What Does Utility-Subsidized Energy Efficiency Really Cost?

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Public policies designed to increase the efficiency of energy use play a central role in energy and environmental policies around the world. Recent concerns about global warming, in particular, have inspired policy-makers to consider how increased energy efficiency may reduce carbon dioxide emissions (*1*, *2*). Opportunities to improve end-use efficiency in the electricity sector have been the focus of special attention both because of the environmental impacts of electricity production and because of claims that enormous opportunities exist to increase efficiency at a negative net cost to society.

Many analysts have argued that in the absence of regulatory obligations or special financial inducements consumers will often fail to adopt, or delay the adoption of, many cost-effective, energy-efficient devices. Two of the most widely cited analyses that form the empirical basis for such arguments are illustrated in Fig. 1. The curves shown here are electricity conservation "supply" curves developed by the Rocky Mountain Institute (RMI) and the Electric Power Research Institute (EPRI) (*3*–*5*). The National Academy of Sciences (NAS) developed and relied on similar curves in formulating its recommendations for "no regrets" responses to global warming (*1*, *2*).

These curves display estimates of the average total cost per kilowatt-hour saved that would be associated with the adoption of efficient electric devices as well as the "technical potential" (TP) for energy savings associated with the adoption of these devices. The projected costs per kilowatt-hour saved are based on assumptions about the costs of energy-efficient equipment and estimates of annual energy savings and equipment lives, before the value of the resulting savings in electricity costs is deducted. The projected energy savings are based on analyses of TP, which are made on the assumption that specific efficiency improvements would be made to essentially all comparable electric devices in the country. These improvements are assumed to be largely in addition to any that consumers would make on their own. The EPRI curve indicates that end-use electric efficiency in the United States can be increased by almost 30% at an average cost of only 2.6 cents per kilowatt-hour saved (in 1991 dollars), and the RMI curve indicates an even larger 75% efficiency increase at an average cost of only 0.6 cent per kilowatt-hour saved.

Whenever the cost of conservation is less than the cost of the electricity supplies that are displaced, society is better off by investing in conservation than by supplying the equivalent quantity of electricity. Current retail electricity prices, which average about 7 cents per kilowatt-hour, can be used as a rough estimate of the average cost of supplying an additional kilowatt-hour of electricity. Thus, the TP curves indicate a great potential for cost-effective conservation beyond what consumers adopt on their own. That consumers do not take advantage of these conservation opportunities, despite the fact that they would reduce their electric bills by more than enough to pay for the investments, is often attributed to a variety of hypothesized "market barriers," including lack of information, credit constraints, and differences between builders or property owners and the occupants who actually use the energy.

Although the differences between the curves in Fig. 1 are substantial (6), both indicate a significant potential to reduce electricity use and its associated environmental damages at a negative net cost to society. Thus, public policies that can induce consumers to take advantage of these opportunities hold the unusual promise of saving money for consumers while reducing environmental damages from the electricity production that would otherwise be required to meet "inefficient" consumer demand.

For that reason, a growing number of state public utility regulators have required electric utilities to design and implement programs that encourage consumers to invest in cost-effective conservation. Through these programs, utilities provide both information about conservation opportunities and subsidies to consumers who install specific energy-efficient appliances and equipment. The subsidies include such inducements as rebates to purchasers of efficient devices (motors, for example) or free installation of such devices (fluorescent bulbs, for example). These subsidies are recovered from a utility's rate payers as a group as part of the cost-based electric rate-making system.

The proponents of these utility programs often point to the energy efficiency costs derived by the TP studies as representative of the societal costs that utilities and their customers will incur when they promote energy conservation in this way. However, neither the TP cost estimates nor the assertion that utility programs can achieve them has been subject to rigorous empirical examination in real, representative settings. The actual history of costs and energy savings of these utility conservation programs provides the only data of which we are aware to compare the estimates of cost and energy savings contained in the TP analyses with the costs of real programs administered by real utilities for the benefit of real consumers.

We recently completed such a comparison using program projections and results reported by a sample of ten major utilities, many of which are regarded as leaders in conservation (6). We found the cost per kilowatt-hour saved in utility conservation

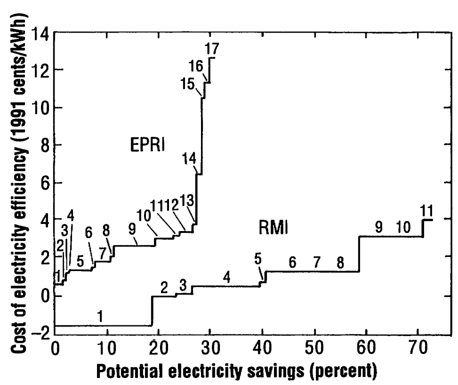

Fig. 1. Electricity conservation supply curves for the United States developed by RMI and EPRI. These show the annual cost of electric conservation, measured in 1990 cents per kilowatt-hour versus the quantity saved. Each step represents a particular application or technology. Electric savings are measured as a percent of total U.S. consumption. Reprinted from (*6*); see also (*3*–*5*). Numbers on the EPRI curve correspond to the following technologies: 1, industrial process heating; 2, residential lighting; 3, residential water heating; 4, commercial water heating; 5, commercial lighting; 6, commercial cooking; 7, commercial cooling; 8, commercial refrigeration; 9, industrial motor drives; 10, residential appliances; 11, electrolytics; 12, residential space heating; 13, commercial and industrial space heating; 14, commercial ventilation; 15, commercial water heating (heat pump or solar); 16, residential cooling; and 17, residential water heating (heat pump or solar). Numbers on the RMI curve correspond to the following technologies: 1, lighting; 2, effects of lighting on heating and cooling; 3, water heating; 4, drive power; 5, electronics; 6, cooling; 7, industrial process heat; 8, electrolysis; 9, residential process heat; 10, space heating; and 11, water heating (solar).

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programs was significantly higher than the projections embodied in the TP analyses. Further, we found that these costs derived from utility reports likely understate significantly the true cost of these programs because of their failure to account properly for all relevant costs and to measure properly the energy savings achieved by the programs.

For residential programs, we computed average costs that ranged from 3.5 to 22.1 cents per kilowatt-hour saved (in 1991 dollars) on the basis of the information reported by the utilities we surveyed. For commercial and industrial programs, the range was 1.5 to 6.7 cents per kilowatt-hour. Roughly 70% of reported utility expenditures on conservation and 80% of the reported savings were associated with commercial and industrial programs, rather than programs designed to counteract the market barriers that residential consumers face. Overall program costs reported by the utilities ranged from 1.9 to 6.9 cents per kilowatt-hour, with an average of about 3.4 cents per kilowatt-hour, which is about 30% higher than the EPRI estimate and almost 500% higher than the RMI estimate. Differences of similar magnitudes were found for subprograms targeted at specific types of equipment (such as refrigerators and lighting). The high costs were not generally associated with immature or experimental utility programs. Indeed, we found that one of the oldest, largest, and most highly regarded programs had the highest costs for several subprograms. Although many of the programs still appear cost-effective on the basis of these cost and savings computations, the savings are much lower than is suggested by application of the TP values. Furthermore, we identified a number of sub-programs that were either only marginally cost-effective or clearly wasteful.

Reported costs exceed those of the TP analyses because program costs are higher and energy savings are lower than these studies assume. Costs associated with equipment and installation often exceed those reported in the TP studies. In addition, program costs often include at least some administrative costs—for example, overhead, program monitoring and evaluation, marketing, and administration—that are either ignored (RMI) or understated (EPRI) by the TP analyses. These costs are significant, averaging more than 30% of direct equipment and installation costs. On the energy side, a few of the utilities in our sample have introduced protocols to measure actual program savings rather than rely on the types of engineering estimates embodied in TP analyses. Measured savings often fall far below engineering estimates; the lower realized energy savings imply a higher cost per kilowatt-hour saved.

Although utility data indicate that conservation costs are significantly higher than predicted by TP analyses, our study also found that these data often understate the full cost and overstate the actual energy savings properly attributable to the programs. On the cost side, many utilities fail to track fully the administrative costs associated with their programs. Utilities also often fail to measure fully the costs incurred by program participants who bear a portion of direct-measure costs as well as a variety of real transaction costs and service quality penalties.

On the electricity savings side, many utilities, as with the TP analyses, still base some or all of their energy savings estimates on engineering projections of savings rather than evaluations of actual changes in consumption. Utilities and independent analysts that have undertaken careful *ex post* evaluations often find actual energy savings to be far below original projections. Realized savings rates of 50 to 60% of engineering estimates are quite common (*6*, *7*) and have been documented both for residential programs and for mature and well-regarded commercial and industrial programs (*8*).

Many of the utility programs also fail to account fully or properly for free riders. Free riders are program participants who would have adopted an efficient technology without a utility program but chose to participate in order to receive a subsidy. Free riders could account for a significant fraction of program participants because at least some consumers would be expected to take advantage of the cheapest energy conservation opportunities without any special utility inducements. Some of the utilities in our sample reported free rider rates of as much as 40% for commercial lighting programs and 60% for efficient motor programs. Other studies have identified free rider rates of over 60% for many residential programs (*9*).

Utility expenditures on free riders have no effect on actual conservation behavior. As a result, they are at best transfer payments to free riders from utility rate payers as a group. Such payments do not add directly to the social costs of a program but do unnecessarily increase electric rates. Moreover, because of the significant costs associated with program administration, it is likely that some costs incurred in service to free riders are real social costs; these expenditures must be included in overall program costs. Proper treatment of free riders would therefore increase the cost per kilowatt-hour saved for a number of the utility programs in our sample.

Thus, our analysis indicates that the true costs of utility-subsidized electricity conservation are often significantly higher than the costs reported by utilities and, in turn, are significantly higher than those suggested by widely cited TP studies. In addition, the experience of utilities with careful measurement programs indicates that the magnitude of energy savings achievable through their programs is substantially smaller than assumed by the TP studies.

These findings do not imply that policies that promote energy conservation are undesirable. Real barriers do exist in energy markets and are a legitimate concern of public policy. Our results do suggest that utility programs will provide much smaller environmental and economic gains than have been suggested by many studies. Furthermore, many improvements in cost accounting, monitoring, and savings estimation are required to measure costs and savings accurately.

More generally, our research indicates that it is a grave error for policy-makers to think about conservation from the perspective of a perfectly informed central planner. They should not assume that the utility and its regulators can identify cost-effective opportunities for millions of customers from crude engineering and economic models and then use subsidies to induce these customers, at minimal transaction costs, to undertake only cost-effective conservation opportunities. The markets relevant to energy efficiency decisions may be imperfect, but so too is the information that utilities and regulators have about how these markets do and should work. The current policy emphasis on utility subsidy programs, and the often complex and costly bureaucratic planning procedures associated with them, is therefore misplaced. Public policy should instead be focused on other measures to ameliorate real market barriers and, in general, to promote well-functioning energy markets (*10*).

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10. Such alternatives may include policies to encourage utilities and other energy services companies to conserve energy without subsidies (financed by shared-savings programs, for example). Other policies, like the Environmental Protection Agency's Green Lights Program, could educate and cajole users of large amounts of energy to pursue profitable conservation opportunities.

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