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Title
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Author
Hoffman, Ian M.

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Case Study of a Midwestern Residential Energy Upgrade Program

Ian Hoffman, Merrian Borgeson and Mark Zimring

Executive Summary

With the proliferation of statewide energy savings targets and other policies favorable to energy efficiency, savings from utility customer-funded energy efficiency programs could rise to offset much of annual load growth by 2025 (Barbose et al 2013). For these increased savings to occur, however, nearly all of these programs must pass screening for cost effectiveness. Some program administrators and state regulators are finding that conventional analyses, which only consider a narrow set of energy-savings related efficiency program benefits, are now resulting in some natural gas efficiency programs failing their cost-effectiveness criteria in the new low natural gas price environment. Regulators are considering whether to scale back or terminate gas portfolios in at least four states (WA, OR, ID, NM) because of cost-effectiveness concerns.

Stakeholders in several regions of the country have asked LBNL to help assess alternatives to reducing the pursuit of energy savings in their regions. We address these requests by producing two working papers: one exploring cost-effectiveness screening policy implications of low to moderate natural gas prices, and a second assessing some of the values that policymakers may take into account in weighing the pros and cons of ending natural gas efficiency programs. In this policy brief, we lay out the challenges that low gas prices pose for cost effectiveness of an electric-gas efficiency program and portfolio. We then quantify options available to regulators and administrators who want to evaluate the tradeoffs among multiple policy objectives.

A multi-measure, residential energy upgrade program in the Midwest is used as a lens to explore the implications of common and emerging cost-effectiveness policies in the context of low prices for natural gas. We illustrate the results across a range of cost-effectiveness screening options, including different discount rates, levels of test application, various benefit-cost tests, and the inclusion of non-energy resource benefits.

While valuing cost effectiveness is a product of many choices regarding inputs and methodologies, this policy brief concentrates on several key issues that are likely to be common across most market and regulatory contexts:

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This document is a part of LBNL's Clean Energy Program Policy Brief series. *These policy briefs highlight emerging program models, important issues that programs face, and how these issues are being addressed. To join the email list to receive briefs and papers from this series, please click here. Please direct questions or comments to Ian Hoffman (ihoffman@lbl.gov).*

1. **Selection of an economic test** – For energy efficiency, cost effectiveness is assessed by comparing costs and benefits of an efficiency measure, program, or portfolio of programs. This analysis is focused on three economic tests – the total resource cost (TRC) test, the societal cost test (SCT), and the program administrator cost (PAC) test. Almost all states use one of these tests as the primary determinants of cost effectiveness. Each test is described in the next section.

2. **Screening level** – Screening may be performed at the measure, project (e.g. multiple measures installed in one building), program, sector (e.g., residential and non-residential), or portfolio (efficiency programs across all customer classes) levels.

3. **Discount rate** – For energy efficiency, benefits such as savings of energy and water, as well as avoided capacity costs, are realized over the lifetime of the energy-saving action or measure being installed. In assessing cost effectiveness, that stream of monetized benefits is "discounted" to the present so that those benefits can be compared to implementation costs in the same time frame.

Our analysis suggests that both low natural gas prices and the cost-effectiveness screening policy choices that are prevalent in many states are likely to pose challenges for the viability of those residential efficiency upgrade programs that target only natural gas savings and possibly those that target both electricity and natural gas savings opportunities as well. Our key findings include the following:

- In the current environment of relatively low actual and projected gas prices, it could be very difficult for individual residential energy upgrade measures such as insulation and air sealing to pass a Total Resource Cost test when applied at the measure level in gas-heated homes. These core measures did not pass screening as either single-fuel or combination electric-gas measures for the Midwest utility program analyzed in this paper.

- Cost effectiveness for gas-only and combination electric-gas residential programs may still be challenging when the Total Resource Cost test is applied at the project and program level. Depending on program and portfolio design and such factors as climate, entire residential gas-only portfolios may be not cost effective under a TRC test. On the other hand, when screened at the portfolio level, the selected Midwest electric-only and combination-fuel portfolios (including programs across all sectors) are cost effective under every test, and the gas-only portfolio draws close to cost effectiveness under a TRC.

- Alternative benefit-cost tests offer mixed results at the program level. The residential energy upgrade program is cost effective as an electric-only, gas-only or combined electric-gas program under a societal cost test. An electric-only version of the upgrade program passes under a PAC test but fails as combined-fuel or gas-only program. For reasons explained below, other program designs may fare differently.

- Using a societal discount rate or adjusting the standard utility weighted average cost of capital to account for what some argue is the lower risk of cost recovery for energy efficiency programs can have a significant positive effect on cost effectiveness. A low discount rate by itself can render the combined-fuel and electric-only versions of our home energy upgrade program cost effective at the program level.

The cost-effectiveness challenges identified in this policy brief draw attention to questions of whether, given increasing efficiency goals and low to moderate projected future gas prices, screening policies and practices are aligned with public policy goals for energy savings and reduced environmental impacts. The difficulties confronting residential programs in general, and gas-only programs in particular, may conflict with achievement of energy savings targets, reductions of greenhouse gas emissions and equitable access to, and delivery of, energy savings across customer classes. The findings in this report suggest difficult choices ahead for regulators and administrators of gas-only and electric-gas programs if more comprehensive, multi-measure residential programs – and several other types of residential gas programs – are to remain part of the strategy for meeting state energy savings targets.

We conclude that certain screening policies can enable the use of these residential energy efficiency programs: adoption of a societal perspective (with a lower discount rate), changing the choice of benefit-cost test employed, relying more on portfolio-level screening, developing approaches to consider uncertainty in gas prices, and accounting for non-energy benefits. Some of these options probably would require a rulemaking and have implications for electric programs as well. State regulators may also want to consider encouraging multi-fuel program approaches to energy efficiency, where they are not already the norm, as this allows implementers to offer packages to homeowners that capture more of the savings available in each home.

Introduction

For energy efficiency programs funded by utility bill-payers, cost effectiveness generally is defined as providing benefits in excess of the costs to acquire those benefits (i.e., the ratio of benefits to costs exceeds one). Yet the definition and accounting of costs and benefits is based on perspective. For regulators, these determinations are a reflection of the values that each jurisdiction's policymakers assign among multiple policy objectives including saving energy, saving money for utility customers, achieving environmental and health goals, and ensuring reasonable energy rates. Cost-effectiveness screening approaches and inputs therefore vary widely among states.

Multi-measure energy upgrade programs for homes are particularly sensitive to cost-effectiveness screening practices. These more comprehensive "whole home" or "home performance" programs take a systems approach to residential energy efficiency, typically starting with a detailed assessment of a home's energy performance. The assessment identifies opportunities for improvement. Improvements range widely in scope (often $2,000 to $15,000 in total project costs), but the baseline upgrade usually involves insulation, air sealing and some additional measures.

These programs typically deliver a range of long-lasting public and private benefits that can be difficult to value and are not captured fully in cost-effectiveness screening. Low current and projected natural gas prices are exacerbating these screening challenges by reducing the monetized benefits of the energy savings. Yet regulators and program administrators are increasingly turning to these more comprehensive approaches to residential energy efficiency for several reasons. New state and federal end-use standards are raising the baseline of energy performance for commercially available products and thus reducing the expected savings from single-measure rebate programs that have traditionally targeted these measures.[1,2] At the same time, program administrators often face energy savings targets or goals that are increasing over time. Many states estimated energy savings potential and enacted savings targets in an era of high gas prices, and the annual growth in gas efficiency program spending associated with meeting those targets is 2.9 percent through 2015, or more than three times the 0.9 percent annual growth rate between 2015 and 2025 (Barbose et al 2013), i.e. funding requirements to meet savings targets is steep in the near term, when gas prices and benefits are likely to remain low.

Home energy upgrade programs are regarded as one potential answer to these coincident challenges of meeting rising savings targets while dealing with potentially leaner opportunities for savings. Cost effectiveness is a key criterion in deciding how and where program administrators will acquire energy savings and whether more comprehensive approaches offer a solution. Five categories of screening policies have the most significant influence over cost effectiveness. For this analysis, we focus on the first three categories of policy decisions because they are likely to be common decision points across most market and regulatory contexts.[3]

1. **Screening test** – The tests embody policy and economic perspectives on who pays and who reaps the benefits of energy efficiency programs. The tests of interest in this analysis are described below.

2. **Screening level** – Cost-effectiveness screening may be applied at the level of individual efficiency measures, projects, programs or program portfolios.

3. **Discount rate** – A range of discount rates may be selected, each reflecting a different perspective on an investment and its benefits.

4. **Definition of avoided costs** – Costs avoided by the implementation of energy efficiency programs typically include avoided purchases or investments in energy, generation capacity, and transmission and distribution capacity. States vary widely on the extent to which they direct program administrators to account for the costs of complying with imminent or reasonably likely environmental controls, reductions in fuel hedging costs and reductions in energy prices as a result of lower demand in assessing the potential benefits of energy efficiency programs.

5. **Inclusion of energy savings from other fuels and non-energy benefits** (NEBs) – NEBs can be categorized as benefits beyond monetized energy savings that accrue to utilities

[1] Savings are determined as the difference between energy use of the new efficient device and the energy use of the baseline device; if the baseline unit uses less energy because of a new standard then the savings determined for using the new device are less than if the new standard was not in place.
[2] A number of standards arising from implementation of the Energy Policy and Conservation Act of 2005 and the Energy Independence and Security Act of 2007 take effect over the next decade, including standards for lighting fixtures, furnaces, and boilers. Some of these end uses have provided a large share of savings for program administrators. For example, compact fluorescent light bulbs in 2009 accounted for 24 percent to 53 percent of electric portfolio savings in California, Massachusetts, New York and Vermont. Program administrators will continue to have single-measure lighting programs after the new standards take effect, but those programs are generally considered less likely to generate the same magnitude of savings as in the past.
[3] A host of other policy options are available but are not explored in this analysis. Forecasts of avoided costs can more explicitly account for environmental compliance costs and utility investments to hedge against fuel price volatility. Benefits can include a variety of "other program impacts" (OPIs), a term recently coined by Woolf et al. (2012), that captures energy savings from fuels other than those supplied by the utility and non-energy related impacts from energy efficiency programs. Bringing OPIs to bear in a more comprehensive and explicit fashion can have significant impacts on cost effectiveness.

(energy providers), society as a whole, and to individual participants. Some research indicates that the value of benefits to society as a whole and individual participants make up the bulk of the value of NEBs.[4] Some specific examples are savings of other fuels, water savings, reduced utility disconnections and arrearages, future environmental compliance costs and environmental externalities, participant comfort, health and safety, enhanced productivity, economic development, and job creation.

Selection of Test

We considered the three tests that nearly all states and program administrators rely upon in screening efficiency programs for cost effectiveness:

- The **total resource cost test (TRC)** is the primary test for more than 70 percent of states (Kushler, Nowak and Witte 2012). The test is intended to include *all* costs and benefits associated with securing energy savings. Costs are defined as incremental measure costs plus program administrative costs. In most states where the TRC is the primary test, benefits include avoided energy, capacity, transmission and distribution costs. The second most common formulation of the TRC where it is the primary test (Kushler, Nowak and Witte 2012) include energy savings from other fuels, savings of water or both. In a few states, the test also may include a subset of other quantifiable economic benefits, such as reduced utility disconnections and collections.

- The **societal cost test (SCT)** is used by six states as the primary test (Kushler, Nowak and Witte 2012). The SCT is a variant of the TRC that takes a societal perspective, which translates into using a societal (i.e., lower) discount rate and typically includes a broader array of benefits (e.g., reduced disconnections and bad debt write off, participant comfort, health and safety, economic development and job creation).

- The **program administrator cost test (PAC)**, previously known as the utility cost test,[5] is used by five states as the primary test (Kushler, Nowak and Witte 2012). The PAC test includes costs and benefits from the perspective of the program administrator, (i.e., all incentives and program administrative costs and system benefits, including avoided energy, capacity, transmission and distribution costs).

Test Application Level

Cost effectiveness tests can be applied to individual efficiency measures, projects,[6] programs or at the sector or total portfolio of programs (i.e., requiring each measure, project, program, etc. to be cost-effective). Screening at the measure level is uncommon for a variety of reasons, including practical difficulties for program implementation. Examples of these challenges are:

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[4] See, e.g., Skumatz, L.A., Khawaja, M.S., Krop, R. (May 2010). Non-Energy Benefits: Status, Findings, Next Steps, and Implications for Low Income Program Analyses in California. Revised Report. Prepared for Brenda Gettig, Sempra Utilities. www.liob.org/docs/LIEE Non-Energy Benefits Revised Report.pdf.

[5] In seven states, a non-utility entity administers some or the majority of energy efficiency programs.

[6] Projects here are defined as the work performed at the level of a house or other structure. Savings and costs may differ from the project level to the program level for several reasons, e.g., policy variability on allocations of administrative costs or different levels of uptake for specific measures.

- Measures that are cost effective for one climate zone or type of home occupancy (e.g. two seniors versus a large family) may not be for another climate zone or occupancy in the same jurisdiction. Measure-level screening also requires a higher level of home-by-home scrutiny and therefore higher costs, as well as having to explain to a consumer why their house is not eligible but that their neighbor's is eligible.[7]
- While every individual measure in a package may not be cost effective by itself, the aggregate package of measure represents a comprehensive approach or includes measures that participants find very appealing and thus make them more apt to perform the work.
- Eliminating measures that, while not cost effective per the set criteria, are still in the long-term cost effective. Without more cost-effective measures, the screened-out measures are unlikely to be implemented (e.g., setting the payback cut off at 10 years eliminates measures with a 15-year payback).
- Paying for the initial energy assessment, in which an expert assesses specific energy efficiency opportunities in an existing home. The assessment may not save energy *per se* but is an essential component of a whole-home energy upgrade. Measure-level screening tends to limit the number and type of measures that can bear the costs of the assessment that identifies cost-effective savings opportunities in the home.

Screening at higher levels (e.g., project, program, sector, or portfolio) allows program administrators to offer more flexible program designs that are aligned with the business practices of service providers and the interests of consumers. This typically includes offering comprehensive packages of retrofits that result in increased savings per facility and installation of measures with longer economic lifetimes that would not normally be implemented.[8] Assessing energy efficiency's cost effectiveness at the program, sector, or portfolio level is also more consistent with integrated resource planning, in which energy efficiency is assessed as an aggregated resource.

Portfolio-level screening can provide program administrators with the flexibility to offer low-income programs, tap hard-to-reach markets and introduce pilot programs that test emerging technologies or program designs aimed at transforming markets so long as the entire portfolio of programs meets the cost-effectiveness criteria.

In many states, regulators and administrators delineate which programs and activities are subject to cost effectiveness screening requirements and which may be handled differently. For example, low-income programs often are assessed using different criteria which attempt to capture other policy objectives, such as health and safety, social equity, and economic stability. Education, information or emerging technology demonstration activities may be characterized as "non-resource programs", and their merits may be assessed without formal cost-effectiveness screening or screened at the sector or portfolio level. Similarly, pilot programs may be exempted from cost-effectiveness testing during initial development and evaluation.

Discount Rate

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[7] Houses differ widely in insulation, tightness against infiltration and other energy performance characteristics. Measure-level screening can require a home energy assessor to determine, for example, exactly what increase in insulation R-value[7] will be cost effective for that house. The extra labor can be time consuming and cumbersome for contractors and increase assessment costs, potentially making the project less cost effective.

[8] It is more likely that a contractor will be able to convince a homeowner to install a package of measures all at once that includes a range of individual measure paybacks that may average seven years, rather than the contractor being able to sell the same homeowner on a smaller set of measures with a five year payback and then come back to sell them on the other measures that have a 15-year payback.

Discounting allows a stream of costs and benefits over time to be valued in the present day. The rate used for discounting is a reflection of economic perspective, the time value of money (cash in hand now is worth more than the same amount in the future) and the risk of the investment. A higher discount rate reflects a lower priority on costs and benefits farther in the future and so has the effect of lowering those future values. A lower discount rate reflects more willingness to continue investments and value benefits of current investments further into the future.

Traditionally, the choice of discount rate and the selection of test have been bound together as a matter of economic perspective. The PAC test takes a utility (or program administrator) perspective and therefore commonly uses the utility weighted average cost of capital (WACC)[9] as a discount rate to assess energy efficiency investments more or less on par with investments in power plants and other supply-side assets. The TRC integrates the interests within the utility system – ratepayers and shareholders. Ideally, the cost of capital for all of these actors would be used to discount the costs and benefits of energy efficiency improvements. However, in practice, a utility WACC is often also used as the discount rate for the TRC. States with more history in offering energy efficiency generally use an after-tax[10] WACC (currently six percent to eight percent) in the TRC and PAC tests or a societal discount rate (typically 2 percent to 5 percent) for discounting in the SCT and some TRC tests.[11] A number of states and utilities use a pre-tax WACC as the discount rate in the PAC and TRC tests (typically 8 percent to 9 percent). Because of the federal tax deduction for interest on corporate debt, the after-tax WACC is closer to what a utility actually pays.

Woolf et al (2012) argue that a standard utility WACC is not well suited to evaluating investments in demand-side resources. The premise for this argument is the high likelihood of cost recovery for energy efficiency program spending, with most costs typically collected from bill-payers at the same time as the expenditures. Woolf et al suggest that "there is little risk to the utility associated with these investments because they are passed directly on to customers independent of utility operations, utility performance or other risk factors. Consequently, an energy efficiency investment is less risky than a supply-side investment on a purely financial basis, in addition to being less risky with regard to planning, construction and operation. Therefore, a lower discount rate than the WACC (i.e., a risk-adjusted discount rate) should be used in applying the PAC or TRC tests."[12]

In terms of cost recovery, energy efficiency investments may have lower financial risk exposure than investments in new, utility-owned generation, but energy efficiency has its own, different set of uncertainties (e.g., the economic lifetime of measures if a home is remodeled or renovated; whether customers will operate and maintain equipment as specified by manufacturer or contractor; whether regulators grant full cost recovery to the program administrator). A key question is how and where to account for differences or changes in risk exposure, through explicit changes to elements of the avoided cost forecast, or by changing the discount rate. In general, states have tended not to base discount rates on differences in supply- and demand-side resource risk but rather on a choice of perspective between a utility stakeholder and society at large. While an analysis of supply and

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[9] The WACC is the combined average of debt and equity rates that the utility must pay, weighted by the amount of capital that each of those sources provide.

[10] A pre-tax WACC is the cost of capital fully burdened by federal, state and local taxes. An after-tax WACC is closer to the actual cost of capital because it reflects the standard deduction for interest paid on business loans.

[11] Note that the California PUC recently adopted the after-tax WACC as the discount rate for cost-effectiveness screening. (Decision 12-05-015 providing guidance on 2013-2014 energy efficiency portfolios and 2012 marketing, education, and outreach in Rulemaking 09-11-014

[12] Woolf et al propose using a 3.2 percent interest rate "risk-adjusted" WACC (compared to a standard pre-tax WACC of 7.5-9 percent).

demand risk profiles is beyond the scope of this paper, in following sections we present several discount rate options and indicate their impact on cost effectiveness.

Single- vs. Multi-Fuel Approaches to Home Energy Upgrades

In states where program administrators face energy savings targets or goals for both electricity and natural gas, some single-fuel electric and gas utilities deliver programs jointly.[13] But these multi-fuel offerings are more the exception than the rule; most single-fuel utilities administer programs on their own. We analyzed cost effectiveness for electric and gas programs separately as well as together in order to get a sense of how low, near-term natural gas prices impact single- vs. multi-fuel program cost-effectiveness.

Analytic Approach

Program Selection

For our test case, we selected a program offered by a combination electric-gas utility in the Midwest.[14] We evaluate cost effectiveness separately for gas and electric measures, programs, and portfolios – and offer some observations on the relative cost effectiveness of each and the implications of test application level, discount rate, and single- versus multi-fuel approaches.

The selected program consists of 1) an in-home energy assessment; 2) free, direct installation of a programmable clock thermostat, compact fluorescent light bulbs, electrical outlet gaskets, water-heater blankets, hot-water pipe insulation, faucet aerators, and low-flow showerheads; and 3) if the participant chooses to invest additional funds, air sealing and insulation measures with a rebate to cover a portion of these air sealing and insulation costs. Project costs for the program in 2012 are estimated at about $2,100 per house,[15] about 80 percent of which is paid by the program. The lifetime cost of electric savings from the measures is estimated at ~$0.05 per kWh and the lifetime cost of gas savings is about $1.11 per therm.

Treatment of Natural Gas Prices in Avoided Costs

The selected Midwest program was initially screened against an avoided cost forecast produced in 2008 and starting in 2009. Some states, especially those with efficiency program cycles that span more than a single year, allow programs to operate for multiple years after cost-effectiveness screening in the initial year utilizing that year's avoided cost forecast. With respect to valuing electricity savings from energy efficiency, the 2008 forecast, as is typically done, includes avoided

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[13] Why and how they do this differ greatly: Regulators ordered Southern California Edison and Southern California Gas to hire a common contractor. State law in Massachusetts encourages development of joint, multi-fuel programs. ComEd and Nicor Gas in Illinois launched pilots on their own and now have formal collaborations on four residential and three commercial programs through detailed coordination and cost allocation agreements and common contractors.

[14] We chose a combination electric-gas utility because single-fuel whole home programs are less common and because a primary driver for the analysis was gaining an understanding of the impact of low/moderate current and forecasted natural gas prices. We chose a Midwest utility in the interest of providing an example that would be salient for states that have avoided costs close to the national average. The comparability of the selected program remains dependent on the commonality of such other factors as program design, portfolio composition, housing stock and technical efficiency opportunities, and fuel mix. However, the selected program and portfolio were not originally designed for single-fuel savings, so some caution is warranted in drawing conclusions about cost effectiveness as a single-fuel program or portfolio.

[15] Additional rebates for higher efficiency heating and air conditioning systems and appliances are available through a separate program, with the associated costs and savings allocated to that program.

energy and avoided generation, transmission and distribution capacity costs. With respect to natural gas savings, the forecast includes the wholesale commodity cost at the nearest delivery point and estimates of avoided gas capacity costs.

A comparison of natural gas prices used in planning the selected portfolio of programs in 2008 with the more up-to-date 2012 projection from the U.S. Energy Information Administration shows a large decrease in projected gas commodity costs, with the new EIA projections about 50 percent lower than the 2008 projections (see Figure 1).

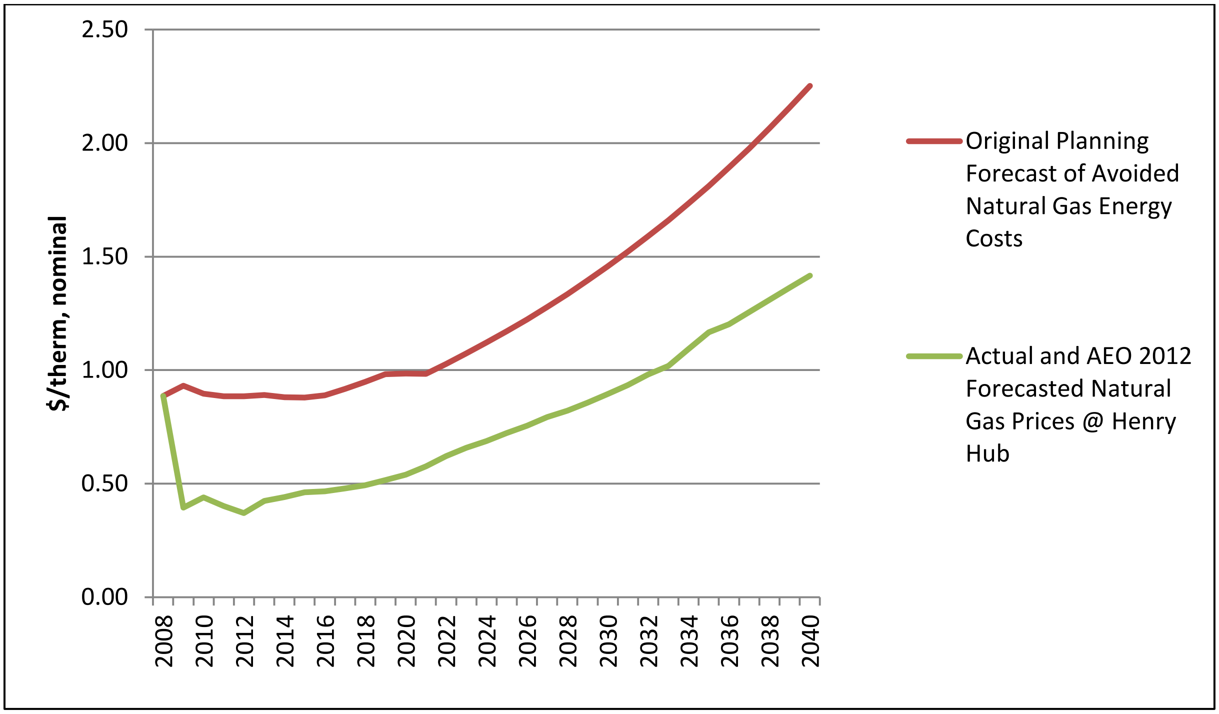

Figure 1. Comparison of original natural gas prices used in 2009 in designing the selected whole-home program with actual wholesale prices at the Henry Hub and the latest projections of those prices from the U.S. Energy Information Administration.

Source: 2011, 2012 utility filings; EIA 2012 Annual Energy Outlook. Price for 2008 in both projections is the actual average for that year. Prices beyond 2035 in the AEO projection are extrapolations.

We substituted the 2008 planning forecast with actual annual average gas prices at the Henry Hub through 2012 and the EIA projections from 2013 forward to reflect the current market environment.[16] The selected utility is in an area where recent annual average prices at nearby delivery points range from zero to $0.09 per million Btu (MMBTU) above the Henry Hub price; we applied a basis differential of $0.08/MMBTU, at the high end of this range.

In this region of the Midwest, utilities have historically used relatively little natural gas for generation; the marginal resource has typically been coal. However, low gas prices clearly are prompting some fuel switching,[17] and gas increasingly has supplanted coal on the margin in at least

[16] The EIA projection is useful for our purposes because we do not intend this analysis to serve as the basis for resource evaluation or planning but rather to illustrate varying approaches to cost effectiveness screening.

[17] See the Federal Energy Regulatory Commission's most recent monthly state of the market report for electricity generation for natural gas in the Midwest.

the last two years. Without using the same dispatch model as the utility, it is not possible to replicate or project its generation mix forward in time. But in order to create a proxy for these market shifts, we examined the recent operational record for single-cycle combustion turbines owned by the utility and used approximately the same peak price triggers as a threshold for adjusting the electric avoided cost forecast.[18] Using this methodology, electricity avoided costs dropped by an average of slightly more than two percent over the study period, again partly because our methodology is premised on the assumptions that gas is infrequently the marginal resource and that fuel switching is modest. Significant deviation from these assumptions would reduce electric avoided energy costs and make electric efficiency programs less cost effective.

Screening Methodology

Test Selection

The starting point for the analysis was a commonly used version of the total resource cost (TRC) test that includes only avoided costs for energy, generation capacity, and transmission and distribution. We used gross electricity and natural gas savings for simplicity.[19] We applied this basic TRC test for each fuel at each application level and each discount rate appropriate for the test. We employed four variants of the TRC test: 1) discounting at an 8.75 percent pre-tax WACC; 2) discounting at a 7.5 percent after-tax WACC; 3) discounting at a 3.2 percent "risk-adjusted" after-tax WACC; and 4) adding water savings from the low-flow showerheads and faucet aerators (see Table 1).[20]

We next calculated cost effectiveness using the societal cost test (SCT) at the portfolio level using the same assumptions as the TRC described above but (a) using a societal discount rate and (b) a generic 10 percent adder as a proxy for other positive program impacts (e.g., water savings, reduced disconnections and bad debt for the utility, participant comfort, participant health and safety, economic development impacts, etc).

Lastly, we applied the PAC test at the program and portfolio level using the same assumptions regarding savings and avoided costs as in screening with the TRC.

Screening Level

Because gas prices were of particular interest, we individually screened the most gas-intensive measures – insulation and air sealing – first assuming just the gas savings along, then electric savings and then for both electricity and gas savings. We then applied the basic TRC across all measures at the project level, with costs distributed to each fuel approximately in proportion with the savings benefits associated with that fuel. We then screened at the program and portfolio level, first for each fuel and then for both fuels. We screened at the portfolio level defined in two ways: 1) all

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[18] For those hours, we adjusted the estimated fuel component of the production costs downward to a "burner tip" gas cost based on our updated gas avoided cost forecast plus an adder charged by the utility to the larger, transportation-only customers in its territory.
[19] Gross savings are the change in energy consumption and demand that results directly from program-related actions taken by participants in an energy efficiency program, regardless of why they participated. Determining net savings involves separating out the impacts that are a result of influences other than the program being evaluated, such as consumer self-motivation or effects of other programs and is not consistently defined or calculated.
[20] Water savings were estimated using deemed values for reductions in water consumption for aerators and low-flow showerheads, taken from the latest draft of the technical resource manual for another Midwestern state. Average household water usage and annual bills were taken from the most recent national and regional water rate and bill surveys taken by the American Water Works Association and Circle of Blue. We did not calculate water savings for all measures in all programs offered by the selected utility, so water savings were not applied at the portfolio level.

programs and activities and 2) all programs and activities except low-income weatherization and a new experimental pilot program.

Discount Rate

At each level, we evaluated cost effectiveness across a range of discount rates. Discounting values used in this analysis range from pre- and after-tax utility weighted average costs of capital (WACC), to a risk-adjusted utility WACC and a societal rate linked to the yield of a 20-year Treasury bill. Pre- and after-tax WACCs also were used in the program administrator cost test (see Table 1).

	Total Resource Cost Test (all values gross; no non-system impacts)			Societal Cost Test	Program Administrator Cost Test (PAC)	
Assumptions	**Measure Level**	**Program Level**	**Portfolio Level**	**Portfolio Level**	**Program Level**	**Portfolio Level**
Discount Rate						
Before-Tax WACC	8.75%	8.75%	8.75%	N/A	8.75%	8.75%
After-Tax WACC		7.5%	7.5%	N/A	7.5%	7.5%
Risk-Adjusted WACC			3.20%	N/A		
Societal Discount Rate (20-year Treasury bill)			2.50%	2.50%		
Externalities						
Water Savings (annual, per household)	$18.29[21]	$18.29	N/A[23]	N/A[23]	N/A	N/A
Flat Adder for All Other Program Impacts	N/A	N/A	N/A	10%	N/A	N/A

Table 1. Input assumptions used in cost-effectiveness screening analysis.

Results

Impact of Updated Avoided Costs

The selected Midwest home energy upgrade program is deemed cost effective using the TRC when evaluated using avoided costs that rely on the natural gas price forecast from 2008 and common assumptions for TRC inputs. However, bringing the avoided cost forecast in line with a more current natural gas price forecast dramatically reduces cost effectiveness (see Figure 2).

In Figure 2, the lighter shading on each bar represents the incremental change in the benefit/cost ratio (BCR) as one moves from a measure- to program-level screening. As a combined-fuel program, the 40 percent drop in natural-gas prices from 2009 to 2012 takes the program BCR from 1.18 to 0.78.[22] Making the program cost effective would require about a 30 percent increase in program benefits, a gap not easily closed by adding externalities as might be done with a SCT.

Impact of Changing the Level of Test Application

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21 See previous footnote regarding estimation of water savings.

22 Looking strictly at the insulation and air sealing that distinguishes this whole-home energy upgrade program from a simple direct-install or efficiency kit program, the measure-level BCR falls similarly, from 0.81 to 0.55.

If the program is no longer cost effective, what impact might changing the screening level have? As Figure 3 illustrates, a change to sectoral-level screening, which is not a common practice among states, does not result in a large increase in cost effectiveness, in part because residential programs can be somewhat less cost effective than commercial and industrial programs. However, a shift to screening at the level of the total portfolio can have a large impact on cost effectiveness (BCR = 1.45). These results underscore the sensitivity of the relative benefits of raising the screening level to the total portfolio level.

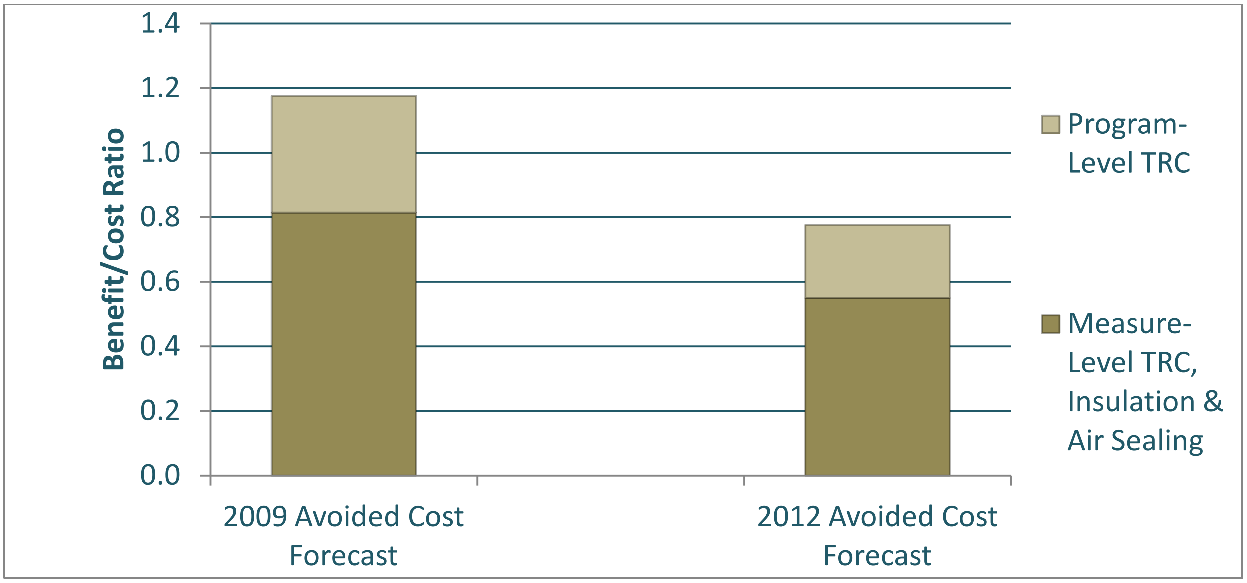

Figure 2. Change in the cost effectiveness of the dual-fuel, home energy-upgrade program attributable solely to the reduction in the avoided cost forecast using current forecast of natural gas prices. Discounted benefits are based on a utility WACC of 7.5%.

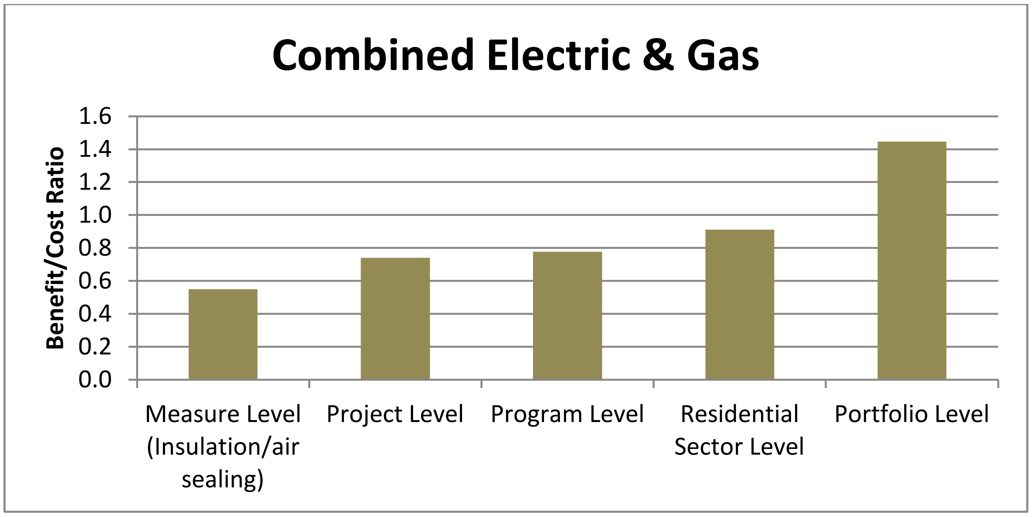

Figure 3. Relative impact on program cost effectiveness of changing the level of test application using 2012 avoided-cost projections.

When cost effectiveness is compared among electric-only, gas-only and combined-fuel programs, the results reveal the differential impact of the change in gas prices for gas versus electric programs and portfolios (see Figure 4). Gas efficiency programs face a more significant decrease in avoided costs than electric efficiency programs, especially in territories where gas-fired generators are infrequently the marginal supply resource, as is the case in the territory selected for this study. In electric markets where gas generation is more prominent and is typically the marginal resource, a sizable drop in electric avoided costs and therefore monetized electric energy benefits would be expected, [23]along with a reduction in cost effectiveness for electric-only and combined-fuel programs.

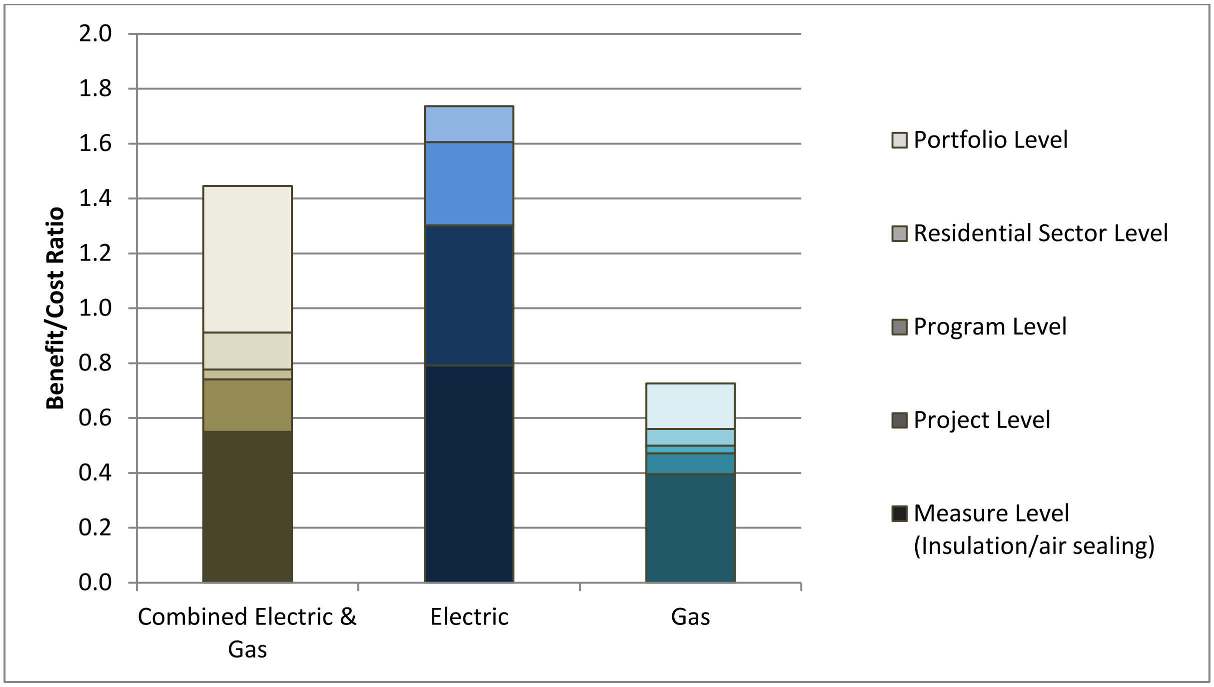

Figure 4.Impact of changing cost-effectiveness screening level by fuel using 2012 avoided-cost projections and a TRC as commonly applied. Higher levels of test screening are represented by lighter hues.

Although the whole home program is no longer cost effective as a combined-fuel offering at the program level, the program is cost effective from the project level upward as an electric program (project BCR = 1.30; program BCR = 1.61). The direct-install measures[24] in the program are inexpensive, and they are cost effective as electric-only measures, especially because of the significant savings from installation of the free CFLs that are distributed to all participants.

As a gas offering, the whole-home program is another story. The direct-install gas measures – faucet aerators, low-flow showerheads and programmable thermostats – are quite cost effective. But the costlier air sealing and insulation measures that are an essential foundation for a home energy upgrade program deliver insufficient benefits to be viable. With the drop in prospective gas prices, these measures perform poorly in terms of cost effectiveness (BCR = 0.39) and are a drag on gas program cost effectiveness (BCR = 0.49). These results indicate difficulties for combination

[23] A reduction in electric avoided costs where gas is the marginal resource is still unlikely to be on par with the reduction in gas avoided costs because avoided generation and T&D costs are typically greater for electric vs. gas utilities.

[24] Measure costs, including program costs, are distributed among measures and between fuels roughly in proportion to the measure benefits.

electric-gas home energy upgrade programs screened at all but the portfolio level, particularly in milder climates where natural gas is the primary heating fuel. The results also spell trouble for gas only programs, which, for this example, would take about a 50 percent increase in gas benefits to make this whole-home offering cost effective at the program level. Raising the screening level even to the portfolio level is insufficient (BCR = 0.73).

These findings underscore the increasing mutual dependency that electric and gas program administrators may confront as new energy efficiency standards for end uses of both fuels coincide with moderate gas prices. In gas-heating regions, electric-only programs may not be able to justify rebating of building envelope shell measures or combined heating and air conditioning systems because the electric-only savings may be insufficient to make these longer payback measures cost effective. Gas-only programs likewise may not be able to justify shell measures on their own and may be less able to justify more efficient heating systems once new furnace standards come into effect. Operating separately, gas- and electric-only program administrators may, under current market conditions, leave substantial opportunities for savings of the other fuel untapped and, in practical terms, less accessible for meeting energy savings goals and other related state policy objectives.

Impact of Changing the Test and Discount Rate

Given the above analyses and conclusions about the case study program and the cost effectiveness results with a standard TRC test, it is useful to assess how the home energy upgrade program might fare with different discount rates and under different tests.

The benefit/cost ratio for the program-level TRC as most commonly formulated is depicted at the far left on Figure 5 below, with each bar to the right representing incremental changes to the test. Adding water savings to the basic TRC, as is the practice in a number of states, increases cost effectiveness by a relatively modest amount for this whole-home program (BCR = 0.83). The water savings here are from faucet aerators and low-flow showerheads. But even though water savings are monetized at retail rates, and water rates are generally rising, residential water prices in the region are lower than the national average, and the monetized value of water savings is fairly modest relative to total benefits.

Using a PAC test, also raises the benefit/cost ratio by a significant margin but not enough to make the program cost effective (BCR = 0.92). This result is highly sensitive to program design. Part of the explanation lies with the size of the incentive. With direct-install measures that are provided at no cost to participants, the total program incentive is more than 80 percent of the incremental costs of measures across the program. As the incentive percentage rises, the benefit/cost ratio for a PAC test draws closer to the ratio for a TRC. Results could be different for "home performance" programs, which usually feature lower incentive levels, higher cost contributions from participating customers and greater savings per house.[25] Such programs would tend to fare better under a PAC test than this program does.

The largest gain in cost effectiveness comes from taking a more societal perspective on the program. Testing with a societal discount rate, makes the program cost effective (BCR = 1.22). Applying an

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[25] For a characterization of these programs, see the SEE Action Residential Retrofit Working Group Roadmap for the Home Energy Upgrade Market, available at. http://www1.eere.energy.gov/seeaction/pdfs/retrofit_energyupgradesroadmap.pdf Accelerating participation in these more comprehensive programs has proven challenging in part because of the larger project costs and larger share that participants pay.

SCT that includes water savings and a 10 percent adder as a proxy for other societal benefits naturally increases cost effectiveness (BCR = 1.37).

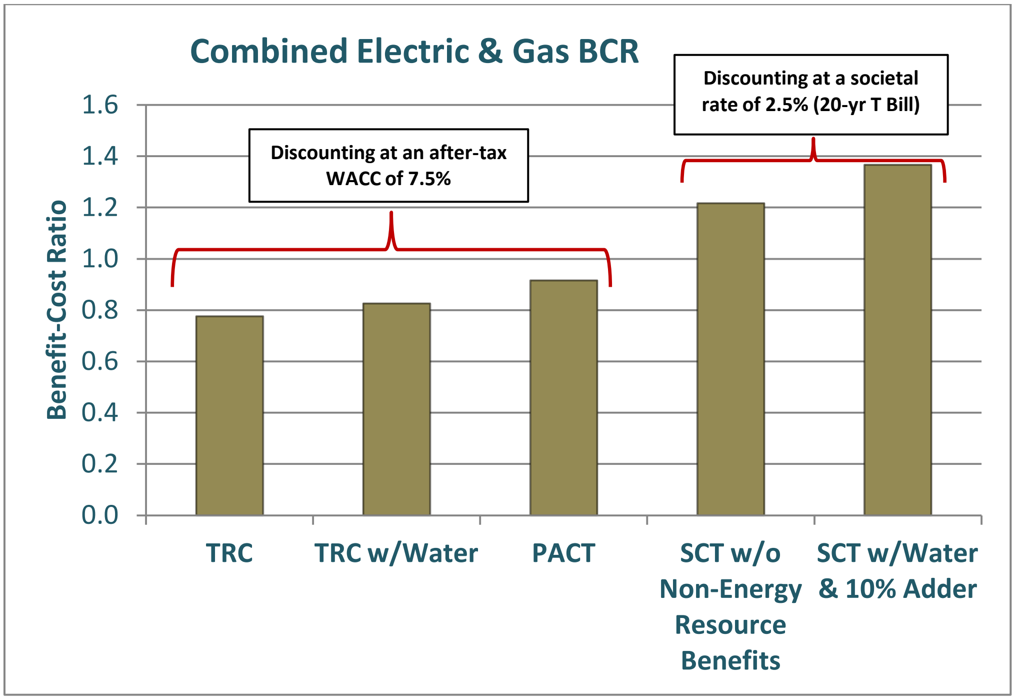

Figure 5. Impact on cost effectiveness of different economic tests and discounting using 2012 avoided-cost projections

When disaggregating these results by fuel (see Figure 6 below), the electric-only analysis is quite cost effective (BCR = 2.17). For the gas-only analysis, a TRC with a societal discount rate is not cost effective (BCR = 0.90), adding water savings brings the program closer still (BCR = 0.97), but the program as designed only is cost effective under a full SCT with the 10 percent benefit adder (BCR = 1.02).

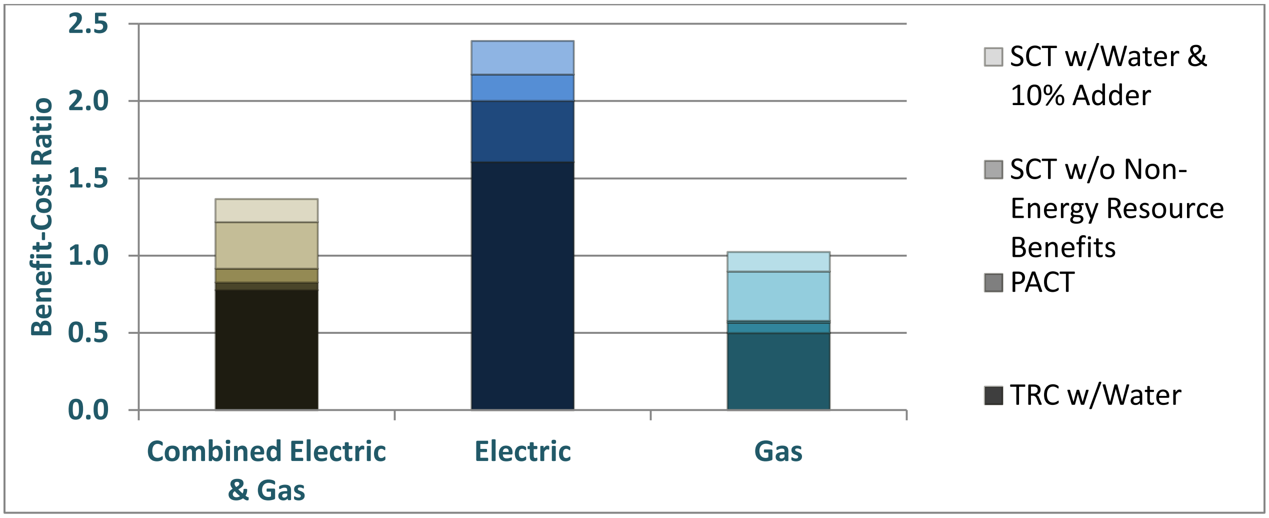

Figure 6. Impact on program cost effectiveness of employing different economic tests and variants using an updated 2012 avoided-cost forecast.

Several of the results above can be reviewed in aggregate in Figure 7, which shows the stepwise increase in incremental cost effectiveness with the application of most of the screening level and test variants discussed above.

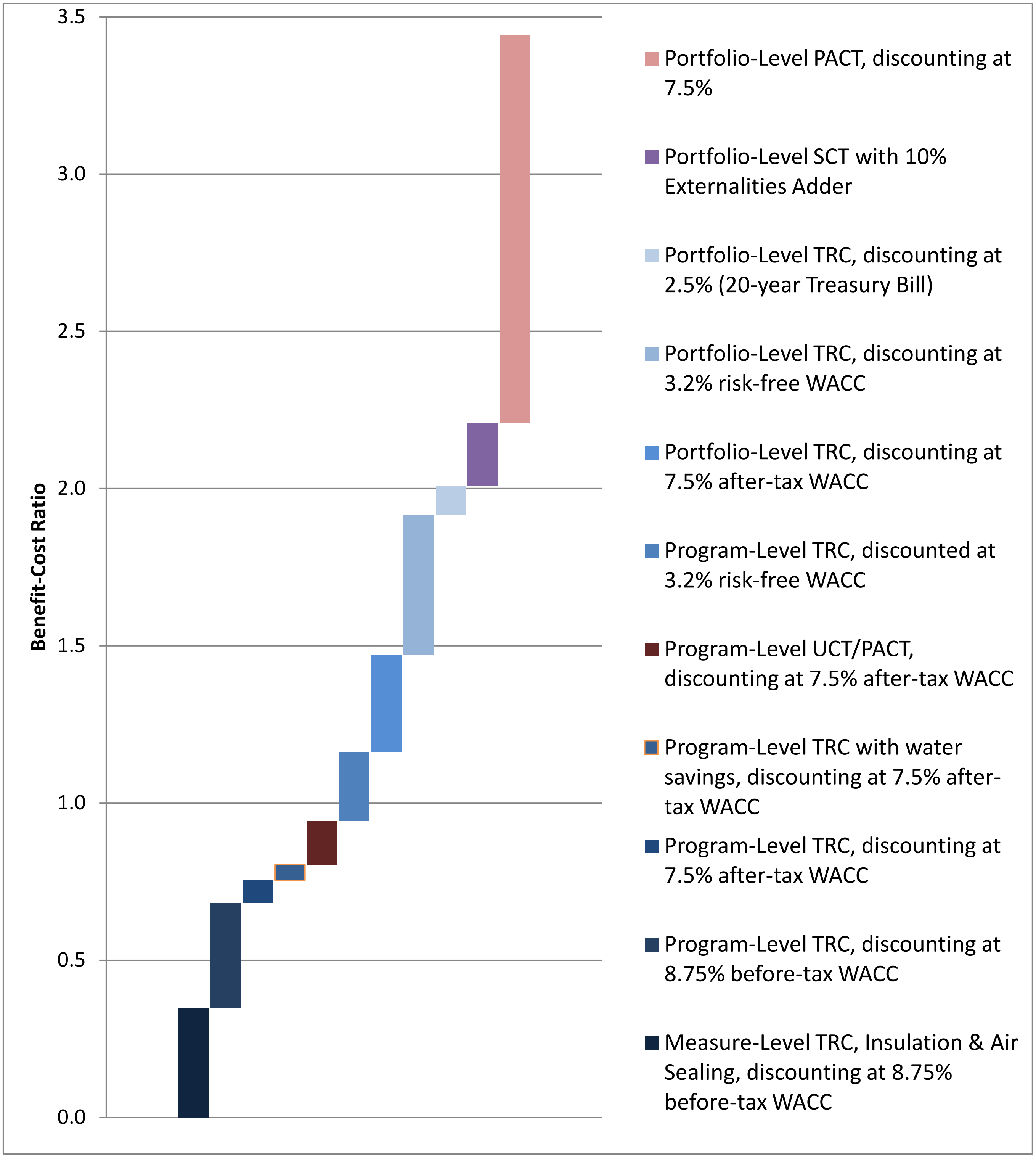

Figure 7. Impact on cost effectiveness of employing different economic tests and variants

Conclusion

Many program administrators are looking toward multi-measure home energy upgrade programs as an important element of residential efficiency portfolios. More comprehensive, multi-measure programs are especially of interest in states that have firm energy savings targets and account for the majority of projected future spending on gas energy efficiency programs. Yet these comprehensive approaches – and a number of other residential gas program designs – may face significant cost-effectiveness challenges, depending on program design, location, fuel mix and other factors.

These challenges arise primarily from the design of conventional cost effectiveness analyses, which only consider a narrow set of energy-savings related efficiency program benefits, combined with current and expected future low and moderate natural gas prices. The findings in this report underscore some of the hard choices that program administrators and regulators face in the new market environment of abundant and moderately priced natural gas. These new market dynamics are causing several states to re-examine whether current cost-effectiveness screening policies and practices align with those states' energy savings targets, environmental objectives, and other policies such as equitable access to energy savings across customer classes.

Program administrators and state regulators have a spectrum of choices in designing cost-effectiveness policies. Ideally, these options would be weighed with an eye to ensuring comparable assessments of supply and demand-side resources on the basis of cost, risk, and various energy-related externalities and non-energy benefits. These types of assessments have proven difficult as a matter of practice[26] and sometimes policy.[27] This analysis provides an illustration of the relative impacts of exercising several of the policy options available. In our analysis, combination-fuel and gas-only residential programs have difficulty passing the most common cost-effectiveness test without shifting either to portfolio-level screening, using a discount rate substantially below a utility WACC, or accounting for the range of non-energy benefits.

The findings also underscore the increasing mutual dependency that electric and gas program administrators may have if and when new energy efficiency standards for end uses of both fuels coincide with low/moderate gas prices. In gas-heating regions, electric-only programs may not be able to justify rebating of shell measures or combined heating and air conditioning systems. Gas-only programs likewise may not be able to justify shell measures on their own and may be less able to justify more efficient heating systems once new furnace standards come into effect. Operating separately, gas- and electric-only program administrators may, under current market conditions, leave substantial opportunities for savings of the other fuel untapped and, in practical terms, less accessible for meeting energy savings goals and other related state policy objectives.

References

Barbose et al. "The Future of Utility Customer-Funded Energy Efficiency Programs in the United States" 2013. Lawrence Berkeley National Laboratory (LBNL). LBNL-5755E
http://emp.lbl.gov/publications/future-utility-customer-funded-energy-efficiency-programs-united-states-

[26] It is difficult first to screen demand-side resources for cost effectiveness before supply-side costs are clearly identified and, second, to test for lower cost solutions across all resources once the "preferred" portfolio is set.
[27] As noted earlier, demand-side resources may be driven by broad policy objectives beyond strictly minimizing system costs.

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Kushler, M., Nowak, S. and Witte, P. "A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs" February 2012. American Council for an Energy Efficient Economy (ACEEE). Report Number U122 http://www.aceee.org/research-report/u122

U.S. Department of Energy. "Annual Energy Outlook 2012". June 2012. http://www.eia.gov/forecasts/aeo/

Woolf, T. et al. "Best Practices in Energy Efficiency Program Screening: How to Ensure that the Value of Energy Efficiency is Properly Accounted For" July 2012. Synapse Energy Economics, prepared for the National Home Performance Council. http://www.nhpci.org/images/NHPC_Synapse-EE-Screening_final.pdf