A kWh Is Not Just a kWh: Comparing Various Energy Efficiency Programs in Terms of GHG, Job Impacts, and Policy Achievements (NEBs and Beyond)

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ABSTRACT

Energy efficiency programs are designed to achieve kWh savings, but designers and "screening" mechanisms rarely consider the varied impacts that these programs may have on economic development, emissions, and other potentially important policy objectives. This paper proposes a methodology for screening programs on multiple grounds, and uses it to identify where selected different residential, commercial, demand response, and renewables energy programs fell relative to each other in reducing carbon and achieving other goals. In total, we examined the effects from ten programs / program types.

We estimated the costs per carbon equivalent for a variety of energy efficiency programs to compare performance, and identify what types / mix of programs have proved most cost-effective in meeting sustainability goals. We also examined issues of relative economic development / job creation performance, and policy issues including ramp up period, retention, peak impacts, and other issues.

This paper represents a multi-program study, and it provides a different analytical approach useful in assessing alternative "green" initiatives. The method recognizes impacts beyond kWh, and the data and methods provide additional input toward selecting optimal portfolios given budget constraints. This approach may be appropriate for consideration by governments at the local, county, state or other level deciding between alternative approaches to sustainability; grant-funding entities assessing alternative submittals; utilities or regulatory bodies selecting among energy demand and supply alternatives; among others.

Introduction

Agencies of all types – utilities, communities, counties, companies, and others[1] – are adopting "green" or sustainability goals, and assessing wide-ranging strategies to move toward those goals. The US EPA's historical sector-based estimation approach identifying the sources of greenhouse gas emissions (Platt 2008) indicate that the use of electricity (34%) is the largest contributor to emissions, and transportation sources account for 28% of emissions. These data have helped lead agencies (including the types listed above) interested in sustainability and emissions to focus programs on these two sectors. EPA's revised accounting methods (systems-based view) confirm energy use by buildings and appliances (32%) and transportation (19%) are among leading contributors; however, the EPA results attribute significant GHG emissions to "provision of goods" (29%). Thus, under the newer EPA accounting approach, waste management strategies can also be important in reducing emissions for some agencies (USEPA 2009).

A variety of energy efficiency (EE) and renewable energy programs across the nation are currently saving energy and, as a consequence reducing emissions.[2] The traditional utility

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[1] Grant-making agencies, municipalities with utilities, regulators, non-profits, and others.

[2] Emissions represent one of several non-energy benefits (NEBs) discussed in this paper; another is job creation.

integrated plan compares supply and demand side alternatives on their kilowatt-hours and the cost per kilowatt-hour. This traditional analysis omits the emission impacts of these kilowatt-hours. However, in emissions terms, all saved kilowatt-hours are not created equal. Some programs cost more; some are operated in areas with more polluting generation fuel mixes, some have differential peak / off-peak effects, and so on.

This paper attempts to compare the relative performance of EE programs on criteria related to (the cost-effectiveness of achieving) emissions reductions, and other criteria beyond pure energy savings. For example, within a utility, different programs deliver kWh at different times of day or year and, thus, affect emissions differently; comparing within a state (e.g. at the regulatory level), emission impacts associated with kWh reductions may also differ between utilities because of generation mix.[3] The authors first examined the concept of comparing cost per metric ton of carbon equivalent (MTCE) for energy programs, as well as calculations and comparisons between energy and solid waste programs, starting in 2007 (Skumatz, 2007 and others). The practice of assessing various actions and policies for their impact on GHG emissions is not new (Jaccard 2007, McKinsey 2009, for example).[4] This, this paper builds on all these studies by arguing for consideration of other non-energy benefits (NEBs), social outcomes, and other program and policy attributes in developing program portfolios.[5]

We assessed the performance of ten anonymous programs from across the nation using an expanded list of criteria to explore the implications of an enhanced variation of the traditional integrated or comprehensive plan approach. Note that this paper is focused on illustrating the lessons, uses, power, and potential of this type of analysis. The paper is not aimed at making specific recommendations regarding any particular programs; thus, the specific programs are not named. In this method, instead of mapping cost per kilowatt-hour against kilowatt-hours, we assess the programs based on their cost per metric ton of carbon equivalent (MTCE) against their MTCE delivery. In addition, we examine variations in the comprehensive plan results based on variations in other key criteria affecting the priorities of addressing the GHG problem:

- Cost per metric ton of carbon equivalent reduced,
- Relative performance in terms of job creation / economic development,
- Timing, coverage, authority and retention issues associated with program delivery, and
- Implications for comprehensive plan timing and cost.

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[3] Or on a more complicated level, due to the impacts or value of changes in emissions due to air shed sensitivities, or other factors, but these impacts are not specifically addressed in this paper.

[4] Academics and consultants frequently assess different policies. For example, Mark Jaccard's Sustainable Fossil Fuels and numerous McKinsey studies offer carbon mitigation supply curves. One reviewer also suggests similar analyses were also conducted as part of the Canadian National Roundtable (www.nrtee-trnee.com/eng/publications/carbon-pricing/carbon-pricing-eng.php); however, that study could not be accessed on-line. These studies provide detailed comparisons of performance of alternatives on GHG terms. The sample McKinsey study assembles energy efficiency curves and GHG abatement curves with a focus on more than 40 energy efficiency programs. (Note that programs beyond energy or fossil fuel alternatives have not generally been included in these analyses. The work in Skumatz 2007 compares results for both energy efficiency and recycling initiatives).

[5] One reviewer suggests that this type of analysis is relevant at a time when many utilities and regulators are struggling with the question of whether their role is to ensure the economically efficient supply of electricity or natural gas versus a broader role (e.g. environmental protection and job creation).

The Energy Program Computations

Using data from evaluation studies of energy efficiency programs across the country conducted by the author, augmented with information from a web search of a few additional program evaluations, we compiled estimates of the costs and energy savings per participant for ten energy efficiency programs. To illustrate our points, we include some programs that were similar to one another (similar types of measures, etc.) that operate in different areas of the country, or show variations in design. The programs assessed follow:

- Low income weatherization programs: We include two programs from different areas of the country, and they are named LIWx1 and LIWx2.[6]
- ENERGY STAR® products: We included programs from two different locations, and they are abbreviated as EstarProd1 and EstarProd2
- ENERGY STAR® lamps program: abbreviated Estar Lamp
- CFL rebate program (CFL)
- Commercial contractor / ESCO incentive program (Coml1)
- Commercial design assistance program (Coml2)
- Small commercial lighting retrofit program (SmComl), and
- Commercial equipment rebate program (ComlEqpt).

To compute the GHG effects, we used the author's peer-reviewed "NEB-It "© model.[7] This model houses an extensive array of published secondary data on emissions per kilowatt-hour from various types of generation plants – including data based on fuel type and age of plant.[8] We used factors refined for the peak / off-peak contributions and resource mix ("margin" operations, rather than system average) associated with the modeled programs. We based our computations of incremental changes in GHG reductions on assumptions related to the generation mix at peak and off-peak times for the various utilities for each of the programs (using data off the utilities' websites). Obviously, the results for any one utility undertaking this type of analysis would necessarily vary based on its generation mix. Utilities with a large share of hydro power will see different results from those generating most of their electricity from coal. Using the estimates for cost per participant, savings per participant, and emissions per kWh, we were able to compute the cost per metric ton of carbon dioxide equivalent from each of these sample energy efficiency programs.

[6] Note that these program choices are examples to illustrate the analysis approach. Each specific program being assessed by a utility or agency will have different results. For example, weatherization is a specific program and may not be representative of other weatherization programs, nor will it be representative of all home retrofit programs.

[7] Versions of this model and its non-energy benefits results have been presented in numerous conference proceedings including ACEEE, ECEEE, EEDAL and others since 2001.

[8] The model allows selection of factors from a number of published studies by Bertraw and Toman, EPA, EIA, eGRID, and EPA between 2000 to 2009. See Skumatz 2009a.

Relative Cost of Emission Reductions between Different Energy Efficiency Programs

For presentation purposes, and because this paper focuses on policy and applications, not evaluation of specific programs, we normalized all figures by dividing by the results for the first of the ENERGY STAR® Products programs (EstarProd1) – so all the figures are presented as a ratio compared to the cost of the EstarProd1 program to highlight *relative* cost results. Figure 1 summarizes the results of the computations for the sample (illustrative) programs we analyzed.[9] The results show:

- Variations in cost per MTCE between programs of the same type, owing to two factors – differences in generation mix and differences in cost per kWh for the program. The results here would indicate LIWx1 is in a more coal-rich generation area than LIWx2 (for example, if we were interested in comparing between regions), or LIWx2 delivers kWh at a lower cost per kWh than LIWx1 (if we were comparing these types of results within one utility).
- Cost differences between classes of programs: Weatherization programs and most of the commercial initiatives were more expensive than ENERGY STAR®-products programs. The Coml2 program – a design assistance program – was relatively low cost per MTCE.

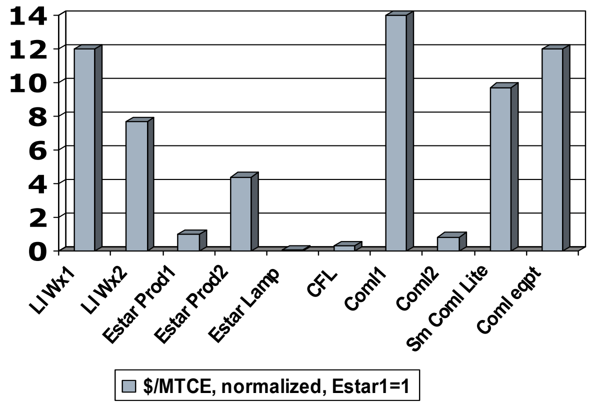
These types of analyses can be used to compare performance of programs within a utility (selecting better-performing programs); for helping select programs between utilities within a state for a more cost-effective statewide portfolio, or to compare the cost and performance of programs in one area of the country or one utility to another on this one criteria – cost per MTCE.[10] These comparisons may also help lead to a utility changing from an emphasis on base load energy-focused programs to those emphasizing peak reductions to optimize emissions performance. However, we suggest that other criteria are also useful in comparing performance and prioritizing programs and strategies.[11]

[9] The results will necessarily differ for specific programs that would be analyzed by specific utilities or agencies. Again, these results are for illustrative purposes.

[10] Of course, there are other criteria on which programs can and should be considered (that is a focus of this paper). One reviewer notes that low income programs have additional goals beyond saving kWh and should potentially not be compared on solely cost grounds.

[11] To address a reviewer question, we conducted a simple assessment of the cost per MTCE for the generation mix and costs for one sample utility, If added to Figure 3, the bar would be a height of about 40. This figure would differ for each utility doing this type of analysis. However, this level of figure is not surprising, since all the programs modeled for this paper were approved by a PUC in some state; thus, their costs should probably be expected to be below generation alternatives. See Skumatz 2009 to see the relative costs for PV and wind alternatives as well.

Figure 1: Relative Cost per MTCE Avoided for Energy Efficiency Programs (Relative to EstarProd1=1)



Comparison of Other Features of EE Programs

Several other considerations associated with these programs provide important policy implications:

- Job creation / economic development; and
- A variety of policy and performance factors including: timing, coverage, authority, persistence, and funding.

In the following paragraphs, key aspects of these criteria are analyzed for the programs.

Job Creation / Economic Development

The authors used input-output models to estimate the job creation and economic development impacts from the energy efficiency programs.[12] We were careful to compare the program scenario case against the jobs and economic impacts from a base case that assumed the funds would otherwise have been spent on electricity generation.[13]

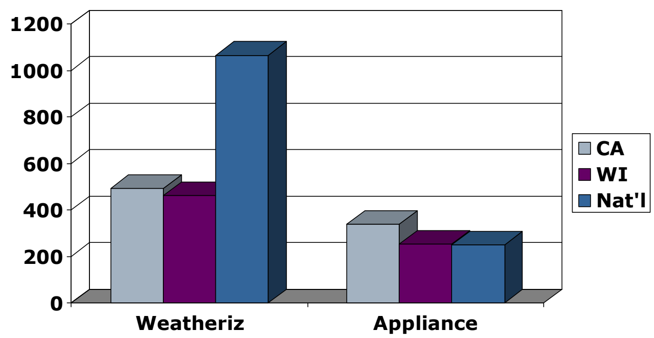
Many energy efficiency programs are more labor intensive than electricity generation, so programs would tend to have job creation and economic development impacts for communities, states, or regions. The size of the impact depends very much on 1) the type of program (weatherization programs are more labor intensive than appliance rebate programs), and 2) the geographic region of concern (local job impacts will be smaller than job impacts that cover a larger geographic region where increasingly more and more of the materials will be manufactured). Figure 2 provides a comparison of the job impacts from two key types of programs over varied geographic regions (Imbierowicz and Skumatz, 2006, Gardner and

[12] The model is run selecting the relevant NAICS / industry code sources, and increasing expenditure in the appropriate business type / sectors, shifting from those that will see the decrease in economic activity. Figure 4 shows general results for illustrative purposes, but was not used as the input data.

[13] There are two widely used schools of thoughts on the baseline case, both widely used in the literature. For energy programs, some researchers compare the effects to the money otherwise being spent on electricity generation, and others use CPI market basket. Credible cases for both have been made in the literature, and the literature is split (Skumatz 2009b). We selected the former assumption.

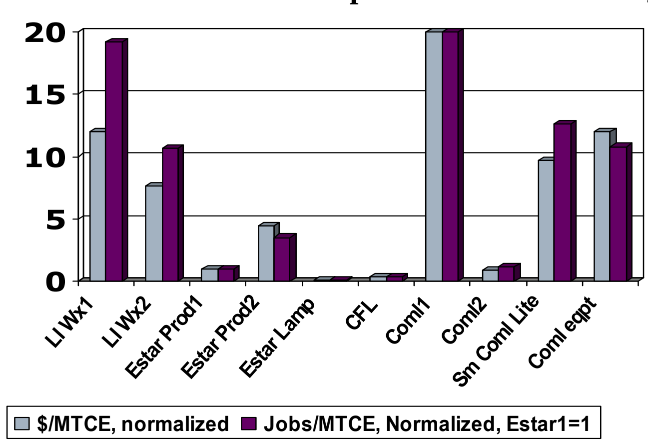
Skumatz 2007). The authors used a widely available third party input-output modeling tool to estimate the economic effects of a $1 million investment in weatherization and appliance replacement programs, modeling programs that covered the State of California, the State of Wisconsin, and a nationwide program. The results indicate that a large share of the weatherization employment is local; on the appliance side, even if the whole US is considered the relevant impact area, few appliances are built in the US so the impacts are smaller. The net impact (illustrated in Figure 2) in jobs and economics from EE over generation is positive, and the sizes vary by program type and local industry mix. Not all energy efficiency programs are equal in their effects on job creation.

Figure 2: Relative Job Impacts per Dollars of Investment in Weatherization vs. Appliance Replacement programs (Source: Imbierowicz and Skumatz, ACEEE 2006)



This type of computation was conducted for each of the ten programs (with some simplifications, due to budget limitations). The results of the job creation computations are summarized in the right-hand (darker colored) bars in Figure 3. The bars represent relative impacts on jobs, either in terms of jobs per MTCE reduced by the program, or in terms of jobs per million dollars invested in the program follow similar patterns to the cost-per-kilowatt-hour computations shown in the previous figure, with commercial and weatherization programs showing the strongest job creation performance. Recalling the lessons of Figure 2 into the results from Figure 3, we see that the direct install-type programs (e.g. the Weatherization efforts) are more job-intensive than lighting rebate programs because the CFLs are rarely made in the US.

Figure 3. Relative Cost and Job Creation per MTCE for EE Programs across the US

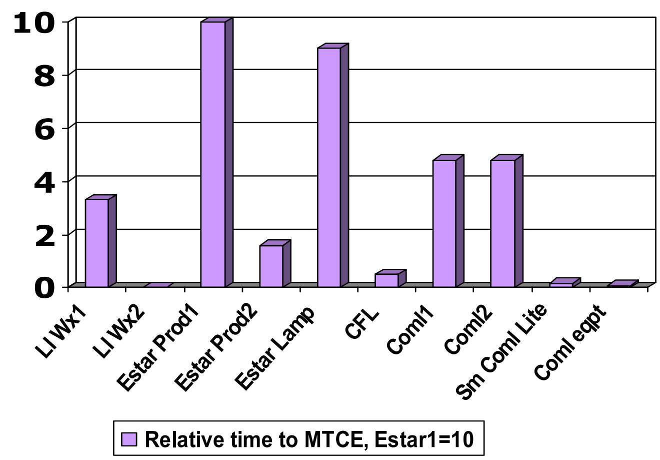


Speed to Implement

The ramp up period for programs varies dramatically. Getting thousands of CFLs into the market can be accomplished fairly quickly; weatherizing thousands of homes, (whether low income or broad residential programs) takes time, and commercial programs can take considerable time to gain thousands of participants. Of course, each CFL saves only a fraction of the savings from a participant in just about any commercial program. The speed to achieve thousands of participants depends on the cost-per-participant, outreach and delivery methods, and the program budgets, among other factors. The time to achieve a MTCE, therefore, also depends on these types of factors – and can be adjusted using alternative designs and budgets.

To provide a metric consistent with our previous analyses, we used the actual budgets and participants funded by the programs we modeled, and we used the data to compute the months to achieve a MTCE for each program. Again, we then normalized the figures relative to the EstarProd1 program. These normalized results are presented in Figure 4. Higher bars take longer to achieve a MTCE.

Figure 4. Relative Speed to Achieve a MTCE from the Sample EE Programs



Although some energy efficiency programs can be implemented quickly (e.g. CFL exchanges); a great many programs take quite a while, with regulatory processes (when delivered by utilities), on top of program implementation. Based on the plan for the national Weatherization Assistance Program, it takes a year or more to get into the first home, counting training / recruitment, equipment acquisition, verifying ownership eligibility, and other steps. Certainly some energy programs are faster.

Looking at the issue in related direction, we might compare programs based on how long they take to exhaust their participant pool. For an energy program, the program is delivered over time to a generally fairly limited share of households or business sector clients served by the utility or within the community.[14] The National Weatherization Assistance Program treated approximately 0.3% of eligible homes in a year, and a similar program in New Hampshire treated approximately 0.9% of eligible homes in a year. Certainly some utilities, NGOs, and jurisdictions can put programs in more quickly; however, if these data are typical, it would take

[14] For example, National Public Radio stated that the stimulus package funds may lead to weatherization of 4,000-10,000 homes in Colorado.

100 years for a weatherization program to reach all eligible households. The results are largely (but not entirely) dependent on the budgets established for these programs. Part of the point of our analysis is that these speeds can be adjusted by adjusting the budgets – and thus, the participants and the resulting emission impacts.[15]

Authority / Perspective

As we mentioned at the beginning of the paper, a variety of entities are working to reach climate change goals, including counties, cities, non-profits, and others. Each has different authorities. Counties and cities can more easily adopt building code standards as an EE strategy – a power that is not provided to energy utilities. Utilities have direct connections to their residential and commercial customers that place them in a position to offer many types of direct assistance programs that may be more difficult for counties. Cities, non-profits, and even retail stores can influence purchases of CFLs and certain other EE equipment. In addition, although utilities can "rate-fund" energy programs, cities and counties have a harder time identifying sources for those funds for programs beyond their own municipal buildings, unless they are able to tap into (generally smaller and more limited timeframe) grants or other sources. Relative rankings of EE programs within an integrated planning exercise will be affected by the perspective (and authority) of the entity doing the planning.

Persistence

To be considered on a level playing field – especially in terms of risk and delivery of effects - persistence (also called measure life or effective useful lifetime EUL) is an important consideration. Persistence of savings from energy efficiency measures have been well-demonstrated through measure lifetime studies, and vary from about 3-25 or more years, depending on the measure installed.[16] Thus, although programs may deliver certain kilowatt-hours of reductions with some computed ramp-up period, some of the programs will deliver savings over a longer period of time because the relative lifetimes of the included measures. This affects relative rankings within an integrated planning framework as well, and is currently addressed by examining lifetime savings against costs. Lifetime savings remain an important consideration in ranking programs.

[15] A reviewer notes that it is important to consider total lead times. CFL programs have achieved a market share of about 1/3 nationally after 15-20 years of operation, and incorporating real lead times would also consider the time to develop the technology, develop factories, establish a distribution chain, etc. That is a very useful and interesting point for considering and estimating timing associated with future programs included in a broad portfolio of existing and potential programs. This particular paper has elected to illustrate our points using "current" programs; there is no doubt that conducting detailed analysis by specific agencies for analysis of broad-ranging portfolios over time takes efforts similar to those currently undertaken in comprehensive planning efforts. We argue a few more steps (assessing other criteria) would provide enhanced information for decision-makers.

[16] It should be noted that it is well-known that there are some programs that have not had well-demonstrated persistence studies – particularly behavioral and outreach / education programs. This is an important omission, and research in this area would be extremely valuable in helping rank these programs in this or any type of comprehensive planning association.

Implications for Integrated Planning / Comprehensive Plans for EE Programs and Energy Portfolios

One purpose of this paper was to present the results of an analysis of various EE programs in terms of a list of performance criteria beyond cost or kilowatt-hours. We specifically explored performance in terms of cost per MTCE avoided; job and economic development impacts; speed; and other criteria for an array of programs. We suggest that an agency choosing among programs could conduct an integrated plan in terms of the traditional kilowatt-hour basis (which climate change advocates might argue is an interim factor), or instead, could focus on assessing the programs in terms of their MTCE performances and consider multiple attributes: cost, economic development, timing, perspective, and persistence. Carrying out this type of analysis, we could assign weights to the various performance criteria. Varying the weights leads to different rankings for the programs, as illustrated simply in Table 1.

We used rounded values of the relative scores for the various programs and also recomputed the scores to assure that low scores were "better" (so we used the inverse of the relative jobs scores). In this example, the three sets of weights represent three different priorities. Set 1 ranks only cost; Set 2 ranks jobs and speed to implement relatively more highly; Scenario 3 also incorporates another factor (here we entered a factor related to "market-based delivery", but a wide range of others could be selected). The rankings for programs change based on these weights (Rank 1 – 3). The difference between Weights 1 and 2, for instance, change the ranking of the Lamps program from first to seventh and other programs change order as well. Another incarnation of the rankings is to change the budget values, which would affect the time to deliver the program. Inputting these values in the "time" row would lead to different scores and resulting priorities. Other rankings will result if the mix of measures in the program are adjusted (lifetimes and cost), and so on.

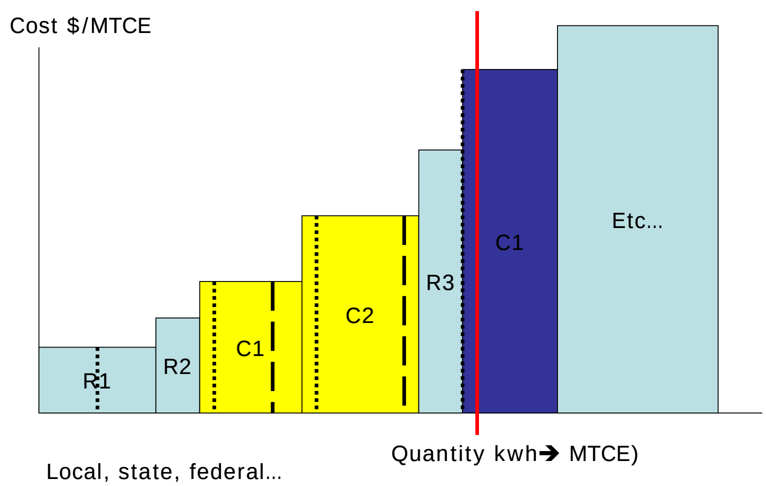
Table 1: Multi-Attribute Priority Assignments for Sample EE Programs in Integrated Plan Program Priorities –Results for Three Alternative Weighted Scenarios

	LiWx1	LiWx2	Estar1	Estar2	Lamp	CFL	Com1	Com2	ComLite	ComEqpt	Weights (1)	Wgts (2)	Wgts (3)
Relative rankings on criteria (lower ranking is "better")											Three weighting scenarios		
Cost/MTCE	12	7	1	4	0.2	0.5	20	2	9	12	100%	40%	60%
1 / jobs	0.06	0.09	1.00	0.33	5.00	2.00	0.05	0.33	0.08	0.09	0%	30%	15%
Speed	3		10	1.5	9	0.5	5	5	0.3	0.1	0%	30%	15%
Authority	1	1	1	1	1	1	1	1	1	1	0%	0%	0%
Other	1	1	0	0	1	0	1	1	1	1	0%	0%	10%
Scores based on three sets of weights at right													
Score1	12	7	1	4	0.2	0.5	20	2	9	12			
Score2	5.7	2.8	3.7	2.2	4.3	1.0	9.5	2.4	3.7	4.9			
Score3	7.8	4.3	2.3	2.7	2.3	0.7	12.9	2.1	5.6	7.3			
Priority of program alternatives based on scores for 3 scenarios of weights													
Rank1	8	6	3	5	1	2	10	4	7	8			
Rank2	9	4	5	2	7	1	10	3	5	8			
Rank3	9	6	3	5	3	1	10	2	7	8			

The traditional approach for utilities and regulatory agencies take into account a fairly limited range of criteria in choosing portfolios – mainly kilowatt-hours, benefit-cost, and some diversification by sector. If climate change is a factor, a number of the criteria we illustrate may be important to add to the analytical assessment.[17]

Figure 5 illustrates another aspect of the integrated planning implications based on the climate change model. This figure presents a supply curve for the energy efficiency programs presented here, using the relative cost data shown in Figure 1, but using hypothetical figures for the quantity values (width of the bars). This figure omits an important third dimension, time. To get toward the time factor, we include vertical lines showing the share of the potential reached by Year 1 (dotted line), and by Year 10 (dashed line). Dashed vertical lines within each program bar represent the amount that the program can deliver within one year (given an assigned budget[18]). Assume some programs completely "max out" in their delivery within one year; others are graphed as if they will take many years to exhaust their MTCE potential. The traditional approach would be to rank programs in terms of cost per kWh and drive the market share of the cheapest programs to 100% as quickly as you can before moving to the less cost effective ones (assuming a total budget constraint).[19] This graph changes the approach slightly to suggest implementing programs in terms of cost per MTCE; but our additional enhancements suggest looking beyond simply cost to the other effects, including non-energy benefits (jobs, etc.) and policy considerations including (but not limited to) those that have been discussed in the paper.

Figure 5. Developing Portfolio for GHG Strategy – "Supply" Curve Year 1 (dotted); Year 10 (dashed)



To illustrate our last point, we can take snapshots and track their resulting MTCE and costs, allowing us to derive a graph like that shown in Figure 6. By varying the program mix in a hypothetical way, we can affect the year in which we achieve GHG goals, and the cost for achieving goals.

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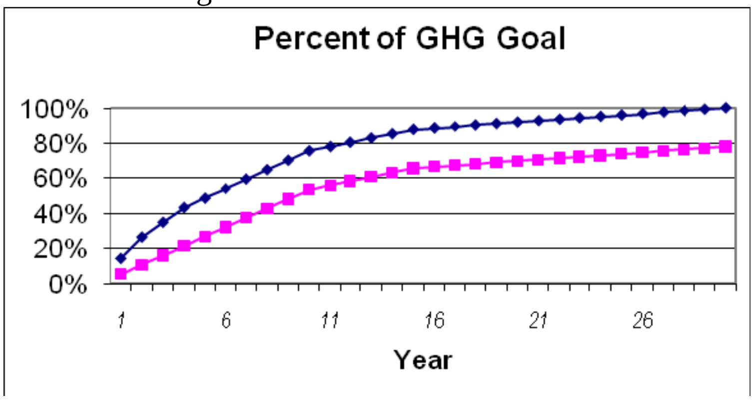
[17] Of course, as a reviewer points out, within one utility or even one state, kWh savings are fungible in terms of CO2 reductions: a kWh off the grid saves the same emissions no matter what, at least holding time of day and year constant.

[18] This again, can be modified to achieve objectives, but are taken as "given" for this step.

[19] As it was put by one reviewer.

Figure 6. Hypothetical Path to GHG Goal Including Different EE Programs

Path 1 vs. Path 2 Reaches 25% 3 years earlier at almost 50% cost savings



		Program Mix 1	Program Mix 2
Years to Goal=>	25%	2	5
	50%	6	10
	75%	10	27
	90%	18	61

Cost at=>	25%	49%
	50%	32%
	75%	38%
	90%	20%

Through integrated planning exercises, utilities, communities, non-profits, regulators, or others can find that the inclusion of different mixes of EE programs (or potentially renewables and other types of resource conservation strategies that avoid GHG emissions) can make a substantial difference in: 1) the time to reach goal, and 2) the cost of reaching benchmarks. An example of this broader analysis, specifically comparing energy efficiency vs. solid waste / recycling initiatives in terms of cost per MTCE, found that a number of solid waste programs were more cost-effective per MTCE than many traditional EE programs (Skumatz 2007, Skumatz and Freeman 2009). In one scenario, we found that by incorporating both energy and recycling programs, the community could likely shave 3 years off their timing to get to 25% of their GHG emissions reduction goal, and they could do so at substantial savings compared to pure energy efficiency program approaches (49% cost savings than costs from a sample EE / renewables program mix). Figure 6 shows the performance differences for other goal levels. The analysis can easily be expanded to include transportation, water, and other initiatives. This multi-attribute decision-making among resources (solid waste, energy, transportation, water, etc.) is a potentially useful tool for communities, counties, states, companies, or others with sustainability or GHG goals (or goals beyond just EE). Moving beyond "silos" is an important consideration for other decision-makers assessing alternative expenditures of budgets, allocation of grant funds, etc.[20]

Conclusions and Policy Implications

Energy efficiency programs have strong potential for reducing GHGs and meeting climate change goals. Traditional integrated planning and supply curve exercises focus on kilowatt-hour achievements. In its simplest application, this paper reminds energy planners that programs vary on performance and non-energy benefit factors beyond the traditional kilowatt-hours and cost, and that factors beyond these traditional elements of the integrated planning supply cost are worth consideration in selecting among programs. However, more broadly, this

[20] This has not been the case recently. As one example, discussions with community and state staff within Colorado make it apparent that American Recovery and Reinvestment Act (ARRA / Stimulus Package) funds that have been available to communities have nearly exclusively favored investment in energy and transportation initiatives to the virtual exclusion of solid waste program alternatives.

paper attempts to demonstrate that if climate change is the goal – or one of the goals – of the planning agency,[21] different analyses can be conducted to assess programs on multiple attributes, allowing the agency to optimize the portfolio on GHG and other grounds. Comparisons of the attributes can be used to benchmark performance between programs at one utility, between utilities within a state (or other planning region), or identify "room for improvement" in programs compared to another utility on program design grounds. For other agencies (for example, a community with a municipal utility and sustainability goals; or a grant-making agency), comparison of a broad range of (energy and other resource) initiatives on these multi-attribute grounds may be particularly appropriate.

The performance of programs on these GHG criteria are directly affected by budgets, measures, time-of-day, and local fuel mix, and these can be changed to enhance performance and improve the portfolio. The paper does not argue that traditional Benefit Cost or kilowatt-hour analyses are flawed, but instead argues that with climate change up front and center, and the economy in a recession, regulators and others may also want to be assessing portfolios on the types of criteria presented here. The analysis involved in quantifying any of the attributes and NEBs included in this paper - or in conducting the multi-attribute analysis - was not very onerous and would not represent a particularly large investment beyond the planning analyses currently being conducted by utilities, regulators, or other agencies.[22]

The study demonstrates differences in the relative performance of different types of energy efficiency strategies - in helping reach goals, and provides an incentive to refine and tweak programs to improve their performance on "green"-related goals.

The study shows that energy efficiency initiatives may all be designed to reduce kWh (or kW), but they do not perform equally on GHG reduction, cost-effectiveness, job creation, or other policy goals, and portfolio selection efforts may want to take these factors into account. In addition, in the goal to achieve broader GHG or sustainability goals, "silo" thinking may not lead to an optimal program mix.

References

Gardner, John and Lisa A. Skumatz, Ph.D. 2007. "**Economic Impacts from Energy Efficiency Programs – Variations in Multiplier Effects by Program Type and Region**", Proceedings for the 2007 European Council for an Energy Efficint Economy (ECEEE), Cote D'Azur France, 2007.

[21] Defined at the beginning of this paper to include communities, counties, states, businesses, utilities, granting agencies, or others. Communities with municipal utilities and states may be especially relevant audiences for the "across silos" (energy and solid waste and transportation and water, etc.) applications of this approach. In countries outside the US, the national governments have the kinds of cross-silo authorities that could make use of this approach.

[22] Although some decision-making agencies will readily see this enhanced perspective within their purview, others (utilities or regulators among them) may see their duty as simply maximizing the cost-effectiveness of delivering energy to consumers. However, all other things being equal, incorporation of non-energy benefits (including economic development, emissions reductions) and other program performance factors (including, potentially, indicators of risk, and other elements) into the decision-making may be an appropriate change, especially as non-economic factors are routinely considered in the assessment of supply. In considering investment in a power plant, regulatory risk, environmental factors, potential market structure and rules changes, Renewable Performance Standards, and other factors are incorporated into the decision-making. These types of factors drive value and decision-making as much or more than gas prices in many situations. (Heidell 2010).

Heidell, James A., 2010, Vice President, NERA's Energy Environment, and Network Industries Practice, Personal Interview with the Author, May.

Imbierowicz, Karen and Lisa A. Skumatz, Ph.D., 2004. "**The Most Volatile Non-Energy Benefits (NEBs) - New Research Results Homing in on Values for Environmental and Economic Impacts**", Proceedings of the 2004 ACEEE Summer Study, Asilomar, CA, 2004.

Jaccard, M. 2006. **Sustainable Fossil Fuels**, Cambridge University Press

McKinsey & Company, 2009, "**Pathways to an Energy and Carbon Efficient Russia**", from www.mckinsey.com/clientservice/sustainability.[23]

Platt, Brenda, et.al., **Stop Trashing the Climate**. Institute for Local Self-Reliance. June 2008.

Skumatz, Lisa A., 2007. "**Recycliing and Climate Change: Finding the "Biggest Bang" Community Strategy for Reducing Greenhouse Gas Emissions**", Skumatz Economic Research Associates, Superior, CO, June. Also presented at Colorado Association for Recycling Conference, June.[24]

Skumatz, Lisa A., Ph.D., 2008. "**Recycling and Climate Change: Finding the "Biggest Bang**" Community Strategies for Reducing GHG", *Resource Recycling*, October.

Skumatz, Lisa A., Ph.D., 2009a. "**Do Energy Efficiency Strategies Outperform Recycling in GHG Mitigation and Job Creation?**", Proceedings of the IEPEC conference, Portland, OR. June.

Skumatz, Lisa A., Ph.D., 2009b. "**Lessons Learned and Next Steps in Energy Efficiency Measurement and Attribution: Energy Savings, Net to Gross, Non-Energy Benefits, and Persistence of Energy Efficiency Behavior** prepared for CIEE, Oakland, CA, December.

Skumatz, Lisa A., Ph.D., 2010. "Reducing GHG: **How do Energy Efficiency Programs Stack Up?**", Proceedings of the Annual Conference of the Association of Energy Service Professionals, Tucson, AZ, February.[25]

Skumatz, Lisa A., Ph.D. and D. Juri Freeman, 2009 – "**Diversifying Diversion: Managing Risk and Expanding Potential**", Presentation to 2009 Western Australia Waste and Recycling Conference, Perth, WA, Australia. September 16.

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[23] There are many additional studies located on this website, as well as summaries in www.mckinseyquarterly.com/A_cost_curve_for_greenhouse_gas_reduction_1911

[24] The paper was presented at Colorado Association for Recycling Annual Summit conference in May 2007 and a 2008 webinar for EPA.

[25] Variations on this AESP paper were also presented as a webinar for AESP on January 20, 2009.

Sumi, David, Eric Rambo, Bryan Ward, Mark Trexler, 2009. "**Quantifying and Valuing Displaced Power Plant Emissions as a Greenhouse Gas Mitigation Option**", Proceedings of the 2009 IEPEC Conference, Portland, OR, 2009.

U.S. Environmental Protection Agency 2009, "**Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices**", Office of Solid Waste and Emergency Response, Washington DC, September.