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Ten Pitfalls of Potential Studies

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Acronyms

ACEEE	American Council for an Energy-Efficient Economy
BCR	Benefit/Cost Ratio
C&I	Commercial & Industrial
CALMAC	California Measurement Advisory Commission
CFL	Compact Fluorescent (bulb)
CPUC	California Public Utilities Commission
DRIPE	Demand-Reduction-Induced Price Effects
Dth	Dekatherm
EISA	Energy Independence and Security Act
EUL	Estimated Useful Life
GWh	Gigawatt-hour
HPwES	Home Performance with Energy Star
IECC	International Energy Conservation Code
IRPs	Integrated Resource Plans
kWh	Kilowatt-Hour
LBNL	Lawrence Berkeley National Laboratory
LI Wx	Low-Income Weatherization
MW	Megawatt
NEBs	Non-Energy Benefits
NECs	Non-Energy Costs
NEIs	Non-Energy Impacts
NTG	Net-To-Gross
NYSERDA	New York State Energy Research and Development Authority
PACT	Program Administrator Cost Test
RFP	Request For Proposal
RGGI	Regional Greenhouse Gas Initiative
RIM	Ratepayer Impact Measure
RUL	Remaining Useful Life
SCT	Societal Cost Test
SEE Action	State and Local Energy Efficiency Action Network
TRC	Total Resource Cost (Test)
VELCO	Vermont Electric Power Company

Executive Summary

Background and Purpose

For nearly three decades, energy efficiency potential studies have been used by utilities, other energy efficiency program administrators, regulators, and various interested stakeholders to inform the parameters, funding levels, and establishment of savings goals for efficiency programs throughout the United States and Canada. These studies have proven useful in identifying cost-effective measures and programs that utilities and program administrators should pursue and in establishing near- and long-term savings and net benefits goals. In addition, potential studies have fed into comparisons of energy efficiency and supply-side resources to meet consumer demand through integrated resource planning, have informed the attainment of carbon reduction goals, and have helped establish metrics for shareholder performance incentives. However, potential study results are derived from forecasts that involve both complexity and uncertainty. As such, findings from these studies need to be viewed carefully, particularly when used to inform and direct long-term policy objectives.

The objective of this report is to identify some of the most common and significant design considerations across potential studies and explain how these considerations impact the way in which results should be interpreted.

The objective of this report is to identify some of the most common and significant design considerations across potential studies and explain how these considerations impact the way in which results should be interpreted. The report also offers guidance to analysts and stakeholders on how to avoid these issues, how to correct them, and how to reinterpret the results of studies in which the issues are present.

Potential studies are nearly always expensive and time consuming undertakings. It is therefore important to "get it right" the first time. This report provides guidance to help ensure that any new potential study will meet the study's stated objectives. These objectives might include informing efficiency program planning and budgeting, providing inputs into more comprehensive integrated resource planning activities, etc. No one wants to re-do a potential study because it fails to meet the needs of its intended users. However, an already completed potential study may have succumbed to one or more of the pitfalls identified in this report. Rather than initiate a new study this report also provides guidance as to how results from such a previous study can be re-interpreted to be more useful. While there are limits to the extent to which prior studies can be re-interpreted, the significant expense to re-do an imperfect potential study does provide considerable incentive to glean as much as possible from prior studies.

The report discusses ten design considerations that were culled from a list of approximately 40 possible issues presented to the project team that produced this report. The team included several national experts in energy efficiency policy, including the project manager of the *EPA's Guide for Conducting Energy Efficiency Potential Studies*.[1] The issues were ranked in importance by team members and discussed thoroughly before and after they were sorted in order to ensure that the report would focus on some of the most significant challenges that arise in the execution of potential study analyses. The ten issues chosen are as follows:

1. Defining "Achievable" Savings
2. Policy Considerations and Constraints
3. Modeling Program Participation
4. Excluding Measures and Savings Opportunities

1 National Action Plan for Energy Efficiency. (2007). Guide for conducting energy efficiency potential studies. Prepared by Mosenthal, P., & Loiter, J. Optimal Energy, Inc. Philip Mosenthal was the project manager for that publication and also advised the project team for this report.

5. Incorporating Codes and Standards into Technology Baselines
6. Issues with Utility Sales Forecasts
7. Consistency with the Integrated Resource Plan
8. Cost-Effectiveness Screening with the Total Resource Cost and Societal Cost Tests
9. Inclusion of Non-Energy Impacts
10. Forecasting Net Savings

Although each of the issues identified presents its own set of unique considerations, two related themes are common to all of them. First, it is important to address these issues as early in the study planning process as possible. Catching and addressing issues early in the process is typically much less costly and time-consuming than reinterpreting results, and it is likely to produce more robust projections.

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Second, the methodology that will be used to address each of these issues should be spelled out in writing and in detail. Ideally a public version of the study methodology should be made available for review so that stakeholders can effectively critique the study's overall goals and objectives, analytical framework, input assumptions, and interim results. An essential aspect of the methodological explanation should be to state clearly how the study's input assumptions have been used to arrive at its results, so that reviewers can make their own reasonable adjustments, given changes or disagreements regarding the assumptions used.

The importance of clarifying the methodology used up front is an example of a more general quality that should characterize all potential studies, namely that of transparency. This report highlights a number of instances in which the methods used to address the issues discussed can be fairly complex. Even when an appropriate methodology is chosen and clearly laid out, the study's projections will necessarily rely upon a wide range of possible inputs. Too often these inputs and methodological choices are buried, inadequately documented, or simply not provided in potential study reports. Failing to fully explain the ways in which the methods and inputs used have impacted the numbers presented leaves the reader at a disadvantage when attempting to interpret study results. Rather than bend to pressures to produce a "right" answer, potential study analysts should be forthright in describing how they arrived at their projections and allow alternative viewpoints to emerge, given differing inputs or approaches. Ultimately this strategy will produce a more robust and realistic range of possible future outcomes.

How to Use This Report

The ten issues outlined earlier are each discussed at a high level in this Executive Summary, which is intended to provide enough detail to give readers a basic understanding of each issue and how each one should be approached. If the reader's primary purpose is to identify some of the key considerations that should be raised in the design and execution of a potential study, then perusing the issue synopses contained in this Executive Summary may be sufficient. Scanning the synopses will also allow readers to identify those issues that may be of particular concern in a given potential study. If certain issues appear to be especially relevant, the reader is encouraged to turn to the specific chapters that address them at greater length (see link on pg. 11). Given the complexities of many of the issues, the synopses are not intended to fully cover the subtleties of each issue. The full chapters provide a more thorough treatment of each topic, including concrete examples and a number of sample calculations, which will assist the reader in designing a methodological approach to the issue or reinterpreting results when the issue is already embedded in a study's projections.

Issue Synopses

1. Defining "Achievable" Savings

Energy efficiency potential analyses can be grouped into three basic categories:

- Technical potential studies analyze all the savings that could be achieved, given either commercially available technology or projected technology that might become available over the study timeframe.
- Economic potential studies apply benefit/cost tests to determine which measures and/or programs would be cost-effective to implement over the same period.
- Achievable potential studies go one step further to ask what level of savings could actually be attained, given the practical realities and market barriers that

must be overcome to implement effective energy efficiency programs and convince customers to participate in them.

Studies that concentrate on achievable potential often begin by analyzing technical potential, then ask what subset of the technical potential would be economic, and finally probe into what portion of economic potential might actually be achievable.

A growing number of potential studies focus primarily on achievable savings, as this framework represents the most realistic portrayal of what might in fact occur in a particular market as a result of the allocation of ratepayer dollars, which many policymakers find most useful for planning purposes. As achievable potential studies best reflect actual savings opportunities, they frequently serve as inputs into other efforts, such as efficiency program planning and the development of utility integrated resource plans (IRPs).

Although the achievable framework is useful from a practical standpoint, too often projections of achievable savings are seen as precise forecasts or even upper limits on what level of demand reduction can be attained through energy efficiency initiatives.

Although the achievable framework is useful from a practical standpoint, too often projections of achievable savings are seen as precise forecasts or even upper limits on what level of demand reduction can be attained through energy efficiency initiatives. Labeling a projection as "achievable" to distinguish it from more theoretical technical and economic projections may sometimes have the unintended consequence of making anything above the forecast seem "unachievable." Yet even within the realm of achievable savings, there can be a range of projected savings depending on what assumptions are used, especially those regarding possible future budget constraints and related funding streams that may support energy efficiency programs. For example, some achievable potential studies project the amount of savings that could be achieved under a budget allocation scenario constrained by regulatory and policy considerations, whereas others focus on "maximum" achievable scenarios in which there would still be market and program constraints but essentially no budget restrictions.

Even under a single set of budget constraints, achievable savings potential may differ in practice from the level that has been projected. Other factors, such as effective program design and the strength of motivation on the part of the utility, can significantly influence what level of savings will ultimately be realized. As such, achievable savings projections should not necessarily be considered maximum limits, even if budgetary allocations cannot be increased. Instead analysts and policymakers should examine both monetary and non-monetary assumptions to determine whether any improvements have not been considered that might allow greater savings to be attained. Achievable savings projections should also be benchmarked against savings levels that have been attained in other jurisdictions and projected savings from studies conducted elsewhere.

Directionally the impact on savings of changing budget constraints can be up or down, depending on whether constraints are added or removed. Adding constraints to an achievable analysis lowers savings projections, whereas removing constraints increases them. The magnitude of the impact depends on the extent of the constraints, the marginal value of the dollars added or removed, and any change in how dollars are allocated as the budget changes. Given that the marginal value of each dollar may vary, the magnitude of the change in savings may not be directly proportional to the magnitude of the change in the portfolio budget.

By contrast, the directional impact on cost-effectiveness may vary depending on how adoption rates of individual measures with different cost-effectiveness ratios are assumed to change as budget constraints and allocations change. If the predominant effect of removing budget constraints is to increase the adoption of measures or programs with higher cost-effectiveness ratios than the existing portfolio, then overall cost-effectiveness will go up. On the other hand, if the predominant effect is to increase the adoption of measures or programs with lower cost-effectiveness ratios than the overall portfolio, which is the more typical outcome when budgets are increased, then overall cost-effectiveness will go down. Adding budget constraints would have the opposite effect in each case. The magnitude of the impact on overall cost-effectiveness depends on the benefit/cost ratios (BCRs) of the particular measures or programs adopted or excluded as budget assumptions change.

In terms of savings, changing non-budgetary assumptions will typically have a similar effect as changing budgetary constraints. If it is assumed that a utility will improve its program design and implementation strategies, for example, then savings will typically go up, whereas savings will go down if these factors worsen. With respect to cost-effectiveness, changes in non-budgetary assumptions will also tend to correlate directly with overall cost-effectiveness. That is, if a utility becomes more effective or motivated in designing or implementing its efficiency programs, then cost-effectiveness will tend to go up, whereas it will go down if a utility becomes less effective. The only exception would be if it were assumed that improvements could be made in the implementation of a program or measure that was less cost-effective than the overall portfolio, which might increase savings while driving overall cost-effectiveness down.

If an explicit set of budgetary and non-budgetary assumptions that define what is "achievable" has not already been set out, then this is one of the first issues that will need to be addressed before going forward with the analysis. If it is not, then reinterpreting potential study findings may become very difficult, especially given that changes in resource allocations may not be directly proportional to changes in potential savings or cost-effectiveness.

2. Policy Considerations and Constraints

Certain policy goals or constraints may impact the potential to maximize achievable savings by restricting the way in which funds can be spent or directing investments away from measures and programs that would produce greater savings levels. Often these policy directives are necessary to achieve various goals, aside from reaching the highest overall quantity of energy savings. Even when such policies reflect prudent considerations, however, their impacts within a given potential study on savings and cost-effectiveness should be recognized and explained. Examples of such policies include constraining energy efficiency spending within a given sector to the proportion of ratepayer funds collected from that sector, as well as directing additional funds toward low-income programs beyond the amount that would maximize cost-effective savings. Such policies will tend to reduce savings levels, although there may be sound public policy reasons to incorporate them. In terms of cost-effectiveness, policies that primarily impact budgetary allocations will not typically impact measure-level BCRs, but they may impact the cost-effectiveness of certain programs, sectors, and the energy efficiency portfolio as a whole.

Policies that impact the kinds of costs and benefits that can be considered in the economic screening process have a direct impact on the way in which energy efficiency measures and programs are evaluated.

Other types of policy considerations may influence a potential study's underlying methodology. For example, policies that impact the kinds of costs and benefits that can be considered in the economic screening process have a direct impact on the way in which energy efficiency measures and programs are evaluated. To the extent that such policies reduce cost-effectiveness and cause fewer measures and programs to pass economic screening, there may be a negative impact on overall achievable savings.

By contrast, certain policy directives may increase the achievable savings potential and cost-effectiveness of an energy efficiency portfolio. For example, a requirement to consider joint promotion of various energy efficiency programs aimed at generating savings of different fuel types may result in synergies that would not necessarily occur naturally, particularly if the utilities in a given jurisdiction distribute only one type of fuel.

These examples provide just a few illustrations of the many kinds of policies and considerations that may impact a potential study analysis. Although a wide range of other policies exists that might be relevant in one jurisdiction or another, the key factor common to all of them is to ensure that their tradeoffs and implications are discussed before the work on a potential study commences. Those policies that are incorporated into a given potential study and impact the results should also be discussed fully in the study narrative. Otherwise it may be difficult to interpret study findings in the proper context.

3. Modeling Program Participation

All achievable potential studies predict in some manner how consumer behavior may change over time, particularly as a result of energy efficiency programs influencing rates of consumer adoption of efficient technologies. Yet modeling consumer behavior is complex and uncertain, particularly several years into the future. Some studies model behavior using technology adoption curves, which generally assume that rates of consumer adoption are a function of simplified economic inputs, such as incentive levels and measure costs. Although these models can be informative, they often overlook additional key factors that can be more uncertain but equally important in influencing consumer choice. Other studies forego technology adoption curves and estimate adoption rates directly based on both economic and non-economic factors, but this can be difficult to do for a wide range of measures over time. These direct estimates are sometimes little more than informed projections based upon past experience in the relevant jurisdiction and in others. Regardless of the approach used, the challenges associated with the methodology should be identified up front and stated explicitly as limitations in the study narrative.

Other steps can also be taken to improve technology adoption forecasts, such as ensuring that both monetary and non-monetary factors are considered in the projection, corroborating forecasts with studies from other jurisdictions, and presenting multiple scenarios to reveal the true range of forecasting uncertainty.

Generally a shift in methodology that leads to a higher projection of energy-efficient technology adoption without exceeding any pre-established budget constraints will also increase the projected level of savings. Higher efficient technology adoption rates will tend to boost cost-effectiveness as well, as the fixed costs of adoption will be spread over more participants. Methodological choices in forecasting can have a considerable impact on projected adoption rates, which in turn may affect both savings and cost-effectiveness significantly.

Forecasting program participation is an issue in any potential study. Given the potentially considerable impact of selecting a particular methodology to forecast adoption rates, the approach that will be used and any associated issues should be identified up front. Analysts should provide intermediate projections over the study timeframe, such as annual participation rates, as a means to assess whether program ramp-up rates are realistic. Other steps can also be taken to improve technology adoption forecasts, such as ensuring that both monetary and non-monetary factors are considered in the projection, corroborating forecasts with studies from other jurisdictions, and presenting multiple scenarios to reveal the true range of forecasting uncertainty. Some of these techniques may be possible to apply retrospectively, but reinterpreting the technology adoption forecast may be difficult to do with any precision, given the uncertainty and complexity that is often involved in the forecasting process.

4. Excluding Measures and Savings Opportunities

The amount of potential savings that can be achieved through a given portfolio depends on the types of measures and programs included. Yet too often, key measures, practices, and consumer segments are left out of the analysis of savings potential. If a potential study overlooks or fails to incorporate important savings opportunities, then the level of achievable potential savings may be significantly understated.

A basic example of overlooking savings opportunities is the failure to include potential savings from a comprehensive set of emerging technologies. Potential studies frequently fail to consider certain technologies that may considerably reduce energy demand in future years. Other savings opportunities may be overlooked because they do not strictly fall into the category of distinct, installable measures. For instance, system-wide savings opportunities may be an important source of savings potential, as in the case of improving the efficiency of an entire set of industrial processes. Interactive effects may also play a role in reducing demand, such as the ability of a lighting retrofit at the time of a commercial chiller replacement to reduce both lighting power density and the necessary size of the replacement chiller. In still other scenarios, savings may be achieved through certain practices or initiatives that do not involve any measure installation, such as retrocommissioning or programs aimed at changing consumer behavior. Some of these types of savings opportunities may be partially captured in projected savings from efficient equipment installation, and analysts should not double count savings in total estimates. Nonetheless, a study that looks only at the savings that can be achieved from basic measure installation may miss some or all of these types of savings opportunities, leading to an undervaluing of achievable savings.

Another common omission in potential studies is a singular focus on "lost-opportunity" or "replacement on burnout" measures, which target savings opportunities that occur in conjunction with specific market events. For example, these measures might coincide with the construction of a new building or the sale of a new product or appliance after an older piece of equipment has burned out. Such market events typically represent opportune moments to direct a segment of the customer population toward making energy-efficient choices. An exclusive focus on lost opportunities, however, would mean that any potential savings not captured at the time of the natural market event potentially would not be available again for many years (e.g., until the burnout of the new equipment).

Unlike lost-opportunity measures, several other types of measures and programs exist that present additional opportunities to generate savings not tied to specific points in time. "Removal" programs, for example, provide incentives for the primary purpose of removing equipment permanently without replacement, such as a second refrigerator or freezer. By contrast, "early replacement or retirement" measures are retrofit measures designed to promote the removal of inefficient equipment and spur its replacement with energy-efficient measures sooner than would otherwise occur. Other "pure retrofit" measures are aimed at encouraging participants in existing buildings to install new energy-saving features, such as air sealing and insulation, which may supplement but do not necessarily replace any previously installed equipment. What these types of measures share in common is the opportunity that each one presents to capture savings at virtually any time. Although the costs of such measures may in some cases be higher than lost-opportunity alternatives, failing at least to consider these types of measures in a potential study analysis can lead to a considerable underestimate of achievable savings. Although savings would rise once such measures are included, the magnitude of the increase and the impact on cost-effectiveness may be more difficult to determine.

Failing at least to consider removal programs and early replacement measures in a potential study analysis can lead to a considerable underestimate of achievable savings.

5. Incorporating Codes and Standards into Technology Baselines

Energy efficiency codes establish baseline requirements for incorporating energy-efficient practices into new construction and, in some cases, addition or renovation projects. Energy efficiency standards institute rules for the minimum efficiency ratings of various types of lighting and appliances sold in the market. Codes and standards are important components in potential savings projections because they determine the delta between baseline and efficient technologies. As future codes and standards are likely to increase technology baselines, they should be taken into account in potential savings assumptions. If they are not, potential savings may be overestimated. At the same time, it should also be recognized that emerging technologies tend to become more efficient over time. Over the period of a potential study, the size of the delta between baseline and efficient technologies will depend on the pace at which baselines increase relative to cost-effective energy-efficient alternatives. In some instances incremental costs may also change as baseline and efficient technologies advance. To estimate potential savings as accurately as possible, potential study analysts should account for both scheduled and likely increases in codes and standards, as well as the increasing efficiency of advanced technologies.

The directional impact on savings and cost-effectiveness of incorporating trends in codes and standards and advanced technologies into the potential study analysis, as well as the magnitude of the impact, will depend on how baselines move in conjunction with efficient alternatives and what impact this will have on the delta between the two.

Before commencing work on the potential study, analysts should explain the methodology that will be used to calculate changes in the delta between baselines and efficient technologies over time, and important upcoming changes in codes and standards should be identified. Given the interplay between codes and standards on the one hand and technology advancements on the other, it may be difficult to reinterpret study results if these factors have not been properly addressed in the study itself.

6. Issues with Utility Sales Forecasts

Utility sales forecasts often play an important role in potential studies, although the forecasts themselves are typically completed as part of an independent process. In the commercial and industrial sector in particular, the sales forecast is typically viewed as the "starting point" in the analysis of potential savings. Using a "top-down" approach, projected sales are disaggregated into building types and end uses; once a disaggregated portrayal of energy usage has been laid out in this way, individual energy-saving measures are then analyzed within each end-use category to determine what percent of the energy consumption within that category might be reduced by promoting a particular measure. Given that the sales forecast serves as the jumping-off point for this analysis, it is important that any methodological issues with the forecast be identified up front, because they may carry through to affect the final potential savings results. The utility sales forecast may impact study results in the residential sector as well, as the forecast may be used to calibrate whether projections of energy usage with and without energy efficiency investments are realistic.

Two common methodological issues that often arise in energy sales forecasts are the inclusion of "embedded" energy efficiency from past investments, which can make the sales forecast lower than it would otherwise be, and the failure to account for future changes in codes and standards, which can lead to the forecast being overstated.

Two common methodological issues that often arise in energy sales forecasts are the inclusion of "embedded" energy efficiency from past investments, which can make the sales forecast lower than it would otherwise be, and the failure to account for future changes in codes and standards, which can lead to the forecast being overstated.

The issue of embedded efficiency is particularly salient in jurisdictions in which past investments in energy efficiency have been sufficiently sustained and substantial to lower historical energy usage and growth rates. If the energy usage forecast is based in part on past consumption and growth rates, then the forecast may be suppressed by the embedded assumption that such investments will continue in the future. Failing to remove this built-in efficiency may lower the overall forecast, which could lower the amount of projected savings potential.

The issue of codes and standards tends to cut in the opposite direction. If the sales forecast does not include future changes in codes and standards, which are designed to reduce energy usage through regulation rather than incentives, then the forecast may be too high. A forecast that is too high may lead to an overestimate of savings potential.

Given that the sales forecast is typically made outside the context of the potential study, methodological issues with the forecast itself may be unavoidable. Only if the embedded issues are identified, however, will it be possible to interpret the original sales forecast in the proper context and assess any relevant impacts on study results.

7. Consistency with the Integrated Resource Plan

An IRP compares energy supply choices and demand-side management options, including various energy efficiency measures and programs, to determine what combination of resources can best meet the energy needs of a given location with a given set of policy objectives and imperatives. The evaluation of demand-side resources in an IRP typically relies on either an independently conducted potential study or a potential savings analysis that is conducted as part of the IRP process itself. If a separate potential study is conducted, input assumptions used in the potential study (e.g., base case energy use, codes and standards, fuel prices, inflation rates, and discount rates) should typically be consistent with those in the IRP to ensure that demand- and supply-side resources are considered on an equal footing.

In some cases it may not be possible to ensure consistency with the IRP at the time the potential study is conducted, particularly if the study takes place before the input assumptions for other pieces of the IRP have been determined. In such cases, IRP analysts should use caution when relying upon potential study results. Reasonable adjustments to the potential study assumptions and related results should be considered, and any discrepancies between potential study and IRP assumptions should be explicitly highlighted in the text of the final IRP. IRP analysts may also consider multiple energy efficiency cases, as an important aspect of an IRP is sensitivity to different events. Where uncertainty exists or a range of potential savings is expressed in the potential study, different energy efficiency cases can be evaluated in an IRP.

In other cases the inputs may have been determined for use in other parts of the IRP before the potential study analysis has been conducted. In such cases, potential study analysts should seek to ensure consistency in the assumptions they use to evaluate demand-side management as a resource option with the inputs used to complete other pieces of the IRP. To the extent possible, these assumptions should be fully documented in the potential study and cross-referenced with the IRP. At times, potential study analysts may find it imprudent to rely upon assumptions made in the IRP that may be dubious. In any case in which IRP assumptions are not used, however, analysts should be very explicit in documenting the differences between the IRP assumptions and those used in the potential study so that readers understand clearly where any inconsistencies may lie.

The directional impact of using different input assumptions in the potential study analysis and other parts of the IRP depends on how these inputs are used to determine savings and cost-effectiveness, as well as how they vary directionally with each other. In some cases, using different input assumptions in the potential study analysis will increase savings and cost-effectiveness, while in other cases savings and cost-effectiveness will decrease. In certain cases, savings and cost-effectiveness may move in opposite directions.

The magnitude of the impact on both savings and cost-effectiveness of using non-IRP input assumptions may depend on which assumptions differ from those used in the IRP and to what extent they are varied. All else equal, the more significant a role the input assumption plays in determining savings and cost-effectiveness, the greater the impact will be of varying that input from the assumption used in the IRP.

One way to help resolve this issue is to conduct the savings analysis as an integral part of the IRP itself. If the potential study is to be conducted independently, however, it should be stated up front in the request for proposals or draft scope of work that potential study inputs should be consistent with those used in the IRP process, or at least that potential study analysts should explain why they have used different assumptions.

Understanding how input assumptions are used to determine savings and cost-effectiveness may make it possible to reinterpret potential study results directionally, although the magnitude of the impact could be difficult to determine. The precise impact may be clear if a given input used in the potential study could simply be substituted with the corresponding input used in the IRP process while holding other variables constant. In some cases, however, methodological differences may exist between the potential study and the IRP that could make this simple substitution process more complicated.

Potential study analysts should seek to ensure consistency in the assumptions they use to evaluate demand-side management as a resource option with the inputs used to complete other pieces of the IRP.

8. Cost-Effectiveness Screening with the Total Resource Cost and Societal Cost Tests

The Total Resource Cost (TRC) Test is one of the most common cost-effectiveness tests that states use to determine whether the benefits of energy efficiency investments outweigh the costs. The test compares the costs and benefits from the combined perspective of all parties in a jurisdiction. Costs generally represent the increment between a baseline measure and a more efficient alternative (in the case of market-driven measures) or the full installed cost of the measure (in the case of retrofit measures), as well as program-related costs such as marketing and administration. The benefits side of the equation is often more complex. Avoided energy supply costs and avoided capacity costs related to the fuel(s) that are the study's focus are always included, but many other types of avoided costs may be considered benefits as well. These might include the avoided costs of additional fuels, avoided water costs, transmission and distribution costs, avoided environmental externalities, and other non-energy benefits such as reductions in operation and maintenance costs.[2] Determining which avoided costs and other benefits to incorporate can have a significant impact on whether the total benefits of a measure or program outweigh the investment costs, which may impact whether certain measures or programs are included in a portfolio. The greater the number of measures that are

2 Some of these avoided costs, such as environmental externalities, may only be considered in some jurisdictions under the Societal Cost Test, described below. However, the line between the Total Resource Cost test and the Societal test is blurred in many jurisdictions with respect to which benefits should be included, and some jurisdictions do include externalities in the TRC. The California Standard Practice Manual, a common reference used to define cost-effectiveness test, only includes externalities under the Societal test but also treats this test as a type of TRC screen, referring to it as "the societal test variation" of the TRC. See "California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects," October 2001, p. 21: "The primary strength of the Total Resource Cost (TRC) test is its scope. The test includes total costs (participant plus program administrator) and also has the potential for capturing total benefits (avoided supply costs plus, in the case of the societal test variation, externalities)."

included, the greater a jurisdiction's overall potential savings will be.

Closely related to the TRC is the Societal Cost Test (SCT). Like the TRC, the SCT compares costs and benefits from the combined perspective of all parties. Under the SCT, however, the geographic scope is broadened to consider all parties in society as a whole, as opposed to only those parties in a given utility jurisdiction. This difference can impact the number of measures that pass cost-effectiveness screening, in part because more benefits may be considered, and in part because future benefits are typically discounted at a lower rate when considered from a societal perspective. Under the TRC Test, the conventional practice is to discount future benefits using the relevant utility's weighted-average cost of capital, which represents the minimum return the utility must receive on its investments. Generally the mix of debt and equity used to finance a utility's operations creates a much higher required rate of return than that faced by society as a whole, meaning future benefits will be discounted more heavily. All else equal, therefore, a greater number of energy efficiency investments will tend to be considered cost-effective from a societal perspective than from the standpoint of the utility or efficiency program administrator alone.

Which cost-effectiveness test will be used and which benefits will be included should be determined early in the study planning process. The choice of screening test should correspond with the perspective being considered. The TRC Test is most appropriate for considering the perspective of all parties in the utility jurisdiction, whereas the SCT is most appropriate for considering the perspective of society as a whole. Other tests may be appropriate to examine the perspective of a specific party or group, such as program participants, non-participants, or the utility/program administrator.

In some cases it may be possible to interpret the direction of the impact on savings and cost-effectiveness that would result from adding benefits or using a lower discount rate, because both of these actions would generally have a positive impact on measure-level cost-effectiveness and overall savings. It may also be possible to quantify the magnitude of the effect on savings and cost-effectiveness, but only if the details of the study's measure and program screening methodology are available.

Which cost-effectiveness test will be used and which benefits will be included should be determined early in the study planning process.

9. Inclusion of Non-Energy Impacts

Many energy efficiency measures provide positive benefits that are not directly related to energy savings. From a customer perspective, these "non-energy benefits" (NEBs) might include reduced operations and maintenance, as well as increased comfort, convenience, air quality, health, or aesthetics. From a utility's standpoint, efficiency measures may lead to reduced collection costs, arrearages, shut-offs, and debt write-offs, as well as fewer customer complaints. From a societal point of view, energy efficiency measures may increase community aesthetics, reduce health costs, and increase domestic energy independence. All of these NEBs have some value, although quantifying the values of each type of benefit can be difficult. In addition, some measures may carry non-energy costs (NECs), such as reduced convenience, which can be equally difficult to estimate. As a result of these complexities, positive and negative non-energy impacts (NEIs) have generally not been included in most potential studies, although there have been exceptions in a few states in which NEIs have been quantified.

The practical effect of including NEIs is conceptually similar to including additional avoided costs in the cost-effectiveness equation. Incorporating positive NEIs (i.e., NEBs) will increase the BCRs of the measures and programs being considered and may cause some measures to pass cost-effectiveness screening. Although most states do not include NEIs in their cost-effectiveness screening, some studies suggest that the total size of positive NEIs for some measures or programs may be as large as or larger than the energy-related benefits themselves. As such, potential studies that employ the TRC or SCT screening process without incorporating NEIs may significantly underestimate the number of measures that should be considered cost-effective.

10. Forecasting Net Savings

The total amount of savings created by participants in energy efficiency programs is often referred to as "gross savings." Gross savings typically do not represent a complete assessment of achievable potential efficiency that can be attributed directly to energy efficiency programs. In part this is because some participants who receive a program incentive for a given measure might have implemented the measure even if no incentive had been offered. Such individuals can be characterized as "free riders." Other individuals may implement a measure as a result of a program but may not take advantage of any incentive (e.g., if the program raises their awareness of the measure or increases the availability of efficient measures at distributors or at retailers). This phenomenon is referred to as "spillover," and such individuals are sometimes called "free drivers." Incorporating these factors into the analysis of achievable potential is essential in forecasting "net savings," which is the level of savings that results directly from program incentives and activities.

If this issue is left open in a jurisdiction, forecasting net savings should typically be the goal of a potential study, assuming the study is designed to assess the level of savings that could be attributed directly to a future suite of energy efficiency programs.

In some cases jurisdictions may have already established savings goals based upon gross savings outside the context of the potential study process, in which case a potential study might need to reflect potential gross savings projections. Many other jurisdictions use net savings for planning purposes, and in these jurisdictions the potential savings analysis should reflect net savings projections. If this issue is left open in a jurisdiction, forecasting net savings should typically be the goal of a potential study, assuming the study is designed to assess the level of savings that could be attributed directly to a future suite of energy efficiency programs.

To convert a projected level of gross energy efficiency savings realized through incentivized measures into a forecast of efficiency that is directly attributable to program incentives and activities, one can multiply gross savings by a "net-to-gross" (NTG) ratio that incorporates both free ridership and spillover. In the context of potential studies, NTG ratios are often taken from other sources, such as previous program evaluations or estimates from similar programs in other jurisdictions, in which case it is important to understand the methodological issues that may have been present when the original estimates were produced. These estimates may have been based upon surveys of participants and non-participants or upon econometric models. Survey-based methods are often fraught with challenges such as ambiguous responses, missing data, self-selection biases, and issues with question wording. In addition, it may be difficult to classify certain respondents, sometimes referred to as "partial free riders," who indicate that they might have implemented an efficient measure without incentives, but would have waited longer and purchased a slightly less efficient model than that incentivized by the program, or purchased fewer units than they did with the incentive. Econometric modeling, on the other hand, can involve a high degree of subjectivity in certain key relationships, such as the payback period at which individuals would likely implement a measure even without incentives. Econometric models may also overlook factors outside the model that influence measure adoption rates.

Other issues complicate the use of NTG ratios as well. For example, using previously observed NTG ratios to project future net savings means relying upon backward-looking information to forecast future trends, despite the likelihood that circumstances will change over time. Given the difficulties in estimating NTG ratios retrospectively, forecasting these values prospectively over the period of a potential study can be a challenge and often entails some level of subjective judgment. Moreover, as NTG ratios may vary for each individual measure (e.g., because natural adoption rates differ), accurately projecting separate NTG ratios for the hundreds of individual measures that are often included in a portfolio only furthers the challenge of forecasting net savings. This issue is sometimes dealt with by estimating and applying NTG ratios at the program level, but such an approach may widen the band of uncertainty into which the estimate falls.

As a result of all of these issues, choosing reasonable NTG ratios is typically not an exact science. In some cases, it may be appropriate to apply a range of possible NTG ratios based on different assumptions and show how outcomes would differ accordingly. At a minimum, the assumptions that underlie the NTG ratios that have been used should be stated explicitly and clearly explained.

Conclusions and Recommendations

As previously discussed, two essential themes common to all of the issues reviewed in this report are the importance of addressing each of these challenges early in the study planning process and the need to clarify in writing how each one will be approached. Several additional threads emerge out of further exploration of these issues, pointing toward certain recommendations to improve potential study analysis and interpretation. Three key points stand out in particular, namely, the importance of clearly defining the study scope, the need to manage the challenges of predicting the future, and the value of placing potential studies into the broader context in which they are used. These essential takeaways are summarized below.

Carefully Define the Study Scope: Many of the issues discussed in this report can be seen as examples of the need to define the study scope clearly and carefully. A basic principle in setting out the study scope is to ensure that it matches the underlying questions the policymakers and key stakeholders wish to answer. The study scope should also correspond with the perspective or perspectives that the study is designed to consider, which may be that of a given set of stakeholders, the entire service territory, or society as a whole. In addition, the study scope should reflect any additional policy considerations and constraints that policymakers may wish to apply. Designing the study scope to be consistent with the questions, perspectives, and objectives of policymakers and key stakeholders is one of the first and most fundamental tasks that potential study analysts should take on.

Manage the Uncertainty of Predicting the Future: Energy efficiency potential studies are by definition projections of possible future scenarios that entail a degree of uncertainty. Yet too often analysts rely heavily upon simplified quantitative modeling techniques that may lend an artificial sense of authority to predicted outcomes. As with any model, potential study forecasts are only as good as the assumptions that feed into them. Often these assumptions are based upon observed historical relationships that may or may not continue in the future. In some cases qualitative judgments based on expertise and past experience may be as useful as quantitative forecasts in judging the likelihood of alternative future outcomes. Another alternative to accepting the false precision of a single forecasted outcome is to consider a range of possible scenarios in which various inputs and their relationships to each other vary over time. Regardless of what method is chosen to make projections, analysts at a minimum should state clearly the limitations of the approaches they have used.

Consider the Broader Context Into Which the Study Fits: Very often energy efficiency potential studies tie into other work that has been or will be conducted in a given jurisdiction. In some instances, this work may affect the inputs used in the potential study analysis and the resulting outcomes. In other cases, potential studies may feed into independent evaluations of energy supply and demand options. It may not always be possible to control the methods and perspectives of independent work that is relevant to the assessment of potential study outcomes. Where reasonable adjustments are feasible to ensure consistency and to address any methodological concerns, analysts should consider making them. Even when adjustments cannot be made, however, analysts should acknowledge and explain any interactions between the potential study analysis and other work that is relevant to a potential study's results.

This imperative to acknowledge and explain the key factors that have influenced potential study results reaffirms the essential quality that should characterize any potential study: transparency. It is better to acknowledge complexity, discuss the methodological choices that have been made, and let reviewers interpret study results for themselves than it is to mask or gloss over potential disagreements with study results. Potential studies are complex by nature, relying upon a wide variety of inputs to predict at best a range of probable outcomes. There is no downside to acknowledging that the outcomes presented may or may not bear out in practice, depending on how key factors change over time. Indeed, highlighting this reality and providing sufficient information to allow reviewers to interpret projections in the proper context, as well as to adjust these projections by varying input assumptions, may be the most valuable service that potential study analysts can provide.

It is better to acknowledge complexity, discuss the methodological choices that have been made, and let reviewers interpret study results for themselves than it is to mask or gloss over potential disagreements with study results.

Introduction

For nearly three decades, energy efficiency potential studies have been used by utilities, other energy efficiency program administrators, regulators, and various interested stakeholders to inform the parameters, funding levels, and establishment of savings goals for efficiency programs throughout the United States and Canada. These studies have proven useful in identifying cost-effective measures and programs that utilities and program administrators should pursue and in establishing near- and long-term savings and net benefits goals. In addition, potential studies have fed into comparisons of energy efficiency and supply-side resources to meet consumer demand through integrated resource planning, have informed the attainment of carbon reduction goals, and have helped establish metrics for shareholder performance incentives. Potential study results, however, are derived from forecasts that involve both complexity and uncertainty. As such, findings from these studies need to be viewed carefully, particularly when used to inform and direct long-term policy objectives.

Potential studies are nearly always expensive and time consuming undertakings. It is therefore important to "get it right" the first time. This report provides guidance to help ensure that any new potential study will meet the study's stated objectives. No one wants to re-do a potential study because it fails to meet the needs of its intended users. However, an already completed potential study may have succumbed to one or more of the pitfalls indentified in this report. Rather than initiate a new study this report also provides guidance as to how results from a previous study can be re-interpreted to be more useful. While there are limits to the extent to which prior studies can be re-interpreted, the significant expense to re-do an imperfect study does provide considerable incentive to glean as much as possible from prior potential studies.

Few public resources exist today to assist potential study analysts and key stakeholders in avoiding some of the common pitfalls of potential study analyses, or to reinterpret study results in the proper context when such pitfalls are already embedded in study results. A practical handbook for conducting potential studies was published in 2007 as part of the U.S. Environmental Protection Agency's National Action Plan for Energy Efficiency, and the project manager of that publication has contributed to this report.[3] The primary focus of that handbook, however, was on the appropriate methodology to use in conducting various types of potential studies that were intended to answer different questions or be used in different ways. Another potential study guidebook published in 2010 by the Bonneville Power Administration has been used as a resource for this report, although this guidebook was centered on explaining methodologies used within that particular jurisdiction.[4] A 2008 paper by Goldstein identifies certain biases that are embedded across a number of potential studies, but it focuses specifically on those issues that might be looked at differently if the overriding policy goal became the advancement of energy efficiency as a first-priority resource.[5] Other papers published on the topic of energy efficiency potential studies have tended to concentrate on specific issues in potential study

3 National Action Plan for Energy Efficiency. (2007). Guide for conducting energy efficiency potential studies. Prepared by Mosenthal, P., & Loiter, J. Optimal Energy, Inc. Retrieved from www.epa.gov/eeactionplan

4 Guidebook for potential studies in the northwest. (2010, October). Prepared by EES Consulting for the Bonneville Power Administration.

5 Goldstein, D. B. (2008). Extreme efficiency: How far can we go if we really need to? Proceedings from 2008 ACEEE Summer Study on Energy Efficiency in Buildings. American Council for an Energy-Efficient Economy.

6 See, e.g., Neubauer, M., et al. (2010). Beyond electricity: Integration of electricity, water, and transportation efficiency potential in North and South Carolina. Proceedings from 2010 ACEEE Summer Study on Energy Efficiency in Buildings. American Council for an Energy-Efficient Economy.

approaches[6] or focus less on methodology and more on reviewing results.[7]

Methodology

The report is organized into a "Top 10" list of issues that those performing potential studies, those reviewing them, and those using the results should consider to ensure the validity and usefulness of the results. These issues were chosen by a project team that included several energy efficiency experts with decades of experience performing and reviewing potential studies throughout North America. The issues considered are as follows:

1. Defining "Achievable" Savings
2. Policy Considerations and Constraints
3. Modeling Program Participation
4. Excluding Measures and Savings Opportunities
5. Incorporating Codes and Standards into Technology Baselines
6. Issues with Utility Sales Forecasts
7. Consistency with the Integrated Resource Plan
8. Cost-Effectiveness Screening with the Total Resource Cost and Societal Cost Tests
9. Inclusion of Non-Energy Impacts
10. Forecasting Net Savings

Each of these issues is discussed in detail, focusing on the same key factors for each one, namely:

- Why Is It an Issue?
- Impact on Savings and Cost-Effectiveness (Direction)
- Impact on Savings and Cost-Effectiveness (Magnitude)
- How to Determine Whether It Is an Issue in a Given Potential Study
- How to Avoid the Issue in the First Place or Correct It
- How to Reinterpret Potential Study Findings When Issue Is Already Embedded

The report focuses on how these issues impact achievable potential studies as opposed to technical or economic potential studies. Depending on the issue and the way in which it is treated in a given study, the impact on savings and cost-effectiveness may be positive or negative, although underestimates of savings are a pervasive problem across many of these topics.[8]

Although each of the issues identified presents its own set of unique considerations, two related themes are common to all of them. First, it is important to address these issues as early in the study planning process as possible. Because in many cases the potential study is a result of a bidding process among competing contractors, it may be prudent to ask about these topics in a request for proposals, seeking respondents' explanations of how they would address these key questions in their work. To the extent that stakeholders or technical experts will be brought into the study planning and execution process, they should be granted opportunities to contribute their insights from the beginning. Ideally a comprehensive stakeholder review process should be established that brings all parties to the table and gives them access to project planning proposals, input assumptions, and interim results. If a particular issue is not addressed before a project team is chosen, it should be discussed early in the project planning process. In certain cases the scope and methodology chosen to address these issues may have budgetary implications. Even if project budget allocations remain the same, it will be much simpler and less costly to address these topics appropriately from the beginning of the process than to correct them after the analysis has been completed. If an issue is not recognized until work has already begun, it can sometimes be corrected by reviewing interim results before the study is published. Once published, the project budget may have been expended, and it may be too difficult, costly, or time-

7 See, e.g., A review and analysis of existing studies of the energy efficiency resource potential in the midwest. (2009, August). Prepared by the Energy Center of Wisconsin and ACEEE for the Midwestern Governors Association. (This paper does include a section on methodological issues that draws upon Goldstein and contributes some additional observations. See p. 15–18). See also, Nadel, S., Shipley, A. M., & Elliott, R. N. (2004). The technical, economic, and achievable potential for energy efficiency in the United States: A meta-analysis of recent studies. Proceedings from 2004 ACEEE Summer Study on Energy Efficiency in Buildings. American Council for an Energy-Efficient Economy.

8 Goldstein, D. B. Extreme efficiency: How far can we go if we really need to? (2008). Proceedings from 2008 ACEEE Summer Study on Energy Efficiency in Buildings. American Council for an Energy-Efficient Economy. p. 2. ("[V]irtually all of the potential studies are subject to systematic biases that cause them to understate the real potential of efficiency if the challenge is to meet serious energy or emissions reductions goals.")

consuming to correct results or reinterpret them with much precision.

A second related point is the importance of spelling out in writing the methodology that will be used to address each of these issues. An important place to provide details of the methodology is in the study scope of work. This document should make clear how each of these key issues will be addressed in the study so that analysts and policymakers are clear that each topic will be properly dealt with as the study progresses. Ideally a public version of this scope of work should be made available for review so that stakeholders and outside experts can comment on it before work begins. In addition to the scope of work, it is also important to be explicit about the methodology used in the study narrative itself, so that those reviewing a completed study are given clear information about the context in which they should interpret study results. An essential aspect of the explanation is to state clearly how the study's input assumptions have been used to arrive at its results, so that reviewers can make their own reasonable adjustments given changes or disagreements regarding the assumptions used. In many of the studies reviewed for this report, insufficient information was provided regarding the underlying methodology used to address some of the most important aspects of the potential study analysis, such that reinterpreting savings and cost-effectiveness projections to reflect input variations was not possible.

As a final matter, it should be noted that although the ten issues identified in this report were chosen because of their importance in impacting potential study projections and the frequency with which they tend to arise, they by no means represent a fully comprehensive list of the numerous methodological considerations that should be addressed before work on a potential study commences. Indeed, these issues were themselves culled from a list of nearly 40 topics identified by the project team that could be worthy of further discussion.[9] The Goldstein paper referenced earlier, as well as other resources and various potential studies themselves, point to an even wider range of methodological questions that may be relevant to any given potential study. A comprehensive stakeholder review process that is made integral to the study project early on is perhaps the most effective way of ensuring that all of these topics are identified and treated appropriately throughout the potential study analysis.

9 Readers are invited to contact the authors for further details regarding this longer list of issues.

1. Defining "Achievable" Savings

Why Is It an Issue?

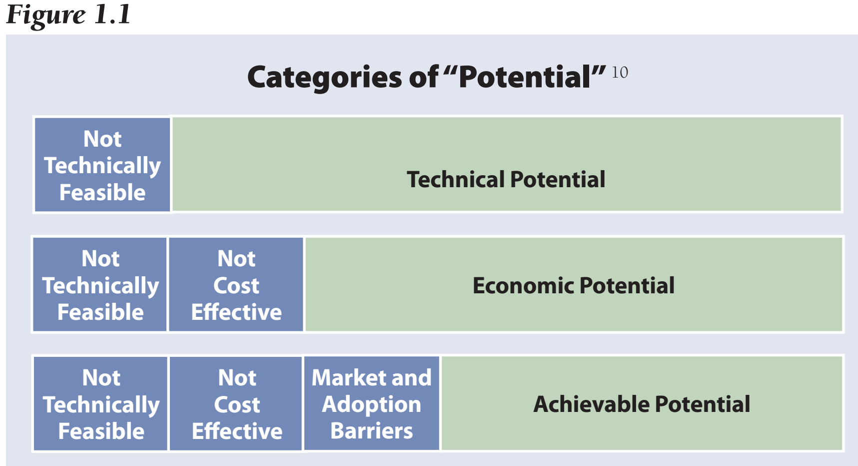
Energy efficiency potential analyses can be grouped into three basic categories:

- Technical potential studies analyze all the savings that could be achieved given either commercially available technology or projected technology that might become available over the study timeframe.
- Economic potential studies apply benefit/cost tests to determine which measures and/or programs would be cost-effective to implement over the same period.
- Achievable potential studies go one step further to ask what level of savings could actually be attained given the practical realities and market barriers that must be overcome to implement effective energy efficiency programs and convince customers to participate in them.

A growing number of potential studies focus primarily on achievable savings, as this framework represents the most realistic portrayal of what might actually happen in a particular market, assuming a given level of resources is directed toward energy efficiency investments. Often these studies begin by analyzing technical potential, then ask what subset of the technical potential would be economic, and finally assess what portion of economic potential might actually be achievable. As achievable potential studies best reflect actual savings opportunities, they frequently serve as inputs into other efforts, such as efficiency program planning and the development of utility integrated resource plans (IRPs).

Although the achievable framework is useful from a practical standpoint, too often projections of achievable savings are seen as precise forecasts or even upper limits on what level of demand reduction can be attained through energy efficiency initiatives. Labeling a projection as "achievable" to distinguish it from more theoretic technical and economic projections may sometimes have the unintended consequence of making anything above the forecast seem "unachievable." Yet even within the realm of achievable savings, there can be a range of projected savings depending on the assumptions applied, especially if different assumptions are made about possible future budget constraints and related funding streams that may support energy efficiency programs. For example, some achievable potential studies may focus on projecting the amount of savings that could be achieved under a "realistic" budget allocation scenario, whereas others may focus instead on "maximum" cost-effectively achievable scenarios in which there would be essentially no budget constraints. (This kind of distinction is depicted in Figure 1.1). Even under a single set of budget constraints, achievable savings potential may differ in practice from the level that has been projected. Other factors, such as effective program design and the strength of motivation on the part of the utility, can significantly influence what level of savings will ultimately be realized. As such, achievable savings projections should not necessarily be considered maximum limits, even if budgetary allocations cannot be increased. Instead analysts and policymakers should examine both monetary and non-monetary assumptions to determine whether any improvements have not been considered that might allow

Figure 1.1



10 National Action Plan for Energy Efficiency, 2007

greater savings to be attained. Achievable savings projections should also be benchmarked against savings levels that have been attained in other jurisdictions and projected savings from studies conducted elsewhere.

Studies that provide multiple savings projections under different scenarios tend to do a good job of explicitly stating the budget assumptions used, as these assumptions drive the different savings projections. Two example studies reviewed for this report are illustrative. In Georgia in 2005, ICF Consulting applied three separate levels of constraints to its achievable savings analysis: "minimally aggressive" (incentives equal to 25 percent of the incremental costs of efficiency measures), "moderately aggressive," (incentives equal to 50 percent of incremental costs), and "very aggressive" (incentives equal to 100 percent of incremental costs). Given that at the time few incentives were available in Georgia for energy efficiency investments, this broad and simple framework was used to give policymakers a general idea of what level of savings might be achievable under different approaches.

By contrast, in Connecticut in 2009, KEMA applied a set of constraints to its achievable analysis that bore a direct relationship to the existing funding streams and programs available for efficiency investments, as well as possible future scenarios related to these funding streams. The scenarios examined were "current" (a continuation of current programs, funded in part by revenues from the Regional Greenhouse Gas Initiative, or RGGI), "base" (a lower case that did not include RGGI funding), and "IRP" (a scenario consistent with the state's proposed IRP, which contemplated a significant increase in funding).

In both Georgia and Connecticut, the different scenarios were clearly spelled out in the study text, suggesting that the constraints had been well defined before the bulk of the analysis commenced. In addition, savings projections were clearly matched with the constraint assumptions under which they were made, making it possible to interpret the projections in context. Although these examples highlight studies in which multiple scenarios were projected, it would be equally essential to spell out the assumptions used even if only one scenario were examined.

As noted previously, even when budgetary assumptions are spelled out clearly, other assumptions may be embedded that can be equally important in defining what level of savings are achievable. To ensure that these non-monetary assumptions are treated as explicitly as budget constraints, policymakers should require that analysts include a discussion of what assumptions have been made about program design, implementation, and other factors that have fed into the projection of achievable savings. Ideally they should also require a comparative analysis with leading programs and other potential savings projections outside the jurisdiction being considered.

Impact on Savings and Cost-Effectiveness (Direction)

The directional impact on savings of changing budget constraints can be up or down, depending on whether constraints are added or removed. Adding constraints to an achievable analysis lowers savings projections, whereas removing constraints raises them. For example, in the Connecticut study, projected demand savings were 597 MW under the current scenario, 531 MW under the base scenario (lower funding), and 1,095 MW under the IRP scenario (higher funding).[11] Similarly, energy savings were 3,333 GWh under the current scenario, 2,946 GWh under the base scenario, and 5,910 GWh under the IRP scenario.[12] These results are summarised in Table 1.1.

Table 1.1

KEMA Estimate of Achievable Energy Savings in Connecticut (2009)[13]

	Base funding scenario	Current funding scenario	Expanded funding scenario
Net Energy Savings — Total GWh	2,946	3,333	5,910
Net Energy Savings — % of base use	10%	11%	20%
Net Peak Demand Savings (MW)	531	597	1,095
Net Peak Day Demand Saving — % of base demand	8%	9%	16%

11 KEMA, Estimate of Achievable Energy Savings in Connecticut (2009), http://ctsavesenergy.org/files/CTNGPotential090508FINAL Connecticut. (2009). p. 1-8.

12 Id., p. 1-12.

13 Connecticut. (2009). Table 5-7.

By contrast, the directional impact on cost-effectiveness may vary depending on how adoption rates of individual measures with different cost-effectiveness ratios are assumed to change as budget constraints and allocations change. If the predominant effect of removing budget constraints is to increase the adoption of measures or programs with higher cost-effectiveness ratios than the existing portfolio, then overall cost-effectiveness will go up. On the other hand, if the predominant effect is to increase the adoption of measures or programs with lower cost-effectiveness ratios than the overall portfolio, which is the more typical outcome when budgets are increased, then overall cost-effectiveness will go down. Naturally, adding budget constraints would have the opposite effect in each case.[14]

For example, using a Total Resource Cost (TRC) Test, KEMA found that the BCR of Connecticut's existing portfolio was 2.59.[15] This number represents the total amount of program benefits divided by all program costs (including incentives, administration/marketing, and participant contributions). Under the base scenario, given certain assumptions about adoption rates with lower funding, KEMA found that the overall TRC Test ratio would actually be higher, at 2.65. In this case, even though total benefits were reduced, the cost of achieving those benefits was lower on a per-dollar basis than under the current existing portfolio.

Interestingly, KEMA also found that the BCR of the hypothetical portfolio under the IRP scenario, with higher than current funding, would also equal 2.65. The fact that the base and IRP ratios were the same is a coincidence, but the fact that both the base and the IRP cost-effectiveness ratios were higher than that of the existing portfolio is not highly unusual. Again, this is because cost-effectiveness can go up or down as budget constraints are added or removed, depending on whether the incremental measures and programs adopted or left on the table have a higher or lower cost-effectiveness ratio than the overall portfolio.

In terms of savings, changing non-budgetary assumptions will typically have a similar affect as changing budgetary constraints. If it is assumed that a utility will improve its program design and implementation strategies, for example, then savings will typically go up, whereas savings will go down if these factors worsen. With respect to cost-effectiveness, changes in non-budgetary assumptions will also tend to correlate directly with overall cost-effectiveness. That is, if a utility becomes more effective or motivated in designing or implementing its efficiency programs, then cost-effectiveness will tend to go up, whereas it will go down if a utility becomes less effective. The only exception would be if it were assumed that improvements could be made in the implementation of a program or measure that was less cost-effective than the overall portfolio, which might increase savings while driving overall cost-effectiveness down.

Impact on Savings and Cost-Effectiveness (Magnitude)

The magnitude of the impact that changing budget constraints will have on savings projections depends on the extent of the constraints added or removed, the marginal value of the dollars added or removed, and any change in how dollars are allocated as the budget changes. Given that the marginal value of each dollar may vary, the magnitude of the change in savings may not be directly proportional to the magnitude of the change in the portfolio budget.

For example, in the Georgia study ICF projected electricity savings equal to 2.3 percent of annual sales (in MWh) by 2010 under the minimally aggressive scenario (incentive levels at 25 percent of incremental costs), 6.0 percent savings under the moderately aggressive scenario (50 percent of incremental costs), and 8.7 percent savings under the very aggressive scenario (100 percent of incremental costs) as depicted in Table 1.2.[16] If changes in savings projections were directly proportional to changing budget assumptions, one might expect that the rate of savings increase would remain constant as the budget doubled from the minimal to the moderate scenario and doubled again from the moderate to the very aggressive scenario. In fact, however, savings projections more than doubled as the budget increased from minimal to moderate, whereas the projected savings increase was much less (on a percentage basis) going from moderate to very aggressive. This suggests that in the Georgia analysis, unlike in

14 How adoption rates are projected will be discussed further in a later section.

15 Connecticut. (2009). p. 4-12.

16 ICF, Assessment of Energy Efficiency Potential in Georgia (2005), http://www.cleanairinfo.com/airinnovations/2005/Addl%20Info/Cyrus%20Bhedwar/GEFA%20Energy%20Efficiency%20Potential%20Study.pdf, p. 1-3.

Connecticut, savings increases were projected to diminish as the budget increased.

Regarding overall cost-effectiveness, the magnitude of the impact of changing budget assumptions depends on the BCRs of the particular measures or programs adopted or excluded as budget assumptions change. For example, in the Connecticut study one significant reason that the BCR increased between the "current" and "IRP" scenarios was that the IRP scenario envisioned a significant increase in the commercial sector budget, which had the highest BCR of any sector. The commercial sector BCR was 3.74 in the current scenario and 3.71 in the IRP scenario, compared to a portfolio BCR of 2.59 in the current scenario and 2.65 in the IRP scenario. Under the IRP scenario, the commercial-sector budget more than doubled as compared to the current scenario. This budget increase was greater than the increase in either the industrial or residential sectors. Because the commercial sector BCR was significantly higher than the overall portfolio BCR, the large increase in commercial sector budget drove the overall BCR up.

The Georgia and Connecticut examples demonstrate that projections of both savings and cost-effectiveness can be highly dependent on where each marginal dollar is invested under different scenarios. In Georgia, the rate of increase in projected savings declined as budget assumptions increased because the marginal value of additional dollars invested diminished. In Connecticut, cost-effectiveness increased from one scenario to another because marginal dollars were invested in the sector with the highest BCR. The key take-away from these examples is that achievable savings projections under different scenarios may vary depending on how it is envisioned that marginal dollars will be invested.

As previously noted, changing budget assumptions is only one way in which achievable savings projections may be influenced. The magnitude of non-budgetary changes such as program design and implementation is highly dependent on the specific changes that are assumed. One way to gauge the potential magnitude, however, is to benchmark against what level of savings has been achieved in leading programs under similar budget constraints.

How to Determine Whether It Is an Issue in a Given Potential Study

Deciding upon the type and level of constraints to apply to the achievable potential analysis will always be important at the outset of a study. In some cases policymakers for whom the study is being conducted may already have clear desires regarding the type of budgetary constraints that they wish to be used, although they will less frequently have predefined assumptions regarding non-budgetary factors. If an explicit set of budgetary and non-budgetary assumptions that define what is "achievable" has not already been set out, then this is one of the first issues that will need to be addressed before going forward with the analysis.

Many completed studies will spell out the budgetary assumptions used in analyzing potential savings, although a simple statement that the study looks at "achievable" potential would not be sufficient. Additional details should be provided that further define what type of achievable savings are the focus of the study. In other cases, studies may use a "best practices" assumption, which would indicate that projected savings are set to correspond with levels being achieved in districts at the high end of the spectrum, with necessary budget allocations following as a result. Alternatively studies that simply project achievable savings based on implementing "all cost-effective measures" may be focused on determining maximum achievable savings.

Often non-budgetary assumptions are more deeply embedded in the analysis, without explicit references to factors such as the likely effectiveness of the utility or program administrator, as well as potential improvements

17 Georgia. (2005). Table 1.

Table 1.2

ICF Estimate of Achievable Energy Savings in Georgia (2005)[17]

Load Type	Minimally aggressive		Moderately aggressive		Very aggressive	
Reduction in electricity sales (MWh)	3,338,924	2.3%	8,704,577	6.0%	12,546,554	8.7%
Reduction in peak demand (MW)	447	1.7%	1,149	4.4%	1,608	6.1%
Reduction in Gas Sales (MMcf)	7,041	1.8%	16,972	4.4%	31,343	5.5%

in program design. Yet although these factors have historically been left out of the discussion in many potential studies, in practice they will almost always be important drivers of what is achievable. As such, a discussion of what non-budgetary assumptions may influence the analysis should take place early in any potential study project, and these assumptions should be laid out in the narrative discussion of achievable savings and cost-effectiveness.

How to Avoid the Issue in the First Place or Correct It

The best way to avoid ambiguity regarding the type of achievable savings being investigated is to address the issue before the study commences. This can be done as part of the request for proposals, either by stating up front what type of achievable savings analysis is desired, or by asking proposal teams to specify a range of options that could be examined.

If the issue has not been addressed at this stage, it can be resolved by bringing all interested parties together to discuss and define the goals of the study before the bulk of the work commences. Parties should decide whether the goal of the study is to project the maximum achievable savings potential without any significant budget constraints, or to apply certain constraints such as a "realistic" or "best practices" level of funding. In some cases, budget constraints may be defined by caps on energy efficiency fund collections, such as system benefit charge percentage caps or, as in the case of Connecticut, RGGI allocation levels. Specific monetary values should be assigned to the constraints that are agreed upon, and these values should then be spelled out in the study narrative.

With respect to non-budgetary factors that may influence achievable savings, a list of these factors should be devised before the study commences, and each factor should be incorporated into the analysis and discussed in the study narrative. Benchmarks should also be included that show how achievable savings projections in the subject jurisdiction compare to results and projections elsewhere.

How to Reinterpret Potential Study Findings When Issue Is Already Embedded

Reinterpreting potential study findings can be very difficult to do when there is already embedded ambiguity regarding the type of achievable savings that a study describes. For many of the reasons discussed previously, increases or decreases in resources are not necessarily directly proportional to increases or decreases in potential savings or cost-effectiveness. Among these is the fact that the value of a marginal dollar spent depends on how and where it is spent. As a result, it is much better to address this issue early in the process, before the analysis of achievable savings has been carried out.

2. Policy Considerations and Constraints

Why Is It an Issue?

Certain policy goals or constraints may impact the potential to maximize achievable savings by restricting the way in which funds can be spent or directing investments away from measures and programs that would produce greater savings levels. Often these policy directives are necessary to achieve various goals, aside from reaching the highest overall quantity of energy savings. Even when such policies reflect prudent considerations, however, their impacts within a given potential study on savings and cost-effectiveness should be recognized and explained. Examples of such policies may include constraining energy efficiency spending within a given sector to the proportion of ratepayer funds collected from that sector, as well as directing additional funds toward low-income programs beyond the amount that would maximize overall savings. Such policies will tend to reduce savings levels, although there may be sound reasons to incorporate them. In terms of cost-effectiveness, policies that primarily impact budgetary allocations will not typically impact measure-level BCRs, but they may impact the cost-effectiveness of certain programs, sectors, and the energy efficiency portfolio as a whole.

Other types of policy considerations may have impacts that go beyond budgetary allocations, in some cases even influencing a potential study's underlying methodology. For example, policies that impact the kinds of costs and benefits that can be considered in the economic screening process may have a direct impact on the way in which energy efficiency measures and programs are evaluated. To the extent that such policies reduce cost-effectiveness and cause fewer measures and programs to pass economic screening, there may be a negative impact on overall achievable savings.

By contrast, certain policy directives may actually increase the achievable savings potential and cost-effectiveness of an energy efficiency portfolio. For example, a requirement to consider joint promotion of various energy efficiency programs aimed at generating savings of different fuel types (e.g., electricity and natural gas) may result in synergies that would not necessarily occur naturally, particularly if the utilities in a given jurisdiction distribute only one type of fuel. Given the complexities that may be involved in determining the cost and savings implications of joint promotion, the approach taken to consider these implications should be discussed at the outset of a potential study project.

In some cases, the impact of certain policy decisions on achievable savings potential may depend on how customers that fall under those policies are treated in the analysis. For example, a policy that allows large industrial customers to opt out of paying cost recovery fees or system benefit charges while pursuing their own self-directed efficiency projects may reduce the projected level of savings that can be achieved from program implementation, unless the self-direct arrangement is itself considered a program and the self-directing customers are incorporated into the analysis.

These examples, discussed in more detail below, provide just a few illustrations of the many kinds of policies and considerations that may impact a potential study analysis. For instance, policymakers may need to determine whether fuel switching, combined heat and power, and renewable technologies will be supported by ratepayer funds, subjected to the same economic screening tests as energy efficiency programs, and included in a potential study. Decisions on this topic may have significant implications in terms of budgetary allocations and portfolio cost-effectiveness. As such, it is important to define the scope of the portfolio clearly with respect to these points prior to engaging in the assessment of potential savings.

Although a wide range of other policies exists that might be relevant in one jurisdiction or another, the key factor common to all of them is to ensure that their tradeoffs and implications are discussed before the work on a potential study commences. Those policies that are incorporated into a given potential study and impact the results should also be discussed fully in the study narrative. Otherwise it may be difficult to interpret study findings in the proper context.

Impact on Savings and Cost-Effectiveness (Direction)

Policy considerations that divert resources away from the goal of maximizing energy savings will tend to reduce overall savings, although these constraints may be necessary to achieve other goals. Typically measure-level cost-effectiveness will not be impacted, but portfolio-wide cost-effectiveness will tend to decrease.

Table 2.1[21]

Program	Five-Year Budget[22]	Lifetime Savings (Dth)	$/Dth Saved
Residential New Construction	$5,000,000	3,579,000	$1.40
Home Performance with ENERGY STAR	$6,000,000	4,275,000	$1.40
Small Heating and Domestic Hot Water	$16,700,000	8,153,000	$2.05
Commercial/Industrial New Construction	$11,400,000	3,694,000	$3.09
Existing Commercial/Industrial Buildings	$25,300,000	6,455,000	$3.92
Food Service	$3,600,000	736,000	$4.89
Low-Income Weatherization Retrofits	$6,900,000	973,000	$7.09

A 2006 natural gas potential study of the Con Edison service area, prepared for the New York State Energy Research and Development Authority (NYSERDA), provides several examples of the kinds of spending constraints that may affect potential savings.[18] For instance, NYSERDA asked study analysts to assume that 20 percent of residential program spending would be targeted specifically to low-income customers.[19] Based on evidence contained in the study, it appears that this policy constraint limited potential savings.

Table 2.1—showing the budget, savings levels, and cost per dekatherm (Dth) for a mix of programs analyzed in the study—indicates that the Low-Income Weatherization program was the most expensive program across all sectors in terms of dollars per Dth saved, by a significant margin.[20] This program was more than four times as expensive as the two other strictly residential programs (Residential New Construction and Home Performance with ENERGY STAR) because the low-income program paid 100 percent of measure costs and included comprehensive, personalized customer education and counseling. It was also more than twice as expensive as the Small Heating and Domestic Hot Water program, a mixed program targeting primarily residential customers with some overlap among small commercial customers. It is likely that if NYSERDA's only goal had been to maximize potential savings and there had been no requirement to spend 20 percent of the residential budget on the low-income sector, more money would have been spent on less expensive programs, generating a higher level of savings. On the other hand, fewer benefits would have accrued to the low-income community, where energy bills can often present the highest burden. Although it may be difficult to determine whether the balance achieved in the study was optimal, the important point is that the study's results should be understood and interpreted in the context of the policy constraints that were incorporated into the analysis.

Other constraints in the study were self-imposed by analysts, although some of them represent the kinds of directives often issued by policymakers. For example, analysts imposed a constraint that the proportion of an assumed $15 million annual energy efficiency budget that could be spent on each sector would be required to match the percentage of total revenues that Con Edison received from each sector.[23] As a result, approximately 46 percent of the energy efficiency budget ($6.9 million) was allocated

18 Mosenthal, P., et al. (2006, March 9). Natural gas energy efficiency resource development potential in Con Edison service area. Prepared for New York State Energy Research and Development Authority by Optimal Energy.

19 Id., p. 5-2 – 5-3.

20 Id. Budget numbers taken from program descriptions on p. 5-16 – 5-28. Lifetime savings taken from Table 5-3 on p. 5-32. Dollars per Dth saved were calculated based on these two inputs.

21 Based upon EFG analysis

22 The five-year budget represents the budget for all investments considered in the study over the five-year period that was considered. Lifetime savings represent cumulative savings resulting from all investments over these five years.

23 Id., p. 5-1. See footnote 41 of the study for additional details on the way in which the budget was allocated.

to the residential sector, with the remainder ($8.1 million) being allocated to the combined commercial and industrial (C&I) sectors. This kind of "sector equity" constraint is common among utility and program administrator spending plans. Although the evidence is less definitive, some indications suggest that sector equity may have reduced potential savings in this study. For example, based on the table above, it can be shown that average dollars per Dth savings across all commercial and industrial programs approximately equaled $3.69, whereas the average across all residential programs approximately equaled $2.04.[24] This suggests that a greater level of savings might have been achievable if more resources had been devoted to the residential sector, although a number of factors such as the cost of additional market penetration in the residential sector would need to be considered before such a conclusion could be definitively drawn. Regardless, this example points to the possible reduction in savings that may occur when resources are allocated to achieve sector equity rather than to maximize savings. In jurisdictions in which these two goals are both being considered, it may be helpful to present an assessment of how projected savings would likely differ under scenarios both restricted and unrestricted by sector-equity considerations.

In terms of cost-effectiveness, shifting budgetary allocations as a result of incorporating policy constraints into the analysis would not impact measure-level BCRs, although program-level and portfolio-wide cost-effectiveness ratios would likely change. In general, a shift in the portfolio budget that diverted resources away from one program with a higher BCR to another program with a lower BCR would tend to decrease portfolio-wide cost-effectiveness. Determining the precise magnitude of this impact may be somewhat complex, as discussed in further detail later in this section.

Beyond low-income and sector-equity constraints, analysts incorporated several other considerations into their budget allocation and portfolio design process that reflected common policy concerns. For example, analysts constructed a portfolio that balanced the goal of achieving immediate savings with longer-term market transformation efforts.[25] In addition, analysts attempted to construct a portfolio that would target all Con Edison customers as well as all important end uses.[26] Finally, the programs incorporated into the portfolio reflected an effort to target multiple energy efficiency opportunities within buildings in each sector, focusing on a comprehensive approach as opposed to cream-skimming with single measures.[27] Each of these considerations may have impacted the potential to achieve shorter-term energy savings over the period of the potential study, although some of the same considerations may have been intended to increase savings over time. Although exploring the full implications of each one of these considerations is beyond the scope of this report, they are noted here to illustrate the wide range of policy-related considerations that may impact how funds are allocated, with varying potential impacts on study results.

Beyond budgetary guidelines, other types of policy constraints may impact the underlying methodology used in the study to determine savings and cost-effectiveness levels associated with various measures and programs. In Pennsylvania, for instance, Act 129 defines the TRC Test as "A standard test that is met if, over the effective life of each plan not to exceed 15 years, the net present value of the avoided monetary cost of supplying electricity is greater than the net present value of the monetary cost of energy efficiency conservation measures."[28] The Pennsylvania Public Utilities Commission has interpreted this language to exclude "environmental and societal costs that are not otherwise already embedded in the wholesale costs for the generation of electricity."[29] As a result, analysts recently conducted a potential study for that state in which

24 For the Small Heating and Domestic Hot Water program, it has been inferred here that $16,600,000 were allocated in the study to the residential sector and $100,000 to the commercial sector. This assumption was based on the fact that a gap of $16,600,000 was left in the residential budget of $34,500,000 (assumed to be five times the low-income budget of $6.9 million) after accounting for the other residential programs. It was also assumed that Dth savings could be allocated in proportion to spending. This latter assumption may not be precisely in line with the study's methodology (which is not explained in detail on this point) but would not likely impact the essential point in the illustration above.

25 Id., p. 2-19.

26 Id.

27 Id.

28 66 Pa. C.S. 2806.1(m)

29 Pennsylvania Public Utilities Commission. (2009, January 15). Implementation order. Energy Efficiency and Conservation Program, Docket No. M 2008 2069887.

they screened individual measures using this regulatory interpretation of total resource costs and excluded other benefits, including natural gas and delivered fuel savings.[30] The impact of considering only selected benefits in the cost-effectiveness screening process is explored further in the section of this report addressing variations in the TRC Test and the SCT. In general, however, a policy constraint incorporating a more limited set of benefits may result in fewer measures passing the cost-effectiveness screen, with an associated reduction in overall potential savings.

Although most of the policy considerations discussed thus far can be characterized as constraints, other types of policy directives may actually reduce costs and increase savings. For example, policymakers may consider requiring that analysts consider the synergies that could result from jointly offering energy efficiency programs aimed at generating savings of different fuel types. The Con Edison study discussed previously took this approach in considering the potential benefits of promoting natural gas efficiency programs jointly with electric efficiency programs.[31] Analysts noted that for natural gas efficiency programs, which were not as well established in the service territory covered, the benefits of this approach might include utilizing established marketing and communication channels, taking advantage of administrative procedures already in place, and providing a single point of contact between programs and customers. Analysts conjectured that these advantages would reduce start-up and development costs for natural gas programs, shrink customer acquisition costs, and provide ongoing cost savings through joint marketing and administration.[32] Although the study did not attempt to project the precise level of additional savings that could be attributed to joint program promotion, the impact was generally projected to be positive.[33] As this example illustrates, while many of the policy considerations that may be incorporated into a potential study will tend to reduce savings and cost-effectiveness, some may in fact have the opposite effect.

Impact on Savings and Cost-Effectiveness (Magnitude)

The magnitude of the impact on savings and cost-effectiveness of various types of policy considerations may depend on how a given consideration affects the potential study analysis. With regard to policy constraints that primarily impact budgetary allocations, the magnitude of the impact on savings will generally correlate with the amount of resources that are reallocated. Quantifying the precise impact may also depend on examining the marginal value of the shifting investment.

The magnitude of the impact on savings of shifting resources in response to a policy directive can be illustrated with a hypothetical example in which Con Edison might require an additional shift of $1 million in the portfolio above from the Home Performance with Energy Star (HPwES) program to the Low-Income Weatherization (LI Wx) program. In the original portfolio, the average cost per Dth in the HPwES program was $1.40/Dth, which is equivalent to about 0.71 Dth per dollar. The average cost per Dth in the LI Wx program is $7.09/Dth, equivalent to about 0.14 Dth per dollar. If marginal costs were assumed to equal average costs, then the $1 million investment would save 710,000 Dth in the HPwES program ($1 million x 0.71) but would only save 140,000 Dth in the LI Wx program ($1 million x 0.14). The resulting drop in savings from the reallocation would equal about 570,000 Dth (710,000 – 140,000 Dth).

In practice, however, the marginal value of the $1 million reallocation would likely differ from the average value of all dollars invested in each respective program. As a result, diverting $1 million away from the HPwES program would not necessarily cost 710,000 Dth, whereas shifting these dollars into the LI Wx program would not necessarily add 140,000 Dth. For instance, if the first $1 million invested in an HPwES program acquired many more customers (who were eager to participate) than could be acquired by each additional $1 million added to the program, then losing $1 million from a budget of $6.9 million might have a lower savings impact than would otherwise be expected. On the other hand, adding another $1 million to the LI Wx budget might achieve less than

30 Electric Energy Efficiency Potential for Pennsylvania. (2012, May 10). Prepared by GDS Associates, Inc. for the Pennsylvania Public Utility Commission. p. 51.

31 Mosenthal, P., et al. (2006, March 9). Natural gas energy efficiency resource development potential in Con Edison service area. Prepared for New York State Energy Research and Development Authority by Optimal Energy. p. 5-7.

32 Id., 5-7.

33 Id., p. 5-9 – 5-11.

the average value of investments in that program if the additional resources were spent on harder-to-reach participants or more costly measures. Methods for estimating the marginal value of resources invested in energy efficiency are discussed to some extent in the section of this report on technology adoption models and are beyond the scope of the discussion here. The essential point, however, is that the magnitude of the impact on savings of shifting budgetary resources in response to a policy directive would depend on the marginal value of those resources.

In terms of cost-effectiveness, shifting budgetary allocations from one program to another in response to a policy constraint would not typically impact the BCR of individual measures, although cost-effectiveness might change at the portfolio level. The magnitude of the impact would depend on both the size of the reallocated investment and the BCRs of the original and new uses of the shifting resources. Quantifying the precise magnitude of the impact would also depend on the relationship between the budgetary allocations and total measure costs, as well as the way in which program- or sector-level BCRs might change with a resource reallocation.

Table 2.2[35]

Original Portfolio					
	Required Allocation	**Budget**	**Cost**	**Gross Benefits**	**BCR**
Residential	33%	$5,000,000	$10,000,000	$20,000,000	2.0
C&I	67%	$10,000,000	$20,000,000	$80,000,000	4.0
Total	100%	$15,000,000	$30,000,000	$100,000,000	3.33
New Portfolio					
	Required Allocation	**Budget**	**Cost**	**Gross Benefits**	**BCR**
Residential	50%	$7,500,000	$15,000,000	$30,000,000	2.0
C&I	50%	$7,500,000	$15,000,000	$60,000,000	4.0
Total	100%	$15,000,000	$30,000,000	$90,000,000	3.0
Change		**0%**	**0%**	**-10.00%-10.00%**	

The magnitude of the impact of reallocating budgetary resources can be demonstrated using a simplified example in which budgetary allocations are set to equal 50 percent of incremental costs across all programs and sectors in which they may be invested. This assumption is reflected in Table 2.2, in which the "Budget" amount is equal to half of the "Costs" in all cases.[34] The illustration also assumes that the BCRs of the residential and commercial sectors will remain constant regardless of the amount of resources invested in these sectors. Given these assumptions, the illustration demonstrates the magnitude of the impact of shifting from a policy in which one third of the budget must be devoted to the residential sector and two thirds to the C&I sector, to a policy in which the budget is required to be split equally between the two sectors.

In this illustration, the BCRs of the two portfolios can be calculated by multiplying the sector-level BCRs by the relative weights of the budget allocations. In the original portfolio, a 33-percent allocation multiplied by a 2.0 BCR in the residential sector, plus a 66-percent allocation multiplied by a 4.0 BCR in the C&I sector results in a portfolio-wide cost-effectiveness ratio of 3.33. In the new portfolio, a 50-percent residential allocation multiplied by a 2.0 BCR, plus a 50-percent commercial allocation multiplied by a 4.0 BCR results in a portfolio-wide BCR of 3.0. In this simplified example, the magnitude of the impact on the portfolio-wide BCR thus is directly related to the shifting weights of the sector-level budget allocations.

In practice, the relationship of budget allocations to program costs might not be directly proportional (i.e., incremental costs might be more or less than 50 percent of the budget). Although some potential studies assume that incentive budgets will equal a certain fixed percentage of incremental costs for all measures, other studies may vary incentive levels by measure. If the relationship between budgets and costs were more complex than the assumption used in the illustration above, then it would be necessary

34 For the sake of simplicity, program-related costs such as marketing and administration have been ignored.

35 Based upon EFG analysis

to examine directly how costs would change with the reallocation in order to calculate the magnitude of the shift in the portfolio-wide BCR.

Furthermore, the program- or sector-level BCRs themselves are in fact likely to change as resources are diverted away from one program or sector to another. For instance, this might occur because the mix of measures in a program or sector could change as dollars were added or removed, or because market penetration levels might change with increasing or decreasing investments. If the BCRs were likely to change as investments were shifted, then it would be necessary to examine the change in the program- or sector-level BCRs in order to determine the magnitude of the impact on portfolio-wide cost-effectiveness.

As noted earlier, other types of constraints may be imposed beyond budgetary prioritization. A policy that influences which factors are considered in cost-effectiveness screening is just one example. The magnitude of the impact of such a change in cost-effectiveness screening on both savings and cost-effectiveness is further explored in the section of this report discussing the TRC Test and SCT.

The magnitude of the impact of some other types of policy directives may be more complex to determine. For example, a requirement to consider joint promotion of electricity and natural gas programs would undoubtedly have both savings and cost-effectiveness implications, but the precise magnitude of these impacts would be highly dependent on the context within a given region. In such cases the best way to estimate the size of the impacts may simply be to rely upon expert judgment and experience, considering all the relevant facts and circumstances in a given area over the time frame of the study.

How to Determine Whether It Is an Issue in a Given Potential Study

Whether the issue of policy considerations and constraints will be relevant to a given potential study depends on whether policymakers are most interested in projecting maximum achievable savings regardless of other considerations or also wish to consider other objectives within the context of the achievable savings analysis. Even if various policy constraints are being considered, it may be useful to conduct an analysis of the level of savings that could be achieved if these constraints were not imposed. If a policy directive is highly likely to impact savings or cost-effectiveness in the future, however, it may also be worthwhile to consider incorporating that directive into the analysis of potential savings. In some cases, it may be valuable to analyze potential savings under multiple scenarios, although doing so would likely expand the scope of work of a given study.

Identifying policy constraints and directives is also an important part of interpreting the results of a completed potential study. This is particularly true if the study is used as a basis of comparison to estimate potential savings in another jurisdiction in which the same constraints and considerations may or may not be relevant. In reading and interpreting completed studies, it is therefore advisable to look for any language or other indications suggesting that certain policy constraints have impacted the results.

How to Avoid the Issue in the First Place or Correct It

The question of which policy directives and constraints ought to be incorporated into a given potential study should be raised in the initial project meeting. Some constraints and requirements may already have been established outside the context of a potential study, in which case they should be reviewed to ensure they are addressed or acknowledged in the study analysis. To the extent that policy considerations and constraints have not been preestablished, they should be weighed against the potential for savings maximization prior to commencing the study. Any constraints and considerations that are incorporated into the study should be clearly defined in the final scope of work, and they should be discussed explicitly in the study narrative so that it is clear how these considerations may have impacted the study's results.

How to Reinterpret Potential Study Findings When the Issue Is Already Embedded

It may be possible to reinterpret potential study results directionally in light of the addition or removal of a policy consideration or constraint. Determining the magnitude of these results, however, may be more difficult. With respect to policy considerations that impact budget allocations, for instance, it will generally be the case that adding constraints will lower total savings and reduce cost-effectiveness. Quantifying the magnitude of these impacts may be challenging, however, and might require examining the marginal value of the shifting investment, as well as identifying how program- or sector-level costs and benefits would change with the reallocation. With regard to constraints that impact the study methodology, it may not be possible to quantify revised results without in-depth access to the study's underlying work product. Finally, in relation to certain other policy directives, such as a requirement to consider joint program offerings, it may be reasonable to reinterpret results to assume that the impact would be positive, although quantifying the precise impact may not be possible in light of all of the various ways in which such an approach might impact program benefits and costs.

3. Modeling Program Participation

Why Is It an Issue?

All potential studies predict in some manner how consumer behavior may change over time, particularly as a result of energy efficiency programs influencing rates of consumer adoption of efficient technologies. Yet modeling consumer behavior is complex and uncertain, particularly several years into the future. Some studies model behavior using technology adoption curves, which generally assume that rates of consumer adoption are a function of simplified economic inputs, such as incentive levels and measure costs. Although these models can be informative, they often overlook additional key factors that can be more uncertain but equally important in influencing consumer choice. Other studies forego technology adoption curves and estimate adoption rates directly based on economic and non-economic factors, but this can be difficult to do for a wide range of measures over time. These direct estimates are sometimes little more than informed projections based upon past experience in the relevant jurisdiction and in others. Regardless of the approach used, the challenges associated with the methodology should be identified up front and stated explicitly as potential limitations in the study narrative.

An illustrative example of over-reliance on technology adoption curves comes from a study conducted between 1997 and 1998 by the Lawrence Berkeley National Laboratory (LBNL) on the potential effects on consumer adoption that could be expected with the proposed implementation of national tax credits for certain energy-efficient products.[36] In that study, analysts first modeled the change in technology adoption by looking only at the "direct price effect" that the credits would have in reducing the cost of the technology. Subsequently, however, analysts realized that these models overlooked previous research suggesting that the act itself of instituting a public subsidy, regardless of its size, could create an "announcement effect" that would likely increase adoption rates. Indeed, the research indicated that an increase in market share could be expected even if the subsidy level were zero.[37] Once the LBNL analysts factored the announcement effect into their model, they projected it to be equally if not more important than the direct price effect.[38]

The announcement effect is closely tied to the concept of "spillover," which refers to any increased adoption of energy-efficient technologies that can be attributed directly to a program, but not to the size of the incentive the program offers. These effects may result from the additional credibility or awareness of a product that results from a publicly supported incentive program, as well as from changes in product stocking and retailer promotion of the technology. Often the uncertainty in predicting the relative importance of these factors can lead analysts to place a higher degree of emphasis on direct price effects.[39]

An alternative to using technology adoption curves

36 Koomey, J. G. (2000, April 12). Avoiding 'the big mistake' in forecasting technology adoption. Lawrence Berkeley National Laboratory.

37 Train, K. (1994, July 22). Customer decision study: Analysis of residential customer equipment purchase decisions. Prepared for Southern California Edison Company by Cambridge Systematics, Pacific Consulting Services, The Technology Applications Group, and California Survey Research Services.

38 Koomey. p. 4. In addition to the announcement effect, the analysts forecast that implementing subsidies on a national scale would likely lead to cost reductions as production of the incentivized technologies scaled up. After accounting for both of these indirect effects, analysts projected that the direct price effect would likely account for only one tenth to one third of the increased adoption rate.

39 See, e.g., Potential for Energy Efficiency in Connecticut, prepared by KEMA for the Connecticut Energy Conservation Management Board, United Illuminating and Connecticut Light and Power, p. 1-3 – 1-4. "The effect on the amount of estimated adoption will depend on where the pre- and post-incentive benefit-cost ratios fall on the curve. … We

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to model consumer behavior is to estimate technology adoption rates directly. This can be difficult to do for individual measures, however, and often must be estimated at a higher level, sometimes under various alternative scenarios. For example, a study of natural gas energy efficiency potential in Massachusetts modeled two alternative scenarios of 80-percent and 60-percent long-term energy-efficient market penetration for all measures that would be replaced by the end of the study's 10-year timeframe.[40] The 80-percent assumption was intended to correlate with aggressive incentive levels and strong educational and marketing campaigns, while the 60-percent assumption correlated with smaller incentives and more limited marketing. Rather than modeling rates as a function of payback, this study based the two adoption-rate scenarios on a review of penetration-rate forecasts from other potential studies, data from the actual experience of multiple energy efficiency programs in various jurisdictions, and the opinions of nationally recognized energy efficiency experts. In this case, no single factor drove the analysis, but the scenario forecasts were much more generalized than those in studies using measure-level adoption curves. In addition, the forecasts only presented possible adoption rates and associated savings levels by the end of the study period, without any analysis of how adoption rates might change in the interim.

Regardless of the approach used to forecast technology adoption, certain techniques can be used to minimize the downsides of the selected methodology. One way to do this is to calibrate the forecast using additional sources or methods, such as evidence from programs offered elsewhere. For example, a potential study conducted for South Carolina Electric and Gas forecast adoption as a function of payback, but validated the results using available information from other utility programs and professional judgment, while also accounting for the time that would be necessary for program ramp-up.[41] Presenting multiple scenarios that explicitly recognize possible changes over time in key factors may also lend credibility to the analysis. In addition, analysts should avoid overemphasizing the mechanics and implied precision of quantitative modeling and de-emphasizing the development of realistic possible outcomes.[42] As one analyst observes, "Quantitative analysis can lend coherence and credence to scenario exercises by elaborating on consequences of future events, but modeling tools should support that process and not drive it, as is so often the case."[43]

Impact on Savings and Cost-Effectiveness (Direction)

Switching to a method of modeling technology adoption that considers more factors than simplified economic inputs may have a positive or negative impact on savings and cost-effectiveness, depending on whether considering those factors leads to higher or lower projections of efficient technology adoption relative to baseline technology. Expanding the analysis to include positive factors beyond the direct price effects of incentives, such as spillover and the announcement effect, is likely to boost the projected rate of energy-efficient measure adoption. On the other hand, taking a more holistic view of possible adoption scenarios may also reveal certain market barriers, e.g., lack of a contractor infrastructure to install an emerging technology that could lower the predicted adoption rate of energy-efficient technology.

Generally, a shift in methodology that leads to a higher projection of energy-efficient technology adoption without exceeding any pre-established budget constraints will also increase the projected level of savings.[44] In some cases, however, the directional impact on savings may be unknown. For example, shifting away from quantitative, mechanical projections of adoption rates may often expose underlying uncertainties that should be considered through multiple possible scenarios. Although a more open forecast may be more realistic, it may also leave ambiguity as to the likely adoption-rate outcome.

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utilize several different market-penetration curves to model different classes of measures, based on perceived market barriers that the measures may face. This is usually based on payback." The study narrative does indicate that customer awareness and product availability were taken into account, and studies by KEMA in other jurisdictions (e.g., Colorado) have incorporated changes in adoption rates over time due to changes in customer awareness.

40 Natural Gas Energy Efficiency Potential in Massachusetts, Final Report. (2009, April 22). Prepared for GasNetworks by GDS Associates, Inc. and Summit Blue Consulting. p. 17.

41 South Carolina Electric and Gas, DSM Potential Study, Final Report. (2007, September 30), ICF. p. 1-9 – 1-11.

Savings may also increase if adoption rates go up as a result of changing assumptions regarding the stringency of measure eligibility requirements. If eligibility requirements are raised for a measure or program (e.g., to lower free ridership rates), this will tend to lower adoption rates, although raising incentive levels may counter this effect.

Higher efficient technology adoption rates will tend to boost cost-effectiveness as well, as the fixed costs of adoption will be spread over more participants. For example, marketing costs may be held constant in the analysis but may be spread out over a larger number of participants if the increased awareness that results from marketing and education is factored into the projections. As with the impact on savings, however, the uncertainty surrounding actual changes in adoption rates over time can make it difficult to predict the directional impact on cost-effectiveness. It should also be noted that if higher adoption rates are driven by higher assumed incentives that create shorter participant paybacks, cost-effectiveness may decrease from a program-administrator or non-participant perspective, but increase from the participant's standpoint. Cost-effectiveness would not be affected within a total resource or societal framework, however, because incentives are treated as transfer payments from those points of view.

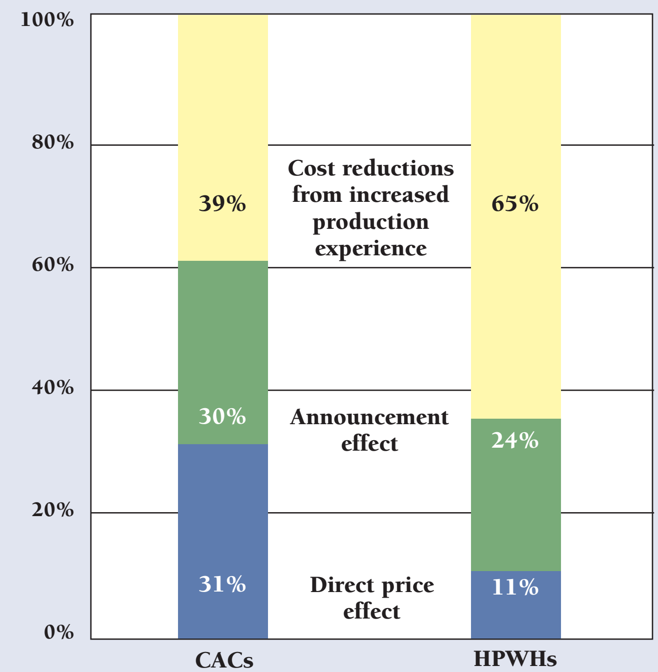
Impact on Savings and Cost-Effectiveness (Magnitude)

The higher the rate of efficient technology adoption attributable to program implementation, the greater the impact on both savings and cost-effectiveness, when all else is held constant. The magnitude of the impact of using different methods to project technology adoption thus depends on the extent to which efficient technology adoption rates are affected.

In some cases the magnitude of the impact may be substantial. For example, in the tax credit analysis described previously, analysts who had originally developed their forecasts based only on the direct price effect later revised their predictions significantly after incorporating certain additional influences on predicted adoption rates, as shown in Figure 3.1. In the case of energy-efficient central air conditioners, the final analysis showed that the direct price effect would likely account for only 31 percent of the adoption increase, while the announcement effect would account for 30 percent, and cost reductions from increased production would account for another 39 percent. In the case of high-performance water heaters, the direct price effect was predicted in the final analysis to account for only 11 percent of increased adoption, with 24 percent resulting from the announcement effect and 65 percent resulting from economies of scale.[45]

Figure 3.1

Sales of Efficient Central Air Conditioners (CACs) and Heat Pump Water Heaters (HPWHs) Attributable to Direct Price Effects[46]



42 Koomey, J. G. Avoiding 'the big mistake' in forecasting technology adoption. (2000, April 12). Lawrence Berkeley National Laboratory. p. 3-5.

43 Id., p. 5.

44 As discussed later in the section on forecasting net savings, this depends on whether the adoption can be directly attributed to program incentives and activities. In addition, because the savings level depends on the delta between the adoption rates of baseline and efficient technologies, an increase in both with a constant delta (e.g., through population growth) would not increase projected savings as a percentage of energy sales.

45 Koomey, p. 4.

46 Id.

It is worth noting that the immediate announcement effect of a new national initiative may be more significant than that which could be expected in a particular service territory (although the duration of the effect may be unclear) and that economies of scale are not likely to occur as a result of programs in a single jurisdiction. Nonetheless, this example illustrates that methodological changes in forecasting can make a considerable impact on projected adoption-rate outcomes, which in turn may affect both savings and cost-effectiveness significantly.

The magnitude of the impact of using a more open forecasting method can also be sizeable once it is accepted that historical relationships between input assumptions and consumer behavior may not remain constant in the future. For example, the receptiveness of consumers to marketing messages around energy efficiency may change as concerns about global warming increase. The uncertainty surrounding this effect, however, may make it difficult to predict its magnitude, in which case presenting multiple possible scenarios may be most appropriate. In some cases, over-reliance on historically observed relationships may unduly narrow the range of the possible impact of this and other future changes.

How to Determine Whether It Is an Issue in a Given Potential Study

Forecasting program participation is an issue in any potential study, given that projected savings depend on the level of energy-efficient technology adoption above baseline. Given the potentially considerable impact of selecting a particular methodology to forecast adoption rates, the approach that will be used and any associated issues should be identified up front. It may be worth addressing this issue as early as the request-for-proposal (RFP) process by requiring respondents to explain the methodology they will use, given that different firms tend to use their own particular methods across multiple studies they conduct. At a minimum, questions surrounding how adoption rates will be estimated, what factors will be incorporated into the analysis, and how those factors will be projected to vary over time should be discussed and set out in writing before work on the analysis commences.

If reading a completed study, the method used to forecast adoption rates will often be stated in the narrative, although the relative weight of the factors considered may not be obvious without a closer look at the underlying model or other sources of information. As a starting point, one can look to see whether participation rates vary in direct proportion to incentive levels, which would suggest a heavy reliance on technology adoption curves based primarily on economic factors such as payback. The study narrative may also include language suggesting that adoption forecasts were calibrated to actual experience or expert opinions, but the specific measures adjusted or the extent of the calibration may be unclear without additional follow-up. If direct estimates were used and multiple scenarios presented, the study may or may not state explicitly how the estimates or scenarios were developed. Following up with the study authors may indicate how the forecasts may have differed if assumptions were changed.

How to Avoid the Issue in the First Place or Correct It

A number of steps can be taken to ensure that the projection of energy-efficient technology adoption presents a realistic picture of possible outcomes. For example, study authors should ensure that both monetary and non-monetary factors are considered in their analysis, even if only in a qualitative manner. Factors such as the spillover effect may contribute significantly to adoption rates, although certain non-monetary barriers may hinder adoption as well. Multiple sources should also be used to corroborate forecasted adoption rates. Adoption curves or direct estimates of measure adoption or program participation rates can be checked against other sources, such as projections in other potential studies or actual results from similar programs in other jurisdictions. Additionally, presenting multiple scenarios that vary key factors over time may help to counter the temptation to assume that historical relationships will remain constant in the future. These scenarios may reveal a greater range of uncertainty in the projections, but accounting for such uncertainty may be more realistic than attempting to forecast exact adoption rates with precision. Finally, analysts should provide intermediate projections over the study timeframe, such as annual participation rates, so that it is clear how they arrived at ultimate forecasts of possible energy-efficient technology adoption by the end of the study period. Examining intermediate projections also provides a means to assess whether program ramp-up rates are realistic and whether and how participation rates may be affected by changes in codes and standards over the forecast timeframe.

How to Reinterpret Potential Study Findings When the Issue Is Already Embedded

If the study itself does not incorporate the techniques described above to calibrate forecasted outcomes, it may be possible to apply some of them after the fact to determine whether the forecasts presented in the study are realistic. In some cases the forecast may be too narrow (e.g., if only one possible outcome is projected), whereas in other cases it may be too optimistic, pessimistic, or simply too broad to be very informative. If only one outcome is presented, one can look to see what assumptions were used to arrive at that outcome and make adjustments by changing the assumptions, assuming that the methodology was adequately described and the key inputs provided. In some cases, however, the relative weight applied to each assumption may be unclear. If the range of possible outcomes appears too broad in one or both directions, it may be worthwhile to benchmark projected participation rates against actual past experience. If this method is used, however, possible variations in conditions both across jurisdictions (climate, energy prices, and so forth) and over time should be taken into account.

4. Excluding Measures and Savings Opportunities

Why Is It an Issue?

The total amount of potential savings that can be achieved through a given portfolio depends on the types of measures and programs that may be included in it. Yet too often key measures, practices, and consumer segments are left out of the analysis of savings potential. If a potential study overlooks or fails to incorporate important savings opportunities, then the level of achievable potential savings may be significantly understated.

A basic example of overlooking savings opportunities is the failure to include potential savings from emerging technologies. Potential studies also frequently fail to consider certain technologies, end uses, and building types that may considerably reduce energy demand in future years but for which costs or savings may be challenging to assess. For technologies, end uses, and building types for which impacts are difficult to quantify, best efforts should be undertaken to estimate costs and savings so that they can be included in the analysis. If consensus cannot be reached as to key inputs, their omission should be clearly noted in the study narrative and the reasons for their exclusion explained. Furthermore, some indication of the relative impact of their exclusion in the potential savings analysis should be provided. Other savings opportunities may be overlooked because they do not strictly fall into the category of distinct, installable measures. For instance, system-wide savings opportunities may be an important source of savings potential, as in the case of improving the efficiency of an entire set of industrial processes. Interactive effects may also play a role in reducing demand, such as the ability of a lighting retrofit at the time of a commercial chiller replacement to reduce both lighting power density and the necessary size of the replacement chiller. In still other scenarios, savings may be achieved through certain practices or initiatives that do not involve any measure installation, such as retrocommissioning or programs aimed at changing consumer behavior. Some of these types of savings opportunities may be partially captured in projected savings from equipment installation, and analysts should not double count savings in their total estimates. Nonetheless, a study that looks only at the savings that can be achieved from basic measure installation may miss some or all of these types of savings opportunities, leading to an undervaluing of achievable savings.

Another common omission in potential studies is a singular focus on "lost-opportunity" measures, to the exclusion of other opportunities such as retrofits and early retirement. The remainder of this chapter focuses on this particular issue, in part because of the significant savings potential that can be excluded when only lost-opportunity measures are considered, and in part because the authors have found that many studies do not properly calculate savings potential from early retirement and retrofit initiatives. Lost-opportunity measures target savings opportunities that occur in conjunction with specific market events. For example, these measures might coincide with the construction of a new building or the sale of a new measure after an older piece of equipment has burned out. Such market events typically represent opportune moments to steer a segment of the customer population toward making energy-efficient choices. A downside of these measures, however, is that any potential savings that are not captured at the time of the natural market event may not be available again for many years (e.g., until the burnout of the new equipment).

Unlike lost-opportunity measures, several other types of measures and programs exist that present additional opportunities to generate savings not tied to specific points in time. "Removal" programs, for example, provide incentives for the primary purpose of removing equipment permanently without replacement, such as a second refrigerator or freezer. By contrast, "early replacement or retirement" measures are one type of retrofit measure designed to promote the removal of inefficient equipment and spur its replacement with energy-efficient equipment sooner than would otherwise occur. Other "pure retrofit" measures are aimed at encouraging participants in existing buildings to install new energy-saving features, such as air sealing and insulation, that may supplement but do not necessarily replace any previously installed equipment. The measures that fit into each of these categories are sometimes grouped together under various programs, although they can be distinguished from each other in important ways. What they share in common, however, is the opportunity that each one presents to capture savings at virtually any time. Given this advantage over lost-opportunity measures, these other types of measures and programs should be considered as possible additions to any portfolio.

Yet although these measures offer more frequent opportunities for capturing savings, the costs associated with achieving those savings are also typically larger than the costs of lost-opportunity measures, as discussed further below. Consequently the costs and benefits must be weighed appropriately to determine which measures and programs should ultimately be incorporated into the portfolio.

Finally, as discussed below in some detail, the appropriate consideration of costs and savings for retrofit measures can be considerably more complex than for lost-opportunity measures. Unfortunately many potential studies do not appropriately address these complexities and screen these measures properly.

Impact on Savings and Cost-Effectiveness (Direction)

At the portfolio level, the impact on savings and cost-effectiveness of considering the types of programs discussed earlier depends first and foremost on whether they ultimately will be pursued. Properly assessing whether they should be promoted depends upon a solid understanding of how the costs and benefits of such measures and programs should be evaluated.

Under a lost-opportunity program, measure costs are typically calculated as the incremental cost between the efficient measure and the baseline measure, because it is assumed that the participant would have installed the baseline measure in the absence of the program. Measure benefits are also represented by the delta between what the baseline and efficient measures would produce. By contrast, the costs and benefits of pure retrofit measures are counted in full, as it is assumed that such measures would not be installed in the absence of a program.

In the case of removal programs, variable costs are valued as the costs of removal, decommissioning, and in some cases waste management or recycling for each piece of equipment to be retired, while benefits are counted as the present value of the full avoided costs from the time of removal to the time at which the equipment would have been retired in the absence of a program or would have burned out naturally. Determining the length of this "remaining useful life" (RUL) and the associated savings over this period can be challenging and may require reliance upon outside measurement and verification to estimate the age of the equipment stock and the extent to which incentives can accelerate equipment removal. In some cases, it may also be necessary to consider whether a certain percentage of "removed" equipment is actually likely to be replaced.

Assessing the costs and benefits of an early-replacement program can be more complex. The key concept to bear in mind is that the primary "measure" being promoted under these programs is essentially the shifting forward of the replacement cycle, although there may be additional benefits if the equipment installed is more efficient than what would be installed naturally. Unlike other programs, the impact of early-replacement programs continues into the foreseeable future, because making one replacement sooner in theory means that all future replacements will happen sooner as well. Fast-forwarding the replacement cycle creates certain costs from a present-value standpoint even if the equipment that would be installed under the early-replacement and natural cycles is equivalent, as every replacement must be paid for sooner. These costs can be calculated by comparing the full cost of the early-replacement cycle to the full cost of the uninterrupted natural cycle, which must be stated in present value terms.

As an example, consider an energy-efficient dishwasher that costs $600 at the time an early-replacement program is implemented.[47] Assume that the dishwasher must be replaced every 12 years and that the replacement cost does not increase in real terms (i.e., $600 in real terms must be spent every 12 years in perpetuity to replace the equipment). If the dishwasher is installed today through an early-replacement program, the full cost of the immediate replacement plus all future replacements

47 To simplify the example, it is assumed that the $600 also includes the cost of removing old equipment.

Table 4.1[51]

	Immediate and Perpetual Replacement Beginning at t = 0	Immediate and Perpetual Replacement Beginning at t = 7
PV Cost of Immediate Replacement	$600	$426
PV Cost of Perpetual Replacement Thereafter	$754	$535
PV of Total Costs	$1,354	$962
Net Cost of Early Replacement	$392	

is $600 plus the value of the perpetual future payments. Mathematically, the formula for a perpetuity is generally given as the real periodic payment amount divided by the real discount rate, or R/*i*. In this example, the real periodic payment amount is $600. If the real discount rate is assumed to be five percent, then the effective 12-year discount rate would be approximately 0.796.[48] The full cost of immediate replacement plus all future replacements would equal:

$600+ $6000.796=$600+$754= $1,354

Note that the first $600 must be added because the formula for a perpetuity does not account for a payment at t = 0, which represents the immediate replacement cost.[49]

To compare the full cost of the early-replacement life cycle to the full cost of the natural replacement cycle, assume that the dishwasher naturally would be replaced in seven years with equally efficient equipment as a result of natural market transformation. Under that scenario, the value of both the initial replacement cost and the perpetuity would be calculated the same way as in the early-replacement scenario, but each of these two components would need to be discounted to its present value (i.e., discounted by 1(1+*i*)*n*). Here, i is the discount rate, while n is the number of years that the payment has been deferred, in this case seven years. The initial replacement cost discounted by seven years is therefore equal to $600(1+0.05)7 or about $426, while the value of the perpetuity discounted by seven years is $754(1+0.05)7 or about $536. From today's standpoint, the present-value cost of allowing the natural replacement cycle to proceed uninterrupted is $426 + $536, or $962. The net cost[50] of instead fast-forwarding this replacement cycle by seven years and beginning it today through the early-replacement program equals $1,354 - $962, or $392. This example is summarized in Table 4.1.

The simplified calculations presented here are often subject to circumstances and expert judgment regarding the likely course of events. For example, it may be that absent the program, perpetual replacements with baseline equipment would continue. In that case, costs under the natural cycle would be calculated using baseline equipment costs. In other cases, the early-replacement program might lead to efficient installation only once, after which the participant would perhaps revert back to installing baseline equipment. In such cases, the cost of the first installation at t = 0 would be the same, but the perpetuity under the early-replacement cycle would be calculated using baseline equipment costs. Alternatively, future replacements may actually be more efficient and cost more in real terms than the initial replacement, such as if efficiency standards increase after the initial replacement but before the subsequent one. In that case, the net present value of the costs of future replacements would need to be calculated using the costs of the more efficient equipment. All of these various adjustments would affect the bottom line net cost

48 The effective discount rate over a multiyear payment period can be calculated as (1+?)?−1, where i is the annual discount rate and t is the number of years in the payment period.

49 It may seem odd to consider costs in perpetuity under an early-replacement program, because cost-benefit analyses of ordinary measures and programs are bounded by the measure life (or lives, at the program level) of the equipment being installed. The difference is that ordinary programs generally do not shift the entire future life cycle of equipment installations, whereas early-replacement programs do so by definition.

50 Not including incentives, which are not considered from a total resource or societal perspective.

51 Based upon EFG analysis.

calculation.[52]

Early retirement measure savings depend on what assumptions are made regarding the efficiency level of the equipment that would be installed at the time of natural replacement in the absence of a program. If it is assumed that an equally efficient measure would be installed naturally, then savings would accrue only for the period between early replacement and when natural replacement would otherwise occur. For example, if the energy-efficient dishwasher produces $80 in annual benefits (calculated as the delta between the efficient and existing equipment) but would be installed naturally in seven years, then the present value of the savings accruing over that seven-year period would equal approximately $463.[53] If there were no other costs and benefits, then the net benefits of the dishwasher would be $463 - $392, or $71.[54]

Alternatively, if it were assumed that baseline or less efficient equipment would be installed at the natural replacement point, then the savings would continue for a longer period and net benefits would be even greater. For example, market forces or efficiency standards could lead to natural replacement with equipment that would be more efficient than the baseline at year zero, but still less efficient than the equipment promoted through the early replacement program. After that point, annual savings might be reduced to $40 every year in perpetuity. Total savings would thus be calculated as $463 for the first seven years, plus the present value of $40 in savings every year in perpetuity starting at year seven, or about $569.[55] This equals $463 + $569 or $1,032 in total savings. Alternatively, the $40 annual savings might continue for only some defined period, after which the savings level might drop again to a lower amount or to zero. The value of any savings stream continuing for a defined number of years could be calculated as a discounted annuity rather than a discounted perpetuity. Note that in some cases, future savings might actually be negative if the equipment installed through natural replacement were actually more efficient than the equipment promoted through an early replacement program. The present value of any negative savings stream would be calculated in essentially the same way, but this amount would be subtracted from any positive savings to produce a net savings amount. It is also important to point out that whatever assumptions are made in these savings calculations must also be applied to the cost calculations. In other words, if the level of savings changes at a future point because it is assumed that equipment with a different level of efficiency will be installed, then the cost of that equipment must also be incorporated into the cost calculations beginning at the same point in time.

A few additional issues can complicate cost-benefit calculations at the program level for early-replacement programs. For example, free ridership can be difficult to sort out because participation may be weighted heavily toward individuals who were already beginning to consider replacing their equipment on their own (e.g., if the equipment were nearing the end of its useful life).[56] In addition, estimating natural replacement dates for the measure stock within a given jurisdiction can be complex. Although some analysts use simple rules of thumb to

52 Another adjustment would need to be made if the measure lives of the equipment installed under the early-replacement and natural scenarios were different. In that case, in order to compare the two cycles, it would be necessary to set the two replacement periods equal to each other and determine how much would need to be spent over the common period for each of the two types of equipment. For example, if the equipment installed under the early-replacement scenario had a replacement cost of $600 every 15 years, then the cost every 12 years would be 12/15 x $600, or $480.

53 The formula for the present value of an annuity is given as ??=?[1−1+?−??]. Here, R is the annual savings amount ($80), the discount rate (i) is still assumed to be 0.05 in this example, and n is 7 (because the savings accrue every year for seven years). There is no additional "immediate" savings amount in this case, because the first $80 in savings accrues after one year.

54 In fact, program costs such as marketing and administration may need to be considered, although these are sometimes calculated only at the program level.

55 This can be calculated as a perpetuity starting in year zero ($40/0.05 = $800), which is then discounted by seven years to equal $800(1+0.05)7 or $569.

56 In some cases it may also be difficult to determine whether these participants should be offered incentives through a lost-opportunity program (if they would have replaced their equipment immediately but with less efficient equipment) or early retirement incentives (if they otherwise would have waited to make the replacement). This would not affect Total Resource Cost or Societal Cost-Benefit Tests, which do not consider incentives, but could affect other tests. For a related discussion, see, Paruolo, J., et al. (2006). Integrating demand

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Table 4.2

Comparison of "Replace on Burnout" and "Early Replacement" Scenarios for Vermont[60]

Indicator	(Column 1) Replace on Burnout Base Case	(Column 2) Early Replacement Scenario	(Column 3) Difference of Column 2 and Column 1 (Column 2 - Column 1)	(Column 4) Percent Difference
NPV Savings	$964,469,346	$1,148,841,435	$184,372,089	19.1%
B/C Ratio	3.45	3.18	(0.27)	-7.7%

estimate the natural time of replacement based on a measure's estimated useful life (EUL), others have suggested plotting RUL as a separate function of both age and EUL.[57]

Ultimately the directional impact on savings and cost-effectiveness will depend on the results of the assumptions and calculations made for each type of measure using the methodologies described previously. The steps involved in the early replacement calculations are the most complex. Despite these complications, however, there may be cases in which early-replacement programs and other non-lost-opportunity measures and programs offer significant opportunities to generate additional savings, and at a minimum the benefits and costs of such measures and programs should be considered. Assuming they offer positive net benefits and are included in the portfolio, their impact on savings will be positive, whereas the impact on cost-effectiveness will depend on whether the BCR of these measures and programs is higher or lower than that of the portfolio overall.

Impact on Savings and Cost-Effectiveness (Magnitude)

The magnitude of incorporating measures and programs into the portfolio beyond only those that target time-sensitive events may be significant in some cases, as the number of opportunities to achieve additional savings will increase considerably. According to some analysts, "The inclusion of early-retirement retrofit opportunities and externalities can increase total achievable potential by as much as 50 percent."[58] Even when savings opportunities are large, however, cost-effectiveness of the overall portfolio from a total-resource or societal perspective may still go down because of the increased costs associated with these types of measures. For example, a 2007 Vermont potential study found that net savings under an early-replacement scenario would be 19.1 percent higher than savings under a "replace on burnout" scenario. The portfolio cost-effectiveness ratio declined from 3.45 to 3.18, however, a decrease of 7.7 percent, as reflected in Table 4.2.[59] In some cases, savings opportunities may be larger in commercial and industrial sectors, given the wider range of measures and the fact that larger customers in these sectors may have a greater level of sophistication and capacity to plan for cost-effective capital investments before they would otherwise be required. Nonetheless, opportunities in all sectors should at least be considered when assessing potential savings.

It should also be noted that the impact on cost-effectiveness of including early-replacement or retrofit programs may be more significant from a utility or

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side bidding with an existing new construction efficiency program: Differentiating early retirement retrofit and new installation. Published in 2006 ACEEE Summer Study on Energy Efficiency in Buildings.

57 Welch, C., & Rogers, B. (2010). Estimating the remaining useful life of residential appliances. Navigant Consulting. Published in 2010 ACEEE Summer Study on Energy Efficiency in Buildings. This paper demonstrates how mortality surveys can be combined with measure stock age estimates and EUL data to construct a probability distribution that predicts RUL. The paper also shows how mortality can be estimated in the absence of direct survey data using shipment data and information on the existing equipment stock.

58 Loiter, J., et al. (2012, April 13). Preliminary assessment of potential. Prepared for the Massachusetts Energy Efficiency Advisory Council. p. 11.

59 Vermont Electric Potential Study, Final Report. (2007, January). Prepared by GDS Associates, Inc. for the Vermont Department of Public Service. Appendix G, p. 2.

60 Id.

non-participant ratepayer perspective than from a total resource or societal perspective. This is because the level of incentives required to promote early retirement programs is often substantially higher than the level of incentives required for lost-opportunity programs. In the case of lost-opportunity programs, incentives are typically based on a percentage of incremental costs only, whereas in retrofit and early-replacement programs, incentives are calculated as a percentage of full installed costs. These incentive costs are considered transfer payments from a total-resource or societal perspective and so are not included in those cost-effectiveness tests. The impact on other cost-effectiveness tests, however, such as the Program Administrator Cost Test (PACT) or Ratepayer Impact Measure (RIM) test, may be sizeable.

How to Determine Whether It Is an Issue in a Given Potential Study

The possibility of capturing additional savings not tied to specific points in time should be explored in any potential study. To some extent, the value of pursuing these savings may depend on the timeframe of the study, because a larger portion of the market will become eligible for participation in lost-opportunity programs as the timeframe is extended. Even if the entire customer base for a particular measure becomes eligible through a lost-opportunity program, however, only a portion of that customer base is likely to be captured at the time of the relevant market event. As such, it is worth considering how market penetration levels and associated savings might differ over time by offering incentives beyond those provided by lost-opportunity programs.

Aside from market penetration there may be other reasons to accelerate the replacement cycle through early-replacement programs, such as hastening progress toward longer-term energy-savings goals or attempting to bring the market adoption cycle in line more quickly with the technology development cycle as emerging technologies are introduced.

Although there are many reasons to consider incorporating these additional types of measures and programs, the value of pursuing them should be weighed in the context of any budgetary constraints. Given that the incentives necessary to promote early-replacement and pure retrofit measures successfully are typically much higher than those required for lost-opportunity programs, the budget allocation required to implement these measures and programs may limit the extent to which they can be put into practice.

If reading a completed study, it should be fairly clear whether measures and programs were considered beyond those targeting specific market events. If this is not stated explicitly, one can look to see whether all measure costs are calculated only as a percentage of incremental costs, which would suggest that only lost-opportunity measures have been considered. What may be less clear, however, is whether the study properly quantified the costs and savings associated with retrofit measures.

How to Avoid the Issue in the First Place or Correct It

It is generally best to consider the issue of assessing these additional types of measures and programs before issuing the RFP for the potential study work, as including these measures and programs in the study will expand the scope of work. If the issue has not been spelled out in the RFP, it should be discussed during the initial meeting to devise the work plan for the study and should also be spelled out in the final scope of work. This discussion should also examine how the costs and savings for these measures will be quantified.

How to Reinterpret Potential Study Findings When the Issue Is Already Embedded

In terms of savings, it may be possible to reinterpret the directional impact on savings of incorporating the types of measures and programs discussed earlier, because adding them into the analysis would generally increase savings. Estimating the magnitude of the impact on savings, however, may or may not be possible. In some cases, independent analysts have reinterpreted potential savings results from previous studies by adding on a conservative—although not insignificant—amount to account for early-replacement programs. For example, analysts in Massachusetts, who relied upon a range of previously conducted potential studies from other jurisdictions to estimate potential savings in that state, “opted to calculate the potential from the early-retirement retrofit market conservatively as a 25 percent addition to each base potential estimate in each year.”[61] Expert judgment should be used to determine whether such estimates are appropriate in other contexts. Reinterpreting cost-effectiveness may be more difficult than reinterpreting savings, however, as even the directional impact would depend on the BCR of the existing portfolio.

61 Loiter, J., et al. (2012, April 13). Preliminary assessment of potential. Prepared for the Massachusetts Energy Efficiency Advisory Council. p. 11.

5. Incorporating Codes and Standards into Technology Baselines

Why Is It an Issue?

Energy efficiency codes establish baseline requirements for incorporating energy-efficient practices into new construction and, in some cases, addition or renovation projects. Energy efficiency standards institute rules for the minimum efficiency ratings of various types of lighting and appliances sold on the market. Codes are generally adopted at the state level, often based on models published by established organizations, whereas smaller jurisdictions may sometimes adopt stricter requirements than those adopted by the state. By contrast, standards are typically promulgated at the federal level, with states, most notably California, sometimes adopting standards on products that the federal government has not covered.

Codes and standards are important components in potential savings projections, given that these projections represent the delta between baseline and efficient technologies. As future codes and standards are likely to increase technology baselines, they should be taken into account in potential savings assumptions. If they are not, potential savings attributable to energy efficiency programs may be overestimated.[62] At the same time, it should also be recognized that emerging technologies tend to become more efficient over time. Over the period of a potential study, the size of the delta between baseline and efficient technologies will depend on the pace at which baselines increase relative to cost-effective energy-efficient alternatives. In some instances, incremental costs may also change as baseline and efficient technologies advance. To estimate potential savings as accurately as possible, potential study analysts should account for both scheduled and likely increases in codes and standards, as well as the increasing efficiency of advanced technologies.

Impact on Savings and Cost-Effectiveness (Direction)

The directional impact on savings and cost-effectiveness of incorporating trends in codes and standards and advanced technologies into the potential study analysis will depend on how baselines move in conjunction with efficient alternatives and what impact this will have on the delta between the two. To assess this impact, savings and cost-effectiveness levels must be calculated and compared before and after the projected implementation of a new code or standard.

For example, consider a split-system central air conditioner in a region with 1,400 full load cooling hours, an electricity cost of $0.10 per kWh, and a capacity cost of $50 per kW. If the current base unit has a rating of SEER 13 and the efficient alternative has a rating of SEER 14, then it can be shown using typical equations for energy and capacity savings that the annual savings of installing the efficient unit would be approximately $37.86.[63]

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62 Note that some energy efficiency studies are primarily concerned with system planning as opposed to planning of energy efficiency programs. If the primary purpose of an energy efficiency potential study is to determine the portion of future demand that may be met through policy-driven energy efficiency (whether through codes and standards or energy efficiency programs), then it may not be as critical to separate out demand reductions attributable to codes and standards versus demand reductions attributable to programs. If the primary purpose of the study, however, is to inform efficiency program planning (as is the case with many studies conducted today), then making this distinction is essential.

63 Equation for energy savings:
ΔkWh=(FLHcool*BtuH*(1/SEERbase -1/SEERee))/1000

Equation used for capacity savings:
ΔkW=(BtuH*(1/EERbase -1/EERee))/1000 *CF

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In terms of cost-effectiveness, the BCR of installing this unit today can be calculated as the present value of the unit's annual savings over the measure life divided by the incremental cost per unit. If the measure life is assumed to be 18 years and a discount rate of five percent is used, then the present value of the savings will equal $442.63. Assuming the incremental cost is $360,[64] then the BCR of this measure would equal $442.63/$360, or 1.23.

Note that although even more efficient units exist in the market today, their BCRs can be shown using the same equations as above to be lower than those of the SEER 14 unit, assuming incremental costs rise at a constant rate of $360 per one-unit increase in SEER rating.[65] For example, using the same equations it can be shown that the BCR of a SEER 15 unit would be only 1.15. As a result, in most jurisdictions the SEER 14 unit with the higher BCR would be chosen as the preferred efficiency measure.

Given that the federal standard for split-system air conditioners in many jurisdictions will be raised to SEER 14 in 2015, it might appear that savings would drop to zero if this standard were incorporated into the baseline assumptions. In fact, however, promoting the SEER 15 unit would become the most cost-effective alternative at that point, and savings could still be achieved.

After implementation of the new standard, both savings and incremental costs from the SEER 15 unit would be calculated using a SEER 14 unit as the new baseline. By performing the same basic calculations as above, it can be shown that annual savings from the SEER 15 unit as compared to a SEER 14 baseline would equal $32.82, a BCR of approximately 1.07. This BCR would be higher than that of any more efficient unit under the assumptions used in this example, meaning the SEER 15 unit would now be promoted as part of the portfolio.

At this point, it is possible to assess the change in both savings and cost-effectiveness after implementation of the new standard. The results on a per-unit basis are summarized table 5.1. At the per-unit level, both savings and cost-effectiveness would go down.

It is important to highlight that the directional impacts shown in this example are dependent on the assumptions specific to this illustration. If these assumptions were changed, the impacts might change as well. For example, in some cases there may not be a more efficient alternative to promote after implementation of the new standard,

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EER is the energy efficiency ratio, which is a measure of energy input to cooling output similar to SEER, but under only one set of operating conditions. EER is used to calculate capacity savings, and can be approximated as 0.875 SEER (see, UI and CL&P Program Savings Documentation for Program Year 2010. (2009, September 25). United Illuminating Company and Connecticut Light & Power, p. 99). CF refers to the summer peak coincidence factor, an estimate of the percentage of central air conditioners likely to be operating during peak hours. An estimate of 0.9 is used in this example (see, Eto, J. H., & Moezzi, M. M. Analysis of PG&E's residential end-use metered data to improve electricity demand forecasts – final report. Table 2-1, p. 7. Estimated based on annual coincidence factors for central air conditioning based on PG&E Zones S [Hot] and R [Extremely Hot]. See p. 9 for map of PG&E climate zones).

64 See, Ohio Technical Reference Manual (TRM), p. 30, which assumes an incremental cost of $119 per ton (12,000 BtuH) of a SEER 14 unit over a SEER 13 unit. For simplicity, this has been rounded to $120 per ton. Note that although the assumption of a linear relationship between increases in efficiency and increases in cost is used for simplicity in this example, in practice the relationship often may not follow this pattern.

65 Ohio TRM, p. 30. This is roughly the assumption made in this TRM (approximately $119 per ton for each one-unit increase in SEER rating).

66 Based upon EFG analysis.

Table 5.1[66]

	Prior to SEER 14 Standard	After SEER 14 Standard	Difference (New Minus Old)	Directional Impact
Annual Savings	$37.86	$32.82	-$5.04	Negative
BCR	1.23	1.07	-0.16	Negative

or it may be that more efficient measures would not be cost-effective. In the example above, if the full load hours for the jurisdiction were assumed to be 1,200 instead of 1,400, then the BCR of the SEER 15 unit as compared to the new SEER 14 standard would be only 0.95. In that case, there would be no cost-effective efficient alternative after implementation of the new standard, and savings from split-system central air conditioners would drop to zero, assuming that individual measures with a BCR less than 1.0 would not be included in the portfolio.

In other scenarios, technologies might emerge over time that would produce higher savings levels and be more cost-effective than the current efficient alternatives, even as compared to new and higher baselines. For example, the advancements in some lighting technologies may outpace increases in lighting standards, both in terms of savings and cost-effectiveness levels. In such cases, both savings and cost-effectiveness would go up even after implementation of a new standard. Note that in such situations, although savings and cost-effectiveness might increase overall, the impact of a new standard would typically still be to dampen the size of the increase.

In certain instances there may actually be a positive feedback loop between increasing standards on the one hand and increasing efficiency and lowering costs of advanced technologies on the other. This might be the case if a trend of increasing standards spurred the market to advance more quickly than it otherwise would. In these instances, the impact of increasing standards may not be to dampen increases in savings and/or cost-effectiveness, but in fact to enhance them. Current trends in lighting technology may present such a case, as federal standards have contributed to increased investment in advanced lighting design and the emergence of "superefficient" options that far exceed regulatory requirements.

Although the directional change in savings and cost-effectiveness may vary by situation, the key is to recognize the importance of incorporating codes and standards, as well as technology advancements, into a potential study's savings and cost-effectiveness calculations both before and after a baseline is projected to shift.

Two final points are worth noting with regard to the directional impact of codes and standards. First, with respect to building codes in particular, the compliance rate will virtually always be below 100 percent. As such, even after implementation of a new code, there may be opportunities to produce additional savings simply by incentivizing compliance. Ideally, potential savings from such activities would be estimated after the completion of a baseline study revealing the pre-existing rate of code compliance, so that savings would only be counted if compliance rates were projected to rise above the baseline compliance level. In practice, appropriate baseline studies may not always be available at the time of conducting a potential study. Consequently other sources may need to be used to estimate compliance rates absent additional incentives.

Second, in a few states, utilities and other program administrators may be credited with some level of energy savings as a result of their work on the promulgation of new codes and standards. The methodologies used to credit such entities for this work are still under debate in several of these jurisdictions and are beyond the scope of this report.[67] It should be noted, however, that crediting program administrators for this work may in some cases counter the negative directional impact that increasing codes and standards might otherwise have on savings potential.

Impact on Savings and Cost-Effectiveness (Magnitude)

The magnitude of the change in savings and cost-effectiveness after the implementation of a new code or standard will depend on the extent of the change in component savings levels and incremental costs. For instance, in the previous example, the components of annual savings were assumed to be energy (kWh) and capacity (kW). Energy savings prior to implementation of the standard were 277 kWh per year, while capacity savings were 0.20 kW per year. Although not shown above as separate components, after implementation of the standard, annual energy savings equaled 240 kWh and annual capacity savings equaled 0.18 kW. The drop in kWh savings from 277 to 240 represents about a 13-percent decline, while the drop in kW savings also represents an approximate 13-percent reduction. As a result, total savings also declined about 13 percent, from $37.86 to $32.82.

67 For additional discussion of this issue, see Cooper, A., & Wood, L. (2011, August). Integrating codes and standards into electric utility energy efficiency portfolios. Institute for Electric Efficiency.

Note that if the percentage changes in kWh and kW savings were different from each other, then the resulting percentage change in annual savings would be weighted by the extent to which each component contributed to annual savings overall.

In terms of cost-effectiveness, the magnitude of the change depends on the size of the change in both the present value of savings over the measure life and the size of the change in incremental costs. In the previous example, the present value of savings decreased approximately 13 percent from $442.63 to $383.61, while incremental costs remained the same. As a result, the change in the BCR in this example was only attributable to the change in savings, declining by about 13 percent from 1.23 to 1.07. In other cases, if the incremental costs changed, then the size of the change in BCR would also depend on the extent of the change in incremental costs. Note that because savings are the numerator and incremental costs the denominator in BCR calculations, changes in the BCR components may in some cases work in opposite directions.

Stepping back from these calculations, it is worth observing in a broader sense that the magnitude of the impact of incorporating codes and standards into technology baselines, as well as increasing efficiency trends in advanced technologies, may be considerable. This issue is particularly relevant at the time of this writing, given that some important codes and standards are in the midst of being developed or implemented. For example, according to the US Department of Energy, the 2012 International Energy Conservation Code (IECC) represents "the largest, one-step efficiency increase in the history of the national model energy code."[68] As some states begin to adopt this model code, large increases in the efficiency of newly constructed buildings can be expected, while achieving additional savings above code through utility-sponsored new construction programs may become more difficult.

With respect to standards, the American Council for an Energy-Efficient Economy (ACEEE) reports that lighting standards issued in 2009 as a follow-on to the 2007 Energy Independence and Security Act (EISA) "will save more energy than any other standard ever issued by any administration."[69] Other important standards are slated to go into effect soon as well, such as the central air conditioner changes noted previously that will also coincide with changes in standards for residential furnaces and heat pumps.[70]

At the same time, energy-efficient building practices and technologies are continuously emerging that may maintain or even increase the delta between baseline and efficient alternatives. For example, while the 2012 residential IECC is roughly 15 percent more efficient than the 2009 IECC,[71] the ENERGY STAR for Homes Version 3 guidelines are approximately 20 percent more efficient than the 2009 IECC.[72] Thus, even in jurisdictions that adopt the 2012 IECC, savings could still be achieved by promoting ENERGY STAR Version 3. Similarly, although the standards for central air conditioners are set to increase in 2015, as noted in the example earlier, several types of units exist already on the market that exceed the forthcoming standards and are likely to be cost-effective in at least some jurisdictions.

Thus, the ultimate magnitude of the impact of incorporating changing codes and standards as well as trends in advanced technologies into the potential savings analysis will depend on a detailed assessment of how the delta may change between baselines and efficient alternatives over time.

How to Determine Whether It Is an Issue in a Given Potential Study

Potential studies should always take codes and standards, as well as trends in advanced technologies, into account when projecting the delta between technology

68 US Department of Energy. (2012). 2012 IECC final action hearings deliver DOE's 30% energy savings goals. Retrieved from http://www.energycodes.gov/status/2012_Final.stm

69 American Council for an Energy-Efficient Economy. (2009, June 29). President Obama announces new light bulb standards. Retrieved from http://www.aceee.org/press/2009/06/president-obama-announces-new-light-bulb-standards

70 Direct final rule: Energy conservation standards for residential furnaces, central air conditioners and heat pumps. (2011, June 27). Federal Register, 76 FR 37408.

71 Elnecave, I. (2012). 2012 International Energy Conservation Code (Residential). Midwest Energy Efficiency Alliance. Retrieved from http://marc.org/Environment/Energy/assets/iecc-code-workshop.pdf

72 Environmental Protection Agency. Version 3 Overview. Retrieved from http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_benefits_utilities_1a

baselines and efficient alternatives. When commencing a potential study, this issue should be spelled out in the draft scope of work to ensure that expectations are clear.

If reading a completed study, the narrative may indicate directly whether these considerations were incorporated into the analysis. For example, a 2011 New Mexico potential study noted that measures were screened "dynamically, taking into account changing savings and cost data over time."[73] This study provided explicit examples of how different technologies were included in the portfolio over time depending on changes in equipment standards. Unfortunately many studies may be less explicit or may not account for shifting baselines and advanced technologies, in part because of the difficulty of predicting future codes and standards over potential study analysis timeframes that can be as long as 20 years or more. If savings and cost-effectiveness levels remain constant over time, it is likely that the study has not taken these factors into account.

How to Avoid the Issue in the First Place or Correct It

During the initial project meeting, analysts should explain the methodology that will be used to calculate changes in both the savings and cost deltas between baselines and efficient technologies over time. In addition, important upcoming changes in codes and standards should be discussed, along with key trends in advanced energy-efficient technologies. The final scope of work should also direct potential study analysts to integrate these trends into savings projections year to year.

How to Reinterpret Potential Study Findings When the Issue Is Already Embedded

If natural advancements in efficient technologies have been included in the analysis but the changes in codes and standards have been left out, this will typically result in an overestimate of future program savings. The direction of the impact in this case can be ascertained, and it can be presumed that a downward adjustment to savings would be necessary to reinterpret results. The appropriate magnitude of the adjustment, however, may be difficult to determine. If market-based advancements in energy-efficient technologies have been left out of the analysis as well, then the change in the delta between the baseline and efficient alternatives after implementation of a new code or standard may be more difficult to determine. Typically the implementation of codes or standards would have a dampening effect on any increase in savings, although in some cases there may be positive feedback between increasing standards and market-based efficiency advancements.

Reinterpreting cost-effectiveness after incorporating codes and standards into the analysis may also be complex. In certain instances, technologies might be removed or deleted at some point over the analytical timeframe because increasing baselines make them no longer cost-effective. In such cases, the impact on cost-effectiveness will depend on how the BCR of the measure that has been removed compares to the BCR of the portfolio overall. In other cases, new advanced technologies may replace previous energy-efficient alternatives in the portfolio. In those scenarios, the change in measure-level cost-effectiveness would depend on how the BCR of the new measure compares to that of the old one, using the appropriate baselines to calculate incremental costs. Changes in portfolio-wide cost-effectiveness would depend on how the two BCRs compared to each other, as well as any changes in measure penetration. Assessing the direction and magnitude of these changes may not be possible without highly detailed information that may or may not be provided in a completed potential study.

73 Kester, B., & Rohmund, I. (2011, June 20). State of New Mexico Energy Efficiency Study, Volume 2: Electric Energy Efficiency, Final Draft. Global Energy Partners, p. 2-12.

6. Issues with Utility Sales Forecasts

Why Is It an Issue?

Utility sales forecasts often play an important role in potential studies, although the forecasts themselves are typically completed as part of a separate and independent process. In the commercial and industrial sector in particular, the sales forecast is typically viewed as the "starting point" in the analysis of potential savings. Using a "top-down" approach, projected sales are disaggregated into building types and end uses; once a disaggregated portrayal of energy usage has been laid out in this way, individual energy-saving measures are then analyzed within each end-use category to determine what percent of the energy consumption within that category might be abated by promoting a particular measure. Given that the sales forecast serves as the jumping-off point for this analysis, it is important that any methodological issues with the forecast be identified up front, as they may carry through to impact the final potential savings results.

As an example of this top-down methodology, an overall commercial and industrial energy sales forecast of 3,500,000 MWh for a given year might be disaggregated such that 100,000 MWh of electricity sales are deemed to be consumed annually on interior lighting in office buildings.[74] Out of that amount, potential study analysts might wish to determine what percentage could be abated by promoting high-performance T8 fixtures. To begin, analysts might estimate that 80 percent of interior office lighting comes from linear fluorescent fixtures, all of which could be replaced with high-performance T8s, and that because the existing baseline technology has a 15-year measure life, about 1/15 (~6.7 percent) of the fixtures would be naturally replaced every year. As a result of these constraints, only 5,360 MWh-worth of fixtures would be eligible for replacement upon burnout with high-performance T8s every year (100,000 x 0.8 x 0.067 = 5,360).[75]

To determine how much of that remaining amount could be abated by promoting high-performance T8s, analysts would need to estimate the amount of savings that each replacement would generate as compared to baseline technology, as well as the likely penetration rate of high-performance T8s in the market, given certain assumptions regarding the level of incentives and other types of promotion. If it were estimated that each replacement would save about 17 percent of energy use as compared to baseline fixtures and that energy efficiency programs could achieve about 10 percent market penetration, then the total expected savings from promoting this measure as an interior office lighting solution would be about 91 MWh per year (5,360 x 0.17 x 0.10 = 91). This result is summarized in Table 6.1. This would equal about 0.091-percent savings as compared to the 100,000 MWh consumed annually on interior office lighting, and about 0.0026 percent of total commercial and industrial consumption for that year. Once all savings opportunities for all measures in all end-use categories are analyzed, they can be aggregated to produce total commercial and industrial savings as both an absolute amount and a total percentage of the overall sales forecast.

In the residential sector, it is more common to use a "bottom up" approach to identify savings opportunities based on the saturation of existing equipment, as well as predictions about when this equipment might be removed

74 This discussion is based on the example provided in "Forecast 20: Electricity Savings in Vermont from 20 Years of Continued End-Use Efficiency Investment (2009, December 8). Prepared by Efficiency Vermont, Green Energy Economics Group, and Optimal Energy for the Vermont Public Service Board and the Vermont Systems Planning Committee. p. 47. The numbers are intended to be illustrative and do not necessarily represent actual estimates.

75 Note that savings opportunities for this same measure in the same end-use category might also be analyzed separately for the retrofit/early replacement and new-construction markets.

Figure 6.1

Example of Top-Down Methodology[76]

Parameter	Description	Value	Cumulative Result
Building type/end-use electric forecast	Electricity sales for interior lighting for offices	100,000 MWh	100,000 MWh
Applicability factor	% of interior office lighting energy use from linear fluorescent fixtures	X 80%	80,000 MWh
Feasibility factor	% of linear fluorescent fixtures that could be replaced with High-performance T8 technology	X 100% (all linear fluorescents could feasibly be replaced with High-performance T8s)	80,000 MWh
Turnover factor	% of existing office space that will naturally replace lighting as a remodel in given year	X 6.7% (typical fixture life of 15 years result in 1/15 replacement per year on average)	5,333 MWh
Savings fraction factor	% energy savings from shifting from standard T8 to High-performance T8 technology (represents weighted average for different number of lamps)	X 17%	907 MWh
Program penetration	The increase in penetration of High-performance T8 fixtures as a result of the efficiency initiative.	X 10%	90.7 MWh

and/or replaced with energy-saving measures.[77] As a result, savings projections in the residential sector tend to be somewhat more independent of the utility sales forecast. Even in this sector, however, utility sales forecasts may be useful as a calibrating tool to determine whether projections of energy usage with and without energy efficiency investments are realistic. Moreover, final study results showing residential savings potential may in some cases be stated as a percentage of the residential sales forecast.

Potential studies relying upon utility sales forecasts in their analyses of savings potential should identify any significant methodological issues in the original forecast that may impact study results. Two common methodological issues that often arise are the inclusion of "embedded" energy efficiency from past investments, which can make the sales forecast lower than it would otherwise be, and the failure to account for future changes in codes and standards, which can lead to the forecast being overstated.

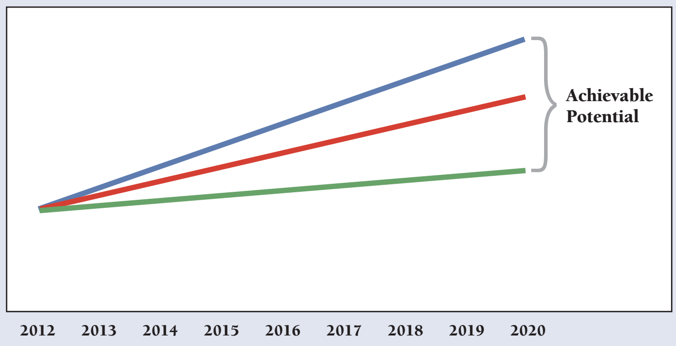
The issue of embedded efficiency is particularly salient in jurisdictions in which past investments in energy efficiency have been sufficiently sustained and substantial to lower historical energy usage and growth rates. As a hypothetical example (illustrated in Figure 6.1), consider a state that has a long history of investments in energy efficiency and an average growth in energy consumption of 0.8 percent per year. But without that history of investment, annual load growth might have been 1.2 percent per year. If the energy usage forecast for this state is based in part on past consumption and growth rates, then the forecast may be suppressed by the implicit assumption that energy efficiency investments will continue in the future. In the context of a potential study, the problem with this assumption is that the study is designed to identify opportunities to save energy as compared to sales before energy efficiency investments are built in. In the commercial and industrial sector, failing to remove this built-in efficiency may lower the overall forecast, which could lower the total absolute amount of projected savings potential. In the residential sector, where the absolute

76 "Forecast 20: Electricity Savings in Vermont from 20 Years of Continued End-Use Efficiency Investment (2009, December 8). Prepared by Efficiency Vermont, Green Energy Economics Group, and Optimal Energy for the Vermont Public Service Board and the Vermont Systems Planning Committee.

77 Here again, separate analyses might be conducted for the retrofit/early replacement and new-construction contexts.

Figure 6.1

Hypothetical Example of Effect of Embedded Efficiency on Sales Forecast[78]



amount of savings is typically determined independently, a sales forecast that is too low for the same reason may cause savings presented as a percentage of sales to be too high.

The issue of codes and standards tends to cut in the opposite direction. If the sales forecast does not include future changes in codes and standards, which are designed to reduce energy usage by requiring that building practices and technologies meet certain minimum energy efficiency thresholds, then the forecast may be too high. A forecast that is too high may lead to an overestimate of absolute savings in the commercial and industrial sector, as well as an underestimate of savings as a percentage of sales in the residential sector.

Although these two issues are discussed in the remainder of this section as primary examples of problems that may impact the utility sales forecast, they also serve to emphasize the broader point that there may be a wide range of issues that should be considered when incorporating an independent sales forecast into a potential study. For example, it may be necessary to examine whether assumptions made about the level of new home construction or increased square footage in the residential and commercial sectors is consistent between the sales forecast and the potential study. In the utility sales forecast, the rate of growth in commercial and industrial square footage will affect the growth rate of the overall sales forecast, which will carry through into any potential study results arrived at through the top-down methodology. In addition, the study itself may make certain assumptions regarding the rate of new home construction and C&I square footage growth (e.g., for purposes of estimating market penetration of new construction measures). If possible, any inconsistencies between the assumptions made in the sales forecast and the potential study should be identified up front.

Another common issue that may arise in incorporating sales forecasts into potential studies is the use of inconsistent or unrealistic assumptions regarding the "naturally occurring" rate of adoption of efficient technologies. Similar to the effects of codes and standards, if the sales forecast assumes a rate of naturally occurring adoption of certain efficient technologies that potential study analysts consider too low, then the forecast may need to be adjusted downward to correct for this problem.

Conversely, increased saturation of new energy-consuming technologies in the future, such as electric vehicles, or increases in the size and consumption per unit of a given technology (e.g., TVs), may result in increased usage that may or may not be appropriately accounted for in the sales forecast.

In some cases, issues with the sales forecast can be corrected in whole or in part by making adjustments to the original sales for purposes of the potential study. Whether it is appropriate to make these adjustments may depend on whether there is sufficient information available to do so in a reasonable manner. An example of how this may be done to correct two particular problems (embedded efficiency and naturally occurring adoption of efficient technologies) is discussed later in the reinterpretation section. The following section discusses the impact that such adjustments would have on savings and cost-effectiveness, using embedded efficiency and codes and standards as examples.

Impact on Savings and Cost-Effectiveness (Direction)

The direction of the impact on savings of adjusting the sales forecast depends on what types of methodological issues were present in the original forecast, as well as which sector is being examined. On the residential side, the absolute amount of potential savings is typically determined independently of the sales forecast. As such,

78 Shenot, J., The Regulatory Assistance Project, 2012

changing the sales forecast generally will not impact the absolute level of savings that can be achieved, although savings as a percentage of sales may change. Note that these impacts may be different if the sales forecast played a more integral role in residential savings projections, such as in calibrating likely energy consumption with and without energy efficiency investments.

On the commercial and industrial side, because potential savings are typically calculated first as a percentage of sales, savings will not change on a percentage basis if sales are adjusted equally across the whole sector, but the level of absolute savings would change. In the high-performance T8 example, if the sales forecast were increased by 10 percent across the entire commercial and industrial sector to remove embedded efficiency, then total consumption would increase from 3,500,000 to 3,850,000 MWh, interior office lighting consumption would increase from 100,000 MWh to 110,000 MWh, and savings from high-performance T8s would increase from 91 MWh to 100.1 MWh. Savings as a percentage of sales, however, would remain at 0.11 percent of consumption in that end-use category and 0.0026 percent of overall commercial and industrial consumption.

Two exceptions may arise to the general rule that commercial and industrial savings will not change as a percentage of sales when the forecast is adjusted. First, savings might increase as a percentage of sales if certain other assumptions were changed along with the adjustment to the forecast. For example, if sales were increased as a result of removing the effects of past efficiency investments, then it might also be assumed that the existing baseline measure stock would be less efficient without these investments. As a result, the percentage of savings as compared to baseline might increase from 17 percent to, for example, 20 percent. Alternatively, with higher sales it might be assumed that a higher percentage of the market could be penetrated (e.g., if higher costs to consumers led to a greater demand for energy savings), say 15 percent instead of 10 percent. Under these scenarios, absolute savings would increase by an even greater amount, and savings would also increase as a percentage of sales.

Savings as a percentage of sales in the commercial and industrial sector might also change if a more granular adjustment were made to the forecast that impacted only certain end-use categories. In some cases, the directional impact on absolute savings could theoretically be different from the directional impact on savings as a percentage of sales. For example, if a predicted federal efficiency standard were incorporated into the adjustment that would impact only interior commercial lighting, then annual sales in the interior office lighting category might decline from 100,000 MWh per year to only 90,000 MWh. This would lead to a lower level of absolute potential savings from replacing a given percentage of interior office lighting with high-performance T8 fixtures. If a higher level of savings as a percentage of sales could be achieved in all other end-use categories, however, then total savings as a percentage of sales would go up, although the total amount of overall sales would be smaller.

The impact on cost-effectiveness of adjusting the sales forecast would follow a pattern similar to the impact on savings. Generally, cost-effectiveness in the residential sector would not be affected, assuming that the portfolio of energy-saving measures was constructed independently of the sales forecast. In the commercial and industrial sector, cost-effectiveness would also not be affected by a constant adjustment across the entire sector, as each measure with its particular BCR would be given the same relative weight in the portfolio. However, a more granular adjustment that impacted the relative weight of each measure as a percentage of overall savings might have a positive or negative impact on overall cost-effectiveness. For example, if reducing interior office lighting consumption from 100,000 MWh to 90,000 MWh primarily impacted the measure mix by reducing the percentage of total savings that could be attributed to high-performance T8s, then overall cost-effectiveness would decline if that measure were more cost-effective than the portfolio overall (or increase if it were less cost-effective).

Impact on Savings and Cost-Effectiveness (Magnitude)

To the extent that adjustments to the original sales forecast impact savings and/or cost-effectiveness, the magnitude of the impact will depend on the size of the adjustment. In the commercial and industrial sector, for instance, a hypothetical increase of ten percent in the overall commercial and industrial sales forecast also led to a ten-percent increase in absolute savings from high-performance T8s in the interior office lighting category (from 91 to 100.1 MWh), although savings did not change as a percentage of sales. A similar ten-percent increase in absolute savings could be expected for all other measures if the sales forecast were increased equally across the board.

By contrast, in the residential sector, the size of the adjustment to the sales forecast would impact the magnitude of the change to savings as a percentage of sales rather than absolute savings. For example, through an independent analysis of lamps and fixtures in existing and newly constructed homes, CFLs might be projected to save 30,000 MWh per year. If the total annual residential consumption forecast were given as 3,000,000 MWh, but was increased 10 percent to 3,300,000 MWh as a result of removing endogenous energy efficiency, then absolute savings from CFLs would still be projected at 30,000 MWh per year, but savings as a percent of sales would decline from 1 percent to approximately 0.91 percent. Similarly, if aggregate potential savings from all measures were projected to be 60,000 MWh per year, then this absolute amount would usually remain the same even if the sales forecast were adjusted, but savings as a percent of sales would decline from 2 percent to approximately 1.82 percent.

As noted above, cost-effectiveness typically would not change unless the relative weight of energy-saving measures also changed with the forecast adjustment. This would be unlikely in the residential sector if the mix of measures were constructed independently of the sales forecast. In the commercial sector, cost-effectiveness might change if a granular adjustment were made that impacted the sales forecast in only certain end-use categories. In that case, the magnitude of the impact on overall cost-effectiveness would depend on the BCR of the affected measure and the size of the change in its relative weight within the portfolio. For example, if a federal efficiency standard were incorporated into the adjustment that reduced potential savings from indoor commercial lighting, it might also reduce the percentage of savings attributable to a given measure, such as T8s. If the percentage of savings attributable to T8s was reduced from ten to five percent of total commercial and industrial savings, but T8s had a BCR of 4.0 while the remaining portfolio had a BCR of 2.0, then the overall portfolio BCR would decline from 2.2[79] to 2.1.[80]

How to Determine Whether It Is an Issue in a Given Potential Study

Utility base-case energy sales forecasts are important in any potential study and are especially important in commercial and industrial studies that take a top-down approach, using the forecast as a starting point to determine potential savings. Given that these forecasts are made outside the scope of the study, it may not be possible to change the forecasting methodology or results. The RFP or draft scope of work, however, can make note of the fact that respondents should be prepared to evaluate the accuracy of the forecast at a high level and to discuss in the potential study how any issues with the sales forecast may impact potential study results. In some cases, an estimated reinterpretation of the results may be possible, as discussed further below.

If reading a completed study, one can look to determine whether the forecast played a central role in the study by examining the methodology used to arrive at the final savings projections. In some cases, particularly in residential studies, the forecast may have been used as a calibration tool, even if it was not the starting point for the analysis. If the forecast was used in the potential study, one can look for any discussion of the forecast methodology to determine what types of issues may need to be considered in the potential study context. It may also be worth accessing the original forecast, if available, to examine the methodology in more detail.

How to Avoid the Issue in the First Place or Correct It

Given that the sales forecast is typically made outside the context of the potential study, methodological issues with the forecast itself may be unavoidable. For related reasons, some analysts have suggested combining the process of creating utility sales forecasts and energy efficiency projections.[81] Even when starting with a pre-existing forecast, however, it should be made clear in the initial project meeting and final scope of work that potential study authors are responsible for addressing any issues with the forecast that may impact study results.

79 2.2 = 10% x 4.0 + (1 – 10%) x 2.0

80 2.1 = 5% x 4.0 + (1 – 5%) x 2.0

81 Enterline, S., & Fox, E. Integrating energy efficiency into utility load forecasts. (2010). 2010 ACEEE Summer Study on Energy Efficiency in Buildings.

How to Reinterpret Potential Study Findings When the Issue Is Already Embedded

As utility sales forecasts are made outside the scope of most potential studies, it may be difficult in some cases to reinterpret potential study results to address any methodological issues. If it is clear what the issues are, however, and there is sufficient information available to make reasonable adjustments, then reinterpreting the original sales forecast may be possible.

For example, in a 20-year Vermont potential study published in 2009, the sales forecast curve was adjusted both by removing the effects of endogenous efficiency and, in the residential sector, by adding in the effects of a more rapid natural transition toward energy-efficient lighting than that which had been predicted in the original sales forecast produced by the Vermont Electric Power Company (VELCO).[82] To remove embedded efficiency, analysts constructed a sector-level regression based upon annual historical spending and verified savings during the period from 2000 through July 2009.[83] Analysts assumed that this spending-to-savings relationship would reasonably approximate the implicit assumptions in the VELCO forecast. They further assumed that the level of future spending implicit in the forecast could be reasonably estimated as the average annual historical spending level from 2000 to 2007. By correlating this average historical spending level with predicted savings through the regression relationship, analysts were able to calculate the incremental level of endogenous efficiency implicit in the VELCO forecast and remove it.

Analysts further adjusted the VELCO sales forecast in the residential sector because they felt that the natural market adoption rate for efficient lighting would be higher than that which VELCO's consultants had used.[84] This adjustment was made by determining the differential between VELCO's forecast of annual lighting consumption per household and the potential study's prediction of annual household lighting consumption, and then multiplying this amount by the number of residential customers forecast by VELCO for each year. This amount was then subtracted from VELCO's forecast of annual residential energy consumption, which suppressed the increase in this sector that resulted from removing endogenous efficiency.

For the residential sector, the independently derived savings predictions could be compared to the new adjusted forecast to determine savings as a percentage of sales with no endogenous program-related efficiency built in. For the commercial and industrial sectors, the adjusted sales forecast was used as a starting point for the disaggregation process described earlier from which commercial savings projections emerged.

This example provides just one methodological approach to adjusting a sales forecast to account for embedded methodological issues. A range of approaches might be appropriate depending on the particular issues embedded in any given forecast. The point is that, with sufficient information, it may be possible to make reasonable adjustments to the pre-existing forecast in order to produce more accurate final results in a potential study in which the forecast is used as part of the analysis.

82 Forecast 20: Electricity savings in Vermont from 20 years of continued end-use efficiency investment. (2009, December 8). Prepared by Efficiency Vermont, Green Energy Economics Group, and Optimal Energy for the Vermont Public Service Board and the Vermont Systems Planning Committee, p. 38-42.

83 Savings through July 2009 were compared to spending that had occurred up to that point in the year.

84 The VELCO forecast in fact accounted for future changes in lighting efficiency standards, but the potential study analysts felt that VELCO had underestimated the rate of adoption of above-standard lighting technology that would occur in the future.

7. Consistency with the Integrated Resource Plan

Why Is It an Issue?

The State and Local Energy Efficiency Action Network (SEE Action), an initiative facilitated by the US Department of Energy and the US Environmental Protection Agency, defines an IRP as "a long-range utility plan for meeting the forecasted demand for energy within a defined geographic area through a combination of supply-side resources and demand-side resources."[85] In essence, the IRP process is intended to compare energy supply options and demand-side management, including energy efficiency, to determine what combination of resources can best meet the energy needs of a given location. As of September 2011, 34 states required at least some type of IRP process for electricity planning, while 13 of those states also required IRPs for natural gas planning.[86] IRPs may also be conducted at larger and smaller scales, such as the regional or municipal levels.

The evaluation of demand-side resources in an IRP

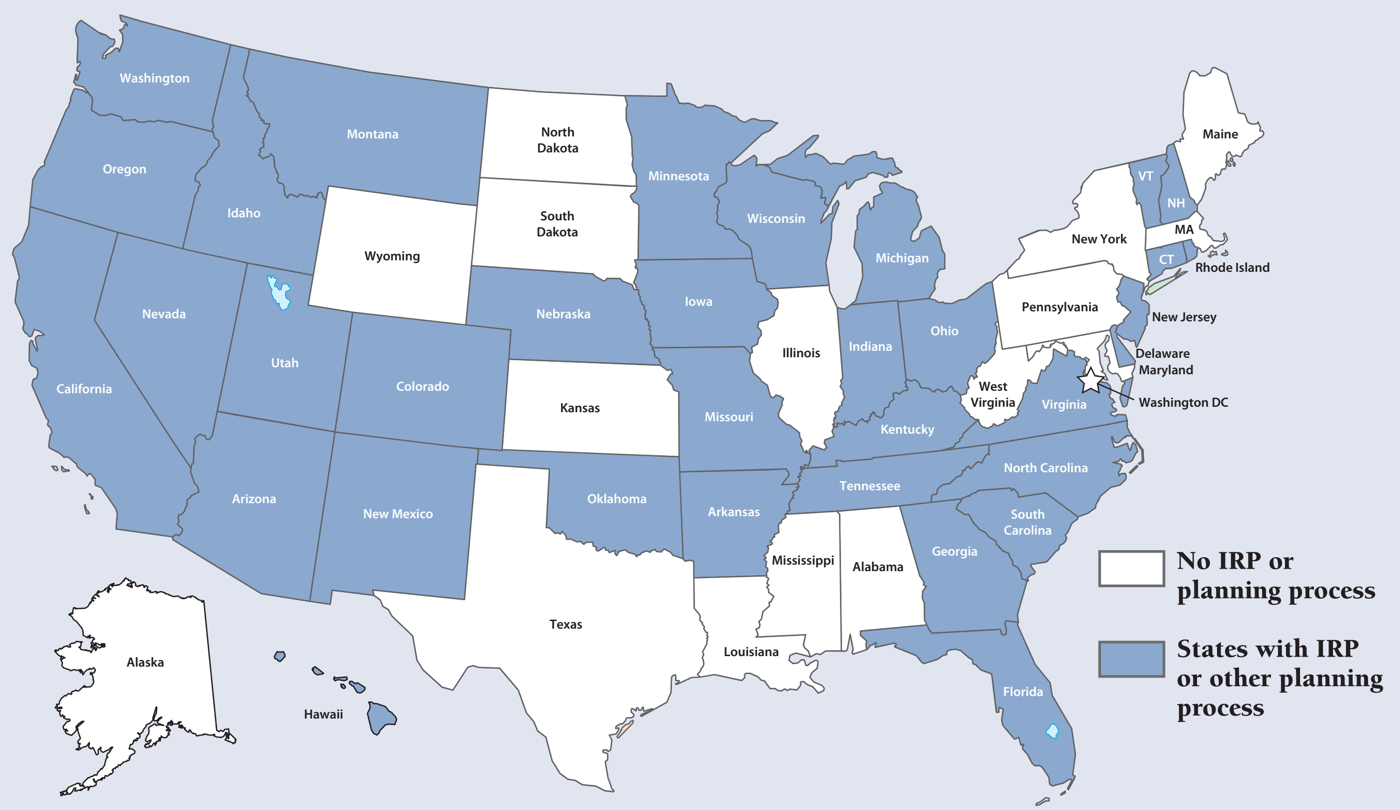
85 SEE Action. Using integrated resource planning to encourage investment in cost-effective energy efficiency measures. (2011, September). p. iv.

86 Id.

87 Regulatory Assistance Project (2011) US States with Integrated Resource Planning or Similar Planning Process. Available at: http://www.raponline.org/document/download/id/4447

Figure 7.1

U.S. States with Integrated Resource Planning or Similar Process, Effective December 2005[87]



typically relies on either an independently conducted potential study or a potential savings analysis that is conducted as part of the IRP process itself. If a separate potential study is conducted, assumptions made in the potential study should be consistent with those in the IRP in order to ensure that demand- and supply-side resources are considered on an equal footing. In some cases, it may not be possible to ensure consistency with the IRP at the time the potential study is conducted, particularly if the study takes place before the input assumptions for other pieces of the IRP have been determined. In such cases, IRP analysts should use caution when relying upon potential study results. Reasonable adjustments to the potential study assumptions and related results should be considered, and any discrepancies between potential study and IRP assumptions should be explicitly highlighted in the text of the final IRP. IRP analysts may also consider multiple energy efficiency cases, as an important aspect of an IRP is sensitivity to different events. Where uncertainty exists or a range of potential savings is expressed in the potential study, different energy efficiency cases can be evaluated in an IRP.

In other cases, the inputs may have been determined for use in other parts of the IRP before the potential study analysis has been conducted. In such cases, potential study analysts should seek to ensure consistency in the assumptions they use to evaluate demand-side management as a resource option with the inputs used to complete other pieces of the IRP. To the extent possible, these assumptions should be fully documented in the potential study and cross-referenced with the IRP. At times, potential study analysts may find it imprudent to rely upon assumptions made in the IRP that may be dubious. In any case in which IRP assumptions are not used, however, analysts should be very explicit in documenting the differences between the IRP assumptions and those used in the potential study so that readers understand clearly where any inconsistencies may lie.

To understand how input assumptions may play multiple roles in the IRP process, it may be simplest to consider a case in which the demand- and supply-side analyses have been conducted in an integral manner and in which common assumptions have been used. One such example is the Sixth Northwest Conservation and Electric Power Plan ("Northwest IRP"), a plan that covers the states of Washington, Oregon, Idaho, and Montana.[88]

In this IRP, fuel prices provide an illustration of an input assumption that plays multiple roles. As a starting point, fuel prices affect the overall energy demand forecast that the combination of supply options and demand-side management is intended to meet. The IRP tests a range of potential fuel price forecasts, with higher fuel prices leading to lower demand and vice versa. On the supply side, fuel prices in this IRP serve as an important component in projecting the cost of various electricity-generating options, as these prices account for the largest portion of variable production costs in many types of power plants.[89] On the demand side, fuel prices help determine the cost of electricity generation, which in turn impacts the wholesale electricity price, a key factor in determining the avoided-cost benefits of efficiency measures. The Northwest Power and Conservation Council ("the Council") explicitly recognizes the interdependency of multiple aspects of the IRP on this single input assumption, observing, "Fuel prices affect not only electricity demand, but also the cost of electricity generation from natural gas, oil, and coal-fired power plants. Because of this, fuel price forecasts help determine the wholesale electricity price and the avoided cost of alternative resources when considering the cost-effectiveness of improved efficiency."[90]

Although fuel prices are highlighted in the IRP as a specific example of an input assumption that impacts multiple aspects of the plan, the Council also points out that a number of other key inputs are used across different parts of the IRP. With regard to financial inputs, for instance, the Council notes, "Basic financial assumptions such as rates of inflation, the cost of capital for investments by various entities, equity-to-debt ratios, and discount rates are used throughout the planning analysis."[91]

These examples demonstrate just some of the ways that input assumptions may impact both the supply-side and the demand-side analyses when both are conducted as part of the IRP process itself. Even if the demand-side analysis is conducted as part of an independent potential study, however, analysts should be aware that the inputs

88 Northwest Power and Conservation Council. (2010, February). Sixth Northwest Conservation and Electric Power Plan.

89 Id., p. 6-9.

90 Id., p. 2-2.

91 Id.

they choose may be relevant in a broader context. Where possible, analysts should seek to ensure consistency in the assumptions they use to evaluate demand-side management as a resource option with the inputs used to complete other pieces of the IRP. Otherwise the portion of energy demand that can be met with energy efficiency may be over- or underestimated.

Impact on Savings and Cost-Effectiveness (Direction)

The directional impact of using different input assumptions in the analysis of savings potential and other parts of the IRP depends on the way in which the inputs correlate with savings and cost-effectiveness and the directional variation between the savings assumptions and inputs used elsewhere in the IRP process. In some cases, using different input assumptions in the savings estimate will increase savings and cost-effectiveness, whereas in other cases savings and cost-effectiveness may decrease. In certain cases, it may also be possible for savings and cost-effectiveness to move in opposite directions.

To return to the example described earlier, the Northwest IRP provides some useful information that helps to suggest what the directional impact might be on avoided costs if a different fuel price forecast were used on the demand side of the analysis. As noted previously, the role of fuel prices on the demand side of this IRP was to help determine the wholesale electricity price, which in turn helped to estimate the avoided-cost benefits of energy efficiency. Analysts used a "base case" set of assumptions to forecast wholesale electricity prices, but they also ran a sensitivity analysis that included two alternative scenarios in which natural gas prices were set either higher or lower than the assumptions used in the base case.[92] Natural gas prices were chosen as the fuel price to vary in this sensitivity analysis, because natural gas-fired plants served most frequently as the marginal resource in the northwest region and hence determined the price of electricity during most hours of the year.[93]

The results of this sensitivity analysis, in which the fuel price variable was shifted both up and down, can be thought of as demonstrating what the effect might be of using a different fuel price assumption in an independent analysis of savings potential. The sensitivity analysis resulted in two new forecast projections of the electricity wholesale price, one above the original projection, caused by higher natural gas prices, and one below the original projection, caused by lower natural gas prices. By 2030, the last year of the forecast period, the base-case assumptions resulted in an electricity price forecast of approximately $75 per MWh (in 2006 dollars), while the low scenario put wholesale prices at approximately $65 per MWh and the high scenario led to wholesale prices of about $80 per MWh.[94]

Wholesale electricity prices are not the only component of the avoided-cost benefit calculation, but in this IRP they play an important role in estimating the benefits of energy efficiency measures. As the sensitivity analysis indicates, using a different assumption for fuel prices may lead to a higher or lower wholesale price projection. As there is a positive correlation between wholesale prices and avoided costs, a higher fuel price input would typically lead to higher avoided costs and a higher estimate of the benefits of energy efficiency, while a lower fuel price input would have the opposite directional impact. If avoided costs were "overstated" because of an inconsistency in the fuel price assumption between an independent potential study and the IRP, then a greater number of measures might pass cost-effectiveness screening, leading to an overestimate of the fraction of demand that could be met using conservation as a resource. By contrast, if avoided costs were understated as a result of a fuel price input that was lower than the one used in other parts of the IRP, then fewer measures might pass cost-effectiveness screening, resulting in lower savings potential and reducing the role of conservation in meeting projected demand.

Although the positive relationship between fuel prices and savings is clear in this example, the directional impact on cost-effectiveness at a portfolio-wide level is less clear. In many cases, portfolio-wide cost-effectiveness could be expected to increase if a higher fuel price input were used, because the avoided-cost benefits of all existing measures would rise at the same time that additional measures passed screening. In other scenarios, however, adding the relatively lower measure-level BCRs of the newly screened measures

92 Id., Appendix D, p. D-2. A sensitivity analysis was also run keeping fuel prices constant but varying the costs of CO_2 allowances.

93 Id.

94 Id.

to the mix could be enough to reduce portfolio-wide cost-effectiveness. Ultimately, determining the directional impact on portfolio-wide cost-effectiveness would require calculating the weighted-average BCR of one measure mix using the IRP input assumption and another using the non-IRP input.

It is worth noting that the directional impacts described in this illustration are specific to the example of fuel prices and that the directional impacts of varying other input assumptions could be different. For example, using a higher discount rate assumption than that used in the IRP would tend to lower avoided-cost benefits. As a result, measure-level cost-effectiveness would decline and fewer measures would pass cost-effectiveness screening, leading to a lower savings potential. In this case, portfolio-wide cost-effectiveness would still depend on how the different measure mixes resulting from the different inputs compared with each other.

Impact on Savings and Cost-Effectiveness (Magnitude)

The magnitude of the impact on both savings and cost-effectiveness of using non-IRP input assumptions to estimate savings may vary, depending on which assumptions are changed and to what extent they are varied. All else being equal, the more significant a role the input assumption plays in determining savings and cost-effectiveness, the greater the impact will be of varying that input from the assumption used in the IRP.

Taking the example used earlier, the magnitude of the impact of varying the fuel price forecast will depend on the extent to which this forecast impacts avoided costs of electricity, as well as the importance of these avoided costs in determining savings and cost-effectiveness. A complete explanation of the methodology used in the Northwest IRP to determine savings and cost-effectiveness is beyond the scope of this report, as it is somewhat complex. It is clear, however, that fuel prices do play a significant role in determining wholesale electricity prices, which are a significant contributing factor in determining avoided-cost benefits. Regarding the various factors that contribute to the costs of electricity (and hence the wholesale price), the Council observes, "Non-fuel variable costs are generally a minor element of production costs," meaning that fuel prices contribute the most to variable costs.[95] At the same time, other significant factors besides variable production costs are taken into account in the electricity cost calculation, such as the potential costs of future CO_2 allowances. In addition, a number of other inputs beyond the wholesale electricity price contribute to the avoided-cost calculation, some of which are unique to circumstances in the northwest.[96]

Even if the magnitude of the impact of fuel prices on the avoided costs of generation could be determined, the ultimate magnitude of the impact on savings and cost-effectiveness might still remain unclear because other benefits are also considered in the screening process. These benefits include deferred transmission and distribution, avoided water costs, and any quantifiable economic benefits of specific efficiency measures, such as enhanced productivity or improved process control.[97] Moreover, the federal Northwest Power Act directs the Council and the Bonneville Power Authority to give a ten-percent cost advantage to energy efficiency measures over other resources.[98] Taking all of these factors into consideration, the significance of varying the fuel price assumption will depend on the relative importance of this particular input as compared to all of the elements in the cost-effectiveness screening process.

In theory, the relative magnitude of varying only the fuel price forecast could still be calculated by holding all of the other relevant factors constant and changing only this one assumption. In practice, however, an independently conducted potential study that used a different input assumption for fuel prices would likely contain additional differences in terms of the methodology and/or other assumptions used in the cost-effectiveness screening process. With this fact in mind, it can be concluded that the magnitude of the impact of allowing inconsistency between the potential savings analysis and the other pieces of an IRP process will depend on how all of the various assumptions may change together, as well as on any changes in the ways these factors are used to calculate both savings and cost-effectiveness.

95 Id., p. 6-9.

96 Northwest IRP, p. 2-15 – 2-16.

97 Id., Appendix E, p. E-13 – E-15.

98 Id., p. E-15.

How to Determine Whether It Is an Issue in a Given Potential Study

The consistency of input assumptions will always be an important issue if the potential savings analysis is used as part of an IRP process. One way to help resolve this issue is to conduct the savings analysis as an integral part of the IRP itself, as was done in the Northwest IRP. If the potential study is to be conducted independently, however, it should be stated up front in the request for proposals or draft scope of work that potential study inputs should be consistent with those used in the IRP process, or at least that potential study analysts should explain why they have used different assumptions. If the potential study is conducted before the input assumptions to be used in other pieces of the IRP have been determined, then the burden of ensuring consistency or explaining any discrepancies may fall upon the authors of the IRP.

If reading a completed potential study to evaluate savings potential, particularly in the context of meeting a portion of the demand forecast, one should check to determine whether the assumptions in the study and those being used in the IRP process are consistent. If they are not, then potential study results should be used with caution, bearing in mind how the inconsistent assumptions may have altered the outcomes.

How to Avoid the Issue in the First Place or Correct It

If an IRP process and an independent potential study feeding into it are to be conducted contemporaneously, then the best way to avoid inconsistencies in input assumptions is to raise this issue in the initial project meetings for both the potential study and the IRP process itself. Once potential study and IRP analysts have resolved which inputs overlap, how they will be determined, and how they will be used in relevant calculations, then these points should be set down in writing within the finalized scope of work for both the potential study and the IRP. In addition, the scopes of work should make clear that analysts should use input assumptions that are consistent across the demand- and supply-side analyses, or at a minimum should explain in writing within the IRP and potential study narratives where and why there are differences.

How to Reinterpret Potential Study Findings When the Issue Is Already Embedded

Understanding how input assumptions are used to determine savings and cost-effectiveness may make it possible to reinterpret potential study results directionally, although the magnitude of the impact could be difficult to determine. The directional reinterpretation will typically follow the general relationship of the input to the overall results. For instance, in the fuel price example used previously, fuel prices were positively correlated with avoided-cost benefits and overall potential savings. As a result, increasing the fuel price input assumption to bring it in line with other pieces of the IRP would typically raise measure-level cost-effectiveness and increase savings, although the impact on portfolio-wide cost-effectiveness might be less clear. The magnitude of the impact may be possible to determine if the input used in the potential study could simply be substituted with the corresponding input used in the IRP process while holding other variables constant. In some cases, however, methodologicalal differences may exist between the potential study and the IRP that could make this simple substitution process more complicated.

8. Cost-Effectiveness Screening with the Total Resource Cost and Societal Cost Tests

Why Is It an Issue?

The TRC Test is one of the most common cost-effectiveness tests that states use to determine whether the benefits of energy efficiency investments outweigh the costs.[99] The test compares the costs and benefits from the combined perspective of all parties in a jurisdiction. The costs generally represent the incremental cost between a baseline measure and a more efficient alternative (in the case of lost-opportunity measures) or the full cost of the measure (in the case of retrofit measures), as well as program-related costs such as marketing and administration.[100] The benefits side of the equation is often more complex. Avoided energy supply costs and avoided capacity costs related to the fuel(s) that are the study's focus are always included, but many other types of avoided costs may be considered as well. These might include the avoided costs of additional fuels, avoided water costs, transmission and distribution costs, environmental externalities,[101] and other non-energy impacts. Determining which avoided costs and other TRC benefits to incorporate can have a significant impact on whether the total benefits of a measure or program outweigh the investment costs, which can be used as a kind of cost-effectiveness "screen" for which measures to include in a portfolio. The greater the number of measures that are included, the greater a jurisdiction's overall potential savings will be.

Closely related to the TRC Test is the SCT. Like the TRC Test, the SCT compares costs and benefits from the combined perspective of all parties. Under the SCT, however, the geographic scope is broadened to consider all parties in society as a whole, as opposed to only those parties in a given utility's jurisdiction. This difference can impact the number of measures that pass cost-effectiveness screening, in part because more benefits may be considered, and in part because future benefits are typically discounted at a lower rate when considered from a societal perspective. Under the TRC Test, the conventional practice is to discount future benefits using the relevant utility's weighted-average cost of capital, which represents the minimum return the utility must receive on its investments. Generally the mix of debt and equity used to finance a utility's operations creates a much higher required rate of return than that faced by society as a whole, meaning future benefits will be discounted more heavily. All else being equal, therefore, a larger set of energy efficiency investments will tend to be considered cost-effective from the societal perspective than from the standpoint of the

99 National Action Plan for Energy Efficiency. (2008). Understanding cost-effectiveness of energy efficiency programs: Best practices, technical methods, and emerging issues for policy-makers. Energy and Environmental Economics, Inc. and Regulatory Assistance Project. p. 5-2 – 5-4.

100 In the case of early retirement measures, which are retrofit measures implemented prior to a naturally occurring market event such as equipment burnout, estimating the cost may be more complicated.

101 Some of these avoided costs, such as environmental externalities, may only be considered in some jurisdictions under the Societal Cost Test, described below. The line between the Total Resource Cost Test and the Societal Cost Test is blurred in many jurisdictions with respect to which benefits should be included, however, and some jurisdictions do include externalities in the TRC Test. The California Standard Practice Manual, a common reference used to define cost-effectiveness tests, only includes externalities under the Societal Cost Test but treats this test as a type of TRC Test screen, referring to it as "the societal test variation" of the TRC Test. See, California Standard Practice Manual: Economic analysis of demand-side programs and projects. (2001, October). p. 21. "The primary strength of the Total Resource Cost (TRC) test is its scope. The test includes total costs (participant plus program administrator) and also has the potential for capturing total benefits (avoided supply costs plus, in the case of the societal test variation, externalities)."

utility or efficiency program administrator's jurisdiction alone.

As noted in the National Action Plan for Energy Efficiency, "Increasingly, benefits historically included only in the SCT are being included in the TRC in some jurisdictions."[102] Although some benefits may only be considered in the SCT in some jurisdictions, one can argue that at a minimum those benefits that directly impact a service territory (including the service provider and its customers) should always be included in the TRC Test, because this is the perspective that the TRC Test is designed to address. Such benefits may include avoided line losses,[103] avoided transmission and distribution costs, avoided environmental compliance costs, and demand-reduction-induced price effects (DRIPE).[104] This is not to say that other avoided cost components should not be included in the TRC Test, but rather that there is no reason to exclude these costs from a TRC Test, as they clearly represent direct costs to key stakeholders in the service territory.

Ultimately whatever benefits are included in the screening test that is applied, it is critical that these benefits be discussed thoroughly before the study commences, as they may help determine which measures and/or programs are ultimately included in the portfolio. The benefits that are considered and the methods by which they are calculated should also be stated explicitly in the study narrative so that readers are aware of the basis under which measures or programs have been included or excluded from bottom-line savings projections.

Impact on Savings and Cost-Effectiveness (Direction)

Adding benefits to a given type of cost-effectiveness test or switching to a test that defines benefits more broadly will increase the overall cost-effectiveness of every measure. Expanding the types of benefits included in cost-effectiveness screens will also tend to increase the number of measures and/or programs that pass cost-effectiveness screening, thereby increasing the measure and/or program savings that are counted toward achievable potential savings and raising the potential savings level overall.[105] In addition, using a lower (societal) discount rate will increase cost-effectiveness and cause more measures to pass cost-effectiveness screening, further increasing total potential savings.[106]

As an example, consider three residential energy efficiency measures: an ENERGY STAR clothes washer, an efficient central air conditioning system, and a typical compact fluorescent bulb (CFL). Each of these measures generates a different level of energy savings (kWh) and capacity savings (kW), as shown in table 8.1 below.[107] The clothes washer also generates therm savings and water savings.

To determine whether each of these measures will pass the cost-effectiveness screening test, it is necessary to know the monetary value of the savings that each measure produces so that the benefits can be compared directly with the incremental costs. Table 8.2 provides illustrative monetary values of each kWh, kW, therm, and gallon of water saved in New England, based on the report "Avoided Energy Supply Costs in New England: 2011" published by Synapse.[109] Two other types of avoided costs are included

102 National Plan for Energy Efficiency. Understanding cost-effectiveness of energy efficiency programs. p. 6-8.

103 Although average line losses are often quantified and publicly available, RAP has noted, "Most analysts who consider line losses at all use the system-average line losses, not the marginal line losses that are actually avoided when energy efficiency measures are installed." As a result, "The line losses avoided by energy efficiency measures are generally underestimated." See, Lazar, J., & Baldwin, X. Valuing the contribution of energy efficiency to avoided marginal line losses and reserve requirements. (2011, August). Regulatory Assistance Project, p. 1. The paper "uses a rule of thumb that marginal losses are about 1.5 times average losses" (p. 5).

104 DRIPE results from the reduction in wholesale prices that occurs when peak demand declines and the use of more expensive marginal generating resources can be reduced.

105 In some cases, it is possible that cost-effectiveness and economic potential may increase while achievable savings remain at the same level, if adding measures and/or programs would exceed an exogenous constraint such as a pre-established budget limit.

106 This does not necessarily mean that a societal discount rate should be used to increase potential savings. The discount rate used depends on the cost-effectiveness test used, which in turn depends on the perspective from which costs and benefits are viewed.

107 The values in this table are intended to be illustrative. They are drawn from Northeast Energy Efficiency Partnership. Mid-Atlantic Technical Reference Manual, Version 1.0. (2010, May).

Table 8.1[108]

Measure Characteristics	kWh	kW	Therms	Water (gallons)	Measure Life	Incremental Cost
ENERGY STAR Clothes Washer	127	0.0137	3.42	5026	14	$250
Central A/C	152	0.18	NA	NA	18	$550
CFL	41	0.0048	NA	NA	8	$3

as well: avoided costs of transmission and distribution (valued at $90 per kW of capacity savings) and avoided environmental externalities such as carbon and other air pollutants (here monetized at 0.7 cents per kWh saved).

The more of these avoided costs that are included in cost-effectiveness screening, the greater the total benefits side of the equation will be. Some conservative potential studies do not include any avoided costs beyond avoided energy and capacity, in which case the monetary value of other avoided costs would effectively be zero.[110] This is reflected in the "Most Conservative" row of Table 8.2. As previously discussed, it can be argued that these studies have not actually applied a full TRC Test, as they have not included those benefits that directly affect key stakeholders in the service territory.

Other studies include all of these types of avoided costs and perhaps others, as reflected in the "Most Comprehensive" row of Table 8.2 below, although the precise values may vary.[111] In this example, the conservative case also uses a higher utility discount rate, whereas the comprehensive case uses a societal discount rate.

To obtain the monetary value of the avoided costs by measure, the per-unit value of the avoided cost is first multiplied by the number of units that the measure avoids (e.g., $/kWh times total kWh per measure produces the annual monetary value of avoided kWh for each measure).

Table 8.2[112]

Avoided Costs	Avoided kWh	Avoided kW	Avoided Therms	Avoided H2O gal	Avoided T&D ($/kW-yr)	kWh Externality Adder	Discount Rate
Most Conservative	$0.07	$48.12	$0	$0	$0	$0	9%
Most Comprehensive	$0.07	$48.12	$0.91	$0.0089	$90	$0.007	3%

108 Based upon EFG analysis. See footnote 107.

109 Values are again provided only for illustrative purposes, and New England avoided supply costs were used because the data were easily available. For convenience and ease of data gathering, in this example we have combined measure savings values from the mid-Atlantic region with avoided supply costs from New England.

110 For example, an August 2008 study by Frontier Associates conducted for Oklahoma Gas & Electric noted, "For purposes of this study, the only avoided costs used were those associated with electricity savings." OG&E Energy Efficiency Potential Study. (2008). Technical, economic and achievable potentials for the residential, commercial and industrial customer base. Prepared by Frontier Associates LLC for Oklahoma Gas & Electric. See p. 57. Note that this study does not explicitly lay out its cost-effectiveness calculations in the narrative, so it is possible that costs "associated with electricity savings" were interpreted broadly to include avoided transmission and distribution costs, although there is no indication that this is the case. As with many other studies, this example points to the need for greater transparency in potential study analyses.

111 See, e.g., Vermont Electric Energy Efficiency Potential Study, Final Report. (2007, January). Prepared by GDS Associates, Inc. for the Vermont Department of Public Service. This study used the state's version of a Societal Cost Test and included avoided costs of electricity, natural gas, propane, #2 fuel oil, kerosene, and water, as well as a per-kWh adder to account for environmental externalities. See p. 14.

112 Based upon EFG analysis

Table 8.3[113]

Conservative Case	Avoided kWh	Avoided kW	Avoided Therms	Avoided H2O gal	Avoided T&D	kWh Externality Adder	Total Bens	Cost	Net Bens	BCR
Clothes Washer	$69.22	$5.13	$0.00	$0.00	$0.00	$0.00	$74.35	$250	($175.65)	0.30
Central A/C	$93.16	$75.84	$0.00	$0.00	$0.00	$0.00	$169.00	$550	($381.00)	0.31
CFL	$15.88	$1.28	$0.00	$0.00	$0.00	$0.00	$17.16	$3	$14.16	5.72

The net present value of the annual savings is then obtained by multiplying the annual savings value by the measure life and discounting the savings over the life of the measure. If the per-unit avoided cost is valued at $0 because it is not included in the study, then the total value of that particular benefit will also be $0. In Table 8.3 above, all of the avoided costs besides energy and capacity savings are valued at $0. As a result, the total benefits of each measure are less than they would otherwise be, and only CFLs pass the cost-effectiveness screening test with a BCR greater than 1.0.

The impact of valuing each of the avoided costs and using a lower (societal) discount rate is that the total benefits of each measure will be higher. This is reflected in Table 8.4 below.[114] In this case, clothes washers pass the cost-effectiveness screening test because of the large monetary value of water savings, as well as other avoided cost savings. Central air conditioners still do not quite pass the screening test, although they come much closer.

In the case of all three measures, the direction of the impact on the cost-effectiveness ratio is positive after adding additional benefits. The overall directional impact on savings would also be positive, because one additional measure now passes the cost-effectiveness screening test and would be included in the portfolio of measures to be promoted.

It should be noted that the overall cost-effectiveness of the portfolio may actually go down as measures are added that have BCRs only slightly above 1.0 when all of their benefits are considered. It is worth emphasizing, however, that this is not necessarily a negative result. What it means is that additional savings will be generated from additional measures, which when considered holistically actually produce a range of benefits that outweigh their costs. Those measures for which the costs still outweigh the benefits even when the full range of benefits is considered will continue to be excluded from the portfolio.

Impact on Savings and Cost-Effectiveness (Magnitude)

In terms of cost-effectiveness, the magnitude of the impact of adding (or removing) benefits depends on which benefits are added and how they are valued. The more benefits that are added and the greater their assigned value, the greater the impact will be on cost-effectiveness. With respect to savings, the magnitude of the impact will depend on which measures and/or programs pass cost-effectiveness screening after benefits are added or removed, as well as the level of savings associated with those measures and/or

113 Based upon EFG analysis.

114 The discount rate impact can be seen most clearly by comparing the kWh and kW savings in each table, both of which are higher in the Comprehensive Case. In those columns, the only change is the rate at which future benefits have been discounted.

115 Based upon EFG analysis.

Table 8.4[115]

Comprehensive Case	Avoided kWh	Avoided kW	Avoided Therms	Avoided H2O gal	Avoided T&D	kWh Externality Adder	Total Bens	Cost	Net Bens	BCR
Clothes Washer	$98.93	$7.34	$34.63	$496.35	$13.79	$9.89	$660.93	$250	$410.93	2.64
Central A/C	$143.65	$116.94	$0.00	$0.00	$219.76	$14.37	$494.72	$550	($55.28)	0.90
CFL	$19.96	$1.61	$0.00	$0.00	$3.02	$2.00	$26.58	$3	$23.58	8.86

programs.

The magnitude of the impact that changing the discount rate assumption will have on cost-effectiveness screening will depend on the extent to which the rate shifts, whereas the magnitude of the impact on savings will depend on which measures and/or programs pass the screening test after the discount rate assumption has been changed. The impact of changing the discount rate will also depend on the life of each measure, because a change in the discount rate has a greater impact in later years.

Table 8.5 below demonstrates the magnitude of the impact that successively adding each of the avoided costs discussed previously would have on the BCR of each measure. The last column shows the impact of shifting from a utility discount rate to a societal discount rate after all the avoided costs have been incorporated.

In terms of avoided costs, adding water savings has the greatest impact on the clothes washer BCR, and adding T&D benefits makes the greatest impact on the BCR of central air conditioners and CFLs (neither of which save water). Regarding the discount rate, using a societal discount rate makes the greatest impact (on a percentage basis) on central air conditioning, which has the longest measure life (18 years), and the least impact on CFLs, which have the shortest measure life (8 years).

Assigning different per-unit values to the avoided cost categories would affect the magnitude of the impact that each one would have on each measure's BCR. For example, in the case of central air conditioners, avoided T&D costs were valued in Table 8.2 at $90 per annual kW saved, which represented the approximate median of six reported figures for T&D costs from six utilities surveyed in "Avoided Energy Supply Costs in New England: 2011 Report." At the high end of the survey, one utility reported avoided T&D costs of $129.20 per annual kW saved. Under the comprehensive case, using this value instead of $90 would shift the BCR of efficient central air conditioners from 0.90 to 1.07. As a result, this measure would pass the cost-effectiveness screening test, and the potential savings from this measure would be included in overall savings potential from the portfolio.[117]

How to Determine Whether It Is an Issue in a Given Potential Study

All potential studies will use some form of cost-effectiveness test to screen measures and/or programs. Which test will be used and what benefits will be included should be determined up front and can be referenced in the RFP. The choice of screening test should correspond with the perspective being considered. The TRC Test is most appropriate for considering the perspective of all parties in the utility jurisdiction, whereas the SCT is most appropriate for considering the perspective of society as a whole. Other tests may be appropriate to examine the perspective of a specific party or group, such as program participants, non-participants, or the program administrator. In general, if the TRC Test or SCT is used, as many benefits as possible should be considered, because the purpose of these tests is to compare all benefits to all costs within a given jurisdiction or society as a whole. In some cases, the complexities and expense of valuing certain types of avoided costs may be prohibitive, although even in such cases a conservative fixed "adder" may be used if it is known that the benefits are at least greater than zero.

If reading a completed study, one can look to see what

116 Based upon EFG analysis.

117 The appropriate assumption for T&D avoided costs will depend largely on the T&D investment costs to the utility in the particular jurisdiction that is the focus of a given potential study. The actual median value in the region covered by the AESC may indeed be higher than $90, however, as the avoided cost study noted certain methodological issues that may have led to under-reporting in the low end of the range of T&D savings. See AESC. (2011).p. 6-70 – 6-74.

Table 8.5[116]

Screening Results	Most Conservative	= + Therms	= + H2O	= + T&D	= + Externalities	With Societal Discount Rate
Clothes Washer	0.30	0.39	1.78	1.82	1.85	2.64
Central A/C	0.31	0.31	0.31	0.57	0.58	0.90
CFL	5.72	5.72	5.72	6.52	7.05	8.86

test was used and which benefits were included in cost-effectiveness screening, either in the calculations themselves or in a narrative explanation. The primary test used will generally be stated explicitly in the text. As discussed below, however, the study narrative may be less clear as to exactly which benefits were included, how they were valued, or how they impacted measure-level screening results. In such cases, it may be necessary to examine the underlying screening tool.

How to Avoid the Issue in the First Place or Correct It

Prior to conducting a potential study, there may or may not be an opportunity to consider which avoided costs to consider or which cost-effectiveness test to use. Depending on a jurisdiction's political and regulatory processes, these decisions may have been made already, or they may have been left somewhat open. In either case, a discussion should take place with all parties during the initial project meeting to determine which benefits will be included in the cost-effectiveness screen, and the benefits to be incorporated into the analysis should be agreed upon in the final scope of work.

Given the central role of cost-effectiveness screening in determining which and how many measures are included in the portfolio, it is essential that potential study authors also spell out the benefits in the study narrative so that readers of the study will be fully aware of the factors that have influenced screening test results and overall energy efficiency potential. Studies reviewed for purposes of this report generally stated which test was being used to screen individual measures, but were sometimes less clear as to how the study was defined and which benefits were considered.

How to Reinterpret Potential Study Findings When the Issue Is Already Embedded

At a high level, it may be possible to interpret the direction of the impact on savings and cost-effectiveness that would result from adding benefits or using a lower discount rate, because both of these actions would generally have a positive impact on measure-level cost-effectiveness and overall savings. In some cases it may also be possible to quantify the effect on economic potential if it can be determined which additional measures would pass cost-effectiveness screening when benefits are added.

Although the final narrative of most potential studies includes at least some mention of the avoided costs being considered, it is not always obvious how those costs were valued or how much they affected the final results at the individual measure level without looking at the underlying screening tool that was used. Indeed, one of the reasons that the hypothetical examples above were constructed was that most potential study narratives reviewed for the purposes of this report did not spell out their avoided cost calculations with sufficient clarity that one could parse out from the narrative how much each avoided cost contributed to the cost-effectiveness screening outcome of individual measures. In such cases, it would be necessary to examine the underlying screening tool in order to determine how changing the avoided cost assumptions would impact cost-effectiveness screening results. Even if it were possible to determine at the measure level how cost-effectiveness screening would change, however, it still might not be possible to determine the magnitude of the impact on achievable savings potential, because factors such as measure penetration and program-related costs would also need to be evaluated.

9. Inclusion of Non-Energy Impacts

Why Is It an Issue?

Many energy efficiency measures provide positive benefits that are not directly related to energy savings. From a customer perspective, these NEBs might include reduced operations and maintenance, as well as increased comfort, convenience, air quality, health, or aesthetics. From a utility's standpoint, efficiency measures may lead to reduced collection costs, arrearages, shut-offs, and debt write-offs, as well as fewer customer complaints. From a societal point of view, energy efficiency measures may increase community aesthetics, reduce health costs, and increase domestic energy independence. All of these NEBs have some value, although quantifying the values of each type of benefit can be difficult. In addition, some measures may carry NECs, such as reduced convenience, which can be equally difficult to estimate. As a result of these complexities, NEIs have generally not been included in the cost-effectiveness analyses of most potential studies, although some progressive states do include them. Massachusetts, for example, estimates the NEI value of each residential and low-income measure that it considers in its cost-effectiveness screening process,[118] whereas Vermont simply includes a 15-percent "adder" on top of the combined energy supply and capacity benefits to account for NEBs.[119]

The practical effect of including NEIs is conceptually similar to including additional avoided costs in the cost-effectiveness equation. Incorporating positive NEIs will increase the cost-effectiveness ratio of the measures and programs being considered and may cause some measures to pass cost-effectiveness screening. Although most states do not include NEIs in their cost-effectiveness screening, some studies suggest that the size of total NEIs for some measures or programs may be as large as or larger than the energy-related benefits themselves. As such, one could argue that most potential studies that employ the TRC Test or SCT screening process without incorporating NEIs may underestimate the number of measures that should be considered cost-effective.[120]

Impact on Savings and Cost-Effectiveness (Direction)

As NEIs are usually positive, including them in cost-benefit calculations will generally have a positive impact on the cost-effectiveness of individual measures. This will result in more measures and/or programs passing the cost-effectiveness screen, which will lead to the inclusion of additional measures or programs in the portfolio and an increase in overall potential savings. Also, program and portfolio net benefits will typically increase when NEIs are included. In some cases, however, portfolio-level cost-effectiveness may go down if the added measures or programs have a lower BCR than the portfolio overall.

Consider the example of efficient central air conditioners, discussed in the previous section on the TRC Test and SCT. Using the illustrative values in that example, central air conditioners did not pass cost-effectiveness screening, even when all of the avoided costs were included and a societal discount rate was used. If positive NEIs are

118 Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. (2011, August 15). Prepared by NMR Group, Inc. for Massachusetts Program Administrators.

119 State of Vermont Public Service Board. Order re Cost-Effectiveness Screening of Heating and Process-Fuel Efficiency Measures and Modifications to State Cost-Effectiveness Screening Tool. (2012, February 7).

120 Indeed, some have argued that the failure to include NEBs in cost-effectiveness screening, which is likely to continue given the cost and complexity of estimating the monetary value of NEBs, should lead to a reconsideration of the primarily role of the TRC Test as the most commonly used cost-effectiveness test. See, Neme, C., & Kushler, M. (2010). Is it time to ditch the TRC? Examining concerns with current practice in benefit-cost analysis. ACEEE.

added to the benefit side of the equation, the BCR for this measure increases. Depending on how the NEBs are valued, the BCR may increase sufficiently such that the measure would pass cost-effectiveness screening and be included in the portfolio.

Table 9.1 below demonstrates how the BCR changes as NEBs are added using different assumptions. In the first row, no NEBs are included and the BCR is 0.90. In the second row, NEBs are incorporated using the Vermont formula of adding 15 percent on top of combined energy and capacity avoided costs. This leads to a BCR of 0.97, meaning the measure comes very close to passing the screening test. Finally, in the third row, NEBs valued at $274.40 are added. This represents a recent estimate from Massachusetts of the NEBs associated with an efficient central air conditioning system.[121] In this example, the NEB estimate represents slightly more than the combined value of energy and capacity avoided costs, which accounts for the added comfort, convenience, and increased property value that the measure provides. Adding this amount to the benefits side of the equation results in the measure passing the cost-effectiveness screening test.

Note that although the individual measure's BCR increases as NEBs go up, the overall cost-effectiveness of the portfolio may decrease once the measure passes the screening test. In this example, if the average cost-effectiveness ratio of the portfolio is higher than 1.40, then adding the measure to the portfolio will cause portfolio-wide cost-effectiveness to go down, although total savings will increase.

Impact on Savings and Cost-Effectiveness (Magnitude)

The magnitude of the impact of adding NEIs to the cost-benefit calculation will depend on which NEIs are included and how they are valued. Including more NEIs with a higher value will increase the BCR by a greater degree. For example, in the previous table, the change in the BCR was relatively small when NEIs were valued at 15 percent of energy and capacity savings, and the measure still did not pass screening. By contrast, the change in the BCR was significant when NEIs were estimated to exceed the energy and capacity benefits, and as a result the measure comfortably passed the screening test.

Although most states do not include NEIs in their cost-effectiveness screening calculations, several studies suggest that the magnitude of including them would be quite large across all sectors. For example, a US Department of Energy evaluation of LI Wx programs suggested that the value of NEBs was slightly greater than the value of the energy benefits[123] A federally funded study of the cost-effectiveness of commercial building commissioning—a service promoted by numerous ratepayer-funded efficiency programs—found NEBs to be on the order of 50 percent of the value of energy savings in existing buildings and more than five times the value of energy savings in new construction.[124] One study of 52 industrial energy efficiency improvements also found non-energy productivity benefits to be more than 120 percent of the value of the energy

121 National Grid (MA) 2012 Mid-Term Modification Screening Tool. (2011, October). Submitted to the Massachusetts Department of Public Utilities.

122 Based on EFG analysis

123 Schweitzer, M., & Tonn, B. (2002). Non-energy benefits from the weatherization assistance program: A summary of findings from the recent literature. Oak Ridge National Laboratory. Prepared for the US Department of Energy.

124 Mills, E., et al. (2004). The cost-effectiveness of commercial buildings commissioning: A meta-analysis of energy and non-energy impacts in existing buildings and new construction in the United States. Lawrence Berkeley National Laboratory – 56637 (Rev.) Prepared for the US Department of Energy.

Table 9.1[122]

Central A/C Screening Results with NEBs	Energy & Capacity Benefits	Non-Energy Benefits	Other (Therm, H20, T&D, Externalities)	Total Benefits	Incremental Cost	Net Benefits	BCR
No NEBs	$260.59	$0.00	$234.13	$494.72	$550.00	($55.28)	0.90
NEBs = 15% of (kWh + kW)	$260.59	$39.09	$234.13	$533.81	$550.00	($16.19)	0.97
NEBs = $274.40 (~105%)	$260.59	$274.40	$234.13	$769.12	$550.00	$219.12	1.40

savings;[125] another concluded that total savings from industrial energy efficiency projects are typically two to four times the value of the energy savings.[126] Finally, one study estimated that NEBs across a wide range of efficiency programs ranged in value from 50 percent to more than 100 percent of the energy benefits.[127]

If these studies are correct, then it is possible that the magnitude of the impact of not including NEIs in cost-effectiveness screening, as is currently the case in most jurisdictions, is rather significant. This practice may lead to a much lower number of measures passing the cost-effectiveness screen than would be the case if indeed all costs and benefits, including NEIs, were truly considered.

How to Determine Whether It Is an Issue in a Given Potential Study

The question of whether to include NEIs will always be an issue in determining what factors will be incorporated into cost-effectiveness screens, although the precise NEIs that might be included may vary depending on the test being used. If the TRC Test or SCT is used, all NEIs can be considered, because these tests consider all of a measure's costs and benefits from the perspective of all parties in a jurisdiction or society as a whole.[128] As noted, however, most studies do not take NEIs into account because of the complexity and controversial nature of assigning specific values to them.

If reading a completed potential study, the narrative should state whether NEIs were included in any cost-effectiveness screening test. In practice, most studies currently do not include them in the cost-effectiveness screen.

How to Avoid the Issue in the First Place or Correct It

Whether NEIs will be included in the study should be determined up front during the initial project meeting and stated in the RFP or draft scope of work. If NEIs will be included, the RFP or draft scope of work should also clearly spell out exactly which NEIs will be considered and how they should be valued. Options to consider include both the Massachusetts approach of assigning a specific NEI value to each measure being screened, as well as the Vermont approach of simply applying a conservatively estimated "adder" so that NEIs are not valued at zero.

How to Reinterpret Potential Study Findings When the Issue Is Already Embedded

If NEIs were not included, it is generally safe to assume that adding them into the analysis would have a positive impact on both measure-level cost-effectiveness and overall potential savings, as more measures would likely pass cost-effectiveness screening. In some cases, it may be possible to quantify the effect on economic potential if it can be determined which additional measures would pass screening when NEIs are added, although this may require an examination of the underlying screening tool. Determining how to value the NEIs for each measure would also be a challenge, unless an agreed-upon blanket assumption or "adder" was used. As discussed earlier, however, the magnitude of the impact of adding NEIs into the analysis may be significant.

Even if the change in economic potential could be estimated, calculating the magnitude of the impact on achievable savings potential would be more difficult, as factors such as measure penetration and program-related costs would still need to be evaluated.

125 Worrell, E., et al. (2001, December). Productivity benefits of industrial energy efficiency measures. Lawrence Berkeley National Laboratory.

126 Elliott, R. N., Laitner, S., & Pye, M. (1997). Considerations in the estimation of costs and benefits of industrial energy efficiency projects. In Proceedings of the 32nd Intersociety Energy Conversion Engineering Conference, paper 97-551, July 27- August 1.

127 Skumatz, L. (2006). Evaluating cost-effectiveness, causality, non-energy benefits and cost-effectiveness in multi-family programs: Enhanced techniques. Presentation at the 2006 International Energy Efficiency in Domestic Appliances and Lighting Conference.

128 As previously noted, NEIs were originally included only in the SCT and not the TRC Test, but have increasingly been incorporated into the TRC Test as states' definitions of the TRC have expanded.

10. Forecasting Net Savings

Why Is It an Issue?

The total amount of savings created by participants in energy efficiency programs is often referred to as "gross savings." Gross savings typically do not represent a complete assessment of achievable potential efficiency that can be attributed directly to energy efficiency programs. In part this is because some participants who receive a program incentive for a given measure might have implemented the measure even if no incentive had been offered. Such individuals can be characterized as "free riders." Other individuals may implement a measure as a result of a program but may not take advantage of any incentive (e.g., if the program raises their awareness of the measure or increases the availability of efficient measures at distributors or at retailers). This phenomenon is referred to as "spillover," and such individuals are sometimes called "free drivers." Incorporating these factors into the analysis of achievable potential is essential in forecasting "net savings," which is the level of savings that results directly from program incentives and activities.

Whether a potential study should project gross or net savings may in some cases be predetermined by the jurisdiction that is the subject of the study. In some cases, jurisdictions may have already established savings goals based upon gross savings outside the context of the potential study process. If this is the case, then analysts should follow the jurisdictional guidance and project gross savings potential. Gross savings may also be most appropriate when potential study projections are being integrated with an IRP, if the baseline energy sales forecast in the IRP does not include naturally occurring efficiency. In many other jurisdictions, however, policymakers use net savings for planning purposes, and in these jurisdictions the potential savings analysis should reflect net savings projections in order to feed into that process. If the question of whether to project gross or net savings is left open, forecasting net savings should typically be the goal of a potential study, because the question that most achievable potential studies are designed to answer is the level of savings that could be realized as a direct result of program implementation.

To convert a projected level of gross energy efficiency savings realized through incentivized measures into a forecast of efficiency that is directly attributable to program incentives and activities, one can multiply the former

Table 10.1[129]

	Year				
	1	2	3	4	5
Efficient Units Implemented with Program Incentives	30	45	65	80	80
Net-to-Gross Ratio	1	1.1	1.05	0.96	0.95
Measure Implementation Attributable to Program	30	49	68	77	76
Free Drivers/(Free Riders)	0	4	3	(3)	(4)
Naturally Occurring Implementation	10	11	12	13	14
Total Efficient Units Implemented Under Achievable Scenario	40	60	80	90	90

129 Based upon EFG analysis.

figure by a "net-to-gross" (NTG) ratio that incorporates both free ridership and spillover. An NTG ratio less than one means that the effects of free ridership outweigh the effects of spillover. An NTG ratio greater than one means the opposite. The first three rows of Table 10.1 provide an example of what such projections might look like for a given measure over a five-year period, with the NTG ratio changing over time, and the fourth row indicates the net level of free riders or free drivers in each year. Units of the energy-efficient measure are used in this example for clarity, but the units could be multiplied by savings-per-unit to produce the same analysis using savings.

This example also includes a projection of "naturally occurring" efficiency, that is, implementation of efficient measures that are not influenced by program incentives or activities. This can be the result of increasing codes and standards, technology evolution, rising energy prices, or other factors. Naturally occurring energy efficiency can be added to program-attributable efficiency to project the total level of efficient-measure implementation under an achievable scenario. By contrast, some studies use a reverse approach in which total and naturally occurring efficiency are projected first, and the latter is subtracted from the former to produce program-attributable implementation.[130] This approach can be represented by reordering the rows in the first table, as shown.

In the second approach, the NTG ratio can be calculated by forecasting program participation and comparing it to the level of efficient-measure implementation directly attributable to the program.

Under either approach, the primary objective is to produce a realistic estimate of the level of energy efficiency directly attributable to program incentives and activities (the third row in Tables 10.1 and 10.2), which is the key result that a potential study should project. Some potential studies project only gross savings, in which case the results do not distinguish between energy savings that can be achieved through program implementation versus the level of savings that would occur naturally in the market.[132]

Obtaining a reasonable forecast of program-attributable energy savings depends on using realistic input assumptions. In the first approach, the inputs are program participation and the NTG ratio. Under the second approach, the inputs are total and naturally occurring

130 One way this can be done is to plot measure adoption rates as a function of measure payback periods or participant BCRs. A naturally occurring rate of adoption for a given measure is assumed, based on the payback period or participant BCR with no incentives, and a higher adoption rate is typically assumed when the payback period shortens or the participant BCR increases as incentives are added. The lower naturally occurring adoption rate can then be subtracted from the higher rate with incentives to produce the adoption rate that is directly attributable to program incentives. A downside of this method is that it may not capture the effects of spillover.

131 Based upon EFG analysis.

132 See, e.g., Natural gas energy efficiency potential in Massachusetts. Prepared for GasNetworks by GDS Associates, Inc. and Summit Blue Consulting. This study projects achievable potential under different levels of market penetration (60 percent and 80 percent) but does not assess the extent of market penetration that would be attributable to program incentives and activities as opposed to natural market forces.

Table 10.2 [131]

	Year				
	1	**2**	**3**	**4**	**5**
Total Efficient Units Implemented Under Achievable Scenario	40	60	80	90	90
Naturally Occurring Implementation	10	11	12	13	14
Measure Implementation Attributable to Program	30	49	68	77	76
Efficient Units Implemented with Program Incentives	30	45	65	80	80
Free Drivers/(Free Riders)	0	4	3	(3)	(4)
Net-to-Gross Ratio	1	1.1	1.05	0.96	0.95

efficiency. Issues in forecasting program participation have been discussed previously in this report, and similar issues arise in forecasting total and naturally occurring efficiency.

The challenges associated with projecting NTG ratios can be equally complex. In the context of potential studies, NTG ratios are often taken from other sources, such as previous program evaluations or estimates from similar programs in other jurisdictions, in which case the key is to understand the methodological issues that may have been present when the original estimates were produced. These estimates may have been based upon surveys of participants and non-participants or upon econometric models. Survey-based methods are often fraught with challenges, such as ambiguous responses, missing data, self-selection biases, and issues with question wording. In addition, it may be difficult to classify certain respondents, sometimes referred to as "partial free riders," who indicate that they might have implemented an efficient measure without incentives, but would have waited longer and purchased a slightly less efficient model than that incentivized by the program, or purchased fewer units than they did with the incentive.[133] Econometric modeling, on the other hand, can involve a high degree of subjectivity in certain key relationships, such as the payback period at which individuals would likely implement a measure even without incentives. Econometric models may also overlook factors outside the model that influence measure adoption rates.

Other issues complicate the use of NTG ratios as well. For example, using previously observed NTG ratios to project future net savings means relying upon backward-looking information to forecast future trends, despite the likelihood that circumstances will change over time. Given the difficulties in estimating NTG ratios retrospectively, forecasting these values prospectively in a 20-year potential study is clearly a challenge and will entail some level of subjective judgment. Furthermore, as NTG ratios may vary for each individual measure (e.g., because natural adoption rates differ), accurately projecting separate NTG ratios for the hundreds of individual measures that are often included in a portfolio only furthers the challenge of forecasting net savings. This issue is sometimes dealt with by estimating and applying NTG ratios at the program level, but such an approach may widen the band of uncertainty into which the estimate falls.

As a result of all of these issues, choosing reasonable NTG ratios is typically not an exact science.[134] In some cases, it may be appropriate to apply a range of possible NTG ratios based on different assumptions and show how outcomes would differ accordingly. At a minimum, the assumptions that underlie the NTG ratios that have been used should be stated explicitly and clearly explained.

Impact on Savings and Cost-Effectiveness (Direction)

The impact on both savings and cost-effectiveness of calculating net savings can be positive or negative, depending on whether adjusting gross savings results in greater or fewer savings being attributed directly to program incentives and activities. If more savings are attributed directly to energy efficiency programs, the impact on both savings and cost-effectiveness will be positive. If fewer savings are attributed to programs, the impact will be negative. Given that NTG ratios used in potential studies are frequently drawn from other sources, the impact may depend on which sources are chosen and how those sources change over time.

For example, some potential studies in various parts of the country have adopted NTG ratios from the Energy Efficiency Policy Manual published by the California Public Utilities Commission (CPUC).[135] Early versions of this policy manual drew their estimates of NTG ratios from a 2000 report by the California Measurement Advisory Commission (CALMAC) that compiled a limited number of NTG ratios at the "program element" level (roughly somewhere between the measure and program level) based on previously conducted program evaluations.[136] In addition, the report estimated a "default" NTG ratio of 0.8, based on a weighted average of all evaluated NTG ratios, to be applied if no specific NTG ratio from a previous

133 National Action Plan for Energy Efficiency. (2007). Model Energy Efficiency Program Impact Evaluation Guide. Prepared by Schiller, S. R., Schiller Consulting, Inc. p. 5-1 – 5-2. Retrieved from www.epa.gov/eeactionplan

134 Id., p. 5-1.

135 California Public Utilities Commission. (2008, March 28). Energy Efficiency Policy Manual, Version 4.0. Retrieved from http://docs.cpuc.ca.gov/efile/rulings/80685.pdf. NTG ratios have also been adopted from earlier versions of this manual.

136 California Measurement Advisory Committee Public Workshops on PY2001 Energy Efficiency Programs. (2000, September 25).

evaluation were appropriate. Some critics argued that this 0.8 default value was too high because the weighted average was based heavily on programs using downstream rebates, which tend to have low free-ridership rates because they require participants to send in rebate forms.[137] In 2008 the 0.8 default rate was revised downward to 0.7 for most new programs "with no convincing strategies to discourage free ridership."[138] In addition, measure-level NTG ratios were calculated for many more measures both above and below 0.8, so that the default rate could be applied much less frequently.

Nonetheless, the 0.8 default estimate had remained in place for approximately eight years and was applied during that interim to a number of programs and measures in multiple potential studies of various jurisdictions outside California.[139] Whether adopting California's revised NTG estimates would have a positive or negative impact on net savings would depend on whether the measures with revised NTG ratios above 0.8 or those with revised estimates below 0.8 predominated in the mix of measures included in a given jurisdiction's portfolio. At the same time, the accuracy of these revised, measure-specific NTG estimates would depend on how they were derived and their applicability to future circumstances in the jurisdiction in which they were applied.

Impact on Savings and Cost-Effectiveness (Magnitude)

The magnitude of the impact on savings and cost-effectiveness will depend on the extent to which changes in NTG assumptions change the level of savings that are attributed to measure and program incentives. The more savings that are attributed directly to efficiency programs, the more positive the impact on both savings and cost-effectiveness. The less that savings are attributed to programs, the more negative the impact on savings and cost-effectiveness. Following on the previous example, the more that California's upward revisions in the NTG ratios of certain measures affected the mix of measures in a given jurisdiction, the greater the positive impact on that jurisdiction's net savings and cost-effectiveness. The more that the mix of measures was affected by downward revisions on other measures, the more negative the impact on savings and cost-effectiveness. As noted previously, the accuracy of the NTG adjustments should be examined both to identify underlying methodological issues and to assess applicability to the adopting jurisdiction's projected future circumstances. For example, if NTG ratios are being used from another jurisdiction, how similar are its programs in terms of program design and incentive levels to the ones being proposed in the potential study being examined?

How to Determine Whether It Is an Issue in a Given Potential Study

Although some potential studies have not included any net-savings adjustment, forecasting net savings should be an issue in most potential studies, because the primary question these studies are typically designed to answer is the level of efficiency that could be achieved with a given allocation of resources for energy efficiency programs. As discussed previously, there are multiple ways of arriving at an estimate of savings that result directly from program incentives and activities. One option is to multiply projected measure incentives or program participation by an NTG ratio, whereas an alternative is to subtract projected naturally occurring implementation from projected total measure implementation both in and out of the program. As previously observed, both of these options involve challenges that must be addressed. A third alternative, common in non-residential projections of savings potential, is to use a "top-down" approach that allocates projected energy sales to various end uses, and

137 Letter from The Utility Reform Network to the California Public Utilities Commission. (2010, July 22). Retrieved from https://www.pge.com/regulation/EnergyEfficiencyRisk-RewardIncentiveMechanismOIR/Other-Docs/TURN/2010/EnergyEfficiencyRisk-RewardIncentiveMechanismOIR_Other-Doc_TURN_20100622-01.pdf

138 NTG Values and Summary Documentation. (2008). 2008 Database for Energy-Efficient Resources. Retrieved from http://www.deeresources.com/index.php?option=com_content&view=article&id=65&Itemid=57

139 See, e.g., ICF. Entergy New Orleans, Demand Side Management Potential Study, Summary. (2009, April 28). p. 2-22 – 2-23. Retrieved from http://www.entergy-neworleans.com/content/IRP/Energy_Smart_Appendix_9.pdf, and ICF. South Carolina Electric and Gas. DSM Potential Study, Final Report. (2009, September 30). p. 1-13. Retrieved from http://www.psc.sc.gov/exparte/briefing2010aug18/Ex_Parte_Briefing_Materials_08-18-2010_13SCEG%20DSM%20Potential%20Study.pdf. Note that these studies adopted the policy manual NTG ratios for purposes of cost-effectiveness screening rather than to project net savings.

then project the percentage of those sales that can be reduced through energy efficiency. Total sales projections will often already account for naturally occurring energy efficiency, such that any additional efficiency projections can be attributed to the proposed programs rather than to naturally occurring efficiency.[140] If this approach is used, it is important to be clear whether and how the baseline sales forecast accounts for the effects of naturally occurring energy efficiency in the future, so that there is consistency between the sales forecast and the potential study results. Regardless of the approach taken, the specific challenges involved should be identified up front, and a strategy to address them should be discussed.

If reading a completed study, one should look for language or calculations that include naturally occurring energy efficiency or NTG ratios. This section of the study should indicate what approach was used to project net savings, if any, which will suggest what types of challenges may have been involved in the forecasting process. If the study only projected gross savings, that issue should also be recognized, and the study's results should be interpreted in that context.

How to Avoid the Issue in the First Place or Correct It

Whether forecasting net energy savings as opposed to gross savings is to be be the focus of the study should be clarified during the initial project discussion. Assuming that projecting net savings will be the ultimate objective, the methodology that will be used should also be discussed, and the challenges associated with the chosen approach should be identified. If NTG assumptions will be used, their source and level of application (measure versus program) should be determined up front and subsequently stated in the RFP and finalized scope of work. Other issues should be addressed as well, such as the applicability of any adopted NTG assumptions to projected future circumstances, and whether and how these values might change over time. Other challenges may need to be discussed if different methods of forecasting net savings are used, most of which are discussed throughout other relevant sections of this report.

How to Reinterpret Potential Study Findings When the Issue Is Already Embedded

In some cases it may be possible to convert a gross savings projection to net savings or change the net savings forecast by adding or changing the input assumptions that go into calculating net savings, such as forecasted naturally occurring energy efficiency or estimated NTG ratios. Typically the net savings forecast will be easier to reinterpret if the given inputs are less granular (e.g., if they are made at the program level rather than the measure level). The fewer assumptions that must be changed to reinterpret the projections, the easier it will be to estimate an adjusted savings forecast.

Even with higher-level inputs, however, reinterpreting results may be challenging if there are questions such as how the inputs might vary over time. In some cases, changes over time may affect both the naturally occurring efficiency (or NTG ratios) and net savings independently, which can make the relationship between the inputs and outputs more complex. For example, if energy prices rise over time, this may make it easier to be successful with program marketing efforts, but it may also increase the level of naturally occurring energy efficiency. Determining the sensitivity of both marketing efforts and naturally occurring energy efficiency to rising energy prices and parsing out the two effects may or may not be feasible.

140 See, e.g., Vermont Electric Energy Efficiency Potential Study, Final Report. (2007, January). Prepared by GDS Associates, Inc. for the Vermont Department of Public Service, p. 39. "For the commercial and industrial sectors, where a top-down approach is used to estimate electric savings potential, free-riders are accounted for through the electric energy and peak demand forecast provided by ISO-New England. This electric kWh sales forecast already includes the impacts of naturally occurring energy efficiency... Because naturally occurring energy savings are already reflected in the electricity sales forecast used in this study, these electric savings will not be available to be saved again through the GDS energy efficiency supply curve analysis."

Conclusions and Recommendations

As noted in the introduction, two essential themes common to all of the issues discussed in this report are the importance of addressing each of these topics early in the study planning process and the need to clarify in writing how each one will be approached. Several additional threads emerge out of the narrative discussion of these issues, pointing toward certain recommendations to improve potential study analysis and interpretation. Three key points stand out in particular, namely, the importance of clearly defining the study scope, the need to manage the challenges of predicting the future, and the value of placing potential studies into the broader context in which they are used. These essential takeaways are summarized below.

Carefully Define the Study Scope

Many of the issues discussed in this report can be seen as examples of the need to define the study scope clearly and carefully. A basic principle in setting out the study scope is to ensure that it matches the underlying questions the policymakers and key stakeholders wish to answer. For example, before defining "achievable" savings, analysts should ask whether the question being explored is the level of savings that could be achieved without any budget limitations or whether specific budgetary restrictions should be applied. Similarly, if the question being examined is the maximum level of savings that can be achieved in a given jurisdiction, analysts should generally consider not only lost-opportunity initiatives, but also additional measures and programs, such as early retirement and retrofit efforts. Furthermore, if the important question is not simply what level of energy efficiency may occur in the future, but rather how much efficiency can be directly attributed to ratepayer or publicly supported programs, then analysts should typically develop appropriate NTG savings assumptions and separate out naturally occurring efficiency.

In addition to answering the right questions, the study scope should correspond with the perspective or perspectives that the study is designed to consider. To the extent that the perspective being applied is that of the entire jurisdiction or society as a whole, this should be reflected in the study's methodology. In such cases, analysts should consider including the full range of energy and other resource benefits, carbon emission reductions, abatement of other environmental externalities, and NEIs in screening measures and programs to determine their level of cost-effectiveness. If a societal perspective is the approach taken, analysts should consider using a discount rate that is consistent with the required rate of return of society as a whole. Other choices in benefits and discount rates may be appropriate if policymakers and stakeholders agree that the perspective of the study should be more limited, or that the perspective of specific parties should at least be included as part of the analysis.

The study scope should also reflect any additional policy considerations and constraints that policymakers may wish to apply. These considerations may vary widely, from budgetary allocations that restrict spending to certain sectors or direct funds toward income-targeted programs, to requirements that utilities and program administrators consider joint promotion of programs aimed at saving energy from different fuels. Many other policy considerations may be considered as well, such as a requirement to mix shorter-term resource acquisition objectives with longer-term market transformation programs or an obligation to tailor programs toward goals such as reaching all customers, addressing all end uses, or achieving deep and comprehensive savings within single facilities. Although many of these policy goals may be worthy of pursuing, they should generally be balanced against the basic goals of achieving immediate and longer-term energy savings. In some cases, pursuing specific policy objectives may limit energy savings, while in other cases, certain policy directives may actually improve savings projections and results.

Designing the study scope to be consistent with the questions, perspectives, and objectives of policymakers and key stakeholders is one of the first and most fundamental tasks that potential study analysts should take on, as it will be far more difficult to adjust the scope once significant analytical work has already been completed. Understanding the study scope when reviewing and making use of study results is equally critical. To the extent that the scope has been shaped according to certain parameters, these parameters should always be part of the discussion when study results are cited. Any limitations or requirements affecting the study scope in one jurisdiction at a given point in time should also be noted if a given study's results are used as a yardstick in other settings or contexts.

Manage the Uncertainty of Predicting the Future

Energy efficiency potential studies are by definition projections of possible future scenarios that entail a degree of uncertainty. This uncertainty impacts a number of aspects of the potential study analysis, from projecting levels of program participation to anticipating changes in codes and standards and predicting advancements in energy-efficient technologies. Analysts should consider using a range of forecasting methods to address the uncertainty underlying these predictions or at a minimum should state clearly the limitations of the methods they have chosen.

Too often, analysts rely heavily upon simplified quantitative modeling techniques that may lend an artificial sense of authority to predicted outcomes. As with any model, however, potential study forecasts are only as good as the assumptions that feed into them. Often these assumptions are based upon observed historical relationships, which may or may not continue in the future.

An alternative to accepting the false precision of a single forecasted outcome is to consider a range of possible scenarios in which various inputs and their relationships to each other vary over time. For instance, in predicting market penetration of various measures, analysts may choose to vary both forecasted measure incentives (which may change depending on how technology advancements progress) and the relationship of incentives to measure uptake (which may change for a wide variety of reasons, such as growing concerns over climate change). This practice will tend to reveal a more realistic range of possible outcomes that can be evaluated according to the likelihood that they may occur. In some cases, qualitative judgments based on expertise and past experience may be as useful as quantitative forecasts in judging the likelihood of alternative future outcomes.

The fact that predicting the future can be complex and imprecise does not mean, however, that possible changes in future circumstances should be ignored. If there is a reasonable likelihood that energy efficiency codes and standards will change, for example, the potential impacts of these changes should be addressed in technology baseline and sales forecast assumptions, in conjunction with possible advancements in alternative efficient measures. Similarly, the fact that it may be difficult to predict the level of naturally occurring energy efficiency in future years does not mean that all forecasted savings should be attributed to programmatic activities. On the contrary, a reasonable range of possible outcomes and potential impacts should be considered and discussed in the analysis.

Consider the Broader Context into Which the Study Fits

Very often, energy efficiency potential studies tie into other work that has been or will be conducted in a given jurisdiction. In some instances, as with independently conducted energy sales forecasts, this work may impact the inputs used in the potential study analysis and the resulting outcomes. In other cases, as with evaluations of supply-side resources and IRPs, this outside work may come into play when evaluating energy efficiency as a resource alternative.

To the extent that independent work determines potential study inputs, any significant issues with these outside sources should be identified and addressed before their results are incorporated into the potential study analysis. For example, sales forecasts should be scrutinized to verify whether the projections contain embedded historical assumptions about energy efficiency investments or account for possible future changes in codes and standards. If methodological choices have been made that do not make sense in the context of a potential study, analysts should attempt to correct them in a reasonable manner so that a more appropriate adjusted set of inputs can be used.

In the case of independent evaluations of supply-side resources or IRPs, care should be taken to ensure that energy efficiency is evaluated on an equal footing with other resources. Inputs used to gauge the costs and benefits of supply-side resources—such as fuel prices, inflation rates, and costs of capital for various parties—should be consistent with those that are used to assess the value of energy efficiency.

It may not always be possible to control the methods and perspectives of independent work that is relevant to the assessment of potential study outcomes. Where reasonable adjustments are feasible to ensure consistency and address any methodological concerns, analysts should consider making them. Even when adjustments cannot be made, however, analysts should acknowledge and discuss the interactions between the potential study analysis and other work that pertains to the evaluation of energy efficiency as a resource and its influence on energy usage over time.

This imperative to acknowledge and explain the key factors that have influenced potential study results reaffirms the essential quality that should characterize any potential study: transparency. It is better to acknowledge complexity, discuss the methodological choices that have been made, and let reviewers interpret study results for themselves than it is to mask or gloss over potential disagreements with study results. Potential studies are complex by nature, relying upon a wide variety of inputs to predict at best a range of probable outcomes. There is no downside to acknowledging that the outcomes presented may or may not bear out in practice, depending on how key factors change over time. Indeed, highlighting this reality and providing sufficient information to allow reviewers to interpret projections in the proper context, as well as to adjust these projections by varying input assumptions, may be the most valuable service that potential study analysts can provide.

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