BACKGROUNDER

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Retrospective Examination of Demand-Side Energy Efficiency Policies

Executive Summary

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RESOURCES FOR THE FUTURE

Retrospective Examination of Demand-Side Energy Efficiency Policies

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Executive Summary

Energy efficiency plays a critical role in energy policy debates because meeting our future energy needs boils down to only two options: increasing supply or decreasing the demand for energy, and the latter implies demand-side energy efficiency policies. The issue is also particularly salient due to the problems of climate change, air pollution, and energy security, all of which cast an undesirable shadow over the prospect of focusing exclusively on increasing energy supply to meet a growing demand. Current U.S. greenhouse gas emissions are approximately 1.58 billion metric tons of carbon equivalent per year and are rising each year (EIA 2003d), posing a daunting challenge to policymakers attempting to grapple with the issue of climate change. Some energy efficiency advocates maintain that much of the problem could be solved, or at least ameliorated, at very low or no cost through the vigorous use of demand-side energy efficiency policies, alongside fuel switching and carbon sequestration.

Several key questions therefore immediately arise regarding the role of policies supporting energy efficiency within a portfolio of prospective energy and climate policies. First, what types of energy efficiency policies have been implemented in the United States, and how well has each of these policies worked in terms of saving energy? And, second, how much have these policies cost the public and private sector, and how cost-effective have they been?

To address these questions, we perform a comprehensive review of energy efficiency programs in the United States, with a focus on the adoption of energy efficient equipment and building practices, rather than on energy research and development. We further limit the scope of the study by omitting building codes, professional codes, and Corporate Average Fuel Economy

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(CAFE) Standards to focus on the remaining programs. We find that the applicable programs and policies tend to fall into the general categories of appliance standards, financial incentives, information and voluntary programs, and the management of government energy use.

Our review of these past energy conservation programs suggests that, taken together, the conservation programs we include likely save up to 4 quadrillion Btu (quads) of energy per year and reduce annual carbon emissions by as much as 63 million metric tons of carbon equivalent (MMtCE). These estimates typically reflect the cumulative effect of programs (e.g., all appliance efficiency standards currently in effect) on annual energy consumption. This total energy savings represents at most 6% of annual nontransportation energy consumption, which has hovered around 70 quads in recent years. Most of these energy savings come from reduced energy use associated with residential and commercial buildings (as opposed to more efficient industrial processes), so another relevant basis of comparison is total energy use in buildings, which accounts for 54% of the 70 quads of nontransportation consumption. Thus, 4 quads of energy saved represents approximately 12% of all buildings-related energy use (EIA 2003b). This also represents about a 3.5% reduction in current annual carbon emissions.

Table E-1 summarizes energy savings, costs, and carbon emissions savings for the largest-scale conservation programs, according to available information. The programs are listed in an order roughly reflecting our degree of confidence in the reliability of the estimates. Existing estimates suggest that minimum efficiency standards and demand-side management (DSM) programs have provided some of the largest energy savings—about 1.2 and 0.6 quads, respectively, in 2000. Estimates of energy savings associated with the Energy Star, Climate Challenge, and 1605b registry programs are also sizable (0.9, 0.8, and 0.4 quads, respectively, in 2000), but it is less clear what portion of these savings would have occurred in the absence of these programs. Energy savings from other programs are relatively small or unavailable. We emphasize the use of quads for comparison between programs because many of the programs cover nonelectricity reductions, which have a different heat rate than electricity.

Table E-1. Summary of Estimates of Energy Savings from Largest Conservation Programs in 2000

Program Name	Date	Energy Savings (quads)	Costs (billion $2002)	Cost-Effectiveness (billion $2002 per quad) [d]	Carbon Emissions Savings (MMtCE)
Appliance standards	2000	1.20	$2.51[a]	$3.28[a]	17.75
Utility DSM	2000	0.62	$1.78[b]	$2.89[b] (high $19.64)	10.02
Energy Star	2001	less than 0.93	$0.05[c]	-	less than 13.80
1605b registry	2000	less than 0.41	$0.0004[c]	-	less than 6.08
DOE Climate Challenge	2000	less than 0.81	-	-	less than 12.04

[a] indicates that total costs and cost-effectiveness estimates are for residential appliance standards only while the energy savings and carbon emissions savings estimates are for commercial and residential standards combined. Residential appliance standards alone yielded approximately 0.77 quads of energy savings in 2000.

[b] Indicates only utility costs are included.

[c] indicates that only direct government administrative costs are included.

[d] Billion dollars per quad can be roughly converted to cents/kWh by multiplying by 1.166, which assumes all of the savings come from electricity using the average mix of generating facilities.

Bringing the energy savings and cost estimates together provides our measure of cost-effectiveness, defined as the annual cost of each conservation program divided by the physical energy savings it achieves.[1] We could calculate estimates of overall cost-effectiveness only for efficiency standards for residential appliances ($3.3 billion/quad of primary energy saved in 2000) and DSM ($2.9 billion/quad, including only utility costs for the energy efficiency portion of DSM).[2] If all energy savings were in the form of electricity, these estimates would translate to 3.8 cents/kWh and 3.4 cents/kWh end-use consumption for appliance standards and utility DSM respectively. The price of the energy that is saved by these programs can be used as a measure of benefits to which one can compare the cost-effectiveness estimates. While this price varies over time, as a benchmark the average price of electricity in 2000 is $6.3 billion/quad of primary energy (or 7.4 cents/kWh end-use consumption). The cost-effectiveness estimates for appliance standards suggest that its average cost of achieving energy savings compares favorably to the

[1] This definition of cost-effectiveness is adopted based on the concept of "negawatt" cost, or cost per kWh saved, and extended to include savings of other energy sources besides electricity.

[2] Note that higher dollars per quad cost-effectiveness estimates imply the program is *less* cost-effective (i.e., it costs more per quad saved).

average value of the resulting energy savings. The cost-effectiveness of DSM is similar, but includes only utility costs.

The average price we use is only a rough measure of benefits, however, and a more accurate measure would account for differences between this price and the *marginal* cost of the energy conserved. Unfortunately, a full accounting of the most appropriate measure of marginal energy cost is beyond the scope of the present study. Comparing the cost-effectiveness estimate to about $6.3 billion/quad suggests that, as a group, efficiency standards are likely to have had positive net benefits (before environmental benefits are included). DSM as a group also appears to be cost-effective, but available estimates only include utility costs, suggesting that closer scrutiny of individual DSM programs may be warranted to identify and emphasize those with high net benefits, including highly valued peak-period energy savings. Of course one must be careful about applying aggregate estimates to draw conclusions about the value of individual program elements.

Although even more uncertain, including the environmental benefits from lower emissions of carbon dioxide (CO_2), nitrogen oxides (NO_X), sulfur dioxide (SO_2), and particulate matter (PM-10) as a result of energy efficiency programs may add approximately 10% to the value of the energy savings relative to basing that value on the price of energy alone. Based on national average emissions rates and available estimates of monetized benefits, the majority (7%) of these benefits come from CO_2 reductions, with fewer benefits from NO_X (2%), and SO_2 and PM-10 (0.5% each). The inclusion of environmental benefits strengthens the case for energy efficiency programs, but does not appear to dramatically change their value based simply on energy savings.

The studies reviewed here raise several issues concerning past efforts to measure both the effectiveness and cost-effectiveness of conservation programs. Measuring the effectiveness or total energy savings from a conservation initiative or program can be problematic due to difficulties in defining the right baseline, failure to correct for free riding or the “rebound” effect, use of inappropriate discount rates, and double counting of the same energy savings attributed to multiple government programs. A major question that arises when measuring program costs or cost-effectiveness is whether or not all of the salient costs (costs to business, costs to consumers, including consumer surplus losses due to quality changes, and costs to the government) are being accounted for. Equally important, the benefits of the programs (including otherwise unaccounted for spillovers) must be properly accounted for. All of these issues combined suggest that considerable care must be taken in interpreting existing estimates of the effectiveness and cost of energy efficiency programs.

This study reveals a lack of independent and detailed ex post academic analyses of conservation programs. Almost all available quantitative estimates are from institutions either administering or advocating the programs themselves. Several studies have presented general critiques of methods used to estimate energy savings and costs of appliance standards and of DSM programs, but there are few independent academic studies that take a detailed look at the effectiveness and the costs of specific programs. Such analyses are key to understanding the robustness of the effectiveness and cost-effectiveness estimates reported here to changes in assumptions about discount rates or assumptions about underlying growth in energy demand. Detailed analysis would be particularly important for classes of programs, such as appliance standards or utility DSM, that policymakers may plan to use more widely in the future.

The continued use of energy efficiency policies over more than two decades and the prospect of expanded and new policies on the horizon suggest that this approach to achieving energy and carbon reductions will have a lasting presence. This is particularly true if conservation programs have positive net benefits in their own right and thus yield emissions reductions at zero or negative net cost. Even if these estimates are overly optimistic, energy efficiency programs would likely be an important part of a relatively low-cost moderate climate policy, with the effect of existing efficiency programs being of a similar magnitude to what rough estimates suggest might come from a moderate carbon tax. While existing estimates indicate that the current impact of these policies is modest, it does appear that well-designed future programs have the potential to reduce energy and emissions, although the magnitude of potential reductions and the cost of achieving those reductions is an open question.