounts for the impacts on utilities and participants; and the PAC test should include the utility-perspective OPIs because this test accounts for the impacts on utilities and customer revenue requirements.

The primary rationale for including OPIs in the cost-effectiveness tests is to ensure that the tests are internally consistent. The whole premise of the tests is to assess the costs and benefits from different perspectives so that regulators and other stakeholders can consider the implications of the programs from those perspectives. If any one test includes some of the costs (or benefits) from one perspective, but excludes some of the costs (or benefits) from that same perspective, then the test results will be skewed, i.e., they will not provide an accurate indication of cost-effectiveness from that perspective. Test results that are skewed are misleading at best, and could lead program administrators to significantly under-invest or over-invest in energy efficiency. In some cases, the test results could be skewed so much as to render them meaningless.

This is especially important in the application of the TRC test.[22] By definition, the TRC test includes the participant's cost of the energy efficiency measure. In some cases, this cost can be quite large. In order for this test to be internally consistent, it must also include the participant benefits associated with the energy efficiency measure, including other program benefits. Excluding the participant-perspective OPIs from the TRC test will provide cost-effectiveness results that are skewed against energy efficiency, will result in under-investment in energy efficiency programs, and will result in higher costs for all customers on average.

Many regulators and other stakeholders are understandably concerned that including OPIs when screening energy efficiency programs is too comprehensive in that it includes costs and benefits that are outside of the regulators' primary objectives. More specifically, many stakeholders are concerned that including other program benefits will require utility customers to pay increased rates in order to achieve certain benefits (e.g., improved health, safety and comfort for participants) that should not be supported with ratepayer funding. This concern is understandable and is a critical consideration that should be made when deciding which cost-effectiveness test to apply and how to apply it. We address this issue in Section 2.4.

It is important to recognize that this issue of scope (i.e., whether to include impacts on participants) arises at the point when a commission (or legislature) decides on which test to use as the primary screening test. If the TRC test is chosen as the primary test, then the commission (or legislature) is making an explicit or implicit decision to include costs to participants, which are typically outside the scope of regulators' primary objectives in the same way that other program benefits are outside that scope. Once this decision is made, the scope is established (i.e., impacts on both non-participants and participants); then it is necessary to determine how to maintain internal consistency within this scope.

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22 This is also important for the Societal Cost test. Here we focus on the TRC test because of its widespread use.

Among the participant-perspective OPIs that should be included in the TRC test, there are two types that deserve mention at this point: low-income other program benefits, and other fuel savings. First, these two types of OPIs tend to have the biggest impact on the cost-effectiveness of certain programs. This is demonstrated in our illustrative example below.

Second, these two types of OPIs tend to support important public policy goals of regulators and other stakeholders. Low-income other program benefits are vital because they help justify programs that serve an important, hard-to-reach, disadvantaged set of customers. Other fuel savings are important because they help justify comprehensive residential retrofit and residential new construction programs that are designed to treat multiple fuels in customers' homes. Combined, these OPIs help to support much more comprehensive residential programs and to serve a more diverse set of residential customers, which promotes greater customer equity, both within the residential sector and between the residential and other sectors. Promoting customer equity is clearly an important public policy goal of regulators. Consequently, we recommend that regulators place priority on finding ways to account for at least these two participant-perspective OPIs.

The Application of Other Program Impacts in Practice Today

As described in Section 2.1, a recent survey by ACEEE provides a summary of how the cost-effectiveness tests are used across the states. The study finds that, while 36 states use the TRC test (which includes participant costs) as their primary test, only 12 of those states treat any type of participant non-energy benefits as a benefit (ACEEE 2012, p.31).

Of those states that do include non-energy benefits, most of them were limited to water and other fuel savings. Only two states quantify a benefit for participant operation and maintenance savings, and no state quantifies benefits for things like comfort, health, safety, or improved productivity in their primary benefit-cost test (ACEEE 2012, p.32).

This survey clearly documents the fundamental imbalance in how the TRC test is often applied today; where many states account for the participant costs of efficiency measures, but few of them account for the full participant benefits. In sum, the majority of states currently conduct cost-effectiveness tests that are inherently skewed against energy efficiency.

Regulatory Options for Addressing Other Program Impacts

There are several options available for including OPIs in energy efficiency cost-effectiveness screening. The states that account for OPIs, as discussed above, typically quantify those OPIs that are readily measureable. This is especially true of low-income programs. A few states take the analysis further by allowing for an adder, allowing for BCRs less than 1.0, or conducting a scenario analysis.[23] Using the current approaches as a starting point, below we identify the possible methods to account for OPIs in cost-effectiveness screening.

- Include all relevant OPIs: Develop quantitative estimates of all OPIs, with a focus on those OPIs that are expected to be most relevant and most significant. In

[23] See Synapse 2012 for additional details on how some states address OPIs in efficiency screening.

theory this approach would produce the most accurate representation of OPIs. The challenges and uncertainties of quantifying OPIs are frequently cited as reasons for not including them in energy efficiency screening. We note that these challenges and uncertainties exist for many aspects of utility regulation and planning, including estimates of avoided costs that form the heart of energy efficiency screening. Some states have been able to develop quantitative estimates of OPIs that are sufficiently reliable for planning purposes.[24]

- Readily measurable OPIs only: Develop quantitative estimates of those OPIs that are readily measurable. This is a practical approach because several OPIs are readily measureable without significant time or financial commitments.[25] However, it may fail to capture the full range of OPIs, depending upon the resources and time dedicated to the effort.

- Sensitivity analysis: Consider cost-effectiveness results with varying ranges of OPIs included. For example, New York regulators are provided with benefit-cost ratios that include a range of OPIs; from zero OPIs, to half of the readily measurable OPIs, to all of the readily measurable OPIs. This approach assists regulators in understanding the range of effects that OPIs can have on benefit-cost ratios, and may help to address concerns about uncertainty in the OPI values. However, this method could require a more qualitative analysis, thus removing the benefit of a "bright line" metric afforded by the use of a cost-effectiveness test.

- Adder: Apply an adder to the efficiency program benefits to reflect all the OPIs. The adder would be used to represent the full range of other program benefits that accrue to customers. Higher adders could be applied to low-income programs to reflect the higher level of OPIs that are likely to accrue to low-income customers. Adders could be applied at the measure, program, sector, or portfolio levels. Overall, this is a simplified approach that does not require extensive evaluation activities. On the other hand it may be seen as too much of an approximation, and determining an appropriate adder may be difficult.

- Reduced Benefit-Cost Ratio Threshold. Apply a lower benefit-cost threshold than 1.0 to efficiency programs, especially for programs that are expected to have significant OPIs. This approach has a similar effect as applying an adder to account for OPIs; an adder can be converted into a lower threshold and vice-versa. Using an adder has the benefit of being more transparent and avoiding the need to change energy efficiency screening thresholds or apply different thresholds for different programs.

- Hybrid: A combination of the various options could be employed to create a hybrid approach. For example, a state could include all readily measurable OPIs, and use an adder for hard to measure OPIs. As discussed above, Vermont uses an adder for OPIs in addition to readily measurable OPIs, while Colorado requires an adder but also allows for readily measurable OPIs. Further, a state could include readily measurable OPIs, and conduct a sensitivity analysis for additional OPIs. This approach is most consistent with the nature of OPIs, whereby some OPIs are easily and readily quantified, while others require

[24] See, for example, NMR 2010.
[25] For additional information on methodologies for quantifying OPIs, see SERA 2010 and NMR 2010.

a more qualitative analysis on the potential range of impacts that accrue to customers from efficiency programs. Additionally, this method affords regulators flexibility in determining the most appropriate OPI policy for their state. Finally, it allows consideration of all NEIs believed to be most significant, with the choice of methodology used to determine each NEI being made on the basis of available resources.

There is one other option that is sometimes proposed to address this issue. The participant cost could be broken into two portions: one portion that is related to energy savings, and one portion that is related to participant other program benefits. Under this approach, the TRC test would include only that portion of participant cost that relates to energy savings (CAPUC Staff 2012; CAPUC 2012b). In this way, the scope of the TRC would include only energy-related costs and benefits: those of the program administrator and those of the participating customers.

Recommendations

All states that use the PAC test for screening energy efficiency should properly account for the utility-perspective OPIs in their cost-effectiveness analyses.

All states that use the TRC test for screening energy efficiency should properly account for utility-perspective and participant-perspective OPIs in their cost-effectiveness analyses. If a state is unwilling to account for participant-perspective OPIs, then the TRC test should not be used for energy efficiency screening purposes because this will lead to misleading results that are skewed against energy efficiency. In the absence of participant-perspective OPIs, the PAC test is the best test to use in screening energy efficiency.

Similarly, all states that use the Societal Cost test should properly account for utility-, participant- and societal-perspective OPIs in their cost-effectiveness analyses.

The TRC or Societal Cost test (including OPIs) should be applied at the program level, while the PAC test should be applied at the portfolio level to ensure that utility customers will experience lower utility costs as a result of the energy efficiency programs. This concept is discussed in more detail in Section 2.4.

Each state should develop an approach for accounting for OPIs that best suits their needs. We recommend that each state should do the following:

- Identify all of the OPIs that are relevant for the energy efficiency programs offered, and the screening test used, in the state.
- Develop quantitative estimates for all OPIs that can be readily quantified. At a minimum, this should include the other fuel savings, because these savings can be relatively easily quantified using forecasts of the prices for those fuels.
- Develop some methodology for addressing those OPIs that are not quantified, e.g., by using an adder to the benefits as a proxy. If the state does not develop quantitative estimates for the low-income other program benefits, then at a minimum these benefits should be addressed through some proxy approach.
- Hire independent contractors to develop the best state-specific OPI estimates possible. The money required for this type of research could come from program administrator's evaluation, monitoring and verification budgets.

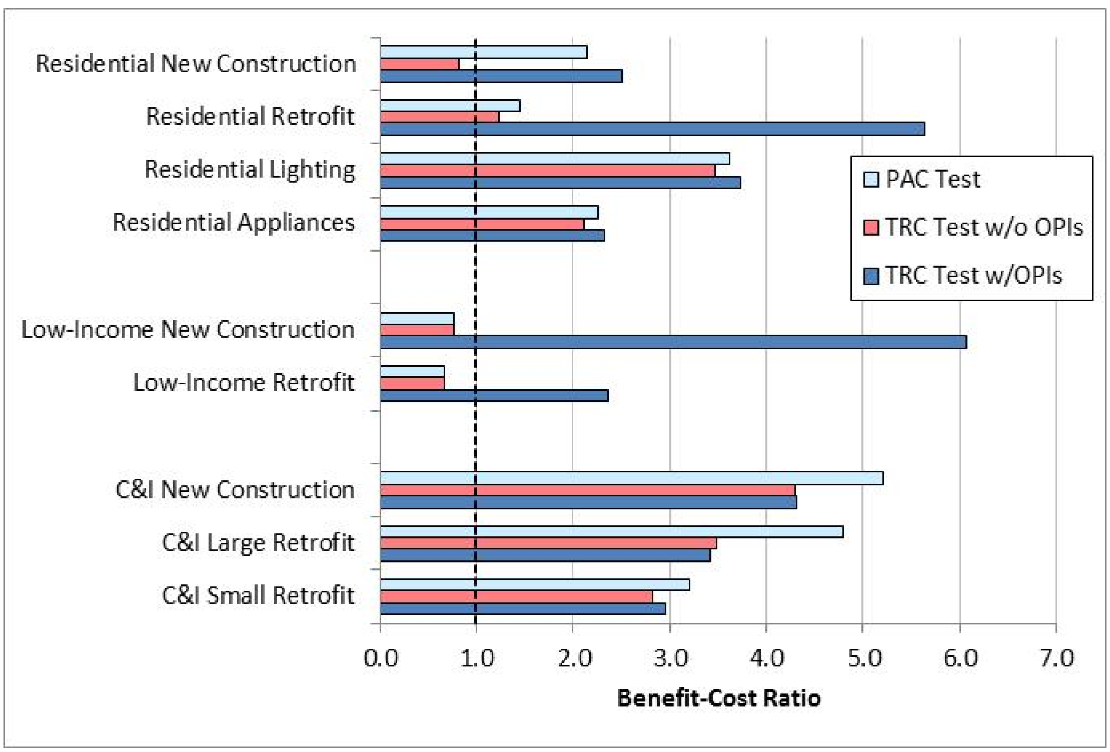
Illustrative Example

Figure 4.1, provides the benefit-cost ratios under the PAC test, the TRC test with OPIs included, and the TRC test without OPIs included for our example utility. The OPIs that we use here are the ones that are currently in use by Massachusetts energy efficiency program administrators (NMR 2010).

First, it is interesting to note the difference between the results under the PAC test relative to the TRC test without OPIs. The low-income programs are identical under these two tests because the customers are not required to make any contribution toward the incremental cost of efficiency measures. The C&I programs are more cost-effective under the PAC test than the TRC test, because customers contribute towards the incremental efficiency measure cost, and the OPIs for C&I programs are assumed to be relatively small.

Second, it is interesting to note the difference between the results under the TRC test with and without OPIs. The low-income programs are much more cost-effective with the OPIs included because of the low-income other program benefits and the other fuel savings. The residential new construction and retrofit programs are much more cost-effective with the OPIs included because of the other fuel savings. These two OPIs (low-income other program benefits and other fuel savings) account for the vast majority of the differences between the cases with and without OPIs.

Figure 4.1. Cost-Effectiveness Analysis for OPIs



Source: The 2012 energy efficiency plan for our example utility, with modified assumptions as noted.

With regard to C&I programs, there are very few OPIs applied to the C&I sector. This may be primarily due to the fact that this sector has not been studied as much as the residential and low-income sector, since C&I programs tend to be highly cost-effective without OPIs.

4.2 Free-Riders, Spillover and Market Transformation

Background

In assessing the cost-effectiveness of energy efficiency programs, program administrators and regulators have sought to identify "net" impacts of the efficiency programs on energy savings. This is so called "net savings", which is the savings net of what would have occurred in the absence of the program.

This approach attempts to isolate savings impacts not directly or indirectly caused by the program. Net savings theoretically include free-riders and spillover, the estimation of which has been historically challenging and controversial especially because it requires identifying the counter-factual as a baseline (i.e., what would have happened in the absence of the program). Nevertheless, many states use a net savings approach because utility regulators wish to know the net impacts of efficiency programs when assessing their cost-effectiveness.

Recently, there has been lively debate on net savings of energy efficiency programs because the audiences for energy savings estimates have grown to include new stakeholders and regulators, especially air regulators with the expectation that energy efficiency efforts may contribute to significant greenhouse gas emissions reduction, while long-standing audiences have increased their scrutiny of net savings estimates, largely in response to increased funding and expanded regional goals for energy savings and reduced emissions (NMR 2010, page 9).

Definitions

There are various parameters that adjust gross energy savings such as realization rates, measure persistence, installation rates, hours of use, free-rider, spillover, and rebound effects. The two key factors that influence the calculation of net savings are free-rider and spillover effects. Market transformation effects can be considered a type of spillover effect.

Free-rider: "A program participant who would have implemented the program measure or practice in the absence of the program. Free riders can be 1) total, in which the participant's activity would have completely replicated the program measure; 2) partial, in which the participant's activity would have partially replicated the program measure; or 3) deferred, in which the participant's activity would have completely replicated the program measure, but at a future time than the program's timeframe." (NMR 2010, page 6)

Spillover: "Reductions in energy consumption and/or demand caused by the presence of an energy efficiency program, beyond the program-related gross savings of the participants and without financial or technical assistance from the program. There can be participant and/or nonparticipant spillover. Participant spillover is the additional energy savings that occur when a program participant independently installs energy efficiency measures or applies energy saving practices after having participated in the efficiency program as a result of the program's influence. Non-participant spillover refers to energy savings that occur when a program nonparticipant installs energy efficiency measures or applies energy savings practices as a result as a result of a program's influence. Additional distinctions may also be made to spillover such as "like" or "unlike" spillover (the former refers to the same measure as the program, while the latter refers to other actions taken as a result of program participation) and "inside" and "outside" of the project (the former referring to non-incented measures taken within the same project that had received an incentive while the latter is adoption of non-incented measures in an unrelated project)."(NMR 2010, page 7)

Market Transformation Program: "An energy efficiency program strategy that leads to a reduction in market barriers resulting from a market intervention, as evidenced by market effects that last after the intervention has been withdrawn, reduced or changed." (NEEP 2009, p.22)

There is also another factor called "rebound" effect that influences the net energy savings. The rebound effect describes an effect where consumers increase the level of energy service due to lower cost of energy usage resulting from more energy efficient measures. Our study will focus on free-rider and spillover and will not discuss the rebound effect in our study for two reasons. First, the literature on this topic indicates that the rebound effect from energy efficiency programs is minimal (Synapse 2011a; Nadel 2011; Ehrhardt-Martinez and Latiner 2010). Second, historically free-rider and spillover effects have been the major focus on net savings.

Current Practice

Recent surveys by NMR (2010), ACEEE (2012), and LBNL (2010) revealed the "operational" definitions and methods for measuring net savings are different by jurisdiction. In general, the surveys found that some states only include free-ridership, some states include both free-ridership and spillover, and some states do not include either (See Table 4.2). Many states adjust for free ridership, but a fewer states adjust for spillover. Even where spillover is used, it is limited to a few cases in some states.

ACEEE makes the following points:

> In current practice, substantial differences exist among states in things like the treatment and measurement of free riders, spillover, net savings, deemed savings, and non-energy benefits. These differences make it difficult to interpret comparisons among states in reported energy efficiency results, and preclude the ability to make true "apples to apples" comparisons. - We explored the net savings issue in a little more detail, and asked whether states made specific adjustments for "free riders" and "free-drivers/spillover." Interestingly, while 28 states (67%) indicated they make an adjustment for free-riders, only 17 states (44%) make an adjustment for free-drivers/spillover. (ACEEE 2012, p.33).

Aside from what factors are included in net savings measurements, we note that there are various methods to measure the effect of free-rider and spillover effects or net to gross savings or ratios, including, but not limited to (a) self-reporting surveys, (b) enhanced self-reporting surveys, (c) market sales data analysis, (d) historical tracing (case study method), (d) structured expert judgment, (d) econometric modeling, and (e) deemed or stipulated estimates (NMR 2010, page 27 – 32; NAPEE 2007, 5-4 – 5-7). Finding the most appropriate method depends on (1) the structure of the energy efficiency program; (2) the availability of market sales data and meaningful comparison groups; and (3) the likelihood of substantial upstream effects (e.g., effects at the manufacture and distributor level (MA DPU 2011, page 10).

Table 4.2. Market Influences and Program Effects Included in Estimates of Net Savings

State	Free-ridership	Spillover/ Market Effects
CA	Yes	Yes in few cases
CT	Yes	Yes in some cases
FL	Yes	Yes
IA	No	No
ID	No	No
IL	Yes	Yes
MA	Yes	Yes
ME	Yes	No
MN	Yes	No
NEEA	No	No
NY	Yes	Yes
OR	Yes	Yes
PA	No	NA
TX	No	No
WI	Yes	Yes in few cases
Total Yes	10	8

Source: NMR 2010, Table 2-2.

Major Issues

NMR recently conducted an extensive survey of net energy savings through a literature review and stakeholder interviews. This study found that the accurate measurement of free ridership and spillover remains challenging despite continual improvement in methods (NMR 2010, page 12). In fact, because there are now numerous programs offered by multiple entities to promote energy efficiency programs (e.g., utility programs, federal tax credits, ARRA funding), it is becoming more complex and difficult to isolate the impact of one program from others, which, some argue, reduces the accuracy of the recent net savings estimates (NMR 2010, p.49).

NMR (2010) summarizes the current practice of measuring net savings as follows:

- Focuses too heavily on narrowly defined metrics of individual program success or failure—especially free ridership—while deemphasizing other important impacts, such as non-energy benefits and behavioral effects, as well as portfolio and policy-level impacts. (NMR 2010, page 18)
- Creates the impression that the estimates accurately represent the savings attributable to the program when, in reality, the methods available often yield results that may not accurately represent actual program-induced savings due to shortcomings related to bias, reliability, and validity because estimating net savings requires "measuring" the counterfactual as a baseline. (NMR 2010, page 18 and 33) This issue includes the difficulty in measuring cumulative spillover effects over time from the programs implemented in the previous years as well as the potential failure to account for any synergistic impacts of the portfolio of programs (NMR 2010, page 35-36). To make matters worse,

spillover from program activity in previous years may be identified as free ridership in the current program year. (NMR 2010, page 34)

- Requires large expenditures of resources that are not in keeping with the importance of the estimates and their reliability and validity, thereby diverting resources from other planning, evaluation, and implementation activities that could yield greater benefits. (NMR 2010, page 18)
- Some parties argue that "the focus on minimizing free ridership is counterproductive and greater savings could be achieved if the focus were on maximizing outreach and not on avoiding outreach to the "wrong people" (i.e., free riders)" (NMR 2010, page 44).

However, NMR (2010) also found that many stakeholders still emphasize the importance of the use of net savings because net savings allow us to assess the effectiveness of various program designs and whether the designs should be replicated, expanded, revised, or discontinued. It also allows us to ensure that ratepayer or taxpayer funds are being spent responsibly and in a manner that ensures that efficiency is the lowest-cost resource (NMR 2010, 18).

Finally, market transformation programs present a distinct challenge with regard to cost-effectiveness screening. These programs are explicitly designed to achieve savings beyond the direct program impacts (i.e., spillover effects); savings that might not occur for several years, might last for many years beyond that, and might be very difficult to quantify. Screening these programs without accounting for their spillover effects would clearly understate their true value and would preclude many valuable programs from proceeding. The options for addressing this issue include: (a) allowing these programs to be implemented even if they do not have a benefit cost ratio of one or greater; (b) including the costs and benefits of these programs within the evaluation of other related programs, and requiring that the combined program be cost-effective; or (c) developing an adder to the estimated benefits to best represent the likely spillover effects of the market transformation program.

Recommendations

We recommend that program administrators and other stakeholder place less emphasis on free-ridership and greater emphasis on spillover and market transformation effects, in order to achieve more balance between these effects. In addition, all of these effects should be accounted for in a more timely and effective manner as part of program process evaluation, in order to inform whether a program should be redesigned or replaced as a result of these effects. [26]

We recommend that free-riders be treated consistently in estimating both the costs and benefits of energy efficiency programs. If the impacts of free-riders are subtracted from the efficiency savings, then the impacts of free-riders should be subtracted from the cost estimates as well.

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[26] In Massachusetts, the state regulator, utilities, and other stakeholders are currently investigating this issue, and trying to develop ways to estimate net savings that achieve three core benefits (1) increased reliability and accuracy in reporting program-delivered savings (which also capture multi-year impacts from program efforts in the multi-year planning cycle); (2) better planning assumptions for program strategies; and (3) increased administrative efficiency (MA Joint Comments 2012)

We recommend that program administrators and other efficiency stakeholders explore options to better capture the cumulative, long-term effects of energy efficiency programs. Programs that are highly successful in educating customers about the advantages of energy efficiency will naturally encourage those customers to adopt additional efficiency measures in the future. Expected savings from such customers should be estimated to the extent possible, and accounted for in screening efficiency programs.

We recommend that market transformation programs be evaluated in a way that accounts for the fact that they will have significant spillover effects by design. One way to achieve this goal is to allow market transformation programs to be implemented even if they do not pass the TRC test, but to include their costs and benefits in the PAC test applied at the portfolio level.

Finally, we recommend regional coordination on the definition and calculation of net savings. As we pointed out above, the operational definitions and methods for measuring net savings are very different by jurisdiction. More consistency on the net savings definition and calculation may be needed to address current policies and/or future policies such aggressive state-wide energy efficiency programs, an ISO capacity market, and regional GHG emissions reduction requirements. The Northeast Energy Efficiency Partnership's Forum on regional energy efficiency measurement and verification is a good example of using a regional approach to address these issues.

4.3 The Risk Benefits of Energy Efficiency

Energy Efficiency Offers Several Important Risk Benefits

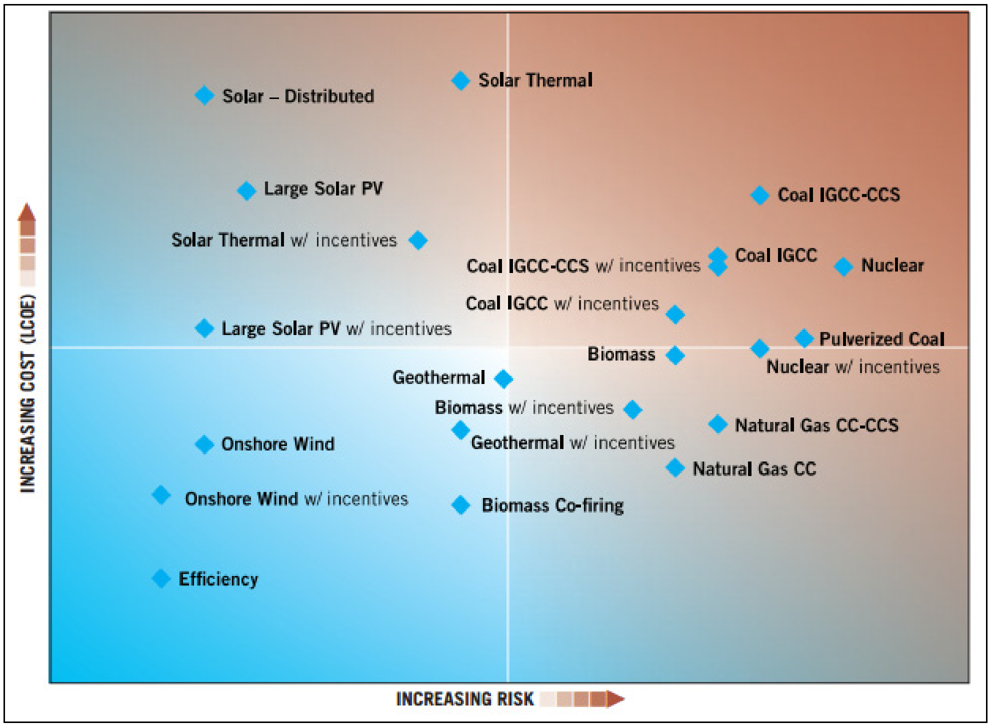
Energy efficiency can mitigate the various risks associated with large, conventional power plants. A recent study evaluated the costs and risks of various energy resources, and found out that energy efficiency is the least cost and least risky electricity resource (Ceres 2012). Figure 4.2 provides a summary of how the Ceres study characterizes the costs and risks associated with various electricity resources. Some of these key risks are described below.

Fuel price risk. Increases in fuel price volatility underscore the significant benefits associated with reducing this risk. Historically, varying demand for and supplies of natural gas and the highly volatile nature of natural gas prices have been primary drivers of more volatile electricity rates.

Construction Cost Risk. The longer development timelines associated with conventional generation as compared to energy efficiency solutions exposes these resources to longer-term increases in the cost of labor and materials – unanticipated cost increases which increase the risk of disallowance and stranded costs. For example, the construction schedule of the proposed Levy nuclear power plant in Florida has been delayed five years due to financial and design problems and its cost estimates has increased from $5 billion to $22.5 billion.[27] In contrast, energy efficiency can be deployed quickly and is one of the least risky resources, both financially and environmentally.

[27] http://www.businessweek.com/ap/financialnews/D9HQ2TN80.htm

Figure 4.2. Projected Utility Generation Resources in 2015 – Relative Cost and Risk



Source: Ceres 2012, p.9.

Planning risk. When it turns out electric demand growth is lower than expected, there is a risk that a portion of the capacity of new power plants may be unused for a long time. In January 2012, lower-than-expected electricity demand along with unexpectedly low natural gas prices, led Minnesota-based wholesale cooperative Great River Energy to mothball its brand-new coal-fired power plant immediately after the plant's completion. The utility expects to pay an estimated $30 million next year just for maintenance and debt service for this plant (Ceres 2012, page 33). Energy efficiency resources that reduce load incrementally never face this type of problem.

Reliability risk**.** Energy efficiency can improve the overall reliability of the electricity system. First, efficiency programs can substantially reduce peak demand, during those times when reliability is most at risk. Second, by slowing the rate of growth of electricity peak and energy demands, energy efficiency can provide utilities and generation companies more time and flexibility to respond to changing market conditions, while moderating the "boom-and-bust" effect of competitive market forces on generation supply (RAP 2001). Lastly the operating risk of a large power plant (i.e., forced outage) can be catastrophic while the operating risk of energy efficiency is minimal because a large power plant could lose the entire energy supply while energy efficiency could lose only a small portion of its expected energy savings.

New regulation risk. Fossil fuel and nuclear power plants have a risk of facing new regulation that makes them more costly or uneconomic. For example, the nuclear safety regulation is likely to become stricter due to the recent accident at Fukushima in Japan, which could increase the operating or construction cost of nuclear power plants (Ceres 2012). The new and proposed US EPA air regulations have already revealed numerous coal-fired power plants that are likely to become uneconomic and retire. AEP recently announced the retirement of its coal-fueled power generation totaling nearly 6,000 megawatts.[28] Further there is a high likelihood that some form of carbon regulations will be enacted at the federal level, which will increase the cost of fossil fuel power plants. In contrast, energy efficiency is not subject to any of these expected regulations and laws, and in fact reduces the level of such risks associated with such power plants to the extent of the energy displaced by efficiency.

Water constraint risk. Electric power plants use about 40 percent of all US freshwater withdrawals, especially for cooling the power plants.[29] In recent years we are experiencing more severe droughts in regions like the Southeast and Southwest. In 2008, Tennessee Valley Authority's nuclear reactor Brown Ferry in Alabama had to shut down its operation because of water shortage as well as the restrictions on the temperature of the discharged coolant.[30] The US electric system is facing a significant risk that a large number of power plants relying on water cooling may need to shut down due to water shortage during the summer peak when energy is most needed. This risk increases with global warming. Energy efficiency is not subject to water constraint risk, and can eliminate or reduce this risk to the extent it can avoid the use of conventional power plants.

Accounting for Risk Benefits in Integrated Resource Planning

The Northwest Power and Conservation Council (NWPCC) has been assessing and developing plans for the future of energy resources in the Northwest region every five years. Risk assessment and management has always been one of the most important elements of the NWPCC's Power Plans. Since the first Power Plan, it has analyzed the value of shorter lead times and rapid implementation of energy efficiency and renewable. Starting in the Fifth Power Plan in 2005, the NWPCC extended its risk assessment and incorporated other risks such as electricity risk uncertainty, aluminum price uncertainty, emission control cost uncertainty, and climate change (NWPCC 2005).

The NWPCC addressed risk by evaluating numerous energy resource portfolios against 750 futures. Risk of one portfolio is measured using a metric called TailVaR90, which is essentially the average value for the worse 10 percent of outcomes. The average value of a portfolio is the most likely cost outcome for the portfolio.

Using these two statistics, the NWPCC develops a chart that compares the risk and the average cost of each portfolio. Figure 4.3 provides an illustrative example of this analysis. The set of points corresponding to all portfolios is called a feasibility space, and the left-most portfolio in the feasibility space is the least-cost portfolio for a given level of risk. The line connecting the least cost portfolios is called the *efficient frontier*, which allows the NWPCC to narrow their focus, typically to a fraction of one percent of these portfolios. NWPCC calls this entire approach to resource planning "risk-constrained, least-cost planning." (NWPCC 2010, pp. 9-5 to 9-6)

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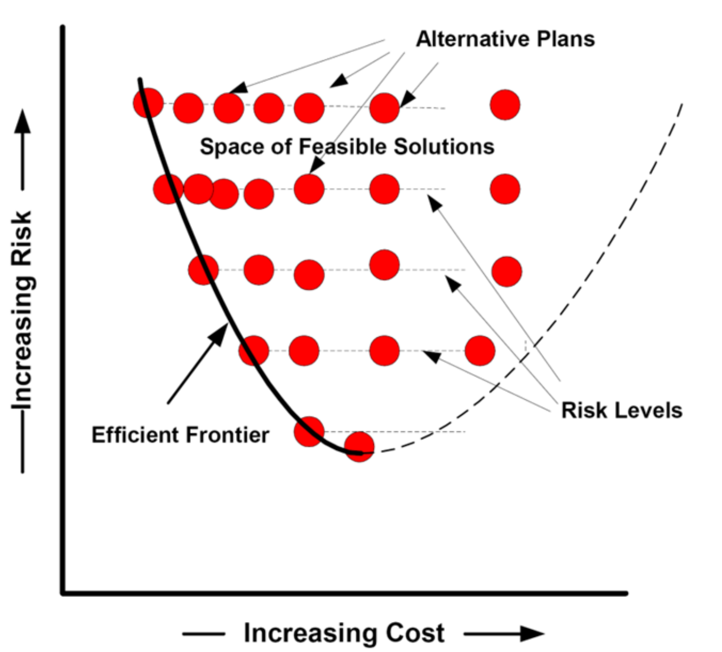
[28] http://www.aep.com/newsroom/newsreleases/?id=1697
[29] http://pubs.usgs.gov/circ/1344/pdf/c1344.pdf
[30] http://www.msnbc.msn.com/id/22804065/ns/weather/t/drought-could-shut-down-nuclear-power-plants/#.T-N_8hdYuM8

Figure 4.3. Efficient Frontier of Feasibility Space



Source: NWPCC 2005, p.6-13.

The NWPCC's Power Plans have historically found that energy efficiency is the most valuable resource for the region in its risk-constrained, least-cost planning. The NWPCC states this point as follows:

> The Council's power plan addresses the risks these uncertainties pose for the region's electricity future and seeks an electrical resource strategy that minimizes the expected cost of, and risks to, the regional power system over the next 20 years. Across multiple scenarios considered in the development of the plan, one conclusion was constant: the most cost-effective and least risky resource for the region is improved efficiency of electricity use … In each of its power plans, the Council has found substantial amounts of conservation to be cheaper and more sustainable than most other types of generation. In this Sixth Power Plan, because of the higher costs of alternative generation sources, rapidly developing technology, and heightened concerns about global climate change, conservation holds an even larger potential for the region … The plan finds enough conservation to be available and cost-effective to meet 85 percent of the region's load growth for the next 20 years. (NWPCC 2010, page 3)

Other Options to Account for Risk Benefits

Options for accounting for risk benefits when using avoided costs for screening include: using a cost adjustment factor, an additional risk hedge value, adjusting the discount rates, and applying a qualitative approach.

Some states account for this benefit of energy efficiency directly in their screening criteria. For example, Vermont applies a 10 percent cost adjustment factor to its energy efficiency program screening to account for the risk benefits. In this process, costs of efficiency measures are decreased by 10 percent.

Oregon also applies a 10 percent cost adjustment factor, which is applied differently into the efficiency program cost screening. The 10 percent adjustment factor is added to the cost of avoided electricity supply to provide advantages for efficiency and conservation measures. This adder represents the various benefits (such as risk mitigation, environmental benefits, and job creation) of energy efficiency in general that are not reflected in the market. The NWPCC advocated the use of the adder and the Oregon PUC has mandated it in its order UM551.

In addition to this type of cost adjustment factor, the Energy Trust of Oregon, and the statewide energy efficiency provider in the state, has applied some risk hedge values developed by the NPWCC to the benefit of energy efficiency. The NPWCC in its Fifth Power Plan conducted an analysis of energy efficiency programs as a hedge against risks associated with high power prices or marked exposure. The Power Plan found that additional conservation measure above the cost-effectiveness threshold lower system cost without adding risk. Specifically, the Council identified $5/MWh of risk avoidance for discretionary programs (i.e., retrofit) and $10/MWh of risk avoidance for lost opportunity programs (i.e., new construction program) to be the optimal additional values above the cost-effectiveness threshold to screen out cost effective DSM measures because such thresholds resulted in the reduction in the total cost and risk for each plan (ETO 2005; Braman 2009).[31] The Energy Trust of Oregon is currently revisiting this issue and planning to use the hedge values developed by two local investor owned utilities, PacifiCorp and Portland General Electric in their most recent IRPs (Gordon 2012).

Recommendations

Efficiency screening practices should properly account for the risk benefits of energy efficiency, either through system modeling or through risk adjustments to the energy efficiency benefits.

[31] Energy Trust of Oregon 2005. Risk Avoidance Value for Energy Efficiency, a summary of Risk Avoidance Value in the 5th Power Plan prepared for the Energy Trust of Oregon staff, November 2005; Personal communication with Matt Braman at the ETO on January 15, 2009

5. Efficiency Screening Methodological Issues

5.1 Discount Rate

The choice of discount rate to use for calculating present values of costs and benefits has significant implications for the cost-effectiveness of energy efficiency programs, because program costs are typically incurred in the first years while program benefits are enjoyed for the life of the energy efficiency measure. This section describes the rationale for which discount rate should be applied when screening energy efficiency programs, for each of the standard cost-effectiveness tests.

The Goal of Discounting

Financial analysis of investments in energy efficiency should account for the fact that an energy efficiency initiative typically consists of an upfront investment in a structure or an end-use piece of equipment, which is expected to provide returns, in the form of energy savings, over a number of years. In order to compare costs and benefits that occur over a number of years, the various cash flows (i.e., the initial investment and the annual savings over the measure life) must be compared in a consistent way, usually as a present value expressed in the dollars of a common reference year.

There is nothing special about energy efficiency in this regard; this challenge exists for analyzing any long-lived investment. Economic and financial theory generally acknowledge that a monetary benefit provided in a given year is more valuable than the same monetary value delivered in a later year.

There are three commonly accepted reasons for this. One is inflation, which almost always causes a dollar in a future year to have less purchasing power than a dollar in an earlier year. The second reason is time preference; economic theory holds that people simply value benefits in the present more than the same benefit in the future, at least with respect to monetary benefits. The farther out in the future an expected benefit, the more such a person would prefer a present benefit. The third reason is risk; future monetary benefits from an investment are rarely guaranteed. The promise of a monetary benefit in a future year has less value than an actual monetary benefit in the current year due to the risk that the future benefit may not occur or may be less than expected.

Accounting for Inflation

This part of the discounting is relatively straightforward, and requires a forecast of inflation rates for the term of the project life. One option is to use an econometric forecast, e.g., from an economic forecasting firm. Another common approach is to use the historical long-term inflation rate or the average inflation rate for a period of recent years. Either way, the assumed inflation rate can be used to turn each year's costs and savings into so-called "real dollars" or "constant dollars." Typically, a project's start year or a base year for a utility's other forecasting efforts would be chosen.

The choice of whether to use a "real" discount rate or a "nominal" discount rate depends upon the inflation assumptions that are used in the annual costs and benefits of the efficiency cost-effectiveness analysis. It is important that consistent assumptions are used throughout. If the annual costs and benefits include the effects of inflation (i.e., are in nominal dollars), then the discount rate should be in nominal terms. If the annual costs and benefits are net of inflation (i.e., are in real dollars), then the discount rate should be in real terms.

Accounting for the Time Value of Money

This is the time preference issue mentioned above. Suppose that an investor is offered a guaranteed return for investing funds. What would that return have to be to attract investments? Certainly it would have to cover the anticipated rate of inflation, but that will usually not be sufficient. Most people would rather have something today than the same thing in a year. Some extra return will be required.

This extra return is usually called a "risk free discount rate," because it assumes there is no risk associated with future benefits. (Risk will be discussed next.) In principle, such a risk free discount rate measures how much the decision maker on a given project values money this year versus next year. Note that the time value of money will be very different for different decision makers. This point will also be discussed below.

Accounting for Risk

Adjusting for risk is the most difficult part of discounting. Again, the risk adjustment depends on the perspective of the decision maker. Perhaps the simplest case is that where the decision maker is a utility's management. The source of an investor-owned utility's investment funds is a combination of bond investors and equity investors, possibly including some preferred stockholders. Utility investments are typically discounted at the weighted average cost of capital (WACC), i.e., the weighted average yield of the company's bonds and preferred stock along with its allowed return on equity. When applying WACC for discounting, it is important to keep in mind that these values come from markets that factor in all three issues: estimated inflation rates, time value of money, and perceived riskiness of investing in the utility.

Application to the Cost Benefit Tests

While it is important to understand the economic theory underlying the application of discount rates, it is also important to recognize that the choice of discount rate is ultimately a policy call by the utility regulators. The choice of discount rates should be informed by considering which party is being affected and what is the time value of money for that party, but it should also be informed by considering how much weight the regulators want to give to the future costs and benefits associated with energy efficiency programs (especially benefits, because these occur well into the future).

Discount Rate for the Societal Cost Test

The Societal Test, as its name implies, should use a discount rate based on society's preferences. Compared to individuals and firms, society should have a broader tolerance for receiving benefits in the future, and also be better able to access funds at a lower borrowing cost. In this case, the discount rate should be relatively low.

Energy efficiency investments for special groups of customers, particularly low income and at-risk populations could also be viewed with a societal discount rate for several reasons. These customers are generally receiving some degree of support from society at large, so the investment can appropriately be viewed in a societal context. It is society investing in society, and should be analyzed using a discount rate appropriate to society as a whole.

The social discount rate should reflect the benefit to society as a whole, and should also take into account both the reduced risk of energy efficiency investments, as well as society's reduced time preference for a societal payback. This social discount rate is typically the lowest discount rate that reflects increased value in future savings. The Societal Cost test also includes environmental externality costs, which should arguably be discounted at a very low discount rate, if at all.

Discount Rate for the PAC and TRC Tests

The purpose of the TRC and PAC tests is to compare energy efficiency investments with the decision-maker's other investment options. Historically, the discounting challenge was relatively straightforward for these tests: the primary decision maker was the utility, and its WACC was used. (See, for example, NAPEE 2008, p.4-8.) This was seen as treating energy efficiency investments comparable to investments in supply-side resources, assuming that consumers would be paying the same cost of capital on any utility investment.

More recently, it has become clear that there are significant differences in the financial risks associated with supply- and demand-side resource investments. Energy efficiency investments are typically funded by a system benefit charge or a balancing account in utility rates. In either case, there is little risk to the utility associated with these investments because they are passed directly on to customers independent of utility operations, utility performance or other risk factors. Consequently, an energy efficiency investment is less risky than a supply-side investment on a purely financial basis, in addition to being less risky with regard to planning, construction and operation. Therefore, a lower discount rate than the WACC (i.e., a risk-adjusted discount rate) should be used in applying the PAC test or the TRC test.

This lower risk also exists in those instances where a third party administers the energy efficiency programs (e.g., Delaware, Hawaii, Maine, New York, Oregon, Vermont). In these cases, the utility WACC would clearly not be an appropriate discount rate, because that rate does not represent the time value of money to the third-party administrator. The discount rate for third-party administrator programs should be low for the same reason that discount rates for utility-administered programs funded by system benefits charges should be low: there is very little financial risk associated with the funding source, since there is no long-term financing involved.

One option for developing a lower, risk-adjusted discount rate is to remove some, or all, of the risk premium and time preference embedded in the utility's WACC. This could be achieved by comparing the utility's financial risk profile to that of other companies with lower risks or with other market indicators of low-risk investment rates.

Another option is to use a more generic, market indicator of a low-risk investment. For example the interest rates on US Treasury Bills are widely regarded as a good indication of low-risk investments. We are aware of at least three states that use the interest rates on US Treasury bills as a low-risk discount rate for assessing the cost-effectiveness of energy efficiency programs (ODC 2012; MADPU 2010; Efficiency ME 2009).

We recommend that states use the interest rates on long-term (e.g., 10-year) US Treasury Bills as the discount rate for the PAC and the TRC tests. This indicator is widely accepted as representing low-risk investments, is straightforward, is transparent and is readily available. It also means that different utilities in a single state will use the same discount rates across the state, as it eliminates the need to develop utility-specific risk-adjusted discount rates.

Discount Rate for the Participant Test

The Participant Test considers whether an energy efficiency investment is cost effective from the program participant's point of view. This test should be used principally to set an incentive level that would be sufficient to make consumers implement efficiency measures. A consumer's discount rate should be used to discount the costs and benefits in this test.

However, choosing a consumer's discount rate is administratively and theoretically complicated as different customers have different discount rates. There is considerable uncertainty over what the reference point should be, as some consumers have home equity credit available, but some only have access to credit card type debt with a much higher cost.

For residential customers, energy efficiency programs are generally of lower risk than almost any investment the household can make, but immediate needs tend to put pressure on household capital, making borrowing rates also a factor. These points suggest that home equity loan or home mortgage rates might be appropriate, especially in new construction and remodeling programs, with higher credit card rates being more applicable to participants in low income programs.

For commercial and industrial customers, a reasonable cost of borrowing proxy could be local commercial lending rates or a prime rate plus an adder for non-prime businesses, e.g., a prime rate plus three percent. For large entities with internal capital rationing, it would be appropriate to use the firm's internal rate of return hurdle rate or its internal payback requirement.

Discount Rate for the RIM Test

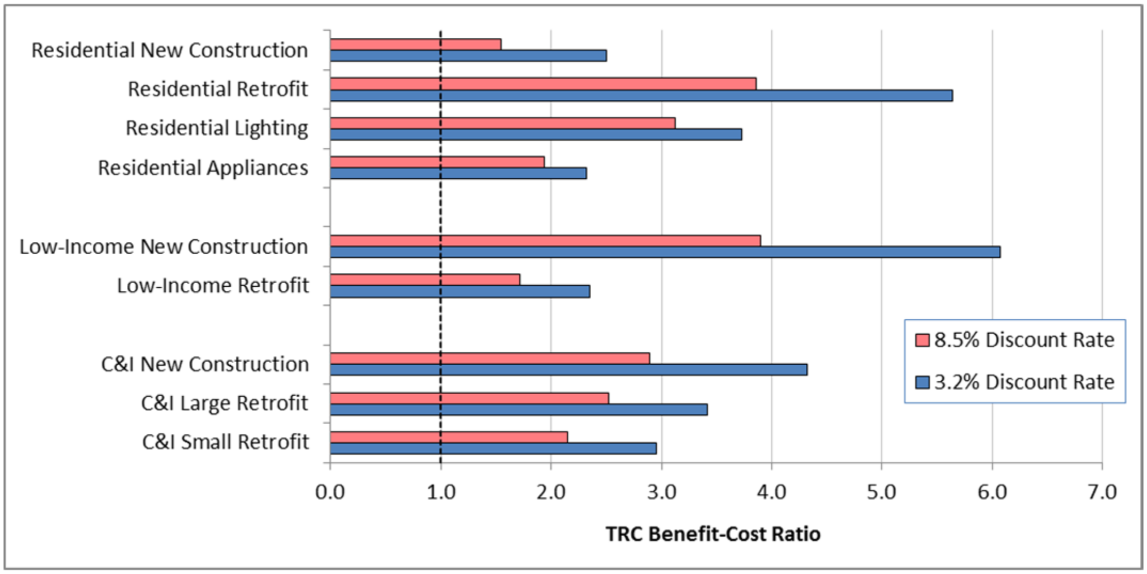
Discounting is a side issue for the RIM test because the key goal of this test is to indicate the effect of energy efficiency programs on retail rates. The utility WACC may be appropriate for this purpose because this is the borrowing cost that ultimately determines utility rates.

Illustrative Example

Figure 5.1 summarizes the impact on program cost-effectiveness when using different discount rates. The blue bars present program cost-effectiveness using a nominal discount rate of 3.2 percent, which is our example utility's actual discount rate for energy efficiency screening, based on 10-year US Treasury Bills. The red bars represent program cost-effectiveness using a high discount rate of 8.5 percent, roughly equal to a utility's after-tax WACC.

This figure illustrates that a higher discount rate will reduce program cost-effectiveness, especially for programs with longer measure lives. As discussed above, the new construction programs typically have longer measure lives than other energy efficiency programs, and so discounting the savings from such programs at a higher rate will have a greater negative impact on program cost-effectiveness than for measures with shorter lives.

Figure 5.1. Cost-Effectiveness with Different Discount Rates



Source: The 2012 energy efficiency plan for our example utility, with modified assumptions as noted.

5.2 Study Period

Energy efficiency measures produce savings over the full course of their useful lives. Depending on the measure, the useful life can be as long as 20 years or more. Energy efficiency screening practices should include the savings available over the full life of the energy efficiency measure. This requires using a study period that is long enough to capture savings over their full useful lives. Shorter study periods will skew the cost-effectiveness results against energy efficiency.

Ideally, a study period of at least 25 years should be used to evaluate the cost-effectiveness of energy efficiency resources, given that some energy efficiency measures affect existing and new buildings and thus can last at least 30 years. After 30 years the effect of discounting significantly reduces energy efficiency benefits, even in cases where relatively low discount rates are used, and thus there is little advantage to using a study period beyond 25 years.

If, for some reason, program administrators do not have the inputs or the models to account for 25 years, then other methodologies should be used to capture the benefits in the years that are not included in the study period. For example, "end effects" calculations can be made to adjust the benefits that are derived using a shortened study period.

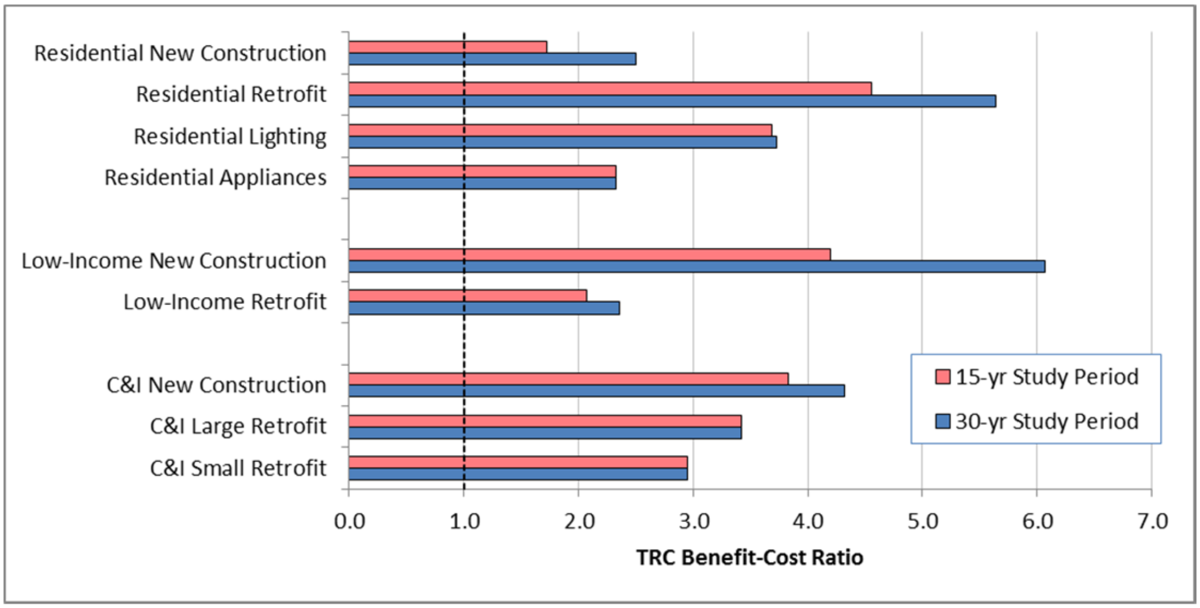
If there is reasonable data regarding the degradation of measure performance, or about early failure of energy efficiency measures, then these factors should be accounted for separately in the program screening process by adjusting the savings or the lifetime assumptions for the measure.

Illustrative Example

Figure 5.1 below provides an example of program cost-effectiveness using two different study periods. The blue bars represent the results for the base case, where the study period is 30 years. This is the actual study period used by our example New England utility. (However, the measure lives used in this example only extend to 25 years, so the effective study period is 25 years.) The red bars represent the resulting benefit-cost ratios if the study period is limited to 15 years.

The low-income new construction program's cost-effectiveness is most affected by this adjustment, moving from a benefit-cost ratio greater than 6.0, to a benefit cost ratio closer to 4.0. The majority of savings in this program, and in the residential and C&I new construction programs, result from measures with lives between 19 and 25 years. Ignoring the savings that accrue in the later years of a measure's life negatively impacts the program's cost-effectiveness, especially for new construction and retrofit programs.

Figure 5.2. Program Cost-Effectiveness Using Different Study Periods



Source: The 2012 energy efficiency plan for our example utility, with modified assumptions.

5.3 Screening Level

Cost-effectiveness tests can be applied at different levels in the energy efficiency portfolio of activities. In general, there are three levels to evaluate cost-effectiveness when planning energy efficiency programs: the "measure" level, the "program" level, and the "portfolio" level. Evaluating cost-effectiveness at the measure level means that each individual component (i.e., measure, equipment, or other action) of an efficiency program must be cost-effective. Screening at the measure level is the most restrictive application of the cost-effectiveness tests, and can create a barrier to greater savings levels. (NAPEE 2008, pp.3-9, 3-10).

Evaluation at the program level means that collectively the measures under a program must be cost-effective, but some measures can be uneconomical if there are other measures that more than make up for them. While non-cost-effective measures may reduce a program's overall cost-effectiveness, the program administrator may be able to achieve greater overall savings through the combination of measures. Additionally, a measure may not be cost-effective on its own, but may become cost-effective when combined with other efforts.[32] (NAPEE 2008, pp.3-9, 3-10).

Evaluating cost-effectiveness at the portfolio level means that all of the programs taken together must be cost-effective, but individual programs can be positive or negative. This is the most flexible application of cost-effectiveness testing, as program administrators have the ability to experiment with different strategies and technologies that may not be immediately cost-effective or require further testing, such as pilot programs, market transformation programs, or emerging technologies. (NAPEE 2008, pp. 3-9, 3-10).

A recent ACEEE report surveyed states on the level at which program administrators screen for cost-effectiveness. The most prevalent responses to the question of "what level" the benefit-cost tests are applied were: the "portfolio" level (30 states, 70%) and the "program" level (30 states, 70%), although nearly half of those states noted that they had some expectations at the program level (e.g., low-income programs, pilot programs, etc.) where the benefit-cost test was not required or waivers were granted. Thirteen states (30%) applied their benefit-cost test requirements at the measure level, and a majority of those states provide exceptions for things like low-income programs and/or situations where measures can be bundled together into a cost-effective package of measures (e.g., certain "whole house" type programs). (ACEEE 2012, p.31).

Finally, it is important to note that in addition to screening energy efficiency programs for planning purposes, it is also possible to screen energy efficiency programs at the point of implementation, i.e., "field screening." Field screening can be applied during the process of auditing homes and businesses for retrofits, and may be important to provide customers with assurance that certain efficiency measures will be appropriate to the unique conditions of their building. The best test to use in field screening is the Participant Cost test, because this test indicates which efficiency measures the customer should adopt and what the customer benefits of those measures will be.

The TRC test should not be used for field screening energy efficiency measures, for several reasons. First, it is especially difficult to properly account for other program impacts at the measure level for each building; and without the OPIs the TRC test will be skewed against the energy efficiency measures. Second, measure level field screening does not account for the interactions between measures, particularly the benefits that one measure might have in encouraging customers to adopt other measures. Third, experience has demonstrated that measure-level field screening is overly restrictive, can exclude measures that are cost-effective to customers, increases the transaction costs of contractors and customers, creates lost opportunities, and hinders the goal of achieving comprehensive, whole-house efficiency savings.

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32 Summing up the benefits of multiple measures at the program level may require some adjustment for what are known as "interactive effects" between related measures. Interactive effects occur when multiple measures installed together affect each other's impacts. When measures affect the same end use, their combined effect when implemented together may be less than (or more than) the sum of each measure's individually estimated impact. (ACEEE 2008, p.3-10).

Recommendation

Energy efficiency programs should not be screened at the measure level, because this is overly restrictive and ignores the important interactions between measures, especially the fact that some measures that might not be cost-effective on their own but might nonetheless have important benefits in terms of encouraging customers to participate in programs or adopt other measures.

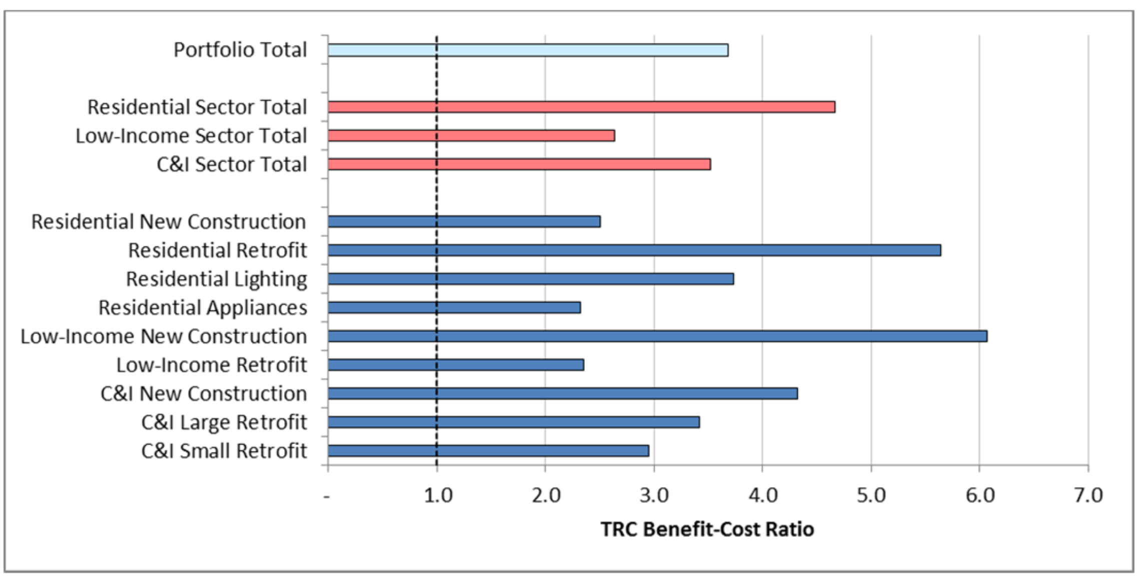
As noted above, we recommend that energy efficiency programs be screened at the program level using the TRC test or the Societal Cost test, and that the entire portfolio of programs be screened using the PAC test. This allows regulators to balance the goal of achieving key public policy objectives (through the use of the TRC test or the Societal test), with the goal of ensuring a net reduction in costs to customers (through the PAC test).

When energy efficiency contractors screen efficiency measures in the field, the Participant Cost test should be used, to provide the customer with relevant information regarding which measures to adopt. The TRC test should not be used for field screening energy efficiency measures.

Illustrative Example

Figure 5.3 presents cost-effectiveness at the program level, sector level, and portfolio level for our example New England utility. While each screening level indicates that the energy efficiency activities are robustly cost-effective, the figure demonstrates that programs or sectors with lower cost-effectiveness can be absorbed by programs or sectors that are more cost-effective. For example, the low-income sector has a benefit-cost ratio of about 2.6, while the residential sector has a benefit-cost ratio of about 4.7, and the C&I sector has a benefit-cost ratio of about 3.5. On average, at the portfolio level of screening, the sectors produce a benefit-cost ratio of about 3.7.

Figure 5.3. Cost-Effectiveness at Different Screening Levels



Source: The 2012 energy efficiency plan for our example utility, with modified assumptions.

6. Summary of Recommendations

Here we provide a summary of the recommendations made above. We recognize that most states have an established set of practices that have been developed with considerable effort and stakeholder input over time, and that some states might have good reasons for adopting an approach that is different than what makes sense for other states. Nonetheless, we urge regulators and other stakeholders to consider these recommendations as opportunities to improve upon current practices where appropriate.

Tests for Screening Energy Efficiency Programs

We recommend that the Societal Cost test be used to screen energy efficiency programs. If a state chooses to use the Societal Cost test, the test should account for utility- participant- and societal-perspective OPIs to the greatest extent possible.

We recommend that all states that choose not to rely on the Societal Cost test use the TRC test to screen energy efficiency programs. If a state chooses the TRC test, the test should account for OPIs to the greatest extent possible.

If regulators are unwilling to account for OPIs, the TRC test should not be used for screening energy efficiency programs. In the absence of participant OPIs, the PAC test is the best test to use in screening energy efficiency.

We recommend that the PAC test be applied to the entire portfolio of efficiency programs, to ensure that the entire portfolio of programs will result in a net reduction in revenue requirements and a net reduction in costs to utility customers.

The RIM test should not be used in screening energy efficiency programs for cost-effectiveness. Instead, efficiency program administrators should take steps to (a) analyze rate and bill impacts in a fashion that provides much more information than what is available from the RIM test; (b) design programs in a way that mitigates rate impacts without sacrificing energy efficiency savings; and (c) work to increase the number of program participants so as to mitigate the equity concerns between participants and non-participants.

Best Practices

Regardless of which test is used, it is crucial that states apply the cost-effectiveness tests appropriately. Accordingly, we recommend the following best practices designed to ensure that tests are implemented in a way that achieves the underlying objective of the test, is internally consistent, accounts for the full value of energy efficiency resources, and uses appropriate planning methodologies and assumptions. These practices include the following.

Calculation of Avoided Costs

Avoided energy and capacity costs should be based on long-term forecasts that properly capture the energy and capacity impacts of energy efficiency resources, account for the structure of the market in which the relevant utility operates, and captures differences in hourly and seasonal peak periods.

Efficiency program screening should account for avoided transmission and distribution costs, distinguishing between those costs that can be deferred or avoided through energy efficiency and those that cannot. Avoided transmission costs should be based on forecasts of future transmission activity, as opposed to historical activity, especially in regions of the country that anticipate significant increases in transmission investments.

The avoided costs of compliance with environmental regulations should be explicitly accounted for in the Societal Cost test, the TRC test and the PAC test. This should include costs associated with compliance with current and anticipated environmental regulations from the US Environmental Protection Agency. This should also include costs associated with compliance with current and anticipated federal, regional and state initiatives to curtail the emissions of greenhouse gases.

Efficiency program screening should also account for the price suppression effects, in those regions of the country that participate in competitive wholesale electric markets. Even a small reduction in a market clearing price can result in significant cost reductions across the entire market.

Efficiency program screening should also properly account for electricity transmission and distribution losses. The estimate of losses should be based on marginal losses.

Capturing All the Impacts of Energy Efficiency

Each state that uses the TRC test or the Societal test should (a) identify all of the OPIs that are relevant for the energy efficiency programs offered in the state; (b) develop quantitative estimates for all OPIs that can be readily quantified; (c) develop some methodology for addressing those OPIs that are not quantified; and (d) pay particular attention to the OPIs that are unique to low-income customers. States should hire independent contractors to develop the best state-specific OPI estimates possible.

Efficiency screening practices should properly account for free-riders, spillover effects and market transformation. These effects should be estimated and accounted for in a manner that is timely, consistent and comprehensive. Programs that are expected to have significant market transformation impacts should be provided with greater flexibility in the screening process.

Efficiency screening practices should properly account for the risk benefits of energy efficiency, either through system modeling or through risk adjustments to the energy efficiency benefits.

Efficiency Screening Methodological Issues

The discount rates that are applied to the TRC test and the PAC test should reflect the fact that energy efficiency investments pose lower risks to the utilities relative to supply-side investments. We recommend the use of a generic market indicator of a low-risk investment such as the interest rate on long-term US Treasury Bills.

Energy efficiency screening practices should account for the savings available over the full life of the energy efficiency measure.

Energy efficiency programs should not be screened at the measure level. We recommend that energy efficiency programs be screened at the program level using the

TRC test or the Societal Cost test, and that the entire portfolio of programs be screened using the PAC test.

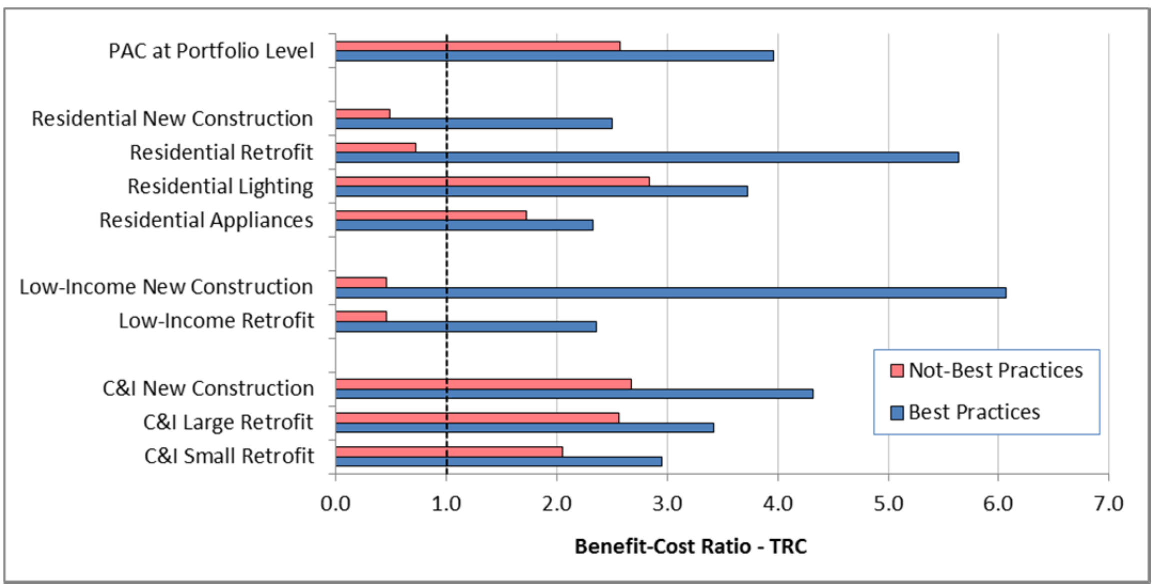
When energy efficiency measures that are screened in the field, they should be screened using the Participant's Cost test, to provide the customer with relevant information regarding which measures to adopt. The TRC test should not be used for field screening energy efficiency measures.

Illustrative Example

Figure 6.1 provides an illustration of how different methodologies and assumptions can affect the cost-effectiveness of energy efficiency programs. We return to the screening results for the programs that we have presented above, using the benefit-cost ratios of the TRC test.

In Figure 6.1 the best practices case (blue bars) includes all the avoided costs described above in Section 3 (except for the high environmental compliance costs), the other program impacts that are used in Massachusetts as described in Section 4.2, a risk-adjusted discount rate of 3.2 percent, and a study period of 30 years to capture all or most of the efficiency measure lives. In contrast, the not-best practices case (red bars) includes all the same assumptions except that an 8.5 percent discount rate is applied, measure lives are capped at 15 years, and all other program impacts are excluded.

Figure 6.1. Cost-Effectiveness Under Best Practices and Not-Best Practices



Source: The 2012 energy efficiency plan for our example utility, with modified assumptions.

As the figure illustrates, cost-effectiveness is reduced significantly when poor screening practices are applied. The low-income programs are most affected by poor efficiency practices primarily because the OPIs are excluded. The residential new construction and retrofit programs are also heavily affected, primarily because the other fuel savings are not accounted for. While this illustration may seem like an extreme example, there are states that use the TRC test without including OPIs, states that use a discount rate based on WACC, and states that limit the study period to less than 30 years.

Checklist of Best Practices

Here we present a checklist for regulators and other stakeholders to use to determine how comprehensively they are accounting for the value of energy efficiency resources.

Do the energy efficiency screening policies and practices in your state:

- Use a screening test that includes the desired scope?
- Apply the screening test in a way that is internally consistent?
- Include the utility-perspective other program impacts in the PAC test?
- Include the participant-perspective other program impacts in the TRC test?
- Include the societal-perspective other program impacts in the societal cost test?
- Properly account for avoided energy costs?
- Properly account for avoided capacity costs?
- Properly account for avoided T&D costs?
- Properly account for price suppression effects?
- Properly account for avoided environmental compliance costs from current and anticipated future regulations?
- Properly account for marginal line losses?
- Include a societal discount rate for the societal cost test?
- Include a low-risk discount rate for the PAC and TRC tests?
- Properly account for spillover effects, as well as free-riders?
- Screen market transformation programs in a way that accounts for their spillover effects?
- Include considerations for the risk benefits of energy efficiency?
- Include a study period that is as long as the longest lived energy efficiency measure?
- Screen programs at the program level?
- Use the Participant's Cost test for field-level screening?

If you answered no to any of these questions, then your state may be understating the value of energy efficiency, and customers in your state may be paying more than necessary for electricity and gas.

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Appendix A – Illustrative Example and Avoided Costs

Introduction

Throughout this paper we have referenced an actual New England utility's energy efficiency programs and screening results, in order to demonstrate the implications of the different screening practices. We have relied on the same utility in each of the examples discussed in the body of the report, and have based each example on the utility's actual efficiency programs, including its projected (or actual where pertinent) budget, savings, benefits, and other assumptions.

This Appendix provides a more complete background on that utility's efficiency programs, as well as the avoided cost assumptions included in its cost-effectiveness analysis. Each of these topics is discussed in more detail below.

Program Descriptions

The report focuses on nine of the utility's programs that are common to efficiency programs in many states. This New England utility actually administers more programs than those discussed in the report, such as a behavioral-based program. By restricting the analysis to these nine programs, our intention is to focus on a core set of programs that are typically offered in states, rather than provide a comprehensive analysis of program portfolios. The identified programs and a brief description of each program's purpose are provided below.

- Residential Retrofit: the purpose of this program is to provide residential customers with energy efficiency recommendations that enable them to identify and initiate the process of installing cost-effective energy efficiency upgrades. The program provides information through outreach mechanisms, incentives, and multiple financing options.
- Residential New Construction: the purpose of this program is to capture lost opportunities, encourage the construction of energy-efficient homes, and drive the market to one in which new home are moving towards net-zero energy.
- Residential Appliances: the purpose of this program is to raise consumer awareness of the benefits of energy-efficient ENERGY STAR-qualified consumer products, encourage consumers to purchase qualified appliances and consumer electronics, promote higher efficiency standards for products, and to help customers reduce energy bills by replacing or recycling inefficient products.
- Residential Lighting: the purpose of this program is to increase consumer awareness of the importance and benefits of purchasing ENERGY STAR-qualified lighting products and expand the availability, consumer acceptance, and use of high-quality energy-efficient lighting technologies and controls.
- Low-Income Retrofit: the purpose of this program is to deliver energy efficient products and services directly to the homes of income eligible customers to help them lower their energy bills to achieve deeper and broader energy savings.

- Low-Income New Construction: the purpose of this program is to capture lost opportunities, encourage the construction of energy-efficient homes, and drive the market to one in which new homes are moving towards net-zero energy.
- Small Commercial and Industrial (C&I) Retrofit: this program focuses on comprehensive gas and electric energy efficiency opportunities associated with mechanical, electrical, and thermal systems in existing commercial, industrial, governmental and institutional buildings. It provides technical assistance and incentives to encourage retrofitting of equipment that continues to function, but is outdated and inefficient, and can be replaced with a premium efficient product.
- Large C&I Retrofit: this program focuses on comprehensive gas and electric energy efficiency opportunities associated with mechanical, electrical, and thermal systems in existing commercial, industrial, governmental and institutional buildings. It provides technical assistance and incentives to encourage retrofitting of equipment that continues to function, but is outdated and inefficient, and can be replaced with a premium efficient product.
- C&I New Construction: this program is designed to optimize the efficiency of equipment, building design and systems in new construction and renovation of commercial, industrial, institutional and government facilities. The focus is on offering a comprehensive set of electric and gas efficiency options that are specific to the needs of each unique facility. The program also targets the brief window of opportunity to install premium grade replacements when equipment fails or is near the end of its useful life.

Avoided Costs Assumptions

Introduction

The avoided cost assumptions used by the New England utility are based on Synapse's Avoided Energy Supply Costs in New England: 2011 Report (AESC Study). The AESC Study provides projections of marginal energy supply costs that will be avoided due to reductions in the use of electricity, natural gas, and other fuels resulting from energy efficiency programs offered to customers throughout New England (Synapse 2011).

The AESC Study provides estimates of avoided costs for program administrators throughout New England to support their internal decision-making and regulatory filings for energy efficiency program cost-effectiveness analyses. Ultimately, the relevant regulatory agencies in each state specify the categories of avoided costs that program administrators in their states are expected to use in their regulatory filings, and approve the values used for each category of avoided cost.

Avoided Energy Costs

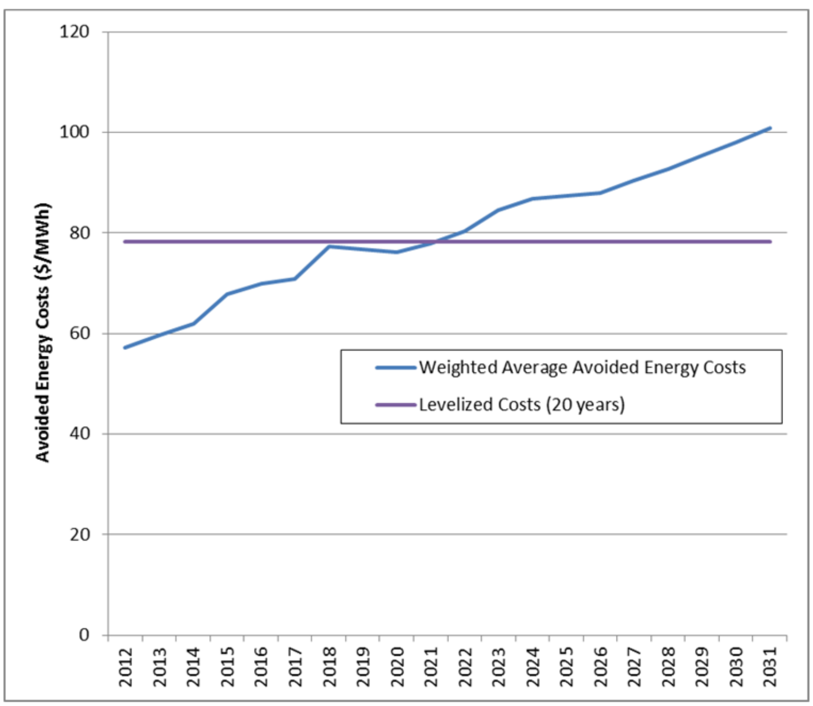
Electric energy costs are avoided by efficiency programs due to a reduction in the annual quantity of electric energy that utilities and competitive suppliers are obligated to acquire for their customers. Therefore, avoided electric energy costs are an estimate of the value of a reduction in annual electric energy use by retail customers. In New England, the competitive, wholesale market determines the value of avoided energy costs.

In general, the fundamental assumption of behavior in competitive energy markets is that generators will bid their marginal cost of producing electric energy into the energy market. Their marginal cost is based on the unit's opportunity cost of fuel, variable operating and maintenance costs, and opportunity cost of tradable permits for air emissions (Synapse 2011, p.2-21).

In New England, natural gas fired units are the dominant marginal source of generation, i.e., they set the market price in most hours of most years (Synapse 2011, p.1-10). Annual gas use for electric generation in New England has been forecasted to grow by an average of 0.6% between 2011 and 2025, and by an average of 1.3% thereafter (Synapse 2011, p.3-2). Therefore, when combined with additional assumptions about the New England market and natural gas prices, the AESC study projects that avoided energy costs will increase over time.

The annual avoided energy costs developed by the AESC Study, as well as a single 20-year levelized avoided cost, are summarized in Figure A.1 (see Synapse 2011, App. B). As presented in Figure A.1, avoided energy costs start at approximately $54 per MWh in 2012, and increase to approximately $100 per MWh by 2031, with a levelized cost of $78 per MWh. The avoided energy costs are weighted by the four energy costing periods: summer on-peak, summer off-peak, winter on-peak, and summer off-peak (Synapse 2011, p.2-1).

Figure A.1. Avoided Energy Costs



<u>Avoided Capacity Costs</u>

Similar to energy costs, capacity costs are avoided by efficiency programs due to a reduction in the annual quantity of electric capacity that utilities and competitive suppliers are obligated to acquire to ensure an adequate quantity of generation during hours of peak demand. In New England, utilities and competitive suppliers acquire capacity from the Forward Capacity Market (FCM) (Synapse 2011, p.1-3).

Under the FCM, ISO-NE acquires sufficient capacity to satisfy the installed capacity requirement it has set for a given power year through a forward capacity auction (FCA) for that power year. The price for capacity in that power year is based upon the results of the FCA for that year. The FCA for each power year is conducted roughly three years in advance of the start of that year. (Synapse 2011, pp.2-4, 2-5).

The 2011 AESC Study's projection of capacity prices is based on the fourth FCA (FCA 4) observed supply curve and extrapolations of that curve. This was considered the best approach for the AESC Study based on the information available and a fair representation of the impacts of projected capacity retirements and additions. (Synapse 2011, p.6-1).

Under the 2011 FCM rules, each FCA will have a ceiling price and a floor price through the sixth FCA (FCA 6). The status of floor prices for auctions after FCA 6 is at this time uncertain. For the first four FCAs, the floors averaged $3.50/kW-month. Each of these auctions concluded when it reached the floor price (Synapse 2011, pp.2-4, 2-5).

Figure A.2. Avoided Capacity Costs

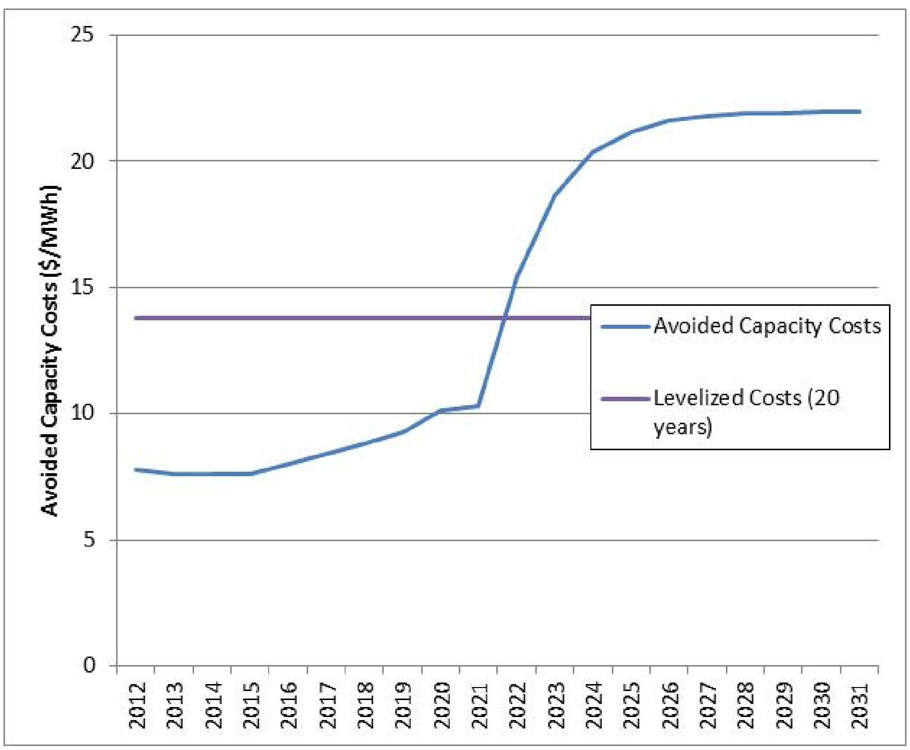


Figure A.2 presents the annual avoided capacity costs developed by the AESC Study, as well as the 20 year levelized avoided costs (see Synapse 2011, App. B).[33] As

33 The avoided capacity costs in $/kW-month were converted to $/MWh in order to make them comparable with the other avoided costs presented in this appendix.

indicated in Figure A.2, avoided capacity costs start at approximately $7 per MWh in 2012, and increase to approximately $22 per MWh in 2031, with a levelized cost of about $14 per MWh.

The costs in the first few years are based on the FCA floor prices. The costs then gradually increase as the supply of capacity becomes tighter. Finally, the costs increase to the capacity costs associated with a peaking unit in the years 2024 - 2026 when new capacity is needed on the system.

(Note that we made some minor modifications to the avoided capacity costs shown in Figure A.2 for the years 2016 through 2019. We removed the floor prices in the FCM for these years because they are now outdated and removing them provides a clearer, more generally applicable indication of likely changes in capacity market prices over time. Specifically, we increased the 2015 avoided capacity cost by five percent each year for 2016 through 2019, instead of using the projected avoided costs for those years. This modification was not applied in the illustrative examples throughout the report; it was only applied to simplify this chart.)

Avoided Transmission and Distribution Costs

Local transmission and distribution (T&D) infrastructure costs are avoided by efficiency programs due to a reduction in the timing and/or size of new T&D projects that have to be built, resulting from the reduction in electric energy that has to be delivered (Synapse 2011, p.1-4). The basic method in most avoided-T&D estimates is to divide actual or expected investment by actual or expected load growth.

Not all types of future T&D investments will be deferrable or avoidable as a result of reduced load growth from energy efficiency. A significant portion of T&D investments might be needed regardless of load growth as a result of deterioration of T&D equipment, on-going maintenance and upgrades, or other factors.

Each utility in New England uses utility-specific estimates of avoided T&D, although a consistent method is utilized by each utility. In New England, avoided transmission estimates range from $1.25 per kW-year (or $0.26 per MWh) to $20.30 per kW-year (or $4.21 per MWh). Avoided distribution estimates range from $29.74 per kW-year (or $6.17 per MWh) to $109.25 per kW-year (or $22.68 per MWh) (Synapse 2011, p.6-70).

The methods used by each utility to forecast avoided T&D costs are based on the relationship between historic T&D costs and historic loads. The future T&D costs in New England, especially transmission costs, are expected to be significantly higher than those in recent years. Therefore, it is quite likely that the forecast of avoided T&D costs listed above turn out to be significantly lower than the actual avoided T&D costs.

Price Suppression Effects

In regions of the country with organized wholesale energy and capacity markets, energy efficiency programs can reduce demand, which then can lead to reduced wholesale energy and capacity prices. Because wholesale energy and capacity markets provide a single clearing price to all wholesale customers purchasing power in the relevant time period, the reductions in wholesale energy and capacity clearing prices are experienced by all customers of those markets. Thus, even a small reduction in a market clearing price can result in significant cost reductions across the entire market. This effect is referred to as the market price suppression effect. (Synapse 2011, pp. 1-17-18, 2-49-50, 6-30-37.)

The market price suppression effect is expected to primarily occur over the short-term period after the energy efficiency measure is implemented. Over the long-term, when new physical capacity is needed to maintain the reliability of the system, the capacity price is likely to be set by the long-run marginal cost of new capacity and will hence be less sensitive to reductions in demand. Even then, capacity prices could be lower with energy efficiency than without because the long-run capacity supply curve is likely to have a lower slope. One of the challenges in estimating the impact of energy efficiency on market prices is distinguishing between the short- and long-term market price impacts (Synapse 2011, pp. 1-17-18, 2-49-50, 6-30-37).

In determining the price suppression effect in New England, the AESC Study followed a two-step approach. The first step is to estimate the impact a reduction in load will have upon the market price, assuming no other changes occur. The second step is to estimate the pace at which suppliers participating in that market will respond to that reduction with actions that offset the reduction and eventually cause the market price to move toward the level it would have been under the Reference Case. In other words, responses taken by market participants will eventually offset, or dissipate, the price suppression impact.

Figures A.3 and A.4 summarize both the annual energy and capacity price suppression effects in New England from the AESC Study. The AESC Study projects an 11 year phase-out for energy-related price suppression effects and a 12 year phase-out for capacity-related price suppression effects (Synapse 2011, p.6-2). This phase out is depicted in Figures A.3 and A.4 by the tail at zero that begins in 2025 for energy price suppression and 2027 for capacity price suppression. The longer projected dissipation of the capacity price suppression effect is based upon a detailed analysis of the various factors that tend to offset the reduction in capacity prices. Those factors include: (1) timing of new capacity additions, (2) timing of retirements of existing capacity, (3) elasticity of customer demand, and (4) the portion of capacity that LSEs acquire from the FCM. (Synapse 2011, p.6-2). Also note that the impact on capacity prices is not experienced until 2016; three years after efficiency measures have been installed.

Figure A.3. Energy Price Suppression

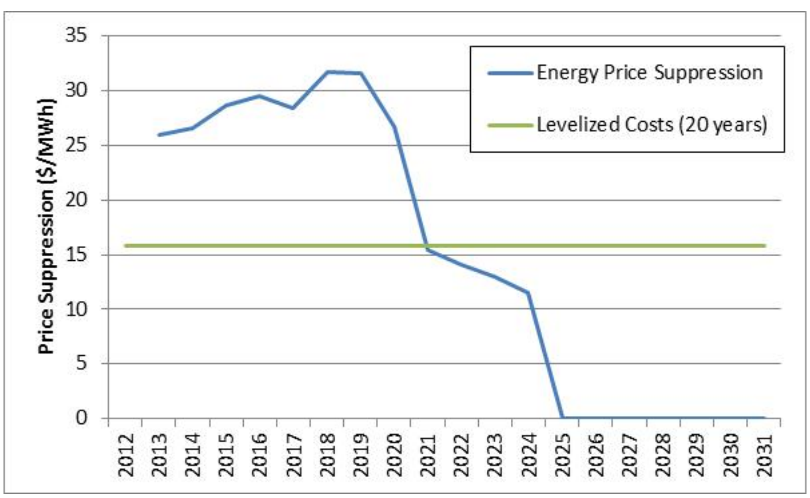
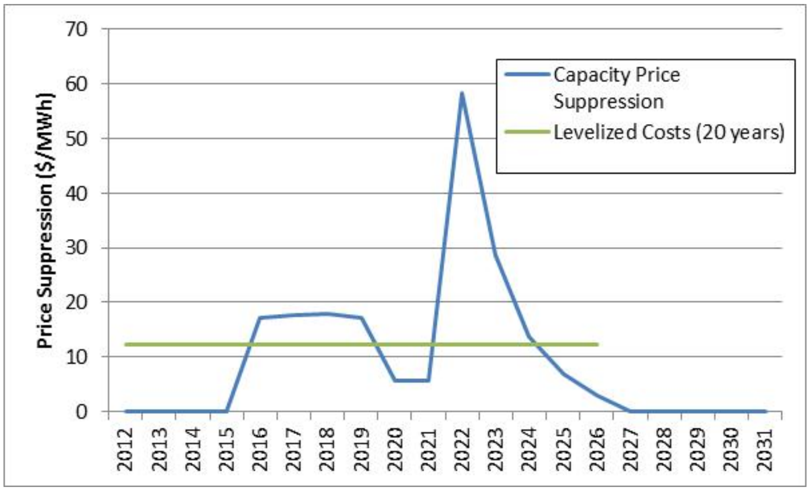


Figure A.4. Capacity Price Suppression



<u>Avoided Environmental Compliance Costs</u>

The AESC Study estimates the cost of complying with regulations governing the emissions of SO_2, NOx, and CO_2. Each of these pollutants is currently limited by a cap-and-trade mechanism, which results in market prices for pollution allowances. These market prices are then included in the operating costs of the power plants that produce these emissions. The AESC Study projects the market prices for each of these emissions, and includes these costs as one of the components of avoided costs. (Synapse 2011, p.2-14). These costs are not environmental externalities; they are the cost of complying with current and future environmental regulations.

The AESC Study's forecast of CO_2 allowance prices is worthy of some discussion here. The projected allowance prices associated with CO_2 are presented in Figures A.5 and A.6, in $/short ton and $/MWh, respectively. These figures also present the 20 year levelized cost of each price forecast. The AESC Study assumes that Regional Greenhouse Gas Initiative (RGGI) allowances prices will persist in the short-term, based on recent auction results which have been at the reserve price and are likely to remain so in the future. After 2017, the AESC Study uses prices estimated for expected federal regulations, in which a national cap-and-trade program for greenhouse gas emissions is enacted. From 2026 onward, the AESC Study assumes allowance prices will rise at the rate of inflation. (Synapse 2011, pp. 2-15, 2-19).

Figure A.5. Forecasted Allowance Price of Carbon Dioxide ($/Short Ton)

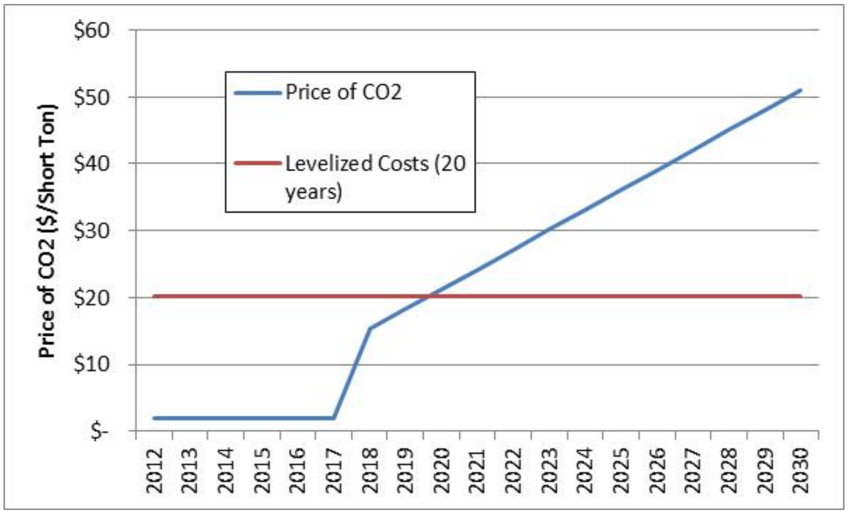
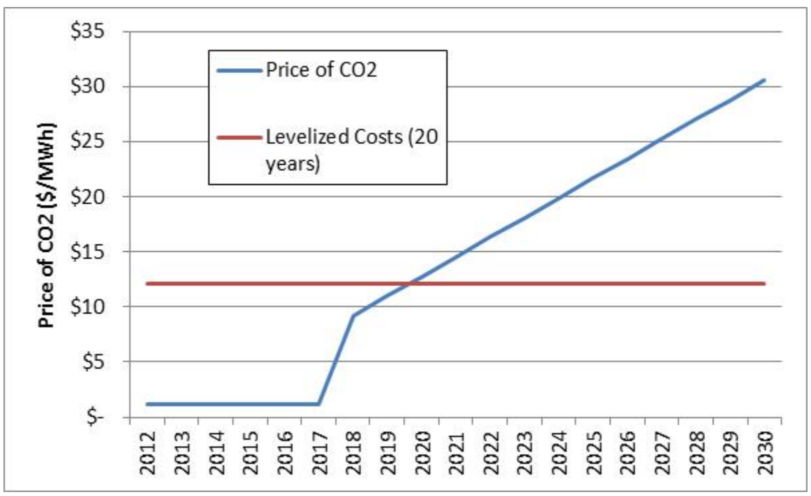


Figure A.6. Forecasted Allowance Price of Carbon Dioxide ($/MWh)



However, the RGGI requirements and the forecasted federal cap-and-trade requirements that result in the CO_2 prices presented above will not eliminate the environmental impacts of greenhouse gas emissions. Additional regulations are already in place in some states to limit greenhouse gas emissions to more stringent levels. States that adopt more stringent GHG standards than the RGGI requirements or the forecasted federal requirements will experience higher environmental compliance costs than those presented above.

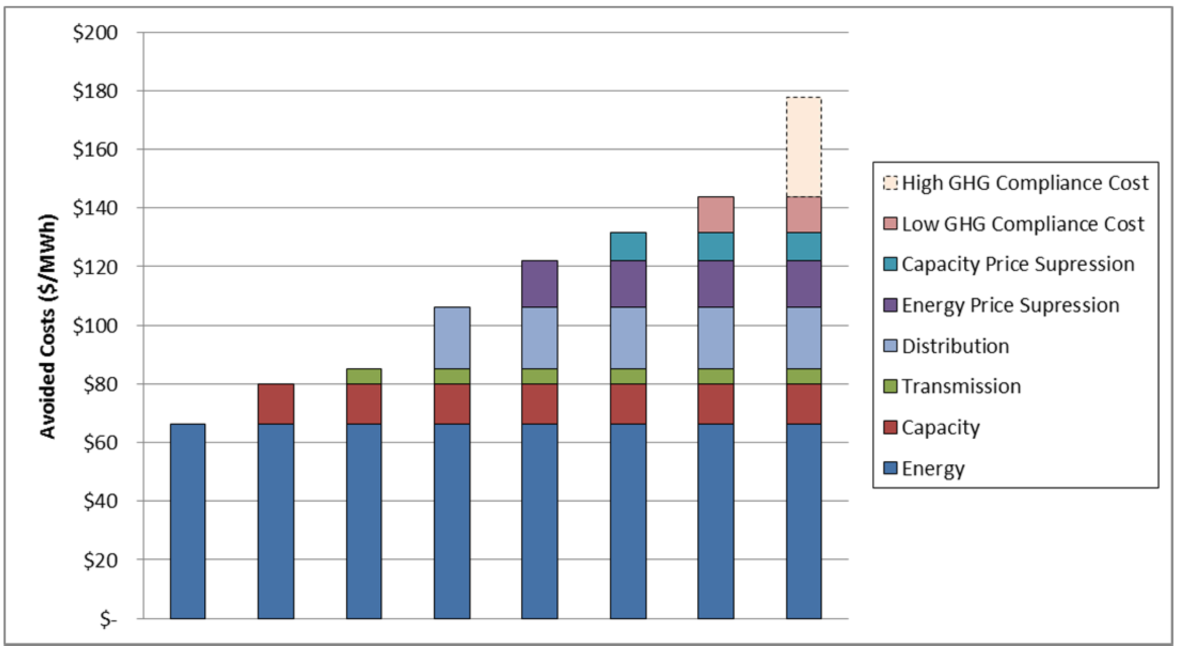
The AESC Study estimates that the long-term cost of reducing CO_2 emissions to a sustainability target of 80 percent below 1990 levels by 2050 can be approximated at $80/ton of carbon, based on a review of several studies of global carbon mitigation options (Synapse 2011, pp.1-18, 1-19). States that establish comparable targets for climate mitigation could view the $80/ton long-term abatement cost as a reasonable estimate of the cost to achieve these sustainability targets.[34] (Synapse 2011, p.4-40). We refer to these costs as the high GHG compliance costs.

Total Avoided Costs

Combining the different avoided costs discussed above demonstrates the total effect that efficiency programs can have in terms of reducing electricity costs. Figure A.7 accumulates the 20 year levelized costs for each avoided cost, with the right-most bar providing the total impact of avoided costs.

The High GHG compliance cost is indicated with dashed lines because these costs would only be considered environmental compliance costs in those states that have GHG requirements comparable to a sustainability target of reducing CO_2 emissions to 80 percent below 1990 levels by 2050. In other states these high GHG compliance costs would be considered environmental externalities, and thus would only be relevant for the Societal Cost test.

Figure A.7. Example of Avoided Costs, Broken Out by Component ($/MWh)



34 Massachusetts is one example of a state that has adopted such targets.