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Energy Efficiency Cost-Effectiveness Screening

How to Properly Account for 'Other Program Impacts' and Environmental Compliance Costs

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Foreword

Why do we in the electric and natural gas regulation business spend so much time and money on energy efficiency cost-effectiveness? Several reasons are highlighted below.

Compliance with energy efficiency obligations is one reason. If an efficiency program administrator (utility or otherwise) is charged with a mission to deliver cost-effective energy efficiency, regulators overseeing the programs need tools to evaluate administrators' claims. Tried-and-true programs may appear to require less work after years of performance data, but the evidence-based oversight process typical in most states requires persistent thoroughness.

Value for consumers is another reason. On behalf of the captive consumers paying for these savings, regulators need reassurance that costs added to electric bills are justified investments that will more than offset those costs over time. History shows that making this case clearly and continuously is important to maintain public support with an ever-changing crop of new regulators, elected officials, editorial writers, and other opinion leaders.

Value to the economy and broader society is still another important reason. Unlike most other utility resource investments, energy efficiency influences an impressive array of other aspects of society, as this paper explores. Thus, a narrower focus only on the value that energy efficiency brings to utility consumers is too limiting an analysis. However, analysis of the effects of energy efficiency investment on other program impacts, such as fuel and water savings, are often ignored or mishandled, and should be properly recognized.

Evaluating utility risk is often over-looked. Cost-effectiveness analyses for energy efficiency and other utility investments do not usually evaluate impact on utility risk. Many risks to the power sector that may drive up costs to consumers, or add regulatory risk to utilities, could be mitigated by energy efficiency. The ability of energy efficiency to mitigate utility risk is factored into the evaluation in only a few states, and these methods are rough and conservative.

We recognize that **energy efficiency is evolving**. As states increase their ambitions for energy efficiency savings from utility consumer-funded programs, the stakes for measuring cost-effectiveness escalate. Justifying the cost to pursue savings is not the only objective. Decisions of whether or not to integrate energy efficiency into utility system planning, capital budgeting, and even system operations are motivated by cost-effectiveness analyses. In the future, states will consider integrating energy efficiency with demand response, distributed generation, and other customer-side services enabled by technology. As they do this, the essentials for cost-effectiveness will still apply, but may be applied in new ways.

State identities may interact with regional approaches. States' values vary as represented by their customized cost-effectiveness tests. Perhaps this will persist, then again it may not. Convergence in approaches among states is also possible, driven by regional imperatives to use energy efficiency and other demand resources as preferred resources.

States want to ensure that energy efficiency investments reflect their values. Why do we in the electric and natural gas regulation business spend so much time and money on energy efficiency cost-effectiveness? Because regulation requires it, but also because the process itself reflects our priorities, and allows us to reassess them from time to time to ensure we are valuing energy efficiency in ways consistent with our values. RAP staff hopes this paper provides useful perspective to regulators and others interested in doing just that. Thanks to the staff at Synapse Energy Economics for providing this useful and clear analysis.

Rich Sedano
Principal and Director, US Program
Regulatory Assistance Project

Executive Summary

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 ratepayer-funded energy efficiency initiatives and establish increasingly aggressive savings goals, it is vitally important that effective practices be communicated and used in screening energy efficiency resources for cost-effectiveness.

The purpose of this report is to address two elements of energy efficiency screening that are frequently treated improperly, namely: other program impacts and the cost of complying with environmental regulations.

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.

The purpose of this report is to address two elements of energy efficiency program screening that are frequently treated improperly: other program impacts (OPIs)[1] and the costs of complying with environmental regulations. In some states, proper treatment of these two elements would likely result in a significantly larger amount of energy efficiency being deemed cost-effective relative to today's practices. We begin our report with a discussion of the cost-effectiveness tests used to evaluate energy efficiency programs, because the choice and use of these tests is directly related to our discussion of these two key elements of program screening.

A goal of this paper is to address some key issues related to application of cost-effectiveness tests that are often overlooked; it is not the goal of this paper to address all aspects of costs and benefits that may be relevant to one or more tests. Many issues relevant to the tests are addressed with only a passing reference, or are left off the discussion entirely. As noted, the focus of this paper is on what we refer to in this paper as the OPIs that are appropriate to include in certain cost-effectiveness tests, and the costs of complying with environmental regulation.

The Best Tests for Screening Energy Efficiency

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 Societal Cost Test, the Total Resource Cost (TRC) Test, and the Program Administrator Cost (PAC) Test. The choice of which test to use – and whether it is appropriately applied – will have a significant impact on the amount of energy efficiency resources that are identified as being cost-effective.

First, we note that ideally all three tests, the broader Societal Cost Test and the TRC Test, as well as the PAC Test, should be considered when assessing energy efficiency cost-effectiveness. We recognize, however, that this still leaves the ultimate question of which test results to use in determining the programs 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 a

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

minimum, 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. 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, including environmental benefits. If a state chooses to use the Societal Cost Test, the test should account for all the 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 (or Societal Cost) Test, the test should account for OPIs to the greatest extent possible. If OPIs are excluded, then the analysis would include all of the relevant costs but not all of the relevant benefits. As a result, the TRC Test will provide misleading results that are skewed against energy efficiency, and will result in underinvestment in energy efficiency programs and higher costs for customers.

We also recommend that efficiency resources be screened using the Societal Cost Test or the TRC Test at the program level. Although there may be, in theory, advantages to measure-level screening, these advantages are outweighed by the practical benefits associated with program-level screening, including accounting for the interactive effects between efficiency measures, increasing customer adoption of efficiency measures, promoting comprehensive efficiency solutions, and avoiding lost opportunities. Screening energy efficiency at the program level achieves an appropriate balance between achieving important efficiency goals and sufficient regulatory oversight. Energy efficiency resources should be *analyzed* at the measures level, in order to provide program administrators and other stakeholders with the greatest level of detail regarding their costs and benefits, but the *screening* is best performed at the program level in order to reduce the risk of screening out measures that provide program-level benefits.

However, when evaluating ratepayer-funded energy efficiency programs with either the Societal Cost Test or the TRC Test it is important to consider potential bill impacts and customer equity concerns. Properly accounting for OPIs and the associated public policy benefits may increase the universe of efficiency measures that are deemed cost-effective. This may lead to increased energy efficiency budgets, or in the case of limited efficiency budgets it may result in the adoption of a different, more expensive mix of efficiency measures. In addition, properly accounting for OPIs and the associated public policy benefits may be seen as burdening 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 these equity concerns, we recommend that the PAC Test be applied, at a minimum, to the entire 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. The PAC test includes only those costs and benefits that affect utility revenue requirements, and thus provides a clear indication of potential impacts on customer bills. 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 and would not be included in the efficiency portfolio. Then the PAC Test would be applied, at a minimum, to the portfolio of programs that do pass the primary test. If a 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. More granular ratepayer equity concerns can be addressed at the measure or program level by applying the PAC Test review at those levels in program design.

This combined screening approach should be simple to apply because it would rely upon a single, primary test (either the Societal Cost Test or the TRC Test) for screening at the program level, and a secondary test (the PAC Test) that would be applied as a check on behalf of utility customers. Regulators and other stakeholders could use the results of the portfolio-level PAC test (expressed as millions of dollars in net reductions in utility costs) to assess the overall value of the efficiency portfolio to utility customers as a whole. Applying the tests in this manner helps regulators and other stakeholders ensure that public policy objectives for acquisition of cost-effective energy efficiency also result in a net reduction in utility costs to utility customers.

Other Program Impacts

OPIs 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, reduced sick days from work or school, increased worker or student productivity, improved aesthetics, 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. 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 will provide misleading results that are skewed against energy efficiency, and will result in underinvestment in energy efficiency programs and higher costs for utility customers.

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 even in those states the quantification is only partial and generally conservative. 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 United States today.

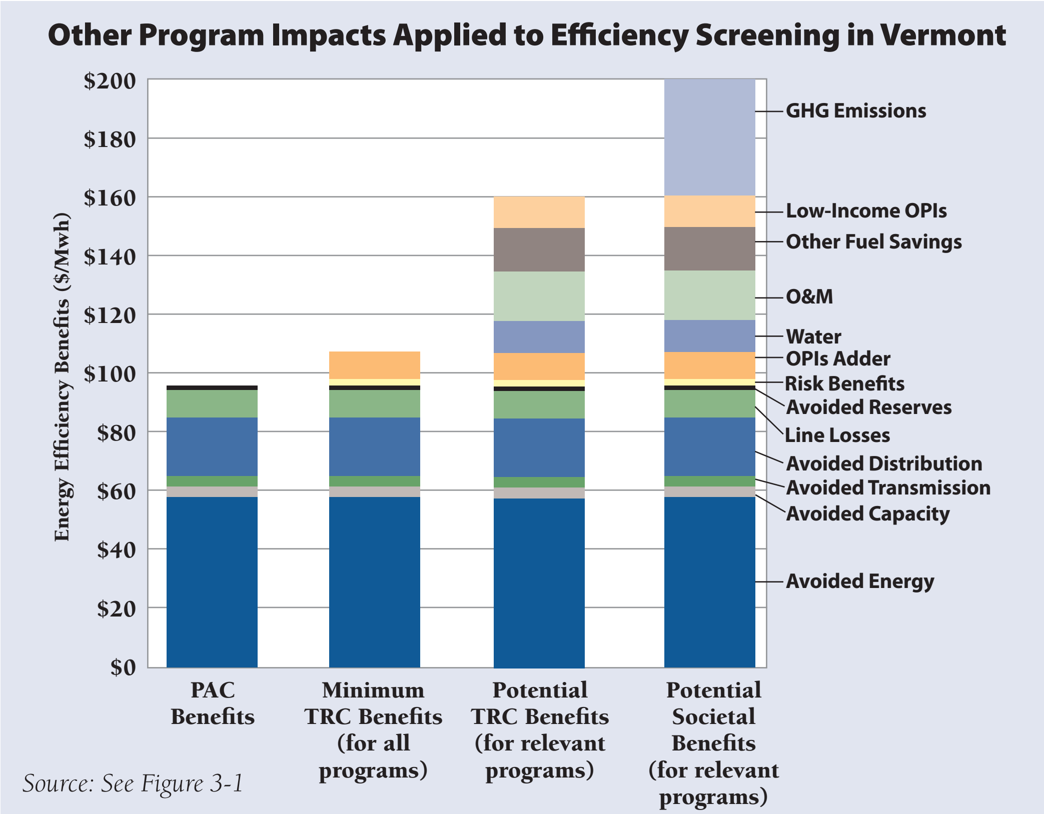
Excluding the participant-perspective OPIs from the TRC Test will provide misleading results that are skewed against energy efficiency, and will result in underinvestment in energy efficiency programs and higher costs for utility customers.

Those states that do account for OPIs have found that they can be quite large. Figure ES-1 presents a summary of the OPIs that are accounted for in energy efficiency screening in Vermont, in terms of levelized costs (in $/MWh). The leftmost column indicates the benefits that would be applied to all programs under the PAC Test. The second column from the left indicates the risk benefits and the non-energy benefits that would be applied to all energy efficiency programs under the TRC Test. The second column from the right indicates the potential magnitude of the water, operations and maintenance (O&M), other fuel savings, and low-income benefits under the TRC Test. The rightmost column also includes the avoided emissions benefit that is applied under the Societal Cost Test.

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 if they are not correctly accounted for, then some programs, including low-income programs, residential retrofit programs, and new construction programs, may be improperly deemed uneconomic. 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.

The importance of properly applying OPIs is apparent in many program administrators' energy efficiency screening results. We recommend caution when considering quantitative estimates of OPIs, such as those presented in Figure ES-1. It is very difficult to fully quantify and monetize all of the OPIs, especially all of the participant-perspective non-energy benefits, associated with all energy efficiency programs. Furthermore, experience indicates that most attempts to do so result in very conservative estimates and a continued understatement of the full benefits of energy efficiency. Nonetheless, when applying the Societal Cost Test or the TRC Test, using the best estimates available is a significant improvement over using no estimates at all.

Figure ES-1



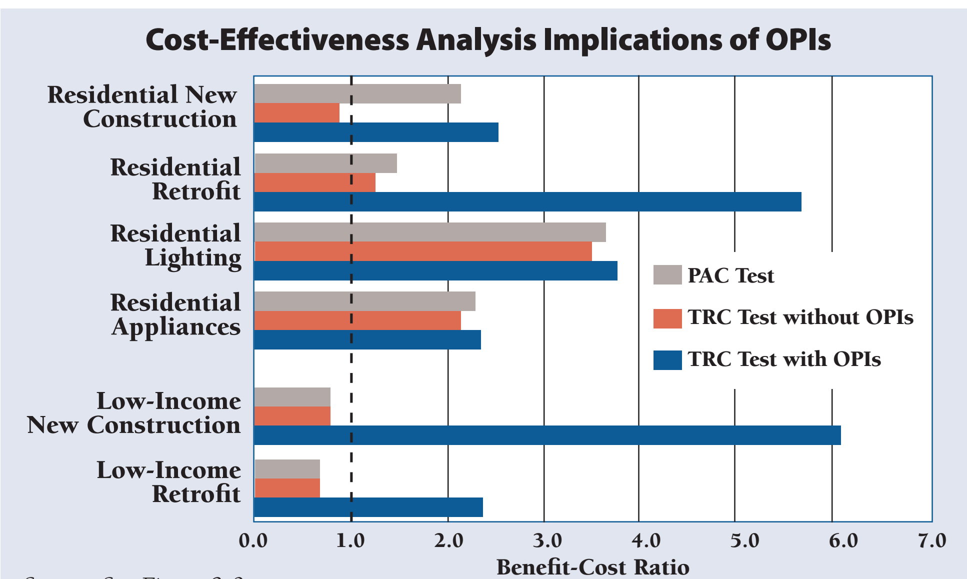
Source: See Figure 3-1

Figure ES-2 presents the actual cost-effectiveness results for an electric utility's 2012 residential efficiency programs. The figure presents the benefit-cost ratios under the PAC Test, the TRC Test with OPIs included, and the TRC Test without OPIs included. When the OPIs are not included in the TRC Test, the low-income, residential new construction, and residential retrofit programs are all at risk for being improperly deemed not cost-effective – even though these are some of the most important residential efficiency programs available.

It is important to recognize that including OPIs in the Societal Cost and TRC Tests is likely to expand the universe of efficiency resources that are deemed cost-effective and may lead to increased energy efficiency budgets, or in the case of limited efficiency budgets, it may result in the adoption of a different, more expensive mix of efficiency measures. In addition, properly accounting for OPIs and the associated public policy benefits may be seen as burdening utility customers with costs for achieving benefits that are not related to utility services.

These concerns are addressed by applying the PAC Test

Figure ES-2*



Source: See Figure 3-2

**Figure ES-2 represents an example of how the choice of economic tests can have significant impacts on the results. These results should not be misinterpreted as extending to other regions and circumstances. The results will likely vary significantly by region, available fuels, and other program impacts that are customer-class and location specific. Further, the fact that some benefit-cost ratios exceed others should not be misinterpreted to favor investments in programs with higher ratio to the exclusion of lower ratios. The objective of the energy efficiency investments should be to get the greatest net economic benefit for the available investment.*

to the entire portfolio of energy efficiency programs at the culmination of the testing process, as described previously. This approach can be used to assure regulators and other stakeholders that utility customer funds spent on energy efficiency programs will result in a net reduction in utility costs for utility customers.

Recommendations

When using the Societal Cost Test, it is important to account for the utility-perspective, participant-perspective, and societal-perspective OPIs to the greatest extent possible.

When using the TRC Test, it is important to account for the utility-perspective and participant-perspective OPIs to the greatest extent possible. It is particularly important to account for the participant-perspective OPIs, because otherwise the TRC Test will be internally inconsistent and will lead to cost-effectiveness results that are skewed against energy efficiency. This in turn will cause program administrators to underinvest in energy efficiency programs, and will impose higher costs on utility customers.

We recommend that each state adopt OPIs for screening energy efficiency initiatives. Each state will inevitably need to develop its own approach for accounting for OPIs that best suits its needs and best accounts for values of the OPIs relevant to it. One of the key barriers to adopting some OPIs is that they are difficult to quantify. Nonetheless, it is important for states to attempt to quantify OPIs to the greatest extent possible, because assuming that they do not exist or assuming that they are worth nothing is clearly inaccurate and incorrect. To this end, we recommend that each state do the following:

- Develop quantitative, monetary estimates for all OPIs that can be readily monetized. At a minimum, this should include the other fuel and water savings, because these savings can be relatively easily monetized using forecasts of the prices for those fuels.
- Develop some methodology for addressing those OPIs that are not monetized, for example, by conducting sensitivities or using an adder to the benefits as a proxy. Although there are limits to these approaches, and adders are sometimes critiqued for being too conservative, these approaches may be necessary to ensure that some of the significant OPIs are not ignored simply because they are difficult to quantify.
- Address the OPIs associated with low-income customers. Many studies have shown that these are among the most significant OPIs and can have a substantial impact on the cost-effectiveness of low-income programs.
- Identify those OPI assumptions, methodologies, and outcomes that can be transferred across utilities and across states, in order to increase awareness of the issues, promote consistency where appropriate, increase acceptance of hard-to-quantify values, and reduce costs.

Environmental Compliance Costs

Current and Anticipated EPA Regulations

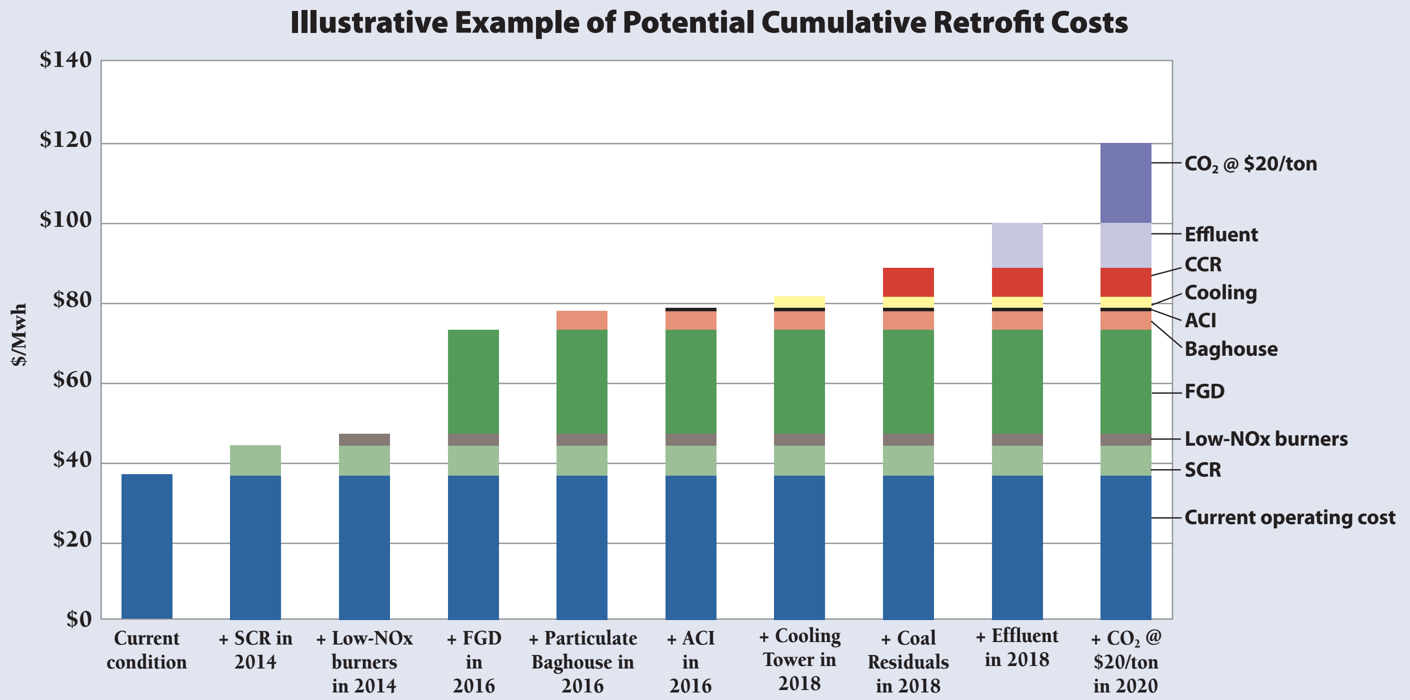
The US Environmental Protection Agency (EPA) has proposed and promulgated a number of environmental rulemakings that have significant implications for the operation of existing and new power plants. Costs associated with complying with these regulations should be included in the PAC, the TRC, and the Societal Cost Tests when evaluating energy efficiency resources.

There is no doubt that energy efficiency should play a significant role, even the primary role, in meeting climate change requirements.

Figure ES-3 provides an illustrative example of potential retrofit costs at an older 300-MW coal-fired power plant. This figure shows how various forthcoming environmental regulations can contribute to total power plant costs relative to the current operating cost. These costs are illustrative; many coal plants will not require all of these controls, and costs are likely to vary considerably between plants. The extent to which any one coal plant will have to install one or more of these controls will depend upon the age of the plant, the efficiency with which the plant operates, and the extent to which some of these controls have already been installed.

Several recent studies have estimated the amount of US coal capacity that is at risk for being retired as a result of the costs associated with the recent EPA regulations. Some of the most recent studies, which include the possibility of federal climate change requirements, estimate that up to one third of the US coal fleet may be uneconomic. This will clearly have important implications for the avoided energy and capacity costs associated with energy efficiency resources.

Figure ES-3



Source: See Figure 4-2

Current and Anticipated Climate Change Requirements

There are currently many initiatives for reducing greenhouse gas (GHG) emissions from power plants at the federal, regional, state, and local levels. Costs associated with complying with these initiatives should be included in the PAC, TRC, and Societal Cost Tests when evaluating energy efficiency resources.

Despite several attempts in the past, the US Congress has yet to pass legislation requiring GHG emission reductions. However, this may change at some point in the near- to midterm future. In addition, the EPA has announced that it will issue New Source Performance Standards for GHG emissions, which will result in compliance costs for new and modified power plants.

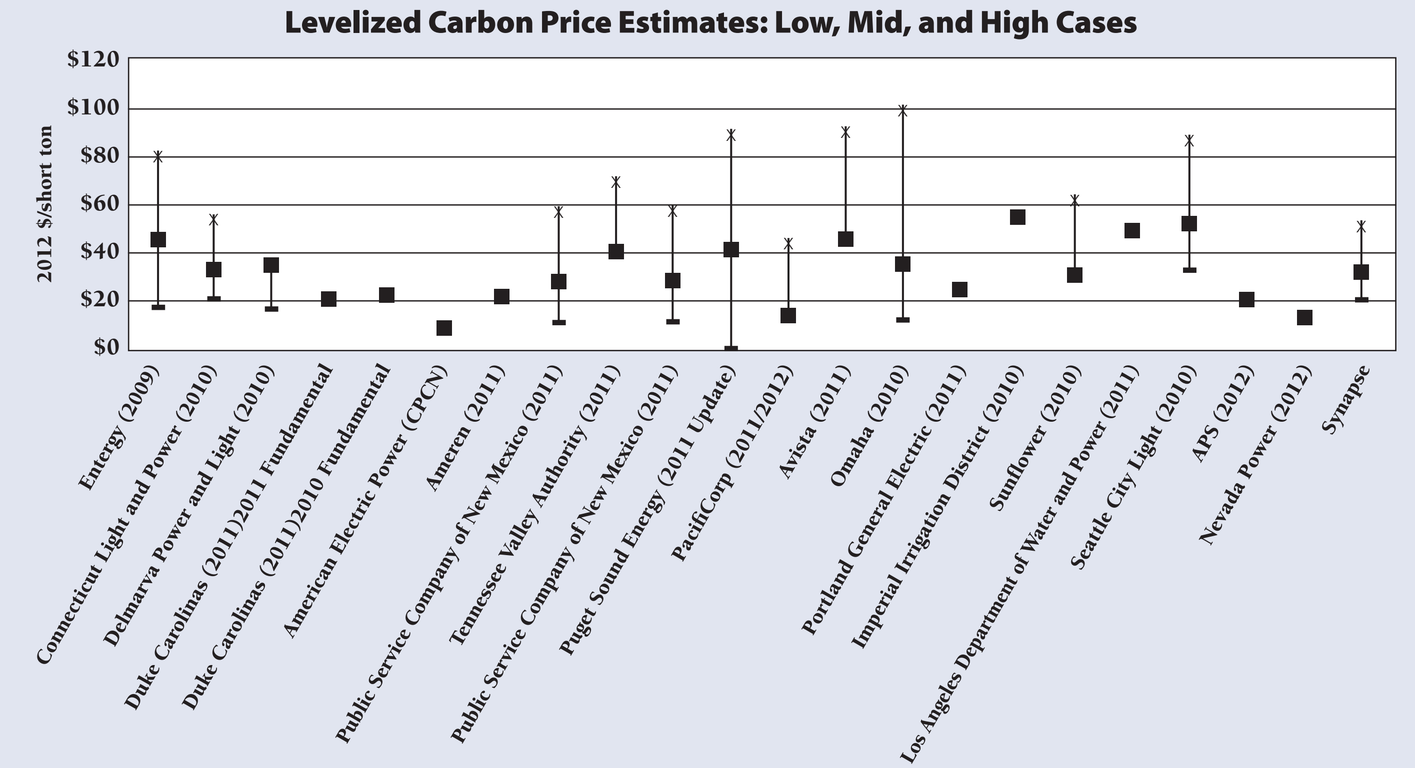
Many utilities recognize the likelihood of federal climate change requirements, and have developed forecasts of the potential CO_2 allowance costs that might result from such requirements. Figure ES-4 presents a summary of the range of recent CO_2 price forecasts that have been used by utilities, as well as independent forecasts from the Edison Electric Institute and from Synapse Energy Economics.

Some recent studies estimate that up to one third of the US coal fleet may be uneconomic as a result of the recent EPA regulations.

Many states have undertaken initiatives to reduce GHGs. Twenty-three US states and five Canadian Provinces currently participate in regional initiatives to reduce GHG emissions from power plants, and are seen as laboratories for future regional climate change activities. Furthermore, roughly 43 states have adopted a GHG inventory and/or registry, 36 states have adopted a state climate change action plan (with additional states in the process of developing such plans), and 23 states have established GHG emission reduction targets. Some of these state targets are relatively stringent, for example, requiring the reduction of CO_2 emissions of 80 percent below 1990 levels by 2050.

Energy efficiency is typically one of the lowest cost options for reducing GHG emissions. In fact, cost-effective energy efficiency programs reduce overall costs, whereas many GHG abatement options lead to increased costs. There is no doubt that energy efficiency should play a significant role, and maybe even the primary role, in

Figure ES-4



Source: See Figure 4-7. The CO_2 prices are in levelized terms. The low value for each forecast represents the levelized value of the Low Case; the middle value represents the levelized value of the Mid Case or Reference Case; and the high value represents the levelized value of the High Case.

meeting climate change requirements. If states do not properly assess the value of energy efficiency in complying with climate change requirements, then they will understate the cost-effectiveness of energy efficiency and will impose higher costs on utility customers over the long-term.

Recommendations

All states should recognize that the costs of compliance with current and anticipated EPA regulations and climate change requirements must be included in the PAC, TRC, and Societal Cost Tests. These costs are not environmental externalities; they will be incurred by utilities and passed on to ratepayers, and therefore should be included in all of these tests.

We recommend that all states recognize the importance of accounting for climate change compliance costs now. Uncertainty regarding the timing and size of those costs does not justify 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 today should be based on the best assumptions available about the conditions that will exist over these long periods of time.

Energy efficiency resources should be screened on a frequent, periodic basis (e.g., every one to three years), because energy efficiency programs may take several years to ramp up to the levels needed to respond to evolving environmental requirements or to replace a retiring power plant.

Energy efficiency program administrators should account for all anticipated environmental compliance costs (EPA regulations, climate change requirements, and others), because this is the most accurate reflection of the future, and these environmental requirements can have significant cumulative effects. Piecemeal analyses of environmental compliance costs can lead to uneconomic decisions and higher costs to customers.

All states should establish energy efficiency screening methodologies that account for the cost of complying with federal climate change requirements. Although some uncertainty about the timing of federal GHG emissions regulations remains, it is likely that limits will be imposed at some point over the near- to mid-term future. If a state or utility does not have its own forecast of federal CO_2 allowance prices, then it could rely upon publicly available forecasts such as those described in this study. Other options include conducting sensitivity analyses or using probabilistic modeling.

Piecemeal analyses of environmental compliance costs can lead to uneconomic decisions and higher costs to customers.

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, economy-wide marginal GHG abatement costs. In the absence of these, states can use reasonable proxies for marginal GHG abatement costs. Such proxies can be developed based on other resources that the state has decided to implement to address climate change concerns (e.g., renewable resources). The key issue here is that energy efficiency resources are evaluated for cost-effectiveness relative to other GHG abatement options that the state has decided are necessary to address climate change.

Introduction

For more than two decades, many states have relied upon a standard set of economic tests to decide what level of energy efficiency is cost-effective. The standard tests include the Ratepayer Impact Measure (RIM) Test, the Participant Test, the Program Administrator Cost (PAC) Test, the Total Resource Cost (TRC) Test, and the Societal Cost Test. These tests have played a significant role in determining the amount and type of efficiency programs implemented to date.

In theory, these tests provide regulators and other stakeholders with the full range of perspectives and the full range of costs and benefits with which to determine energy efficiency cost-effectiveness. In practice, however, these tests are frequently not applied properly. In many cases important benefits are excluded, energy efficiency is undervalued, and utility customers bear higher costs as a result.

Some of the energy efficiency program impacts are difficult to quantify, such as benefits to low-income customers, and are often ignored altogether. Other energy efficiency program impacts are uncertain, such as the cost of compliance with future climate change requirements, and are often understated or ignored altogether.

This report briefly describes the current state of energy efficiency cost-effectiveness analyses and makes recommendations for how to fill in the missing pieces. We focus on two key issues: accounting for other program impacts (OPIs) and accounting for the cost of compliance with environmental regulations.

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 cost, or the avoided cost, of energy provided by the utility funding the efficiency program. In addition to NEIs, 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. These other fuel savings are typically included in non-energy impacts, even though they actually involve energy savings. We use the term OPIs to refer to both NEIs and other fuel savings. OPIs can include both other program benefits and other program costs.

One of the premises underlying this report is that energy efficiency program administrators should implement all cost-effective energy efficiency, and therefore it is critical that the cost-effectiveness tests be properly designed and implemented. Another is that regulatory commissioners, consumer advocates, and other key energy efficiency stakeholders need to have confidence that the design and application of the energy efficiency cost-effectiveness screening is in the public interest and will result in reduced costs to utility customers.

We note that this report was prepared in conjunction with a similar report for the National Home Performance Council (Synapse, 2012). Some of the analyses, conclusions, and recommendations are the same in both reports. The purpose of this report is to provide more depth on the two issues of OPIs and environmental compliance costs.

While a goal of this report is to address these key issues related to application of cost-effectiveness tests, it is not the goal of this report to address all aspects of costs and benefits that may be relevant to one or more tests.

2. Cost-Effectiveness Tests and Their Uses

2.1 Defining 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. 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 and Figure 2-1.[3]

- **The Societal Cost Test[4] –** 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.

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	X	—	—	—	—
Avoided Energy Costs	—	X	X	X	X
Avoided Capacity Costs	—	X	X	X	X
Avoided Transmission and Distribution Costs	—	X	X	X	X
Wholesale Market Price Suppression Effects	—	X	X	X	—
Avoided Cost of Environmental Compliance	—	X	X	X	X
Other Program Impacts (Utility Perspective)	—	—	X	X	X
Other Program Impacts (Participant Perspective)	X	—	—	X	X
Other Program Impacts (Societal Perspective)	—	—	—	—	X
Energy Efficiency Program Costs					
Program Administrator Costs	—	X	X	X	X
EE Measure Cost: Program Financial Incentive	—	X	X	X	X
EE Measure Cost: Participant Contribution	X	—	—	X	X
Non-Energy Costs	X	—	X	X	X
Lost Revenues to the Utility	—	X	—	—	—

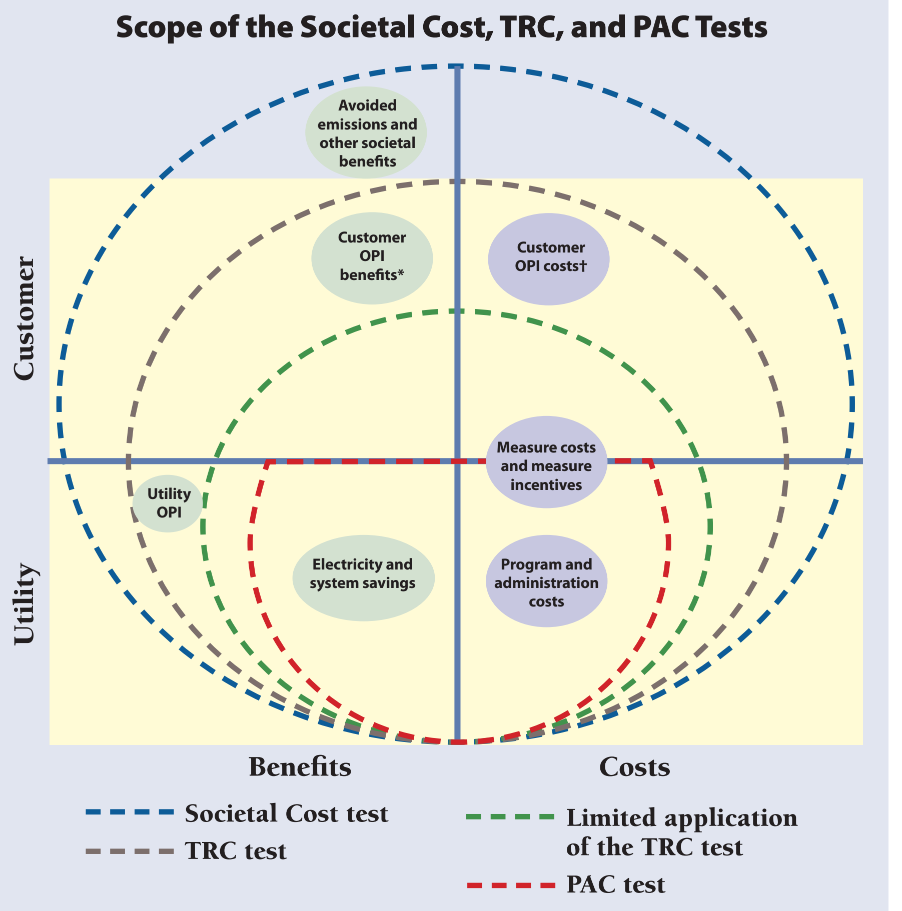
3 These tests are sometimes defined slightly differently by different public utility commissions. For comprehensive descriptions and discussions of these tests, see CA PUC, 2001 and NAPEE, 2008.

4 The California Standard Practice Manual (SPM) considers the Societal Cost Test to be 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.

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 Societal Cost Test also includes the use of a lower societal discount rate.

- **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, plus all the costs incurred by the customers. The benefits include all the avoided utility costs, plus any OPIs experienced by the participating customers, such as avoided water costs, other fuel savings, reduced O&M costs, improved productivity in school and at work, improved sales for businesses with improved aesthetics, improved comfort levels, health and safety benefits, and more.
- **The Program Administrator Cost (PAC) Test**[5] – This test includes the energy costs and benefits that are experienced by the energy efficiency program administrator. 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).
- **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, any financial incentive paid by the program administrator, and OPIs experienced by the participating customer.[6]
- **The Ratepayer Impact Measure (RIM) Test**[7] – 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

Figure 2-1



**Includes other non-electric fuel and resource benefits, increased comfort, and other ultility fuel and resource benefits such as water and natural gas savings.*

†Could include other fuel costs from energy efficiency measures and programs that result in additional fuel costs from non-electric initiatives.

Source: RAP

5 This is sometimes referred to as the Utility Cost Test or the Energy System Test.

6 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.

7 This has previously been referred to as the Non-Participant Test and the No-Losers Test.

efficiency on those customers who 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.

How the Cost-Effectiveness Tests are Being Used Today

A recent survey by the American Council for an Energy-Efficient Economy (ACEEE) provides a useful summary of how the cost-effectiveness tests are used across the states.[8] Nationwide, a total of 45 jurisdictions have some level of formally approved ratepayer-funded energy efficiency programs in operation.[9] All of these jurisdictions use some type of benefit-cost test in connection with their ratepayer-funded energy efficiency programs.[10] 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 for defining energy efficiency cost-effectiveness, as follows:

- The TRC Test is used by 29 states (71 percent) as the primary test for screening efficiency.
- The Societal Cost Test is used by six states (15 percent) as the primary test for screening efficiency.[11]
- The PAC Test is used by five states (12 percent) as the primary test for screening efficiency.
- The RIM Test is used by one state (2 percent) as the primary test for screening efficiency.[12]

Most states (70 percent) apply the cost-effectiveness tests, often with exceptions, at both the program and the portfolio level. A minority of states (30 percent) apply the cost-effectiveness tests at the measure level (ACEEE, 2012, p. 5).

2.2 Implications of the Cost-Effectiveness Tests

In theory, all of the 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. This approach is rarely used in practice, however, due to the challenges of working with multiple tests showing different results. Most states rely upon one or two tests as the primary standard for screening energy efficiency programs.

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

8 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 examines many aspects relating to how states conduct their evaluations and the key assumptions employed, including the use of cost-effectiveness tests (ACEEE, 2012).

9 The 45 jurisdictions include 44 states and the District of Columbia. The states that have essentially no formally approved utility ratepayer-funded energy efficiency programs are Alabama, Alaska, Louisiana, Mississippi, North Dakota, and West Virginia (ACEEE, 2012, p. 3).

10 This is not the case for load management/demand response programs or renewable energy programs, where only 67 percent and 28 percent of states, respectively, report using benefit-cost tests for those ratepayer-funded programs (ACEEE, 2012, p. 30).

11 Note that, while only six states were identified as using the Societal Cost Test for screening energy efficiency programs, a larger number of states include environmental impacts in their resource planning and siting practices in general. A 2001 study found that a majority of states include environmental protection in certification and citing decisions by regulatory commissions, and 16 state commissions have general authority or responsibility to consider environmental matters in regulatory decisions (Dworkin et. al., 2001). Several states also require electric and gas utilities to account for environmental impacts in their integrated resource plans.

12 Shortly after ACEEE published its findings, the one state using the RIM test as the primary test (Virginia) enacted a new law providing that a program or portfolio of programs "shall not be rejected solely based on the results of a single test" (see Code of Virginia, C. 821, §§ 56-576 (Approved April 18, 2012)). The practical impact of this new law on efficiency screening in Virginia is not yet clear.

Test provide "distributional" information, that is, 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 that follow we summarize some of the key implications of each of the five cost-effectiveness tests. Table 2-2 summarizes some of the key points. In Appendix A, we provide some additional detail about the important differences between the cost-effectiveness tests, with some clarifications regarding the differences between the PAC, the TRC, and the Societal Cost Tests.

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.[13] 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

13 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 customers.

Table 2-2

Implications of the Five Principal Cost-Effectiveness Tests

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
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 costs and benefits of the efficiency measure, including participant and utility costs and benefits
Program Administrator Cost	Will utility costs decrease?	Includes the costs and benefits experienced by the energy efficiency program administrator	Limited to impacts on utility revenue requirements; indicates net impact on utility costs and utility bills
Participant	Will program participants' costs decrease?	Includes the costs and benefits 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 as well as lost revenues	Provides distributional information; useful in program design to find opportunities for broadening programs; should not be used for cost-effectiveness screening

Adapted from NAPEE, 2008, p. 2-2, with modifications.

which portion is paid for by the customer. In practice, however, the TRC Test is frequently misapplied. Many states that use the TRC Test do not include all of the costs and benefits to customers, in particular the non-energy 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 3.

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.[14] This test is most consistent with the way that utilities typically evaluate the cost-effectiveness of supply-side resources. The PAC Test, however, does not include several significant impacts that have important public policy implications and are important in planning energy efficiency programs, most notably other fuel savings, other resource savings (e.g., water), and improved health and safety.

The Participant 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 cost-effectiveness tests. As noted, it provides an indication of the distributional effects of the energy efficiency program, along with the RIM Test, and may be useful in optimizing program design for participation.

It is important to note that there are additional benefits of energy efficiency that accrue to the utility system as a whole that are not necessarily captured in the benefits listed earlier. Energy efficiency offers significant benefits in terms of reducing risk (e.g., the risks associated with fossil fuels and the risks inherent in load forecasting), as well as benefits in terms of improving the overall reliability of the utility system (e.g., by reducing peak demand and by slowing the rate of growth of peak demand). A comprehensive assessment of energy efficiency resources should include these benefits in all of the cost-effectiveness tests described previously.

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). Achieving the lowest rates is not the primary goal of utility planning and regulation, however, 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. Lost revenues are not a true cost to society, however. 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.[15] 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

14 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.

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

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 program.
- 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 in which 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. It is important to recognize, however, that the rate impacts of energy efficiency programs are not a matter of cost-effectiveness. (As noted previously, 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 who experience reduced bills and non-participants who experience increased rates and therefore increased bills.[16]

The RIM Test therefore should not be used in screening energy efficiency programs for cost-effectiveness. Instead, efficiency program administrators should take steps to (1) analyze rate and bill impacts in a fashion that provides much more information than what is available from the RIM Test; (2) design programs in a way that mitigates rate impacts without sacrificing energy efficiency savings; and (3) work to increase the number of program participants so as to mitigate the equity concerns between participants and non-participants.[17]

2.3 Considerations in Applying the Cost-Effectiveness Tests

Which Test to Use as the Primary 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 & 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. Although 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 that will need to balance several public policy considerations, discussed subsequently.

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.

16 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.

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

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. The TRC Test creates a dilemma for policymakers, however. In order to be internally consistent, the test must include OPIs on the program participants, but regulators are often wary of doing so because some of the benefits are uncertain and difficult to quantify. In addition, including OPIs in the TRC test is likely to expand the universe of efficiency resources that are deemed cost-effective and may lead to increased energy efficiency budgets, or a more expensive mix of efficiency measures. Properly accounting for OPIs in the TRC test may burden utility customers with higher-cost efficiency measures in order to achieve benefits that are not related to utility services.

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 frequently 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 ratepayers. 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-effective energy efficiency resources.

Relying on the PAC Test has one significant disadvantage, however, 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 measures, some of which are clearly important to policymakers. The other program benefits that are typically most important to regulators are (1) benefits that pertain to low-income customers, due to the significant public policy implications of this sector; and (2) other fuel savings, as these savings are important for promoting 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 of 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 OPIs 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?

At What Level Should the Screening be Performed?

Cost-effectiveness tests for energy efficiency resources can be applied at different levels of detail. 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. Evaluation at the program level means that collectively the measures within a program must be cost-effective, but some measures might not be if there are other measures that more than make up for them. (There must, however, be sound reasons for including measures that do not screen, such as sound program design.) Evaluating cost-effectiveness at the portfolio level means that all of the programs taken together must be cost-effective, but some programs might not be. (Here too, there must be sound reasons for including programs that are not cost-effective on their own.)

We note that there is an important distinction between *analyzing* energy efficiency resources and *screening* them. Analyzing includes comparing the costs and benefits for the purpose of understanding the broad economic impact, whereas screening includes making a decision as to which programs should be implemented through ratepayer-funded programs and which should be redesigned or not funded.

We recommend that all energy efficiency resources be *analyzed* at the measure level. This is important so that the energy efficiency assessment can (1) be based on the most detailed level of information; (2) provide the greatest transparency for regulators and other stakeholders; and (3) allow program administrators and other stakeholders the ability to consider the implications of energy efficiency resources at the greatest level of detail.

Efficiency resources, however, do not need to be *screened* at the same level at which they are analyzed. We recommend that energy efficiency resources be screened at the program level. In theory, measure-level screening offers the advantage of ensuring that every component of the efficiency program will result in net benefits, and that programs will not include measures that are exorbitantly expensive or uneconomic. In practice, however, these advantages can be outweighed by several benefits associated with program-level screening.

Program level screening allows for program administrators to account for the interactive effects between efficiency measures, including the fact that some measures may be uneconomic but may have a big impact on encouraging customers to participate in the program or to adopt other, more cost-effective measures in the program. Program-level screening also allows for comprehensive, whole-house or whole-building energy efficiency improvements, which may be important to customers, program administrators, or other stakeholders. Additionally, program-level screening helps prevent lost opportunities by allowing program administrators to implement all appropriate energy efficiency measures while they are engaging with program participants (Synapse, 2012).

Allowing for program-level screening does not mean that program administrators should be allowed to implement efficiency measures that are clearly not cost-effective. Program administrators should be encouraged to include in their programs only those efficiency measures that are cost-effective, unless there are marginally uneconomic measures that are appropriate to include in a program because of their ability to promote customer participation, their interactive effects with other measures, their ability to promote comprehensive efficiency solutions, or their ability to avoid lost opportunities.

2.4 Recommendations for Applying the Tests

With all of these considerations in mind, we offer the following recommendations.

First, we note that ideally all three tests, the broader Societal Cost Test and TRC Test, as well as the PAC Test, should be considered when assessing energy efficiency cost effectiveness. We recognize, however, that this still leaves the ultimate question of which test results to use in determining the programs 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 programs. 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.

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. Not accounting for OPIs will result in a biased application of the test, leading to undervaluing of energy efficiency and higher costs for customers.

When evaluating ratepayer-funded energy efficiency programs with either the Societal Cost Test or the TRC Test, however, it is important to consider potential bill impacts and customer equity concerns. Properly accounting for OPIs and the associated public policy benefits may increase the universe of efficiency measures that are deemed cost-effective. This may lead to increased energy efficiency budgets, or in the case of limited efficiency budgets, it may result in the adoption of a different, more expensive mix of efficiency measures. In addition, properly accounting for OPIs and the associated public policy benefits may be seen as burdening 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 these equity concerns, we recommend that the PAC Test be applied, at a minimum, 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. The PAC test includes only those costs and benefits that affect utility revenue requirements, and thus provides a clear indication of potential impacts on customer bills. 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 and not be included in the efficiency portfolio. Then, the PAC Test would be applied, at a minimum, 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. More granular ratepayer equity concerns can be addressed at the measure or program level by applying the PAC Test review at those levels in program design.

This combined screening approach should be simple to apply because it would rely upon a single, primary test (either the Societal Cost Test or the TRC Test) for screening at the program level, and a secondary test (the PAC Test) that would be applied as a check on behalf of utility customers. Regulators and other stakeholders could use the results of the portfolio-level PAC Test (expressed as millions of dollars in net reductions in utility costs) to assess the overall value of the efficiency portfolio to utility customers as a whole. Applying the tests in this manner helps regulators and other stakeholders ensure that public policy objectives for acquisition of cost-effective energy efficiency also result in a net reduction in utility costs to utility customers.

We note that good judgment should always be applied at all levels of cost-effectiveness screening. This should apply at all levels of screening using both the TRC and the PAC Tests. Program administrators should design programs to ensure that on a portfolio basis the PAC net benefits are significant relative to the PAC costs (i.e., that the PAC benefit-cost ratio is significantly greater than one).

3. Other Program Impacts

3.1 Description of Other Program Impacts

OPIs are those costs and benefits that are not part of the cost, or the avoided cost, of energy. There is a wide range of OPIs associated with energy efficiency programs. OPIs are categorized by the perspective of the party that experiences the impact: 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:** From the utility perspective, a number of NEBs are realized from efficiency program implementation in the form of financial savings. 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 NEBs 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:** 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 materials (NMR, 2011, p. 4 11).
- **Safety:** 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).

Participant-Perspective OPIs

Participants in energy efficiency programs can realize a variety of OPIs (NMR, 2011, pp. 2-6, 5-1). Most of these participant-perspective OPIs are relevant to both low-income and non-low-income customers. Some of these OPIs, however, may have significantly greater value for low-income customers than for non-low-income customers. Participant-perspective OPIs can be divided into the following categories:

- **Resource savings:** Energy efficiency can result in reduced water and/or sewage costs. Resource savings can also include heat (or lack thereof) generated by efficient equipment, as well as other fuel savings or costs (NMR, 2011; SERA, 2010).
- **Equipment cost and performance:** Participants often experience efficient equipment performing better than previous equipment or inefficient equipment, resulting in reduced (or increased) maintenance costs, improved lighting quality, and so on (NMR, 2011, pp. 5-13–5-15; 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).

- **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 a comfort NEI (NMR, 2011, p. 5-9; SERA, 2010).
- **Reduced costs for businesses:** There are a variety of OPIs that pertain to commercial and industrial customers, including reductions in O&M costs, administration costs, materials handling, other labor costs, spoilage/defects, water usage, and waste disposal (Tetra Tech, 2012, p. 3-9).
- **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).
- **Improved productivity:** Improvements in comfort and lighting can result in increased worker and student productivity. Health and safety benefits can result in reduced student and worker sick days (NZ EECA, 2012).
- **Increased sales revenues:** Customer service-oriented businesses can increase sales as a result of improved aesthetics and improved comfort levels in stores (Tetra Tech, 2012, p. 3-9).
- **Property value:** Increased property value is frequently recognized as a non-energy benefit 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).[18]
- **Benefits for owners of low-income rental housing:**[19] Owners of low-income rental properties can experience NEBs such as marketability/ease of finding renters, reduced tenant turnover, property value increases, reduced equipment maintenance for heating and cooling systems, reduced maintenance for lighting, greater durability of property, and reduced tenant complaints (NMR, 2011, pp. 1-8, 7-1).
- **Utility-related benefits:** Just as 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 and Riggert, 2002).

Societal-Perspective OPIs

Societal-perspective OPIs are indirect program effects that accrue to society at large beyond those realized by utilities, their ratepayers, or program participants (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 GHGs, SO_2, NO_X, 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).

18 Although 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 include only those changes in property value that are not accounted for in the other categories of energy efficiency benefits. Also, from a societal perspective, increases to property value may be a benefit to owners but a cost to buyers and renters.

19 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).

- **Healthcare:** To the extent that energy efficiency programs can improve health and reduce healthcare 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). Healthcare costs can fall on individuals, insurance providers (which are generally passed to individuals through higher premiums), or taxpayers.
- **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). Energy efficiency can offer significant benefits in terms of creating jobs, even relative to alternative supply-side resources. These employment impacts tend to be particularly important to legislators and regulators, as well as other efficiency stakeholders. These benefits are rarely accounted for in energy efficiency program screening practices, however.
- **Reduced tax burden:** Energy efficiency programs provided to government facilities, including public schools, town halls, libraries, police and fire stations, military facilities, and others, will help lower the costs of supporting those facilities. These lower costs will often translate into lower taxes to the local, state, or federal taxpayers.[20]
- **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).

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 decision of whether and how to include OPIs has significant implications for the cost-effectiveness of energy efficiency programs. The inclusion of OPIs can frequently make the difference between a program being cost-effective or not.

In theory, the different categories of OPIs should be included in those tests in which 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.

3.2 The Rationale for Accounting for Other Program Impacts

The primary reason for including OPIs in the cost-effectiveness tests is that they provide a more complete and balanced indication of the impacts of energy efficiency programs on customers. In fact, including OPIs in the cost-effectiveness tests is necessary 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 underinvest or overinvest 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.[21] 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

20 The reduced bills from energy efficiency programs are already accounted for in the participant's benefits. Energy efficiency at government facilities, however, can help to reduce taxes, which can provide incremental benefits to society.

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

provide cost-effectiveness results that are skewed against energy efficiency. This results in underinvestment in energy efficiency programs and will result in higher costs for all customers on average.

A second reason for including OPIs in the cost-effectiveness tests is that they help achieve important public policy goals. Achieving other fuel savings, improving health and safety for low-income customers, and reducing O&M costs for struggling businesses are all public policy objectives that are important to regulators and other stakeholders. In addition, accounting for OPIs helps to support more comprehensive, whole-building programs and to offer a more diverse set of efficiency measures to a broader range of customers. This promotes greater customer equity, both within sectors and between sectors, which is clearly an important public policy goal of regulators.

A third reason for including OPIs in the cost-effectiveness tests is that they often play an important role in customers choosing to implement energy efficiency measures. Customers will frequently adopt efficiency measures because of the resulting improvements to comfort, improved aesthetics, reduced O&M costs, improved quality of energy services, and more. Sometimes these benefits are more important to customers than the reductions in their energy bills. This indicates that these OPIs are of significant magnitude and should not be ignored in assessing the full costs and benefits of the energy efficiency programs.

Regulators and other stakeholders, however, may understandably be concerned that including OPIs when screening energy efficiency programs is too comprehensive. Including OPIs in the TRC Test is likely to expand the universe of efficiency resources that are deemed cost-effective and may lead to increased energy efficiency budgets to support increased numbers of measures, or they may lead to a more expensive mix of efficiency measures for those program administrators with fixed budgets. In addition, properly accounting for OPIs in the TRC Test may burden utility customers with higher-cost efficiency measures in order to achieve benefits that are not related to utility services. These concerns are very important and should be addressed when deciding which cost-effectiveness tests to apply and how to apply them. We recommend that these concerns be addressed by applying the Societal Cost Test or the TRC Test when screening efficiency at the program level, and then applying the PAC Test at the portfolio level as a check on whether the impacts on utility costs are appropriate. We discuss this recommendation in more detail in Section 2.4.

It is important to recognize that the 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 that 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.

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. Consequently we recommend that regulators place priority on finding ways to account for at least these two participant-perspective OPIs.

3.3 The Application of Other Program Impacts 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, although 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.

On the other hand, several states have taken steps to incorporate OPIs into energy efficiency program screening.[22] Some of the more interesting regulatory approaches are described below.

- **California:** The California Public Utility Commission (PUC) requires program administrators to account for utility-perspective and participant-perspective NEBs when assessing the low-income efficiency programs (SERA, 2010, p. 34). The participant-perspective NEBs include: water and sewer savings; fewer shutoffs; fewer calls to the utility; fewer reconnects; property value benefits; fewer fires; reduced moving costs; fewer illnesses and lost days from work or school; net benefits for comfort and noise; and net benefits for additional hardship (CA PUC, 2012b). The state hired a consultant to construct a model to monetize the low-income NEBs (SERA, 2010, p. 34). Historically NEBs have not been applied to the non-low-income efficiency programs. The PUC is currently investigating modifications to its energy efficiency cost-effectiveness practices, however, including whether to account for NEBs in assessing all programs (CA PUC, 2012a, 2012b).

- **Colorado:** The PUC of Colorado requires a 10-percent adder in TRC Test cost-effectiveness calculations to represent non-energy benefits. The percentage is applied to the sum of the other quantifiable benefits and is used when calculating TRC Test values for specific DSM programs and the overall portfolio. The Colorado PUC also allows for the option of including specific non-energy benefits, on a program-by-program basis, when such benefits are clearly occurring and can be easily calculated. Furthermore, in applying the TRC Test to low-income DSM programs, the benefits included in the calculation are increased by 20 percent to reflect the higher level of non-energy benefits that are likely to accrue from DSM services to low-income customers (CO PUC, 2008, p. 26-27, 43).

- **Massachusetts:** OPIs that can be quantified and monetized are included in cost-effectiveness screenings, including reduced operation and maintenance, increased health, safety, and comfort, increased property value, and others. In 2011 a study was prepared for the Massachusetts program administrators assessing and monetizing the OPIs applicable to the residential and low-income programs in the state (NMR, 2011). The results of this study have been incorporated into the Massachusetts Technical Resource Manual to ensure that all program administrators include the same NEI assumptions. In 2012 a second study was prepared for the Massachusetts program administrators assessing and monetizing the OPIs applicable to the commercial and industrial programs in the state (Tetra Tech, 2012). The results of these studies are discussed in more detail in Section 3.4.

- **New York:** Detailed evaluation of OPIs is conducted for many or all of the programs in the program administrator's residential, commercial, and industrial portfolio. OPIs such as comfort, safety, air quality, productivity, and so on are included in regulatory cost-effectiveness evaluations for informational purposes only, but are not used for specific decision-making with respect to cost-effectiveness. Program administrators present the benefit-cost results both with and without OPIs. Occasionally program administrators use a scenario approach in which regulators are shown the benefit-cost results including zero OPIs, 50 percent of OPIs, and 100 percent

22 Skumatz Economic Research Associates, Inc. (SERA) recently published a paper that provides a comprehensive analysis of the "state of the art" in NEIs, and reports on the status and recommendations on estimation approaches for low-income programs in California (SERA, 2010, p. 1).

of OPIs (or similar). For utility OPIs, the program administrators generally rely on defaults and proxy values from the literature, adjusted for New York, and do not generally conduct arrearage or similar studies. For participant OPIs, they generally use the survey method developed in the literature. For societal figures (emissions and jobs), they use specialized regional models developed by a consulting firm (SERA, 2010, p. 34-35; NYSERDA, 2005; NYSERDA, 2012).

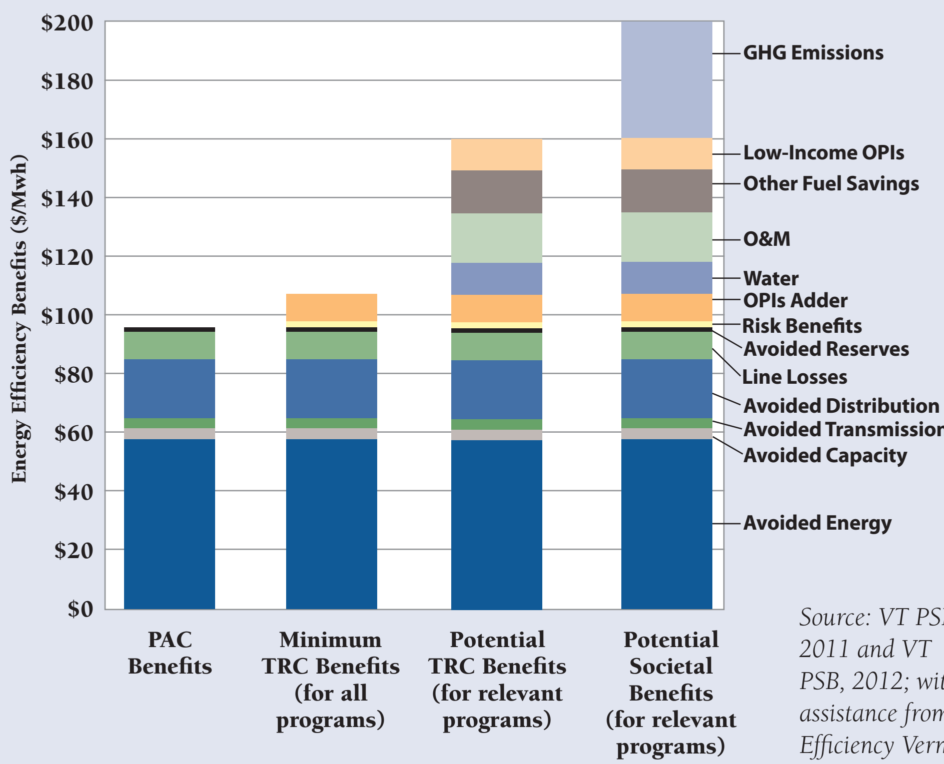
- **Oregon:** The PUC of Oregon has a long-standing policy that utilities (now the Energy Trust of Oregon) should calculate non-energy benefits if they are significant and there is a reasonable and practical method for calculating them (OR PUC, 1994, p. 15; SERA, 2010, p. 34-35).

- **Washington:** Puget Sound Energy: Puget Sound Energy categorizes OPIs as quantifiable and non-quantifiable. Where possible and easily quantifiable, Puget Sound Energy may include dollar values for non-energy benefits in its TRC Test, including values for water usage savings or maintenance savings. Non-quantifiable OPIs may include legislative or regulatory mandates, support for regional market transformation programs, low-income health and safety, low-income energy efficiency, or experimental and pilot programs. Where there is a significant amount of non-quantifiable OPIs, then Puget Sound Energy is able to accept energy efficiency programs with a benefit-cost ratio of less than 1.0, as long as the ratio exceeds 0.667 (PSE, 2012; SERA, 2010, p. 35).

- **Vermont:** The Vermont Public Service Board requires that several OPIs be accounted for in energy efficiency screening. First, the risk benefits of energy efficiency resources should be accounted for by applying a 10-percent discount to the energy efficiency costs. Second, the non-energy benefits of energy efficiency resources should be accounted for by applying a 15-percent adder to the energy benefits (Vermont PSB, 2012). Third, water, O&M, and other fuel savings should be accounted for with quantified and monetized estimates of those benefits, and applied to those programs in which these savings are expected to occur. Fourth, the non-energy benefits of low-income programs should be accounted for by applying a 15-percent adder to the energy benefits associated with those programs. The Board acknowledges that this adder is an approximate, conservative estimate of the value of low-income benefits, but notes that such a value is better than assuming zero, which is clearly not correct (VT PSB, 2012, p. 30). Finally, the environmental externalities associated with GHG emissions should be accounted for by assuming a CO_2

Figure 3-1

Other Program Impacts Applied to Efficiency Screening in Vermont



Source: VT PSB, 2011 and VT PSB, 2012; with assistance from Efficiency Vermont allowance price of $80/ton (VT PSB, 2011). Note that the Vermont Public Service Board requires program administrators to use the Societal Cost Test to screen energy efficiency resources, which includes the costs of environmental externalities.

Figure 3-1 presents a summary of the OPIs that are accounted for in energy efficiency screening in Vermont. These costs are presented in terms of levelized costs (in $/MWh). The leftmost column indicates the benefits that would be applied to all programs under the PAC Test, using the avoided costs currently applied in Vermont. The second column from the left indicates the risk benefits and the non-energy benefits that would be applied to all energy efficiency programs under the TRC Test. The second column from the right indicates the potential magnitude of the water, O&M, other fuel savings, and low-income benefits under the TRC Test. These benefits would not necessarily be applied to all programs; they would be applied only to those programs in which the measures are expected to result in the relevant benefits. Also, the size of the benefit can vary depending upon the amount of savings from any one measure or program; the values presented in Figure 3-1 are averages based upon the actual savings for Efficiency Vermont in program year 2010.

The rightmost column includes the avoided emissions benefit that is applied under the Societal Cost Test. The sum of all the benefits in the rightmost column should be seen as the potential amount of societal benefits; the water, O&M, other fuel savings, and low-income benefits would only apply to relevant programs.

3.4 Estimating the Value of Other Program Impacts

Methodologies for Monetizing Other Program Impacts

Some OPIs are priced by markets; many are not. Those OPIs that are market-based (e.g., other fuel savings, water savings) should be quantified and monetized using market prices to the extent possible.

Two primary approaches are used to quantify OPIs that are not priced by a market: computational and survey-based. Computational approaches use primary or secondary data assembled from program records or literature-based sources (SERA, 2010, p. 17).

Survey-based approaches rely on commonly used types of survey-based data gathering and estimation approaches, including stated preference surveys and revealed preference approaches. Revealed preference approaches include willingness to pay and willingness to accept contingent valuation studies, comparative or relative valuations, and other revealed preference and stated preferences approaches (SERA, 2010, p. 18).

Direct computation approaches have obvious benefits. Unfortunately an extensive array of less tangible but potentially important benefits cannot generally be estimated directly by a computational approach, including comfort, aesthetics, and other factors. Relying solely on computational methods thus is not sufficient in deriving overall estimates of participant-perspective OPIs. Economists, social scientists, and researchers in the environmental and advertising fields have used a variety of survey-based valuation methods to develop estimates of the monetary value of externalities and intangible goods. Examples of a few methods with particular applicability to energy include the following:[23]

- Computational approach using primary data;
- Computational approach using secondary data;
- Computational approach using statistical techniques, including regression analysis;
- Survey methods, including contingent valuation (e.g., willingness to pay and willingness to accept techniques); and
- Other survey methods, including relative scaling approaches, ranking approaches such as conjoint analysis, and customer motivation approaches.

It is important to emphasize that many OPIs, especially the non-energy benefits, are extremely challenging to measure, to quantify, and to put into monetary terms. In addition, some of the NEBs may be unique to certain customer types, and some of the NEBs may depend upon the unique preferences or conditions of different customers. Under even the best of circumstances it will be very difficult to ensure that all relevant NEBs are accounted for, and that their magnitudes are properly assessed. Experience to date indicates that adders and other proxies designed to account for NEBs typically understate the magnitude of these benefits. Program administrators, regulators, and

23 For a more detailed discussion of these options, see SERA, 2010, p. 17-24.

other stakeholders should be aware of these limitations when attempting to estimate the value of OPIs and NEBs.

Examples of Recent Estimates of Non-Energy Impacts

This section provides an illustrative list of the NEIs that have been monetized and recommended for inclusion in cost-effectiveness tests by recent studies.[24] Most of the NEI values reported were derived from the existing literature or by developing modified algorithms from the literature, whereas some values were derived by surveys of program participants.

In some cases, quantifying an NEI is not recommended for one of several reasons. Sometimes quantifying the NEI would amount to double counting, as it is already accounted for through a separate NEI or benefit. In other scenarios, an NEI is not monetized because there is insufficient evidence for its existence or because the NEI is too intangible (NMR, 2011, p. 1-1-2; 2-1). On occasion, a case might be made that an NEI is too hard to quantify meaningfully, but that outcome should be an exception rather than a rule for the reasons discussed previously and because experience shows that reasonable methods clearly exist for quantifying most NEIs.

For the discussion in this section, we have included only NEIs that have been monetized. It is important to note that many significant NEIs have not previously been monetized, and therefore the information below should not be seen as an exhaustive list of the most significant NEIs. It is also important to note that the NEI estimates presented in the tables below do not necessarily represent the full range of NEIs that have been monetized to date. These tables should be seen as an illustrative list of monetized NEIs, based on recent literature reviews. Finally, we do not recommend that only monetized NEIs be accounted for when screening energy efficiency programs, as described in more detail in Section 3.6.

Typically NEIs are considered either as a one-time or an annual impact, and are applicable on either a per-housing unit basis (also referred to as per-participant) or per-measure basis. The values presented in this section are expressed in dollars per housing unit or dollars per participant on an annual basis, unless otherwise noted.[25]

Utility-Perspective NEIs

Utility-perspective NEIs represent tangible benefits in the form of direct monetary savings to the utility, and therefore

Table 3-1

Utility-Perspective Non-Energy Impacts

Impacts Quantified to Date	Value or Range of Values
Financial and Accounting NEIs	
Reduced arrearages	$2.61
Carrying costs on arrearages	$2.00 - $32.00
Bad debt written off	$2.00 - $3.74
Customer Service NEIs	
Terminations and reconnections	$0.00 - $50.00
Customer calls	$0.58
Collection notices	$0.34
Safety-related energy calls	$0.50-$8.43

Source: SERA, 2010; NMR, 2011. The values presented in this table are expressed in dollars per housing unit or dollars per participant on an annual basis.

tend to be relatively easy to quantify. Most of the NEIs used are monetized from the literature or from algorithms using inputs from utilities. In general, the utility-perspective NEIs are relatively low in value, ranging from less than a dollar to nearly $9 per participant (NMR, 2011, p. 1-3-6; 4-1). Table 3-1 summarizes the range of values associated with utility-perspective impacts.

Participant-Perspective NEIs

Table 3-2 presents a summary of participant-perspective NEIs for residential efficiency programs from two recent studies. This table is not meant to represent an exhaustive summary of the literature or the potential NEIs, nor is it meant to suggest that the values of NEIs are limited to the values and the ranges presented. Instead, the table is meant

24 In this section we present estimates of NEIs but not OPIs, because estimates of other fuel savings are highly dependent on the relevant efficiency measure, the fuel type, and the utility.

25 The values presented in the following tables from NMR are in 2010 dollars. The SERA study does not explicitly state which year's dollars it uses. Because the report was prepared in 2010, we assume that the SERA values are also in 2010 dollars.

to provide an indication of the types and potential values for NEIs as identified in two recent, relevant studies.

Note that the values in Table 3-2 are presented in terms of dollars per housing unit treated. If these values were to be used in screening residential energy efficiency programs, they would be multiplied by the number of housing units served to get the total value for the program. Some housing units might experience several of these NEIs from program participation, depending upon the measures installed in each unit.

Table 3-2

Participant-Perspective Non-Energy Impacts – Residential

Impacts Quantified to Date	Value or Range of Values
Comfort NEIs	
Higher comfort levels	$14.00 - $125.00
Quieter interior environment	$13.00 - $40.00
Aesthetics/appearance	Few dollars to more than $20.00
Equipment/NEIs	
Lighting quality and lifetime	$3.50 per CFL fixture; $3.00 per CFL bulb, one-time impact
Equipment maintenance	$17.00 - $124.00
Equipment performance	$14.00 - $18.00
Property Value	
Increased housing property value	Few dollars to more than $2,000
More durable home and less maintenance	$35.00 - $149.00
Health and Safety	
Fewer fire deaths, injuries, and property loss	$0.03 - $37.40
Improved safety (lighting)	Approximately $20.00
Health-related NEIs	$4.00 - $19.00
Utility-Related NEIs	
(Bill-related) calls to utility	Approximately $0.30
Control over bill	Approximately $30.00
Termination and reconnection	$0.00 - $12.00
Resource NEIs	
Reduced water usage and sewer costs	$3.70 - $12.00
Economic Stability NEIs	
Reduced need to move and costs of moving, including homelessness	Less than $1.00 to $60.00
Owners of Low-Income Housing	
Marketability/ease of finding renters	$0.96
Property value	$17.03 one-time impact only
Equipment maintenance (heating and cooling systems)	$3.91
Reduced maintenance (lighting)	$66.73
Durability of property	$36.85
Tenant complaints	$19.61

Source: SERA, 2010; NMR, 2011. Note: The values presented in this table are expressed in dollars per housing unit or dollars per participant on an annual basis, except where noted otherwise.

As indicated, some of the values are quite large and will have a significant impact on the cost-effectiveness of energy efficiency programs. (See Section 3.5 for an example of how some of these values affect program screening results.) Also, note that some of the benefits have a wide range of estimated values, indicating the uncertainties and the variability of these estimates.[26]

Commercial and industrial (C&I) customer NEIs have not been subject to the same level of research as residential NEIs, perhaps because C&I programs tend to be highly cost-effective anyway. A groundbreaking study was recently conducted to quantify participant-perspective NEIs for C&I retrofit programs in Massachusetts through in-depth interviews with program participants (Tetra Tech, 2012).

The Tetra Tech study specifically addressed the following NEI categories: O&M, administration, materials handling, materials movement, other labor, spoilage/defects, water usage, waste disposal, fees, other costs, sales revenue, rent revenues, and other revenues (Tetra Tech, 2012, p.

26 With regard to the recent NMR study, some stakeholders have raised questions and concerns about the study's results, with several specific arguments that certain values are too low. These concerns are currently being addressed as part of an ongoing proceeding with the Massachusetts Department of Public Utilities (see docket number D.P.U. 11 120).

3-9). O&M benefits are the most significant category of C&I NEIs, representing 74 percent of total electric NEIs. After O&M, sales revenues represented roughly seven percent of electric NEIs, other labor benefits represented roughly six percent, and reduced administration costs represented roughly five percent (Tetra Tech, 2012, p. 4-39).

The Tetra Tech study investigated the potential NEIs from 789 different types of electric and gas C&I efficiency measures. They found that 57 percent of the measures had some form of non-energy benefit, 3 percent of the measures had some form of non-energy cost, and the remaining 40 percent of measures had neither a non-energy cost nor a non-energy benefit. Of those measures that had a positive non-energy benefit, most of the benefits were in the range of $5,000 per measure or less (Tetra Tech, 2012, p. 4-34).

Table 3-3 presents the participant-perspective NEI values for electric C&I prescriptive efficiency programs. C&I NEIs are presented by measure end-use to provide statistically reliable NEI estimates across each of the key end-use categories (Tetra Tech, 2012, p. 4-38). As indicated, HVAC and lighting measures show the highest estimated NEI values.

The values presented in Table 3-3 are specific to Massachusetts customers and focus only on C&I retrofit programs, which may limit the applicability of the NEI estimates in other jurisdictions (Tetra Tech, 2012, p. 1-7). Nonetheless, this study suggests that the C&I NEIs can be numerous and quite large. Program administrators in other states may experience C&I NEIs of similar magnitude.

Table 3-3

Participant-Perspective Non-Energy Impacts – C&I [27]

Measure End-Use	Average Annual NEI per Measure	Benefit/MWh Saved
HVAC	$7,687.00	$96.60
Lighting	$1,636.00	$27.40
Motors and Drives	$541.00	$4.30
Refrigeration	$5.00	$1.30
Other	$28.00	$3.90
Average	$1,439.00	$27.40

Source: Tetra Tech, 2012

Societal-Perspective Other Program Impacts

There is a large amount of research and literature regarding the environmental externality benefits and the economic development benefits of energy efficiency. Conversely there is much less literature regarding the other types of societal OPIs, such as national security and healthcare cost savings.

This category of OPIs is beyond the scope of our study, thus we do not provide a summary of these values here. Nonetheless, states choosing to apply the Societal Cost Test to evaluate energy efficiency should consider ways to account for these important OPIs.

Prioritizing Other Program Impacts

Given the large number of OPIs and the difficulty in measuring and accounting for all of them, it may be helpful for regulators to prioritize the impacts to identify those that are most likely to affect the outcome of the energy efficiency cost-effectiveness screening.

Utility-perspective OPIs are generally considered to be relatively small, as indicated in Table 3-1. Some studies, however, have identified significant benefits associated with reduced shutoffs and reconnects, as well as bad debt write-offs and carrying costs on arrearages. In addition, utility-perspective OPIs can be significantly larger for low-income customers, particularly in states where low-income customers are offered discounted rates or shutoff protection provisions that can sometimes result in large arrearages.

Participant-perspective OPIs have been found to be quite large, sometimes even exceeding the value of the energy savings (NMR, 2011, p. 5 1; NZ EECA, 2012). The participant-perspective OPIs that are considered to be most valuable include: health and safety related impacts; improved comfort; improved home durability; reduced home maintenance; improved equipment performance; and reduced equipment maintenance (ACEEE, 2006, p. 12; SERA, 2010, p. 28). Many of these impacts, such as health,

27 The values provided in Table 3-3 are for electric measures within the prescriptive C&I retrofit program. The Tetra Tech study also provides OPI values for custom C&I retrofit programs, as well as gas prescriptive and custom C&I retrofit programs.

safety, and comfort, are higher for whole-building retrofit programs than for individual measure programs.

Many of these participant-perspective OPIs are particularly large for low-income customers, because of the conditions of their dwellings, the other demands on their limited resources, and other hardships they may face. In addition, low-income energy efficiency programs are often less cost-effective than other efficiency programs because the customers are harder to reach and the barriers are more difficult to overcome. Consequently regulators frequently place a higher priority on the participant-perspective OPIs that apply to low-income efficiency programs.

It is important to avoid giving greater priority to those impacts that are readily measurable and quantifiable simply because they are easier to obtain. The utility-perspective OPIs tend to be relatively easy to quantify, but they also tend to be low in value. Conversely some participant-perspective NEIs can be difficult to quantify, but are expected to be quite large.

For example, health-related OPIs can be difficult to quantify, but some research indicates that the benefits can be very large. A recent New Zealand study found that health benefits of some residential retrofit programs were even larger than the original energy benefits. In some cases, more than 90 percent of the total program benefits (energy plus non-energy) were attributable to health-related improvements, including reduced hospital admissions for respiratory conditions, reduced days off from school and work, psychologic and stress benefits, and reduced health issues from indoor dampness and mold (NZ EECA, 2012).

Part of the difficulty in quantifying and prioritizing OPIs is that the impact can be very specific to the location, utility, customer, property, or measure. For example, health and safety benefits are significantly greater for customers whose homes are in disrepair prior to the efficiency improvements. Improved comfort benefits can be very dependent upon the climate where the customer is located, where the benefits are greater in regions experiencing either extreme cold or extreme heat conditions. These variations partly explain the ranges of values found in the literature for many of the OPIs discussed earlier. These variations also suggest that analysts need to be cautious about applying OPIs from one utility, state, or region in another.

3.5 Implications for Efficiency Program Screening

The importance of properly applying OPIs is apparent in many program administrators' energy efficiency screening results. Figure 3-2 presents the actual cost-effectiveness results for an electric utility in Massachusetts, for energy efficiency programs implemented in 2012. The figure presents the benefit-cost ratios under the PAC Test, the TRC Test with OPIs included, and the TRC Test without OPIs included. The OPIs that we use here are the ones that are currently in use by Massachusetts energy efficiency program administrators.

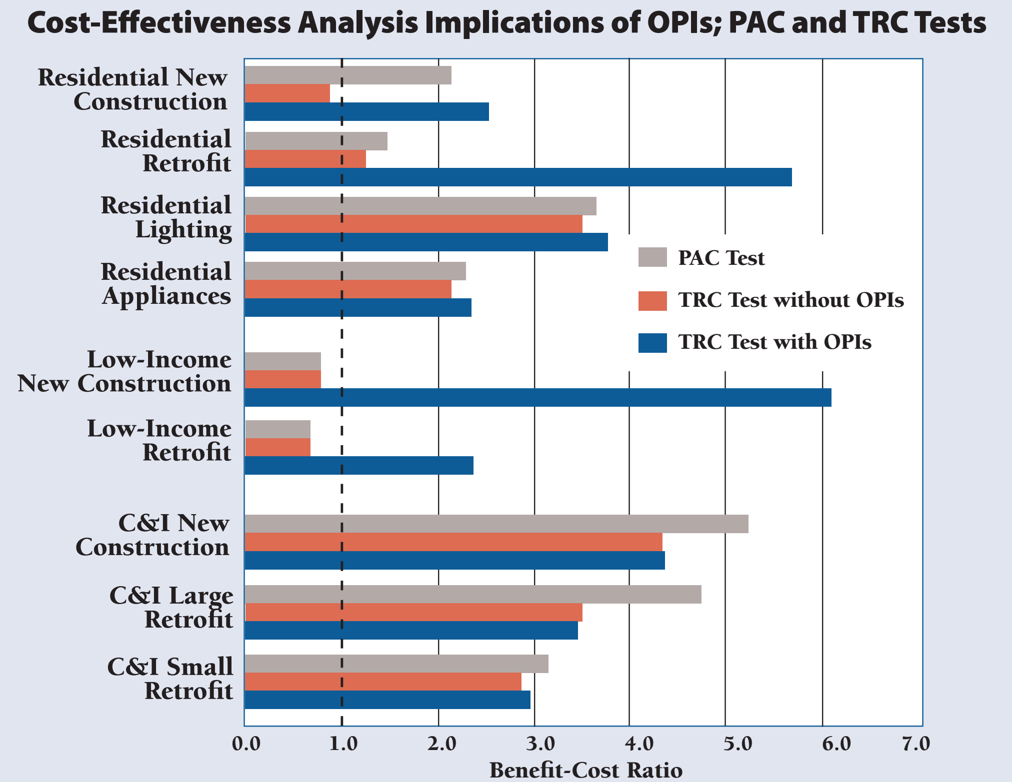
First, it is interesting to note the difference between the results under the PAC Test relative to the TRC Test without OPIs. The low-income programs are identical under these two tests because the customers are not required to make any contribution toward the incremental cost of efficiency measures.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

Most important, note that if the OPIs are not included in the TRC Test, then the low-income, residential new construction, and residential retrofit programs are all at risk for being improperly deemed not cost-effective. These energy efficiency programs are especially important because they help to support more comprehensive efficiency services to 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 objective underlying the energy efficiency programs.

Many program administrators find that low-income efficiency programs are not cost-effective without the

*Figure 3-2**



Source: Synapse Energy Economics, 2012a

**Figure 3-2 represents an example of how the choice of economic tests can have significant impacts on the results. These results should not be miss-interpreted as extending to other regions and circumstances. The results will likely vary significantly by region, available fuels, and other program impacts that are customer-class and location specific. Further, the fact that some benefit-cost ratios exceed others should not be misinterpreted to favor investments in programs with higher ratio to the exclusion of lower ratios. The objective of the energy efficiency investments should be to get the greatest net economic benefit for the available investment.*

inclusion of OPIs. Low-income programs are generally more expensive than other programs because they require higher incentive levels; they require additional marketing delivery costs; they must overcome barriers such as the landlord-tenant split incentive; and they may face other barriers such as the need to serve customers with limited ability to speak English.

At the same time, most utility regulators recognize that low-income customers are an important sector to serve with energy efficiency programs. The average low-income household in the United States spends upward of 15 to 20 percent of their total monthly income on energy costs. Energy efficiency upgrades to low-income homes help struggling families use less energy and lower their utility bills while still meeting their daily energy needs. A family living in an older home, for example, could cut their yearly energy bill in half with a full home weatherization (Center for American Progress, 2012).

Note that for the C&I sector there is very little difference between the TRC Test results with and without OPIs. This is because at the time these programs were screened (fourth quarter 2011) the program administrators in Massachusetts assumed very few OPIs for C&I programs, primarily because they did not have much information available regarding the magnitude of those OPIs. As described in Section 3.4, a recent study for the Massachusetts program administrators indicates that the C&I OPIs can be quite significant. If the analysis presented in Figure 3 2 were conducted again with the results of the new study, the benefit-cost ratios for the TRC Test with OPIs would be significantly higher than those in the figure.

3.6 Considerations in Setting Customer Financial Incentives

Including OPIs in energy efficiency screening not only allows more measures and programs to be considered cost-effective, it also allows program administrators to provide greater financial incentives to customers to participate in the programs. This raises an important question for regulators and other efficiency stakeholders. Should program administrators be allowed to pay customer financial incentives that exceed the energy benefits of the efficiency measure or program? In particular, will such incentives result in uneconomic decision-making by customers or inequities across customers?

The first thing to note here is that under the Societal Cost and the TRC Tests, the assessment of whether an efficiency measure is cost-effective is independent of the decision of what the customer financial incentive should be. Energy efficiency screening provides an indication of *whether* it is in the public interest to promote an efficiency measure. The choice of customer financial incentive will affect *how* to promote the measure.

The rationale for offering a customer financial incentive is to help the customer overcome the market barriers to energy efficiency. The amount of customer financial incentive (in combination with technical support, education, and other support) thus should be as large as necessary to overcome the market barriers to energy efficiency, but no larger. Once an efficiency measure has been deemed to be cost-effective, the size of the customer financial incentive can be determined based on this principle. Under both the Societal Cost and the TRC Tests, the amount of the customer financial incentive will not affect the cost-effectiveness results.[28]

Nonetheless, the two questions remain. First, if a program administrator offers a financial incentive that exceeds the energy benefits of the efficiency measure, could this result in an uneconomic decision from the customer? In other words, could the customer choose to implement a measure that was not in the public interest as a result of such high financial incentives? One might argue that the customer already experiences the participant-perspective non-energy benefits, and therefore does not need to be paid a financial incentive that covers both the energy benefits and a portion of the non-energy benefits. Receiving such a high financial incentive could result in a customer choosing a very costly efficiency measure that is not in the public interest (i.e., is not cost-effective).

We believe that offering customers financial incentives that exceed the energy benefits will not lead to customers making uneconomic decisions. First, the efficiency measures and programs are screened by the program administrators, using the methods described in this study, and thus the program administrators identify the universe of measures that are cost-effective. Customers will only be able to choose from those measures that are first deemed to be cost-effective. Second, as noted earlier, the rationale for offering customer financial incentives is to overcome market barriers, and the amount of the financial incentive should be set high enough to overcome those barriers. In some cases, for example, low-income customers or small businesses, the market barriers might be especially high. These market barriers might be so high as to prevent the customer from recognizing both the energy benefits and the non-energy benefits, in which case a higher customer incentive may be necessary to get the customer to adopt the measure.

This leaves the second question. If a program administrator offers a financial incentive that exceeds the energy benefits of the efficiency measure, will this result in inequity across customers? In other words, why should all utility customers provide funding to pay a program participant a financial incentive that exceeds the energy benefits? Does this approach result in paying too much ratepayer funds to achieve non-energy benefits?

We believe that this approach does not necessarily lead to customer inequity concerns. This issue is parallel to the issue raised in Section 2.4 about whether utility ratepayer funds in general should be used to pay for non-energy benefits. We believe that this issue is best addressed through the program screening practices, not through the practices for setting the customer financial incentives. The program screening practices account for all of the costs that need to be covered by the utility funding: the customer financial incentive, the technical support offered to customers, the delivery costs, the auditing costs, the administration and planning costs, and the monitoring and evaluation costs. The program screening practices thus allow for a more comprehensive assessment of the potential for customer inequities as a result of the energy efficiency programs. If the customer inequity issues are resolved through the program screening practice, then there is no need to address them in establishing the customer financial incentives.[29]

28 This will not be true if the customer financial incentive exceeds the full incremental cost of the energy efficiency measure.

29 Furthermore, customer equity concerns might actually be mitigated by enabling more customer types and a greater number of customers to participate in energy efficiency programs, as discussed in Section 3.2.

As discussed in Section 2.4, we believe that it is vitally important to ensure that utility ratepayer funds that are used to support energy efficiency programs will result in a net reduction in ratepayer utility costs, that is, that the energy benefits will exceed the efficiency program costs. This goal can be achieved by applying the PAC Test to the entire portfolio of energy efficiency programs offered by a program administrator. If the portfolio passes the PAC Test, then customers and consumer advocates can be confident that the energy efficiency programs as a whole will reduce utility costs to customers.

Nonetheless, there is an important perception issue here. At first glance, it appears as though paying financial incentives that exceed the energy benefits could lead to uneconomic decision-making or inequitable outcomes, or at least create the risk for such outcomes. We therefore recommend that program administrators should not offer customer financial incentives that exceed energy benefits as a general rule. This is consistent with the principle of setting the customer incentive as large as necessary to overcome market barriers, but no larger. However, in those cases in which the program administrator has evidence that it may be necessary to offer customer financial incentives that exceed the energy benefits in order to overcome market barriers, for example, for some low-income customers or for some small business customers, then they should have the flexibility to do so.

3.7 Regulatory Options to Address Other Program Impacts

There are several options available for including OPIs in energy efficiency cost-effectiveness screening. The ideal approach is to develop quantitative, monetary estimates for all relevant OPIs. These dollar values of the OPIs would be added to the energy benefits and the energy costs for each measure, as appropriate. This would allow for a comprehensive comparison of the energy efficiency costs and benefits, including OPIs.

There are, however, several challenges and uncertainties associated with developing quantitative monetary estimates of some OPIs. Consequently regulators have developed several approaches for incorporating OPIs into energy efficiency screening practices despite these challenges. These approaches are summarized below.

- **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 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.[30]

- **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.[31] This approach will fail to capture the full range of OPIs, however, 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 NEIs, from zero NEIs, to half of the readily measurable NEIs, to all of the readily measurable NEIs. This approach assists regulators in understanding a range of effects that NEIs can have on benefit-cost ratios, and may help to address concerns about uncertainty in the NEI values. The New York approach is inherently conservative, however, in that it only assesses the impacts of NEIs of magnitudes that are lower than the readily measurable magnitudes. A better approach would be to include higher levels of NEI values in the sensitivity analyses as well.

- **Adder:** Develop and apply an adder to the efficiency program benefits to reflect the non-energy benefits.

30 See, for example, NMR, 2010.

31 For additional information on methodologies for quantifying OPIs, see SERA, 2010 and NMR, 2010.

For example, the adder could be a percentage increase or a $/MWh increase to the energy benefits. The rationale for using an adder is that it is meant to be a proxy for the difficult-to-measure non-energy benefits. It is an explicit acknowledgement that the non-energy benefits are higher than zero, and that the adder is the best approximation available at the time. Adders could be applied at the measure, program, sector, or portfolio levels. Adders applied at the measure or program levels could be tailored to the specific non-energy benefits associated with those measures or programs, while adders applied at the portfolio level should represent non-energy benefit levels across the portfolio on average. Overall this is a simplified approach that does not require extensive evaluation activities and lends certainty to the routine of program screening. On the other hand it may be seen as too much of an approximation, and determining an appropriate adder may be difficult, or may be very conservative owing to estimates and politics.

- **Reduced Benefit-Cost Ratio Threshold:** Apply a lower benefit-cost threshold than 1.0 to efficiency programs to reflect the non-energy benefits. This approach has an effect similar to applying an adder, that is, an adder can be directly converted into a lower threshold and vice-versa. However, we prefer using an adder relative to reducing the benefit-cost threshold. Using an adder has the benefit of being more transparent, because there is an explicit increase in the benefits to reflect the non-energy benefits, whereas reducing the benefit-cost threshold has implications for both the benefits and the cost. Also, it is more transparent and easier to understand the application of a different adder for different efficiency programs to reflect different non-energy benefits, relative to the application of a different cost-benefit threshold 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 NEIs, and use an adder for hard-to-measure NEIs. As discussed earlier, Vermont uses an adder for NEIs in addition to readily measurable NEIs, while Colorado requires an adder but also allows for readily measurable NEIs. Furthermore, a state could include readily measurable NEIs and conduct a sensitivity analysis for additional NEIs. This approach is most consistent with the nature of NEIs, whereby some NEIs are easily and readily monetized, while others require 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 NEI 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.

The approach used may depend upon the particular OPI being evaluated. Other fuel savings and resource savings (e.g., water and sewer) are relatively easy to quantify and monetize, and thus they should always be monetized in cost-effectiveness analyses. Some of the non-energy benefits, such as improved health, safety, and comfort, can be more difficult to quantify and may be better suited for sensitivity analyses or adders if resources are not available to develop monetary values.

Ideally the approach used to account for OPIs should be applied at the measure level. If they cannot be applied at the measure level, then the next best approach would be to apply them at the program level. OPIs can vary significantly by efficiency measures, and many OPIs are only relevant for certain measures (e.g., water savings associated with water heater measures; other fuel savings associated with space heating measures; and health, safety, and comfort benefits associated with space heating measures). Applying OPIs at the measure level offers a more accurate depiction of the magnitude of their benefits.

3.8 Recommendations

The Best Tests to Use for Screening Energy Efficiency Programs

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 other fuel savings, low-income benefits, and environmental benefits.

We recommend that all states that choose not to rely on the Societal Cost Test use the TRC Test to screen energy efficiency programs. This test includes many of the important energy efficiency costs and benefits and helps address many important public policy benefits, such as other fuel savings, low-income benefits, and customer equity.

There is an important concern, however, 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 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.

The Application of Other Program Impacts in Screening Energy Efficiency

When using the Societal Cost Test, it is important to account for the utility-perspective, participant-perspective, and societal-perspective OPIs to the greatest extent possible.

When using the TRC Test, it is important to account for the utility-perspective and participant-perspective OPIs to the greatest extent possible. It is particularly important to account for the participant-perspective OPIs, because otherwise the TRC Test will be internally inconsistent and will lead to cost-effectiveness results that are skewed against energy efficiency, will cause program administrators to underinvest in energy efficiency programs, and will impose higher costs on utility customers.

When using the PAC Test, it is important to account for utility-perspective OPIs. The utility-perspective OPIs are relatively certain and relatively easy to quantify. In addition, the utility-perspective OPIs will directly affect utility revenue requirements, and thus have a direct impact on utility customer costs.

We recommend that each state develop an approach for accounting for OPIs that best suits its needs and best accounts for values of the OPIs relevant to it. To this end, 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, regardless of whether reliable, monetized values are available for them. This should be based on a state-specific assessment of which OPIs are likely to be most significant, not simply on those that are readily measurable. This step is important to at least understand the type and breadth of the OPIs relevant to the state efficiency programs.
- Develop quantitative, monetary estimates for all OPIs that can be readily monetized. At a minimum, this should include the other fuel savings, because these savings can be relatively easily monetized using forecasts of the prices for those fuels.
- Develop some methodology for addressing those OPIs that are not monetized, for example, by conducting sensitivities or using an adder to the benefits as a proxy. Although there are limits to these approaches, and adders are sometimes criticized for being too conservative, these approaches may be necessary to ensure that some of the significant OPIs are not ignored simply because they are difficult to quantify.
- Address the non-energy benefits associated with low-income customers. Many studies have shown that these are among the most significant NEBs, and many analyses have indicated that these NEBs can have a substantial impact on the cost-effectiveness of low-income programs, frequently making the difference between programs that are cost-effective and those that are not. If the state does not develop quantitative estimates for the low-income non-energy 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 the program administrator's energy efficiency budgets, as a part of the evaluation, monitoring, and verification activities. The value of this research would likely be well worth the cost, given the magnitude of OPIs that could be identified and pursued through the energy efficiency programs.

- Identify those OPI assumptions, methodologies, and outcomes that can be transferred across utilities and across states, in order to increase awareness of the issues, promote consistency where appropriate, increase acceptance of hard-to-quantify values, and reduce costs.

Recommendations for Further Research

Also, as noted earlier, each state should hire independent consultants to develop state-specific OPI estimates. In addition, some national level research could help advance our understanding of some of the more important non-energy benefits (SERA, 2010, p. 46-47; 78-79). This research could also lend support to the analyses that are conducted at the state level. The following list includes those NEIs that we believe are likely to be significant and to benefit from further research.

- Indoor air quality and health effects at home and at work
- Reduced sick days off from school or work
- Increased productivity at businesses and at schools
- Family stability and fewer household moves
- Safety, fires, and insurance, and damage prevention

4. Environmental Compliance Costs

4.1 Environmental Compliance Costs Versus Externalities

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 certain environmental regulations, such as the costs of purchasing SO_2 and NO_X allowances. It is much less common, however, 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.

The costs of environmental compliance should not be confused with environmental externalities. 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 both the TRC Test and the PAC Test, as well as the Societal Cost Test. In contrast, environmental externalities represent costs of environmental damages to society in general, or the costs of abating those actions that lead to the damages.[32] These externalities would be included in the Societal Cost Test, but not the TRC or the PAC Tests.

Note also that environmental compliance costs are separate from environmental externalities, and it is important to ensure that they are not double counted. The environmental externalities represent all of the environmental damages that might happen after the environmental regulations are met, if there are any. Over time, if environmental regulations become increasingly stringent, the environmental compliance costs will tend to increase while the environmental externality costs will experience a corresponding decrease.

Estimates of the avoided costs of environmental compliance should be based on the environmental requirements pertinent to the relevant state, which might include federal regulations, state regulations, or both. These costs should include all current and reasonably anticipated future regulations that impact the electric sector, including those that regulate criteria pollutants (such as ozone, particulate matter, SO_2, and NO_X), water effluent and use, air and water toxics, solid waste management, and GHGs. In the sections that follow we focus on EPA regulations and GHG requirements, because these are expected to result in significant costs of compliance, in both the near term and long term.[33]

4.2 Current and Anticipated EPA Regulations

Summary of Current and Anticipated EPA Regulations

The 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 (CAA), the Clean Water Act (CWA), and the Resource Conservation and Recovery Act (RCRA).

The CAA is a comprehensive federal law that regulates

32 A useful frame of reference is that environmental regulations are a mechanism by which regulators and policymakers can "internalize" otherwise external environmental costs. Harm from pollution is considered an environmental externality cost imposed on society in general; by compelling power plants to spend money to reduce pollution and hence harm, environmental regulations move the burden of pollution from society (an externality) to polluters (an internal cost realized in the cost of service).

33 We recognize that utility management will be making decisions based on a number of factors (e.g., low natural gas prices) in addition to pending environmental regulations. (Brattle Group, 2012).

air emissions from stationary sources, such as chemical plants, steel mills, and electrical generators, as well as mobile sources (US EPA, 2012a). Under the CAA, the 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 following:

- **Mercury/Air Toxics Standards (MATS):** MATS is the first national emission standard to reduce mercury and other toxic materials such as arsenic and acid gas from power plants. MATS was proposed in 1990 and finalized in December 2011. It became effective in March 2012. Sources effectively have four years to comply with the rule (US EPA, 2012b).

- **Cross-State Air Pollution Rule (CSAPR):** The EPA's CSAPR was expected to replace the 2005 Clean Air Interstate Rule (CAIR) for the regulation of SO_2, NO_X, and particulates. A December 2008 court decision allowed the requirements of CAIR to remain in place temporarily, but directed the EPA to issue a new rule to implement the CAA requirements concerning the transport of air pollution across state boundaries. CSAPR was finalized in July 2011 but was stayed in December 2011 pending judicial review. On August 21, 2012, the US Court of Appeals for the District of Columbia vacated CSAPR, ordering that CAIR remain in effect (US EPA, 2012c; US Court of Appeals, 2012).[34]

- **New Source Performance Standards (NSPS):** In December 2010, the EPA announced it would propose an NSPS to regulate GHG emissions from new and modified electric power plants under section 111(b) of the CAA, and from existing electric power plants under section 111(d). On March 27, 2012, the 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 natural gas power plants and far below the average emissions from coal power plants (Washington Post, 2012). This issue is addressed in more detail in Section 4.3.

Although CSAPR was recently vacated, this rule should continue to be included in a review of EPA regulations. As stated earlier, it is important to consider regulations that are expected to result in significant costs of compliance in both the near term and the long term. Although CAIR remains in place as a backstop, the EPA must promulgate a replacement for both CAIR and CSAPR in order to meet the requirements of the CAA. This new rule may need to achieve emission reductions above and beyond those anticipated from CSAPR, as National Ambient Air Quality Standards (NAAQS) for NO_x, SO_2, ozone, and particulates are updated and become more stringent. The requirements for pollution abatement to meet these new standards could result in significant costs of compliance and should be accounted for in energy efficiency cost-effectiveness screening.

The EPA has established and periodically revised state-by-state NAAQS for criteria pollutants. The EPA maintains air quality monitoring stations across the nation, and air managers in each state are responsible for crafting plans to meet NAAQS at these monitors. States where monitors show that air quality is out of compliance are required to submit State Implementation Plans (SIPs) to the EPA detailing how the state will implement, attain, maintain, and enforce NAAQS (US EPA, 2011). The EPA regularly revisits the NAAQS, and has over time ratcheted down the acceptable level of pollution at these monitors. In 2010, the EPA strengthened standards for NO_2 and SO_2, and is currently considering more stringent standards for ozone (US EPA, 2012d).

The EPA has also proposed a few other environmental standards under the CWA and the RCRA, which will have direct impact on the operation of existing power plants and factories:

- **316(b) Cooling Water Rule:** The proposed 316(b) will establish requirements for power plants and factories to adopt certain control technologies or

34 In vacating CSAPR, the US Court of Appeals for the District of Columbia objected to two significant requirements: (1) the EPA's cost-based standards for determining how much pollution power plants could eliminate if they applied available controls at or below given cost-effectiveness thresholds; and (2) the EPA's failure to give states an opportunity to implement CSAPR's obligations first through State Implementation Plans rather than through Federal Implementation Plans, which were simultaneously promulgated with CSAPR.

practices to reduce injury and death of fish and other aquatic life caused by cooling water withdrawals. The proposed rule applies to all existing power generating, industrial, and manufacturing facilities that have the design capacity to withdraw more than two million gallons per day (GPD) and use at least 25 percent of that water exclusively for cooling (US EPA, 2011b).

- **Wastewater Rule:** The EPA found that the current regulations under the Wastewater Rule, which were last updated in 1982, do not adequately address the pollutants being discharged, mainly from steam electric power plants, and have not kept pace with changes that have occurred in the electric power industry over the last three decades. Coal ash ponds and flue gas desulfurization (FGD) systems used by such power plants are the source of much of these pollutants (US EPA, 2012e). No new rule has been proposed, but the EPA intends to issue proposed regulations in mid 2012 and a final rule in late 2013 (RAP, 2011).

Table 4-1

Major EPA Rulemakings Impacting Power Plants

Proposed Regulation	Targeted Pollutant	Control Options	Schedule
316(b) Cooling Water Rule	Cooling water intake design	Intake design upgrades: cooling water intake structures	• Proposed rule April 20, 2011 • Final rule July 2012 • Facility compliance due by 2020
Wastewater Rule	Wastewater toxic metals	Treatment or zero discharge	• Proposed rule July 2012 • Final rule January 2014
CSAPR	Reduced downwind contribution to ozone and PM2.5 non-attainment	NOx removal: SCR 70-95%; selective non-catalytic reduction 30-75%; SO2 removal: scrubber ≥95%; dry sorbent injection <70%	• Final rule July 2011, vacated August 21, 2012 • Schedule unknown (the EPA is considering whether to petition the US Court of Appeals for rehearing)
Mercury/Air Toxics Rule	Hazardous air pollutants (Hg, HCl, metals, organics)	Hg removal: fabric filter baghouse - activated carbon injection 80-90%; scrubber-SCR co-benefit >90%	• Proposed rule May 3, 2011 • Final rule due by November 2015 (3 years, case-by-case 1-year extension)
New Source Performance Standards for Greenhouse Gases	Greenhouse gases	CCS, market-based approaches	TBD
Coal Combustion Residuals Rule	Coal combustion waste disposal	Phase out wet surface impoundments (ash ponds); composite liners; other changes for disposal sites	• Proposed rule March 2010 • Final rule TBD • Ash pond closures 5-7 years after final rule (2016-2018)

Abbreviations: CSAPR, Cross-State Air Pollution Rule; CCS, carbon capture and sequestration; EPA, US Environmental Protection Agency; HCl, hydrochloric acid; NOx, nitrous oxide; SCR, selective catalytic reduction; SO2, sulfur dioxide

Source: RAP, October 2011

- **Coal Combustion Residuals Rule:** Coal combustion residuals (CCRs), also known as coal ash, are the materials that remain after burning coal for electricity. CCRs include fly ash, bottom ash, boiler slag, and FGD gypsum. These materials are currently exempt wastes under an amendment to the RCRA. The EPA, however, has proposed a new rule to regulate CCRs on June 21, 2010. This initiative was triggered by the massive coal ash spill at the Tennessee Valley Authority's Kingston facility in December 2008. Since then, the EPA has taken aggressive steps to gather information from and assess impoundments at facilities managing CCRs nationwide. No date has yet been set up for a final rule (US EPA, 2012f).

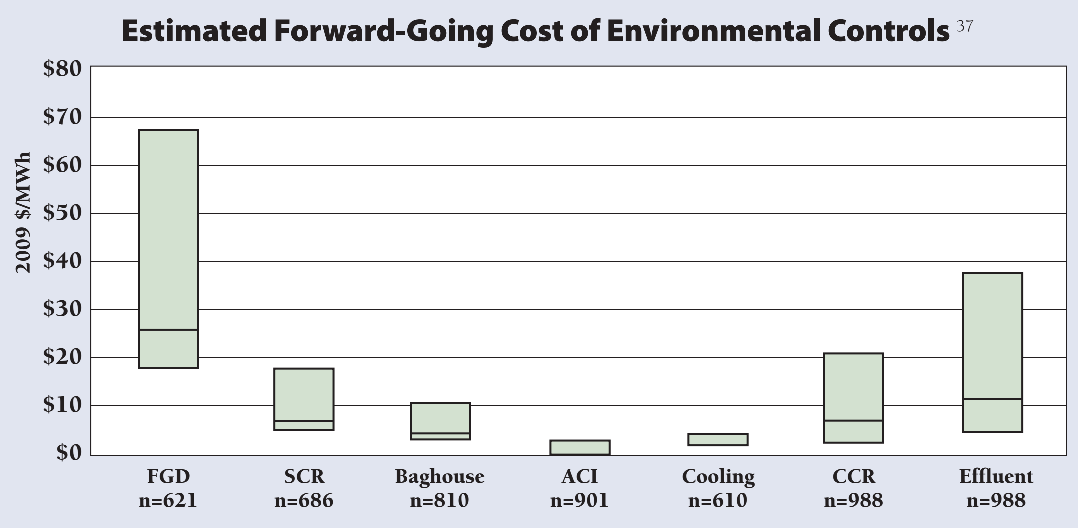
Table 4-1 presents a summary of the major EPA rulemakings that affect power plants. It includes the regulation, the pollutant targeted, the primary control options, and the schedule for compliance.

Figure 4-1 presents some estimated ranges of forward-going costs of these environmental controls.[35] These costs were estimated by Synapse Energy Economics for actual coal units (with the number of units indicated by "n"), using control cost methodologies developed by Sargent & Lundy, the US EPA, and EPRI. Data for current environmental controls, MW capacity, heat rate, and coal type were used to calculate $/kW costs for each of the control technologies for each unit.[36] The variable costs for O&M of the incremental controls were then added to the amortized capital cost to determine a unit's total forward-going cost in $/MWh. As indicated, FGDs are likely to be the most expensive controls.

The costs in Figure 4-1 do not necessarily represent the costs that would eventually be incurred to comply with EPA regulations. The regulations are often specific about the facilities impacted, by region, age, size, heat rate, capacity factor, pollution produced, or a combination thereof. Generally speaking, however, it is a reasonable starting assumption that coal-fired power plants that are currently uncontrolled for SO_2, NO_X, particulates, or mercury will likely require environmental controls.

Figure 4-2 provides an illustrative example of potential cumulative retrofit costs at an older 300-MW coal-fired power plant. This figure shows how various forthcoming EPA environmental regulations can contribute to total power plant costs in $/kWh terms relative to the current operating cost. The costs are illustrative, as both the

Figure 4-1



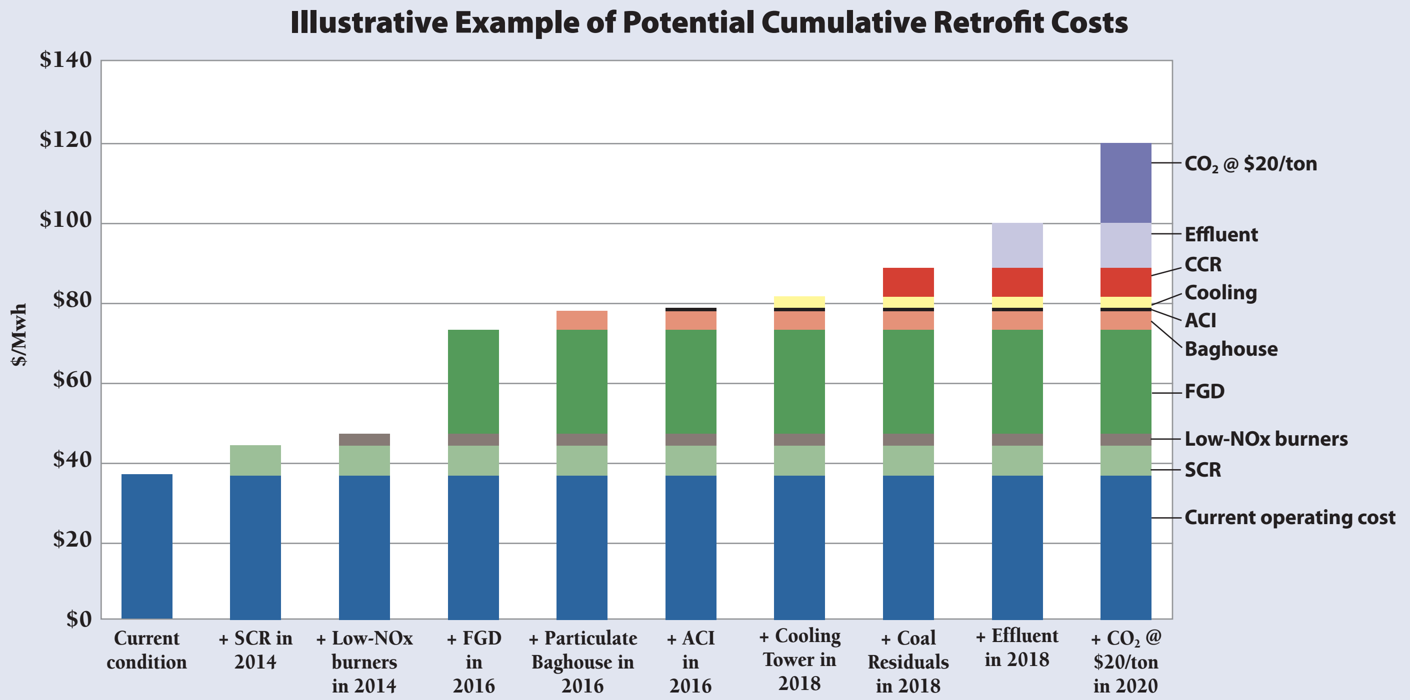
Note: The upper bound of each box represents the 75th percentile of a given control's forward-going cost. The middle line of each box represents the median forward-going cost, and the bottom bound of the box represents the 25th percentile of the cost.

35 Forward-going costs are calculated for all coal units that do not currently have that control installed.

36 The capital costs were amortized based on a 12.7 percent capital recovery factor and were converted to $/MWh using an average of 2008-2010 annual capacity factors.

37 Cost estimates for FGD, SCR, Baghouse, and ACI controls are based on calculations developed by Sargent & Lundy for EPA Base Case IPM Model v.4.10 (US EPA, 2010). Cost estimates for cooling controls are based on estimates in the 2011 EPA document "Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule" (US EPA, 2011b). Cost estimates for CCR and effluent controls based on estimates from the 2010 EPRI document "Engineering and Cost Assessment of Listed Special Waste Designation of Coal Combustion Residuals Under Subtitle C of the Resource Conservation and Recovery Act" (EPRI, 2010).

Figure 4-2



Source: Estimates for current operating cost and low-NOx burners are based on RAP 2011 estimates (RAP, 2011, p. 15). All other cost estimates are based on Synapse Energy Economics analysis of Sargent & Lundy research for EPA IPM Base Case v4.10 model (US EPA, 2010).

operating costs and retrofit costs can vary significantly and will be dependent on each particular coal unit. The right-most bar in the figure indicates the additional cost of CO_2 allowance price of $20/ton starting in 2020. (The cost of complying with CO_2 regulations is discussed in the following section.)

Responding to expected EPA rulings in 2009, the Edison Electric Institute (EEI) suggested that environmental control costs could result in a "train wreck" for the US coal fleet. In May 2010 ICF International prepared a report for EEI predicting that environmental regulations could result in significant coal retirements (ICF International, 2010). Other organizations followed. Studies from Bernstein Research, Credit Suisse, the North American Electric Reliability Council (NERC), Charles River Associates, and the Brattle Group, all suggested that between 20 and 60 GW of coal capacity (or 12-19 percent of coal nameplate capacity) could face retirement under the confluence of environmental regulations (Bernstein Research, 2010; Credit Suisse, 2010; NERC, 2010; Charles River Associates, 2010; Brattle Group, 2010; EEI, 2011; EPRI, 2012).

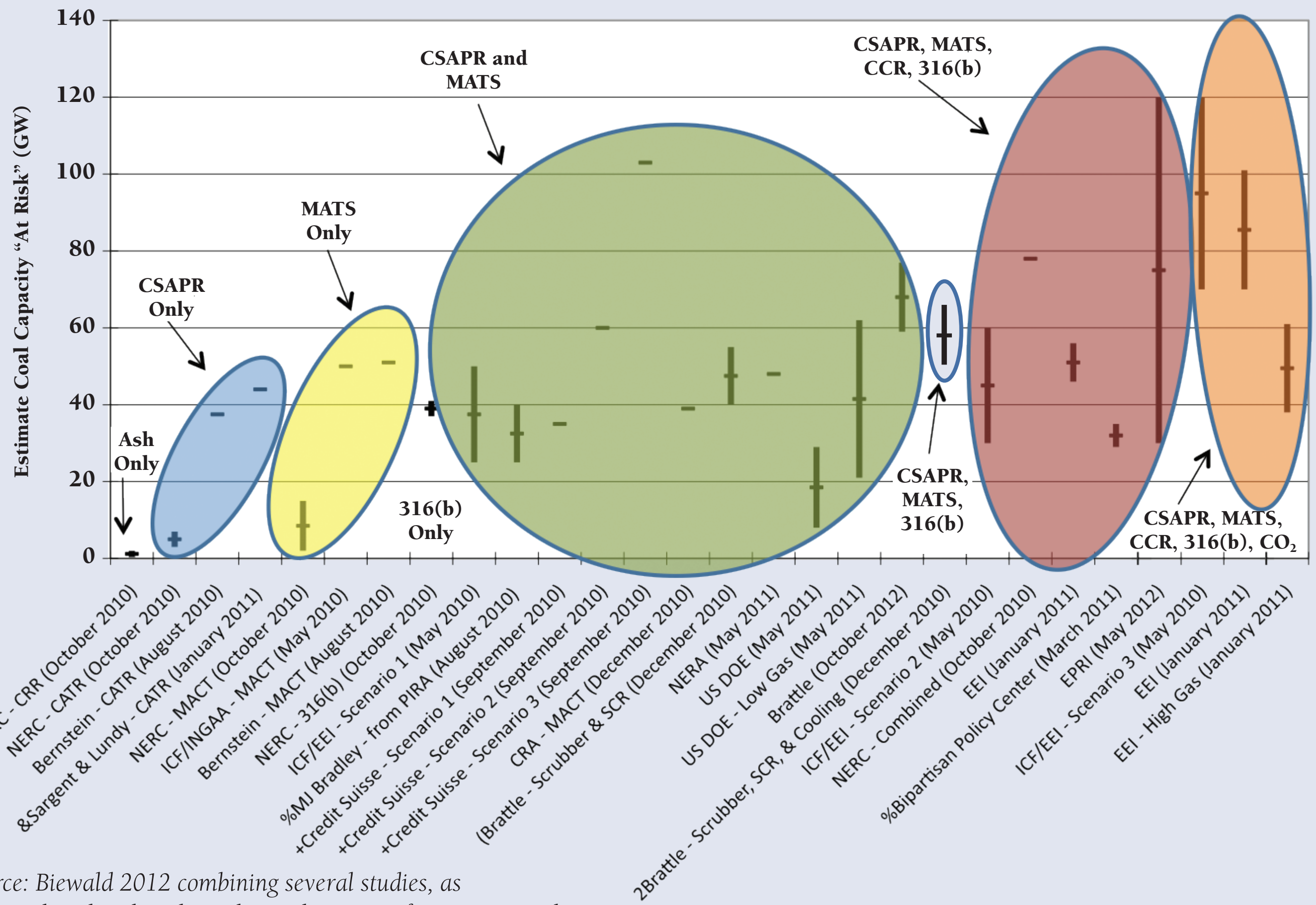
An updated study from EEI reviews this confluence of rules with the significantly lower gas prices of 2010 and estimates 50-73 GW of "unplanned coal retirements" by 2015 (EEI, 2011). Finally, a recent study from EPRI predicts 35-113 GW of retirements, or up to 36 percent of the US coal fleet, rendered non-economic by stringent capital requirements and dropping gas prices (EPRI, 2012).

Figure 4-3 summarizes the range of potential coal plant retirements estimated by these studies. The ranges indicate either uncertainty in a particular study or a sensitivity range of gas or carbon dioxide (CO_2) prices. The most recent studies examining the confluence of CSAPR, MATS, the CCR rule, the 316(b) regulation, and the possibility of CO_2 regulations estimate that up to a third of the US coal fleet may be non-economic.[38]

38 As discussed earlier, we maintain CSAPR in our analysis of EPA regulations even though the US Court of Appeals recently vacated this rule. The number of studies in Figure 4-3 that have considered the impact of CSAPR demonstrates the importance of the intent of that EPA rule.

Figure 4-3

US Coal Capacity at Risk Due to Compliance with EPA Regulations



Source: Biewald 2012 combining several studies, as indicated. Colored circles indicate the range of environmental regulatory assumptions in each study.

Note that none of the studies listed here consider the EPA's renewed interest in modifying effluent limitation guidelines to prevent the leakage of toxic wastes from air emissions controls. The proposed version of this guideline is expected to be released in 2012, and may put additional existing coal capacity at risk for retirement.

Also note that some of the recent EPA regulations will apply to more than just coal units. Some of the older, less efficient oil and gas units may face compliance requirements as well.

The Importance of Considering Potential Compliance Costs

It is clear that over the next four to eight years many coal units will become considerably more expensive to maintain and operate than they are now. Utilities have been, and will be, conducting analyses of the economics of either retrofitting their coal units to meet the new regulations or retiring the units and replacing them with alternative resources.

This has two important implications for the evaluation of energy efficiency resources. First, the avoided energy and capacity costs associated with energy efficiency could be higher in the future, under either a retrofit scenario or a retirement scenario. Some of the retrofit technologies can reduce the capacity factors and increase the O&M costs of the existing coal units. Under a retirement scenario, some of the replacement facilities might have higher fuel or operating costs than the existing coal unit. These future changes should be factored in to the energy efficiency cost-effectiveness analysis in order to properly capture the full value of the efficiency.

Second, and more important, energy efficiency can offer a low-cost alternative resource in a coal plant retirement analysis. In some cases, energy efficiency might be able to provide sufficient energy and capacity, possibly in conjunction with other resources, to enable a utility to retire a coal plant at a lower cost than retrofitting it.

In evaluating a coal unit retirement, it is critical that the evaluation be conducted as early as possible, and the energy efficiency resources be assessed as thoroughly as possible, to identify the full potential for energy efficiency. If efficiency resources are insufficient to replace the retired coal plant within the timeframe required, then they could be combined with other resources as needed to develop the lowest cost option to replace the coal unit.

If efficiency resources are not properly assessed in the analysis of EPA regulation compliance options, then customers could likely pay significantly higher electricity costs.[39] If a utility decides to install control technologies to comply with the regulations, when plant retirement in combination with efficiency resources would be a less expensive option, then customers will bear the increased costs of those control technologies. If, on the other hand, a utility decides to retire a coal plant and replace it with another supply-side resource (e.g., a natural gas combined cycle plant) without first considering lower cost efficiency options, then customers will bear the increased costs of the new supply-side resources, and associated environmental compliance costs for these resources.[40]

To make matters worse, if a new supply-side resource is constructed to replace a retired coal plant without first considering lower cost efficiency resources, then the future avoided energy and capacity costs would likely become much lower, making energy efficiency resources less cost-effective. It is thus essential that analyses of EPA regulation compliance options be conducted as early as possible, and that such analyses assess energy efficiency resources as thoroughly as possible, in order to ensure that the compliance plan will result in lowest costs to customers.

It is also important that utilities assess coal unit retrofit options as comprehensively as possible. Some utilities have taken a piecemeal approach, analyzing one regulation at a time or just the few regulations that would be effective in the short-term. This limited approach can lead to uneconomic decisions regarding plant upgrades versus retirements. Once one retrofit technology is installed at a plant then it is that much more cost-effective to retrofit it with the next technology, even if retirement would be most economic if all retrofit requirements were considered at once. Any assessment of retirement options must account for all of the potential control technologies that might be required by all of the EPA regulations that are anticipated over the relevant study period (as well as costs associated with the climate change initiatives discussed in the next section). This is the only way to ensure that the eventual compliance plan will result in the lowest costs to customers.

In addition, energy efficiency should be viewed as a tool for helping utilities and states comply with some of the EPA regulations. The EPA is currently considering mechanisms to be able to quantify emissions reductions resulting from energy efficiency and renewable energy. Synapse Energy Economics is currently working with the EPA to develop publicly available, transparent tools to help integrate efficiency into SIPs for NAAQS compliance.[41]

The implications of the EPA regulations on the economics of energy efficiency will vary around the country, depending upon the extent to which each utility relies upon older, uncontrolled coal plants. They will also depend upon the structure of the electricity industry. Those utilities operating in regions with organized wholesale markets could be affected by any of the coal plants in the region of the market, because the costs of complying with the EPA regulations could be passed on through wholesale energy and capacity prices throughout the region, either directly by increasing costs of plants that sometimes set clearing prices or indirectly by removing plants from the bottom of the bid stack. Those utilities that are vertically integrated will be primarily affected by the implications

39 There could be an argument made that customers should not bear environmental compliance costs that are higher than necessary due to inadequate or imprudent utility planning, including insufficient consideration of energy efficiency opportunities. This issue is beyond the scope of this report.

40 For example, while replacing coal capacity with natural gas-fired generation will avoid SO_2 and air toxics emissions, new natural gas will emit, among other things, CO_2 and NOX. There will be compliance costs associated with these pollutants.

41 For more information, see the EPA's website: http://www.epa.gov/airquality/eere/manual.html.

of the EPA regulations on their own coal units, but may also be affected by cost pressures on plants in the region supplying purchased power.

Recommendations: Accounting for Recent and Proposed EPA Regulations in Energy Efficiency Screening Practices

Evaluate Efficiency Resources on a Timely Basis. It is important to screen for energy efficiency opportunities on a frequent, periodic basis, because energy efficiency 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. If energy efficiency is considered as an alternative to a coal plant retrofit with only one or two years available before the retrofit is required, then it is likely to be too late to develop anywhere near the full amount of efficiency that is potentially available.

Consider All Likely Future EPA Regulations. Clearly the most important step for regulators is to ensure energy efficiency screening accounts for all current and anticipated future EPA regulations over time, because this is the most accurate reflection of the future and will lead to more efficient economic decisions than piecemeal analyses. Furthermore, as discussed in Section 4.3, it is important to account for the potential costs from climate change requirements along with all the current and anticipated EPA regulations to more accurately reflect the future and avoid piecemeal analyses that lead to uneconomic decisions.

Apply Comprehensive Planning Practices. Many states use some form of integrated resource planning (IRP) for evaluating energy efficiency resources. When screening energy efficiency resources as part of preparing an IRP, several steps should be taken to ensure a valid, unbiased result:

- Energy efficiency must be properly and comprehensively modeled in all coal plant retirement/refurbishment scenarios.
- Planning models must properly account for risk associated with EPA regulations, as well as coal plant retirements.
- Planning models must properly account for the interactive effect of plant retirements, (i.e., the retirement of one plant will have implications for the economics of other plants in the region).

Even in a more simplified avoided cost methodology for screening energy efficiency resources, it is important to ensure that:

- Avoided costs used in efficiency screening properly account for all potential power plant refurbishments and retirements. For states in regions with organized wholesale markets, this should include the best possible forecast of all of the coal units likely to be retired or refurbished within the market region. For states with vertically integrated utilities, this should include the best possible forecast of all the utility's coal units that are likely to be retired or refurbished, plus a similar forecast for neighboring utility systems that may affect purchases and sales of power.
- Avoided cost forecasts must properly account for increased fuel and O&M costs associated with compliance with EPA regulations, including outage and replacement power costs incurred during upgrades.

4.3 Current and Anticipated Climate Change Requirements

Although there is considerable uncertainty about federal requirements to address climate change, this does not mean that there will be no future costs associated with climate change requirements or that such costs should be ignored in evaluating energy efficiency cost-effectiveness. Evaluators should use the best information available and most pertinent to their state, and should determine the best estimate possible of the costs of complying with climate change requirements.

Many states have climate change requirements and objectives, and many utilities do incorporate projections of the costs of GHG requirements in evaluating energy efficiency cost-effectiveness. Below we provide an overview of current climate change initiatives that might affect electric and gas utility planning.

Current and Anticipated Climate Change Initiatives

Federal Initiatives

Climate Legislation

The 111th Congress from 2009 through the end of 2010 had a major focus on climate policy. Congress considered enacting legislation that would reduce GHG emissions through a federal cap on GHG emissions and trading emissions allowances, or through other means. Legislative proposals and President Obama's initiatives aimed to reduce GHG emissions by approximately 80 percent from current levels by 2050. Despite passage of comprehensive climate legislation in the House in the 111th Congress, the Senate ultimately did not take up climate legislation in that session.

The 112th Congress from 2011 through 2012 has shown to be markedly different from the 111th Congress, with a Republican majority in the US House of Representatives and a diminished Democratic majority in the Senate. Rather than debating measures to reduce GHG emissions like the 111th Congress, the 112th Congress has focused on preventing the EPA from regulating GHG emissions under its existing authority. Much of this deliberation has taken place within the context of larger political battles over government spending levels (CCES, 2012a).

Congressional action, however, is only one avenue in an increasingly dynamic web of activities that will lead to internalizing a portion of the costs associated with GHG emissions. As Congress wrestles with the issue, the states, the federal courts, and federal agencies are undertaking initiatives to address climate change. Many efforts are proceeding simultaneously.

EPA Efforts

The EPA has been pursuing several approaches to address GHG emissions. The EPA's initiative was also in response to the Supreme Court mandate in *Massachusetts v. EPA* that determined that the harms associated with climate change are serious and well recognized, that GHGs fit within the CAA's definition of "air pollutant," and that the EPA has the authority to regulate GHGs.[42] As a first step, the EPA issued its 2009 Endangerment Finding, in which the "EPA formally found that six key GHGs emitted from motor vehicles contribute to climate change, resulting in a threat to the public health and welfare" (CCES, 2012b). This Endangerment Finding led the EPA to regulate GHG emissions under the CAA. Since then, a few rules associated with GHG regulation have been proposed or adopted as follows:

- On August 12, 2010, the 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 GHGs. These rules became effective in early January 2011.

- December 2011, the EPA announced that it will issue the NSPS for new and modified electric power plants under section 111(b) of the CAA, and for existing electric power plants under section 111(d). On March 27, 2012, the 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 1000 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 (Washington Post, 2012). A recent study by the University of California Center for Energy and Environmental Economics revealed that about 84 percent of natural gas combined cycle gas turbine (CCGT) units that commenced operating between 2006 and 2010 would meet this emission standard, whereas the EPA reported 95 percent of such units would meet the standard (Kotchen & Mansur, 2012). The study also concluded that only 71 percent of the planned CCGT units would meet the target largely because of a trend toward smaller capacity (Kotchen & Mansur, 2012).

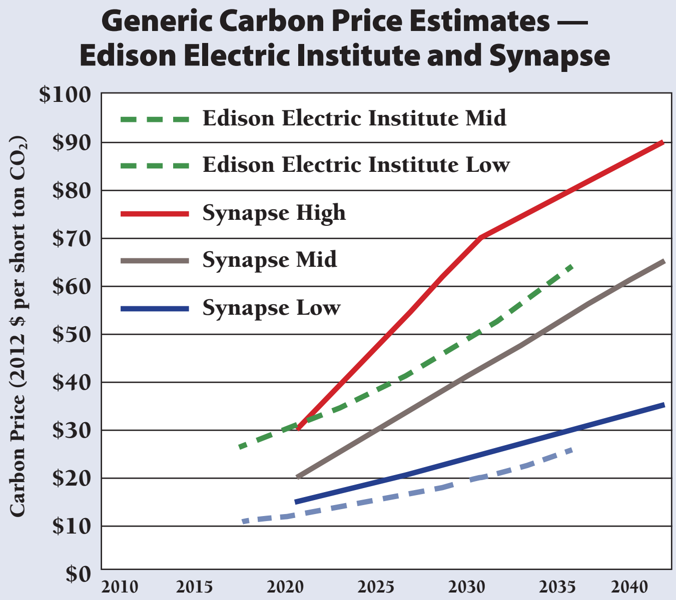
Forecasts of CO_2 Prices Resulting from Federal Initiatives

Figure 4-4 presents two forecasts of the potential CO_2 allowance prices resulting from federal climate change initiatives. One forecast was prepared by EEI and is meant to represent a proxy for regulatory action by the EPA and/or potential future legislation from Congress (EEI, 2011, p. 50). The EEI forecast includes a Mid Case and a Low Case.

The other CO_2 price forecast in Figure 4 4 was prepared by Synapse Energy Economics (Synapse, 2012b). The Synapse Energy Economics CO_2 price forecast is intended to represent a reasonable range of expectations regarding the timing and magnitude of costs for federal GHG emissions. The Synapse Energy Economics forecast is

42 Information on the EPA's plans and regulations are available from the EPA website on climate change regulatory initiatives at http://www.epa.gov/climatechange/initiatives/index.html.

Figure 4-4



Sources: Synapse, 2012b; EEI, 2011

based on regional and federal level policy developments in the near term, as well as various projections of legislative compliance costs from past proposed federal climate change bills in the long term. An earlier version of the Synapse Energy Economics Reference Case CO_2 price forecast is used for screening energy efficiency programs in California and in several New England states.

Regional Initiatives

Over the past several years, several states and provinces in North America have developed or have been developing multistate climate initiatives, including GHG caps and allowance trading to reduce GHG emissions.

- **North America 2050:** The most recent effort in this area is North America 2050: A Partnership for Progress (NA2050) launched in March 2012. NA2050 is the successor to the 3-Regions Initiative, which was a collaboration among members of the three North American regional cap-and-trade programs: The Midwestern Greenhouse Gas Reduction Accord, the Regional Greenhouse Gas Initiative, and the Western Climate Initiative. NA2050 is currently comprised of a group of US states and Canadian provinces (16 States and five Canadian provinces) committed to policies that move their jurisdictions toward a low-carbon economy while creating jobs, enhancing energy independence and security, and protecting public health and the environment (CCES, 2012c; NA2050, 2012).

- **Regional Greenhouse Gas Initiative:** The Regional Greenhouse Gas Initiative (RGGI) is an effort of nine northeast and mid-atlantic states to limit GHG emissions and is the first market-based CO_2 emissions reduction program in the United States. Participating states have agreed to a mandatory cap on CO_2 emissions from the power sector with the goal of achieving a ten-percent reduction in these emissions from levels at the start of the program by 2018.[43] This is the first mandatory carbon trading program in the nation.

- **Western Climate Initiative:** In 2007, governors of five western states signed an agreement establishing the Western Climate Initiative (WCI), a joint effort to reduce GHG emissions and address climate change.[44] Subsequently two more states and four Canadian provinces also joined the effort.[45] Fourteen states and provinces also are official observers of the process.[46] WCI members signed a Memorandum of Understanding agreeing to jointly set a regional emissions target and establish a market-based system—such as a cap-and-trade program covering multiple economic sectors—to aid in meeting this target. The WCI regional, economy-wide GHG emissions target is 15 percent below 2005 levels by 2020, or approximately 33 percent below business-as-usual levels. The WCI Partners released the Design

43 The nine states are: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. Information on the RGGI program, including history, important documents, and auction results, is available on the RGGI Inc. website at www.rggi.org.

44 The five states are Arizona, California, New Mexico, Oregon, and Washington.

45 Utah, Montana, British Columbia, Manitoba, Ontario, and Quebec.

46 Alaska, Colorado, Idaho, Kansas, Nevada, and Wyoming, as well as the provinces of Nova Scotia and Saskatchewan and the Mexican states of Baja California, Chihuahua, Coahuila, Nuevo Leon, Sonora, and Tamaulipas.

for the WCI Regional Program in 2010. In November 2011, WCI, Inc., a nonprofit corporation, was established to provide administrative and technical services to support the implementation of GHG emission trading programs in the region (CCES, 2012c; WCI, 2012).

- **Midwest Greenhouse Gas Reduction Accord:** In 2007, six states and one Canadian province established the Midwest Greenhouse Gas Reduction Accord (MGGRA).[47] Three additional states are official observers.[48] The members agree to establish regional GHG reduction targets, including a long-term target of 60 to 80 percent below current emissions levels, and to develop a multisector cap-and-trade system to help meet the targets. The MGGRA Advisory Group presented final recommendations in May 2010 (CCES, 2012c).

State Initiatives

Many states are taking action to address climate change and reduce GHG 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. For example, 43 states have adopted a GHG inventory and/or registry; 36 states adopted and two states are currently developing a state climate change action plan; and 22 states have established GHG emissions targets.

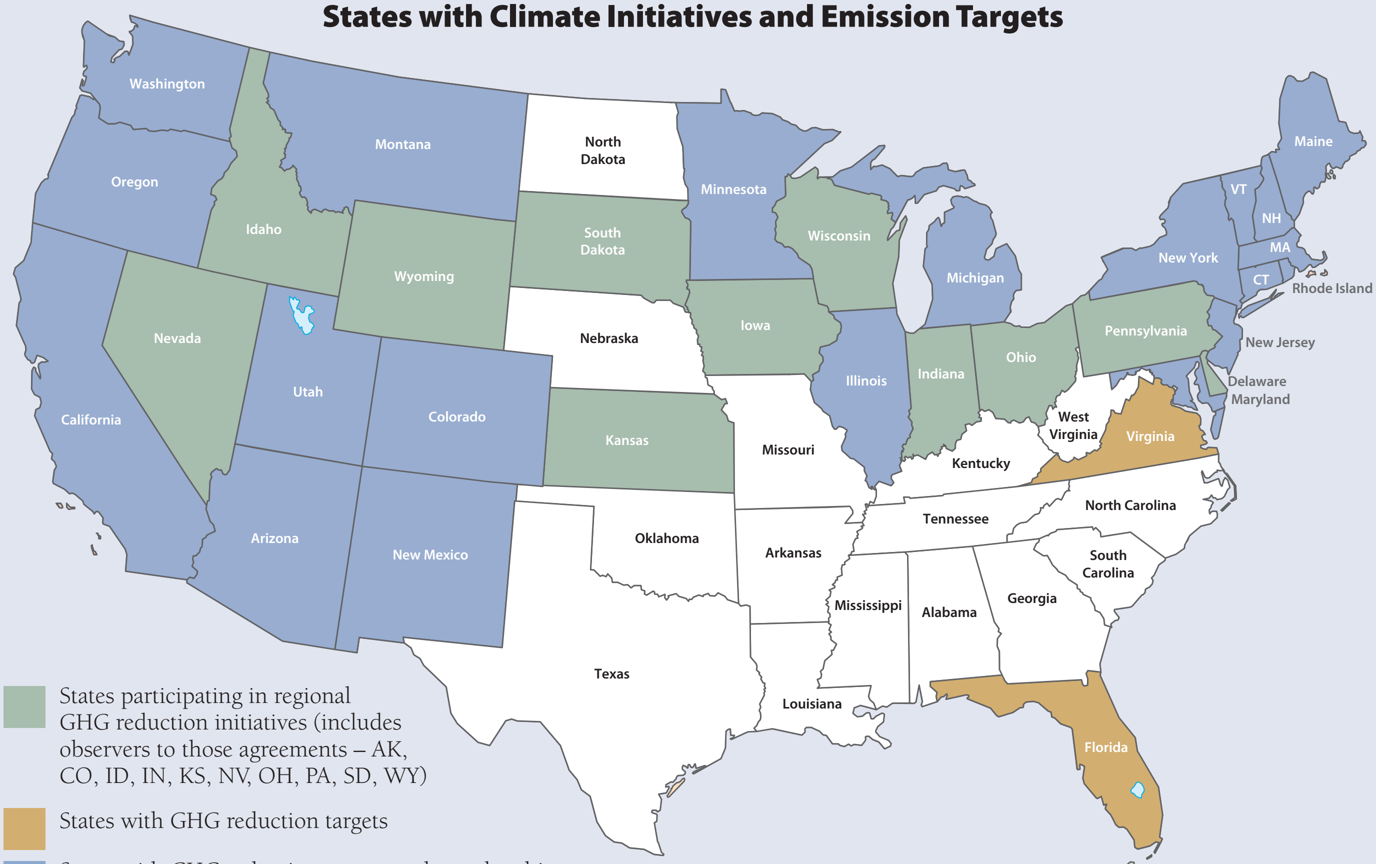
Figure 4-5 shows states with emission targets and those participating in or observing regional climate initiatives as

47 The states are Illinois, Iowa, Kansas, Michigan, Minnesota, and Wisconsin, as well as the Premier of the Canadian Province of Manitoba.

48 Observers are Indiana, Ohio, and South Dakota.

Figure 4-5

States with Climate Initiatives and Emission Targets



States participating in regional GHG reduction initiatives (includes observers to those agreements – AK, CO, ID, IN, KS, NV, OH, PA, SD, WY)

States with GHG reduction targets

States with GHG reduction targets and membership in regional GHG reduction initiatives

Source: Pew Center on Global Climate Change of October 2011. States that have adopted emissions targets and/or that are participating actively in regional climate initiatives comprise 44 percent of US electrical generation, 48 percent of retail electricity sales, and 58 percent of US population. The observer states add an additional 17 percent of electrical generation, 16 percent of retail electricity sales, and 15 percent of the US population.

Regulatory Options to Account for Climate Change Requirements

Compliance with Federal Climate Change Initiatives

Many utilities and utility regulators recognize that the federal government will, in one way or another, impose carbon restrictions on energy resources in the near- to midterm future. There remains considerable uncertainty regarding exactly what those restrictions will be, when they will be in place, and what they will cost. Nonetheless, it is important to use the best forecasts possible of the cost of complying with federal climate change initiatives, particularly in the context of planning for energy resources that will operate for 20, 30, or even 40 years into the future.

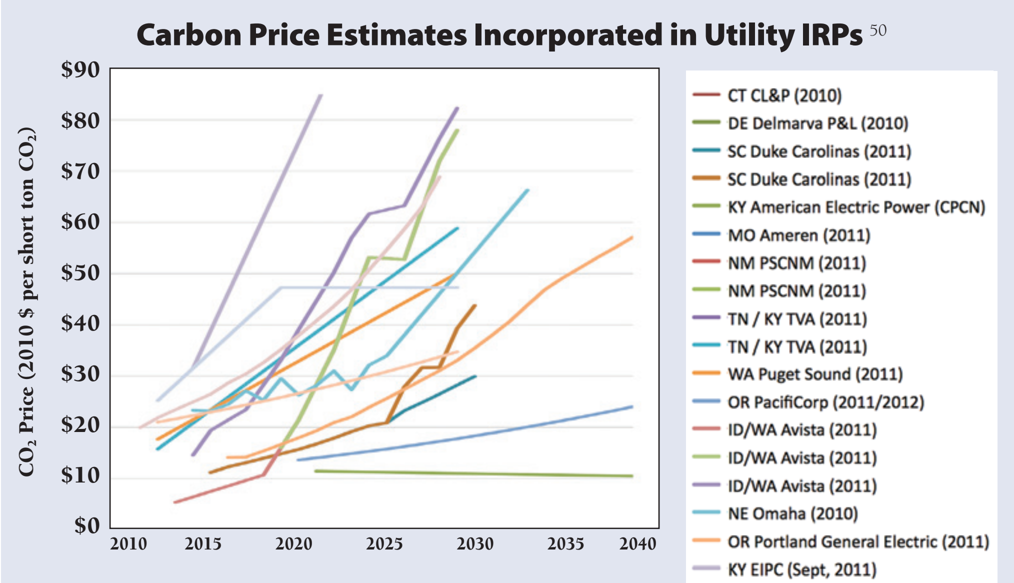
Utilities use two interrelated approaches to account for the cost of complying with climate change requirements when assessing energy efficiency resources: through integrated resource planning and through energy efficiency screening practices. The typical approach is to assume a CO_2 allowance price that would be in effect under the environmental requirement. (The requirement could be a cap-and-trade mechanism that literally required GHG emitters to purchase CO_2 allowances, or a different type of climate change requirement that is expected to lead to compliance costs that are comparable to the price of CO_2 allowances.)

If a CO_2 allowance price is used, then a forecast of such prices should be added to the dispatch costs of all generation resources that emit GHGs, either as part of IRP or as part of estimating avoided costs for screening energy efficiency resources. A CO_2 allowance price forecast should be used as a "base case" planning assumption, as opposed to simply being included in an "environmental case" or a "carbon constrained case," because the forecast should represent the most likely future cost of complying with federal climate change requirements.

Figure 4-6 provides a summary of the CO_2 allowance price forecasts used recently in several utility IRPs.[49] In general, the price forecasts range from \$10 to \$30 per ton of CO_2 in the early years, and increase to a range of \$30 to \$60 per ton in 2030. Most of these forecasts are based on analyses of potential future federal GHG legislation.

Those utilities that do not have the resources to develop

Figure 4-6



Source: Utility IRPs reviewed by Synapse Energy Economics

49 This graph is not intended to be a comprehensive presentation of all CO_2 price forecasts used in IRPs. Instead its purpose is to provide an indication of the magnitude and range of CO_2 price forecasts used by many utilities.

50 The CO_2 prices presented here are for the Reference Case, the Mid Case, or the case that is used to develop the preferred resource plan in each IRP. Note when IRP only provides a CO_2 price at the beginning and the end of an analysis period, we interpolated the values for the interim years. All CO_2 units are converted to short tons and constant dollars.

their own forecast of CO_2 allowance prices can adopt a forecast available from public sources. Figure 4-4 presents two examples of publically available forecasts of CO_2 prices; one from EEI and one from Synapse Energy Economics.

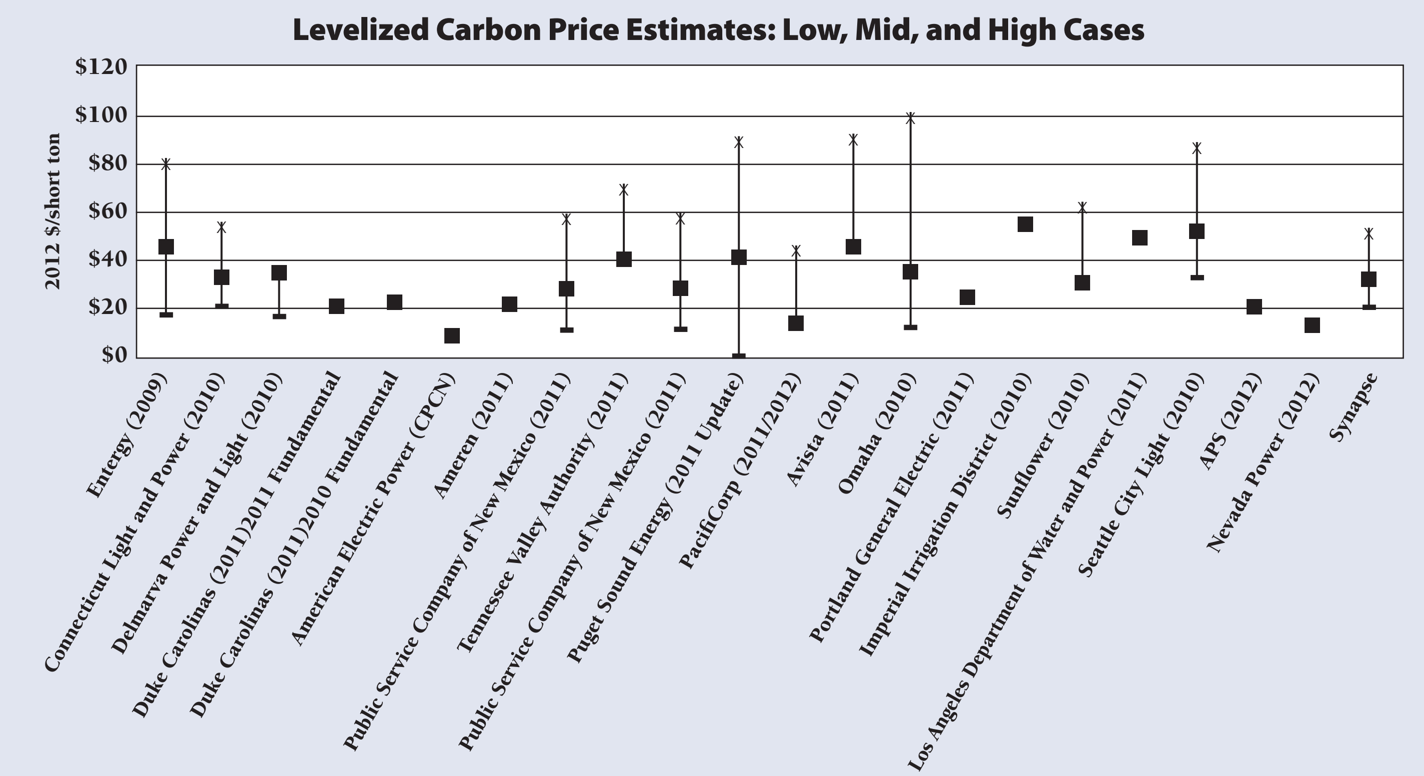
Figure 4-7 presents a summary of the range of recent CO_2 price forecasts in levelized terms. The low value for each forecast represents the levelized value of the Low Case; the middle value represents the levelized value of the Mid Case or Reference Case; and the high value represents the levelized value of the High Case. For those forecasts in Figure 4-7 that include only a single value, the value represents the Mid Case or Reference Case. As indicated, the levelized costs for the Mid Case forecasts tend to be in the range of \$20 to \$50/ton of CO_2.

Many state regulatory commissions require energy efficiency program administrators to account for the cost of complying with current and anticipated GHG regulations in screening energy efficiency programs. Below we list several examples of such regulatory policies.[51]

- **California.** California has been incorporating CO_2 prices in evaluating cost-effectiveness energy efficiency programs since 2004 when an E3 report examined a range of carbon values from \$5 to \$69 per ton of CO_2 and recommended the use of \$8 per ton as a levelized cost in its analysis (based on a trend of \$5 per ton in the near term, \$12.50 per ton by 2008, and higher values thereafter [E3 and RMI, 2004]). In 2009, California adopted the CO_2 price forecasts prepared by Synapse Energy Economics (a previous Synapse Energy Economics forecast than the one presented above) for estimating the cost of

51 This list is not intended to be a comprehensive list of all states that require energy efficiency screening to account for the costs of compliance with environmental requirements, nor is it meant to be an exhaustive discussion of any one state. We present these summaries as illustrative examples.

Figure 4-7



Source: Utility IRPs reviewed by Synapse Energy Economics; Figure 4-4; and Figure 4-6 power plants used as a benchmark against renewable energy contracts under the State's renewable portfolio standard (RPS) (CPUC, 2009, p. 9). For evaluating energy efficiency programs, California Public Service Commission has recently proposed to adopt the same CO_2 price forecast adopted in the RPS case (CPUC, 2011, p. 2).

- **New England.** All New England states rely on avoided cost estimates from the Avoided Energy Supply Component (AESC) Study produced every two years for the region. The most recent version of the AESC was prepared by Synapse Energy Economics, and includes a forecast of future CO_2 compliance costs. The forecast is based on CO_2 allowance prices from RGGI in the early years, and then assumes that federal climate change requirements will begin to take effect in 2018 (Synapse, 2011). The CO_2 allowance prices for the federal requirements are the same prices presented in Figure 4 6. The most recent AESC study also includes an estimate of $80/ton for the long-term cost of CO_2 abatement sufficient to achieve climate stabilization. Each state decides whether to include the avoided costs of complying with environmental regulations in screening energy efficiency measures. Vermont, which uses the Societal Cost Test in screening energy efficiency, uses the $80/ton CO_2 abatement cost. Connecticut, Maine, Massachusetts, and New Hampshire use the CO_2 allowance price forecast. Rhode Island uses a forecast of the RGGI allowance prices.

- **New York.** In the Order Establishing Energy Efficiency Portfolio Standard and Approving Programs, the Commission found that implementation of energy efficiency programs will have a more favorable impact on air quality than the no action alternative (New York PSC, 2008, p. 67). At Appendix 3 of this order the TRC Test was amended to include a CO_2 adder of $15/ton ($2008) as an estimate of the benefit of carbon reductions. This CO_2 value is currently being used to screen efficiency programs implemented by NYSERDA and the investor-owned utilities (Tress & Kim, 2012; NYSERDA, 2012).

- **Oregon.** In the early 1990s the Oregon PUC required utilities to analyze a range of environmental cost adders in the utility IRP process. The CO_2 costs ranged from $10 to $40/ton (in 1990 $) (Oregon PUC, 1993). In 2008 the Commission adopted a new rule entitled "Guideline 8" on environmental costs (Oregon PUC, 2008). Guideline 8 does not provide any specific numbers, but instead establishes broad guidelines as to how utilities should assess environmental compliance costs as follows:

  The utility should construct a base-case scenario to reflect what it considers to be the most likely regulatory compliance future for carbon dioxide (CO_2), nitrogen oxide, sulfur oxides, and mercury emissions. The utility also should develop several compliance scenarios ranging from the present CO_2 regulatory level to the upper reaches of credible proposals by governing entities…. The utility should identify at least one CO_2 compliance "turning point" scenario which, if anticipated now, would lead to, or "trigger" the selection of a portfolio of resources that is substantially different from the preferred portfolio (Oregon PUC, 2008, Order No. 08-339, Appendix C, "Adopted Guideline 8").

  The Energy Trust of Oregon, the state's third-party efficiency program administrator, incorporates the cost of carbon in their energy efficiency cost-effectiveness analysis based on the values used in PacifiCorp and PGE's IRPs (Gordon, 2012).

- **Wisconsin.** Wisconsin's state energy efficiency program administrator, Wisconsin Focus on Energy (FOE) categorizes externalities into economic and non-economic externalities. Economic externalities are assumed to be internalized, for example, through mitigation requirements or cap-and-trade markets (PA Consulting Group & KEMA, 2009, p. 3-9, 6-9). CO_2 is part of economic externalities and is included in their benefit cost called "simple benefit cost test," which combines elements of the TRC and Societal Cost Tests' approach (PA Consulting Group & KEMA, 2009, p. 2-3). Wisconsin FOE assumes $26/ton of CO_2 in 2020 and $28 in 2035. Mercury, which is currently considered a non-economic externality, is included in a test called "expanded benefit cost test." This test incorporates non-energy benefits as well as macroeconomic benefits.

Compliance with State Climate Change Initiatives

As indicated in Section 4.3, many states have established initiatives to address climate change, and several of them have established GHG emission targets. For these states, the environmental compliance costs may be more certain than those associated with federal initiatives, and may be experienced much sooner. In addition, some of these state climate change requirements could be significantly more stringent than the anticipated federal requirements.

For these states with climate change requirements, it is important that the cost of complying with the current and anticipated requirements is properly accounted for when screening energy efficiency programs. Ideally each state should assess the cost of complying with its own state-level climate change requirements. If the state requirements are expected to be less stringent than the federal requirements, then the federal requirements should be used as the basis for the cost of compliance (see earlier discussion). If the state requirements are expected to be more stringent than the federal requirements, then the state requirements should be used as the basis for the cost of compliance.

Ideally each state's cost of climate change compliance should be based on a statewide analysis of all GHG abatement options across all sectors of the state's economy. If possible, each state should develop a forecast of the marginal GHG abatement option that would be necessary for complying with that state's climate change requirements. This marginal climate change compliance cost should then be added to other avoided costs when screening energy efficiency resources. In this way, energy efficiency would be evaluated on an equivalent basis with other GHG abatement options.

In the absence of a statewide GHG abatement analysis, estimates could be based on an analysis of electricity sector GHG abatement options. Ideally this would include a supply curve of all the electric sector GHG abatement options, ranked from lowest cost to highest cost. The marginal GHG abatement option could then be used to indicate the avoided cost of complying with the state's GHG requirements. This approach is likely to be conservative relative to an estimate of economy-wide abatement options, because the electricity sector typically has some of the lowest-cost abatement options, and the electricity sector is expected to play a significant role in meeting economy-wide climate change requirements.

Massachusetts Example

In 1992 the Massachusetts Department of Public Utilities (DPU) required all utilities to consider the consequences of various environmental externalities when selecting new electric power generation sources (MA DPU, 1992). This decision was subsequently appealed to the state's supreme judicial court by the Massachusetts Electric Company. The court found that the DPU did not have the jurisdiction to require utilities to account for environmental costs in their resource planning and selection process. The court noted, however, that the DPU did have the jurisdiction to require utilities to account for all costs required to comply with current and reasonably anticipated future environmental regulations, because the costs of complying with these regulations will be included in utility rates, and thus are within the DPU's jurisdiction (MA SJC, 1994).

In 2009 the DPU required all energy efficiency program administrators to include the costs of complying with existing and reasonably anticipated future environmental regulations when screening energy efficiency programs (MA DPU, 2009, p. 17). The DPU noted that one of the most important such regulations was the Massachusetts Global Warming Solutions Act, which requires reductions of Massachusetts CO_2 emissions of 25 percent by 2020 and 80 percent by 2050. The DPU currently has a docket open to identify the best means of estimating the costs of compliance with environmental regulations (MA DPU, 2011).

In the absence of a supply curve of all the electric sector GHG abatement options, a state could develop estimates of the marginal cost of complying with GHG requirements using proxies. We discuss three examples below: forecasted renewable energy certificate (REC) prices, RPS alternative compliance payments, and estimates of marginal abatement costs. Although each of these examples should be considered as approximations of an uncertain cost, they may nonetheless be very valuable improvements to those planning processes that assume that compliance costs will be zero.

Forecasted REC Prices as a Proxy for Marginal Abatement Costs

RPSs are frequently established to address environmental concerns and climate change requirements, and the cost of renewable resources is very likely to be less than or equal to the marginal cost of complying with climate change requirements. Energy efficiency resources offer many of the same energy and non-energy benefits as renewable resources, and thus there is a sound economic and public policy rationale for paying as much for efficiency as is paid for renewables.

Under this approach, energy efficiency program administrators would develop a forecast of the REC prices for their state. These REC prices would then be assumed to be a proxy for the cost of compliance with that state's environmental requirements, including climate change requirements. This cost of compliance would then be included in the Societal Cost, the TRC, and the PAC Tests when screening energy efficiency resources.

There is a significant disadvantage to this approach, however, because REC prices can be volatile, depending upon the extent to which renewable supply matches the RPS demand. Furthermore, a state's RPS requirement might not be sufficient to develop enough renewables to meet that state's climate change goals, in which case the REC prices will be less than the marginal cost of complying with climate change regulations, and thus will understate the value of energy efficiency resources. For these reasons, we prefer using the RPS alternative compliance payment level as a proxy for marginal abatement costs.

RPS Alternative Compliance Payments as a Proxy for Marginal Abatement Costs

Most RPS mechanisms have an alternative compliance payment (ACP), that load-serving entities can pay if they are unable to purchase RECs at lower cost. The ACP is meant to serve as a cap on the amount that load-serving entities (and eventually customers) might have to pay to comply with the RPS. In effect, the ACP represents the maximum cost that legislators and regulators are willing to impose upon customers to acquire the benefits of renewable resources. Load-serving entities will typically pay the ACP when the demand for renewable resources exceeds the supply and the REC prices exceed the ACP.

For those states with relatively stringent climate change requirements, the ACP could be used as a proxy to represent the cost of compliance with environmental regulations, including climate change regulations. In such states, the renewable resources developed as a result of the RPS alone are unlikely to be sufficient to meet the stringent climate change requirements, thus more expensive GHG abatement options will be required in addition to the RPS renewables. Consequently the ACP is likely to be less than or equal to the marginal cost of complying with climate change requirements, and thus would represent a reasonable proxy for the cost of compliance.

This approach would result in applying the same cost cap for both renewable resources and energy efficiency. This can be justified on the grounds that energy efficiency offers essentially the same (and in some cases more) environmental compliance benefits and other non-energy benefits than renewable resources.

This approach would put energy efficiency on a level playing field with renewable resources and other GHG abatement options. It would allow efficiency program administrators and other planners to choose efficiency whenever it is a lower cost option for meeting climate change requirements. Consequently this approach would ultimately lead to lower costs for customers.

Note that the costs to customers for efficiency resources will not necessarily include the full ACP. The ACP would represent a cap, in which the maximum amount that would be paid for efficiency resources would be equal to the avoided supply-side costs plus the ACP. The ultimate costs to customers will be the average cost of saved energy across the efficiency portfolio, which is certain to be much less than this cap due to the many low-cost efficiency measures and programs offered by program administrators.

Literature Available on Marginal Abatement Costs

There is a large amount of literature available on marginal GHG abatement costs. Program administrators and utility regulators can draw upon this literature to develop costs that are relevant to the climate change requirements in their state.

In recent years there has been a lot of research on the marginal abatement costs required to achieve climate stabilization, by reducing global carbon emissions to 80 percent below 1990 levels by 2050. For those states with climate change mandates that are comparable to these climate stabilization targets, this literature may prove useful in developing a marginal abatement cost for the state.

For example, the recent study by Synapse Energy Economics to estimate the avoided costs of energy efficiency in New England reviewed the international literature containing estimates of the abatement costs to reduce global carbon emissions to 80 percent below 1990 levels by 2050 (Synapse, 2011). The study indicated that there is a wide range of GHG abatement cost estimates available, but concluded that a CO_2 price of $80/ton represents a conservative estimate in the middle to lower end of that range, and that such a price could be appropriate for screening energy efficiency resources in New England.

Recommendations to Account for Climate Change Requirements

Include GHG Compliance Costs in the Societal Cost, TRC, and PAC Tests. It is important to recognize that including the cost of complying with climate change regulations is not the same as including externalities (future environmental regulation costs are internal to the utility, not external). The costs of compliance with such future climate change requirements thus should be included in the Societal Cost, TRC, and PAC Tests.

Recognize the Importance of Accounting for GHG Compliance Costs Now. Federal action on climate change is likely within the mid- to long-term future, and many states have already established climate change requirements. Uncertainty regarding the timing and magnitude of compliance costs is not an excuse for inaction. Not accounting for compliance costs now is equivalent to assuming that the costs will be zero, even though it is clear that they will be significantly greater than that within the mid- to long-term future. Failure to account for climate change compliance costs in power plant comparisons and in determining avoided costs for energy efficiency screening will lead to suboptimal outcomes for ratepayers. 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 periods of time.

Account for Federal Climate Change Initiatives. 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, such as the EEI and Synapse Energy Economics forecasts presented in Figure 4-4.

Account for State Climate Change Initiatives. As indicated earlier, there are 22 states that have set state emission targets, while 36 states have state climate change action plans. All states that have such climate change requirements should account for the costs of complying with those requirements in screening energy efficiency programs. Ideally they should use state-specific marginal GHG abatement costs. In the absence of these they should use reasonable proxies for the marginal GHG abatement costs.

Include All Types of Environmental Compliance Costs. It is important to account for all likely environmental compliance costs, for example, climate change and EPA regulations (e.g., air, water, solid waste), as they can have 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.

Recognize the Limits of Cap-And-Trade Mechanisms. If a state, region, or the federal government were to eventually establish some form of CO_2 cap-and-trade system as a method for imposing climate change requirements, it will still be important for utilities to implement all cost-effective energy efficiency on an ongoing basis. A cap-and-trade system alone will not bring forth much energy efficiency, let alone all cost-effective energy efficiency, due to the many barriers to energy efficiency. Ratepayer-funded energy efficiency programs are necessary to overcome these market barriers; and in the absence of such energy efficiency programs, society will underinvest in efficiency and pay too much to comply with cap-and-trade programs. In sum, energy efficiency programs, with comprehensive screening practices, are an important complement to CO_2 cap-and-trade programs.

Ensure That Efficiency Resources Are Treated Comparably With Other Resources Built to Address Climate Change. If a utility proposes to construct new supply-side resources specifically to address climate change requirements (e.g., new wind facilities, a new nuclear plant, or a new coal plant with carbon sequestration), then it should (1) use these proposed resources as the marginal cost of compliance with climate change requirements when screening energy efficiency resources, and (2) implement all energy efficiency resources that cost less than these proposed resources. Failure to do so would lead to uneconomic outcomes and potentially significantly higher costs to electric customers for complying with the climate change requirements.

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Appendix A: Principles Underlying the Tests

The Purpose of this Appendix

The purpose of this appendix is to review some of the theoretical underpinnings of the cost-benefit tests. First we define a few key terms that are critical to understanding the difference between the tests, such as "external costs" and "non-energy impacts" (NEIs). Then we describe each test and provide some detail on exactly which types of costs and benefits it should, and should not, include.

We focus on the distinctions between the Program Administrator Cost (PAC) Test, the Total Resource Cost (TRC) Test, and the Societal Cost Test. These tests have not been well defined in practice, and this has led to some deviations from the theoretical underpinnings of the tests.

The Cost-Benefit Tests in Theory

As discussed in more detail in Section 2 of this report, five cost-effectiveness tests have been developed to consider efficiency costs and benefits. Each of these tests combines the various costs and benefits of energy efficiency programs in different ways, depending upon which costs and benefits pertain to the different parties.

To understand the definitions of the cost-benefit tests, it is important to recognize three important principles. First, each test is meant to indicate the cost-effectiveness of the efficiency resources from a particular perspective (program participants, all utility customers, society, and so on). Once the perspective is clarified, then it becomes clear which cost and benefit is appropriate to include in which test.

Second, each test must be internally consistent, that is, it must include all the costs and benefits associated with the perspective being evaluated. For example, if all the costs of a particular perspective are included in the test, then it is important to include all of the benefits from that same perspective. Otherwise the results of the test will be skewed and misleading.

Third, each test must properly account for "transfer payments" between different parties. Transfer payments occur when a benefit to one party is caused by a cost to another party. According to economic theory, these payments should not be considered either a cost or a benefit because they cancel each other out. Whether a particular cost impact is considered a transfer payment depends upon the perspective that is used for the economic analysis. For example, in the Participant Test, the participating customer's bill savings are considered a benefit, whereas in all the other tests they are not considered a benefit because they are a transfer payment from other customers (or from utility shareholders in the cases in which lost revenues are not recovered by the utility).

Below we summarize the five cost-effectiveness tests, with an emphasis on the perspective that each is meant to represent.

- **Societal Cost Test.** This test includes the costs and benefits experienced by all members of society.
- **Total Resource Cost (TRC) Test.** This test includes the costs and benefits experienced by all utility customers, including energy efficiency program participants and non-participants.[52]
- **Program Administrator Cost (PAC) Test.** This test includes the energy costs and benefits that are experienced by the program administrator of the energy efficiency program. In other words, these costs and benefits are limited to the impacts on revenue requirements from the energy efficiency program; the costs equal the increase in revenue requirements necessary to implement the programs, and the benefits equal the savings in revenue requirements as a result of implementing the programs.[53]

52 The name for this test is misleading, because it does not include the total cost of the resources. A more accurate name for this test would be the All Customers Test.

53 The name for this test is misleading, because these costs and benefits are not all from the perspective of the utility or other agency administering the efficiency programs. A more descriptive name for this test would be the Revenue Requirements test.

- **Participant Test.** This test includes the costs and benefits that are experienced by the customer who participates in the efficiency program.
- **Ratepayer Impact Measure (RIM) Test.** This test provides an indication of the impact of energy efficiency programs on utility rates.

Some of the most important differences between these tests are in whether they include NEIs and externalities. We discuss this issue in more detail below. First we provide some definitions of NEIs and externalities, to be clear on what is meant by each term.

Definitions of Terms

Internal Versus External Costs and Benefits

Utilities and customers make resource decisions that take into account the costs and benefits they, themselves, incur. Those costs and benefits are said to be "internal" or "internalized," because the utility or customer bears them directly and takes them into account in its internal decision-making. For instance, in choosing between a natural gas generator and a coal generator to install at a given location, a utility would consider the capital and operating costs of each technology, as well as the benefits provided (energy, capacity, ancillary services, and so on) and other non-monetary values, such as availability, black start capability, and the various risks each entailed. In choosing between a natural gas furnace and an electric heat pump for a new home, a customer would also consider her capital and operating costs and non-monetary values affecting the quality of service provided by the appliance, such as ability to provide cooling, noise levels, and so forth. The key point in each case is that all of the costs and benefits listed accrue to the decision maker, which in general is the buyer or seller of a good; for our purposes it is the utility or the utility customer.

Some costs and benefits accrue to a party other than the decision makers. In the example of a utility choosing between two generating technologies, the usual example of an externality is the emission of air pollutants. In this instance, it might be that the coal technology would emit more air pollution per kWh of generation than the natural gas technology. (Assume for purposes of this discussion that we are discussing a form of air pollution that is not subject to a tax or fee.) Other examples could include noise levels or traffic congestion from transportation of fuel. The cost of the air pollution might include health effects on the population downwind of the plant, damage to crops and buildings, or global climate change. The cost of noise pollution could be lowered property values in the neighborhood and lost sleep. The cost of traffic congestion could be time lost and extra fuel consumed by local traffic. The point is that the utility does not bear those costs; members of the public bear them. That makes those costs externalities.

When regulators establish pollution abatement requirements (e.g., the EPA cap-and-trade program for SO_2 emissions), the costs of complying with those requirements will be borne by the polluting entity and will thus become internalized. There may still be external costs associated with SO_2 emissions, if there continues to be some environmental and health damages after the requirements are met. In this case these incremental environmental and health damages would be external costs.

Whether a cost or benefit is an externality does not depend on whether there is a monetary value associated with it. In our examples, there is a monetary cost when air pollution causes increased medical bills and crop damage or when traffic congestion causes increased fuel consumption by vehicles in local traffic (the dollar per gallon price of the fuel), but there might not be one for lost time of the travelers. Either way there is a cost, and that cost is an externality.

Monetized Versus Non-Monetized Costs and Benefits

The party to whom a cost or benefit accrues, whether internal or external, may experience that cost or benefit as a cash income or expense item, or as a change in its assets and liabilities on its balance sheet. In the utility generator case above, the capital costs for the technology show up as both a cash outlay and (usually) a change on the balance sheet reflecting the asset and its financing. The operating costs show up as expense items. The power supply benefit shows up as revenue from sale of the energy and capacity. These all happen to be internal costs and benefits, and they are also directly experienced by the company as monetary values, so they are said to be "monetized." The monetary values typically arise directly from market prices of the various goods and services consumed or produced.

The utility also experiences internal but non-monetary costs and benefits. One technology might provide black start capability (the ability to restart a generator without a supply of power from the grid), a vital need but not one for which there typically is a market price. This is an example of an internal cost but one that either has no monetized value or for which one needs to be estimated, say by determining the market cost of installing a diesel generator solely for black start service.

The cost of medical care in the community due to increased air pollution is an example of an external cost that can be monetized. It is an externality because those medical costs are borne by individuals, insurance companies, or society as a whole, not the utility. It has a monetary value because the market price for the various medical services (emergency room visits, medical appointments, asthma drugs, and so forth) can be determined.

Economists and social scientists have developed methods of estimating dollar values for costs that do not have market prices. For example, lost productivity and shortened life expectancy for the population due to air pollution can be treated as if it had a dollar value by estimating a person's lost earning potential (as is often done in setting the damages in a civil liability case). Other examples include regulators' revealed preference, contingent valuation surveys, and willingness-to-pay or willingness-to-accept surveys.

Non-Energy Impacts

Most readers will be familiar with the range of energy costs and savings considered in energy efficiency cost-benefit tests. These include savings in capital and operating costs of generators or natural gas supply, avoided line losses, and avoided costs for market purchases of power, gas, or ancillary services. Energy efficiency cost-benefit tests also include the relevant efficiency program costs.

Non-energy impacts are those costs and benefits that are not part of the cost or avoided cost of energy. NEIs are described in detail in Section 3 of this report. NEIs might be internal or external, depending on whom they affect, and might be monetized or not.

Taking a residential efficiency program for low-income customers as an example, we can identify a number of illustrative NEIs and categorize them. (This discussion does not seek to do so exhaustively.) Certain costs and benefits would accrue to the low-income customer, some to the utility, and some to society as a whole. Table A-1 presents a sample of key NEIs from a low-income home retrofit program, and indicates whether they are market-priced, and whether they are internal costs from the perspective of the program participant, the utility, or to society.

Utility-perspective NEIs, such as reduced arrearages and reduced bad debt, can be priced by markets, because these are direct operating costs borne by the utility. These costs are internal to the utility and internal to society.

Some participant-perspective NEIs, such as increased property values and reduced consumption of other fuels, can be priced by markets, whereas others, such as increased comfort and increased safety, cannot be priced so easily using markets. All participant NEIs are internal costs from the participant and the societal perspectives, but are external costs from the utility perspective.

Some societal-perspective NEIs, such as reduced health care costs, can be priced by markets, whereas others, such as reduced environmental impacts, cannot be priced so easily using markets. All societal-perspective NEIs are internal costs from the societal perspective, but are external costs from the participant and utility perspectives.

Table A-1 demonstrates that NEIs will be experienced in different ways by different parties, can be priced using markets in some cases but not others, and will represent internal costs from some perspectives but external costs from other perspectives.

Table A-1

Sample NEIs for a Low-Income Program: Internal vs. External Costs

NEI	Market Priced	Internal to Participant	Internal to Utility	Internal to Society
Utility-Perspective NEIs				
Reduced arrearages	Yes	–	Yes	Yes
Reduced bad debt	Yes	–	Yes	Yes
Reduced terminations and reconnections	Yes	–	Yes	Yes
Participant-Perspective NEIs				
Increased comfort	–	Yes	–	Yes
Increased property value (for homeowners)	Yes	Yes	–	Yes
Increased safety	–	Yes	–	Yes
Reduced water consumption	Yes	Yes	–	Yes
Reduced consumption of other fuels	Yes	Yes	–	Yes
Reduced lost pay from sick days	Yes	Yes	–	Yes
Societal-Perspective NEIs				
Reduced environmental impacts	–	–	–	Yes
Reduced health care costs	Yes	–	–	Yes
Increased productivity due to fewer sick days	Yes	–	–	Yes

Appendix B: Choice of 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 previously. 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 in which 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), that is, 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

Although 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 Cost 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 costs were recovered in a comparable fashion and that consumers would be paying the same cost of capital on both supply-side and demand-side investments.

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. A lower discount rate than the WACC (i.e., a risk-adjusted discount rate) should therefore be used in applying the PAC Test or the TRC Test.

This lower risk also exists in those instances in which a third party administers the energy efficiency programs (e.g., Cape Cod, 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, as 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 and is straightforward, transparent, and 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.

Choosing a consumer's discount rate is administratively and theoretically complicated, however, 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.

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts focused on the long-term economic and environmental sustainability of the power and natural gas sectors. We provide technical and policy assistance on regulatory and market policies that promote economic efficiency, environmental protection, system reliability, and the fair allocation of system benefits among consumers. We work extensively in the US, China, the European Union, and India.
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