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Energy efficiency resource standards: Economics and policy

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ABSTRACT

Twenty states in the United States have adopted energy efficiency resource standards (EERS) that specify absolute or percentage reductions in energy use relative to business as usual. We examine how an EERS compares to policies oriented to meeting objectives, such as reducing greenhouse gas emissions, correcting for consumer error in energy efficiency investment, or reducing peak demand absent real-time prices. If reducing energy use is a policy goal, one could use energy taxes or cap-and-trade systems rather than an EERS. An EERS can be optimal under special conditions, but to achieve optimal goals following energy efficiency investments, the marginal external harm must fall with greater energy use. This could happen if inframarginal energy has greater negative externalities, particularly regarding emissions, than energy employed at the margin. We conclude with a table of suggestions policy makers should consider when deciding whether and how to adopt an EERS.

1. Introduction

Twenty states have adopted energy efficiency resource standards (EERS), broadly regarded as standards or policies that require a minimum reduction of energy use, particularly through energy efficiency (EE) programs (Palmer et al., 2012). Some, including Maryland, specify not just reductions in overall electricity use, but also reductions in peak demand (Maryland Energy Administration, 2008). EERS programs can cover natural gas and electricity; we focus here primarily on the latter. These programs vary greatly in their percentage reductions, dates by which they would nominally be achieved, and baselines or reference cases—what energy use would have been absent the EERS. They can also differ in a number of aspects of implementation, including the identification of responsible parties, methods of verification, incentives, and penalties for noncompliance.

Because an EERS is typically a target for reductions, and not a cap on use, the choice of the reference case becomes crucial. One cannot look only at how much electricity is used by a target year to see if an EERS is effective; one must have some way to estimate what the use would have been if the supporting EE programs had not been in place to see whether the absolute or percentage reduction goals were met. The energy savings that count are those that can be attributed to the EE programs rather than to independent factors, such as mild weather, economic downturns, or higher energy prices.[1] One can estimate the reference case either by making an independent estimate of what energy use would have been absent the policies or by attributing energy savings to the policies directly (e.g., determining that X megawatt-hours of annual energy savings can be attributed to each subsidized compact fluorescent light bulb).

A broad question is whether an EERS is itself a policy, or a guidepost by which other policies are measured. Whether in fact an EERS is a "policy" alternative or an aspirational goal depends on whether the EERS has independent penalties for failure to comply.

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[1] An example based loosely on the Maryland policy may make this clear. Suppose that energy use in 2007 is 100. An EERS requiring electricity use to fall to 85 percent of 2007 levels by 2015 would cap energy use in that year at 85. However, in general, an EERS would only require energy use to be 15 percent less than it would have been in 2015 absent policy interventions. So if energy use in 2015 would have been 110, the EERS would cap energy use at 95 (110–15), not 85 (or 15 percent less than the 2007 level). If use in 2015 would have been 120, then use under the EERS would be 105, exceeding the 2007 level. Different observed levels of energy use may be consistent with an EERS; to know whether the standard is satisfied, one needs to know the reference case from which reductions are calculated.

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If it does, those charged with compliance will treat the EERS as a policy in and of itself; if it is a goal, then the primary focus should be on the policies that an EERS engenders, rather than the EERS itself.

One way to understand this "policy or goal" question is to consider whether an EERS is a substitute for, or a complement to, alternative policies. If it is a substitute, this implies that the EERS is a policy unto itself that takes the place of other policies. For example, were a cap-and-trade program in place, states might be less likely to adopt an EERS, believing that the goals of the EERS are being addressed in another way. An EERS is a goal, rather than a policy, if other policies are complements in that having an EERS in place increases the demand for them. For example, if having an EERS makes it more likely that a utility, state agency, or other entity will adopt policies, such as energy efficiency equipment subsidies or cap-and-trade mechanisms, to meet the EERS, then the EERS is a complement to those policies, not a substitute for them. Viewed in this light, an EERS would appear to be more of an aspirational goal for direct policy interventions to meet, rather than a policy itself.

Justifications for EERS programs usually appeal to factors beyond energy use directly; these include mitigating emissions and reducing electricity use during expensive peak demand periods. States may also institute EERS programs to encourage energy efficiency investments when the benefits from reduced spending on energy exceed their up-front costs, but consumers nevertheless fail to take advantage of them. Other rationales include promoting economic development and employment ("green jobs") and addressing energy security (Palmer et al., 2012).

We begin by examining how an EERS compares to policies designed to address those specific justifications. We then turn to how an EERS would be designed if energy use reductions were the objective, to reach the level of energy use where its marginal value—willingness to pay less marginal cost—equals its marginal external harm. Using that framework, we identify conditions under which an EERS, specified by an absolute amount of energy reductions or an amount based on a percentage of business-as-usual (BAU) use, could lead to an optimal amount of energy use reductions as the underlying demand for energy changes. When the change in underlying demand is the result of increased investments in energy efficiency, the resulting reduction in the elasticity of demand for energy implies that an EERS leads to an optimal outcome only if the marginal external harm falls the more energy is used. This may well be the case when, for example, marginal megawatt-hours of electricity are generated using natural gas, which pollutes less than using coal to generate inframarginal megawatt-hours. We conclude with a table with suggestions for policy makers in considering whether and how to adopt an EERS, including consideration of justifications, alternative policies, energy savings measurement, the role of utilities, and structure of the program.

2. Rationales for EERS

As noted above, the rationales offered by states for EERS policies focus on improving the environment, reducing the need for new generation and transmission, helping consumers realize the benefits of energy efficiency investments, encouraging economic development and green jobs, and promoting energy security. For each rationale, we look at how an EERS might perform compared to policies specifically designed to address it.

2.1. Environmental benefits

One of the leading concerns motivating policies to reduce energy use involves reducing the emissions of harmful pollutants that accompany the generation of electricity. This is not a new concern; federal policies going back more than two decades have addressed small particulates associated with an increased risk of heart or lung disease and premature death; sulfur dioxide, which can affect respiratory and cardiovascular functions and can create habitat-threatening acid rain and fine particles; nitrous oxides associated with smog and ozone as well as particulate creation; and mercury, which can cause renal and neurological problems, particularly in developing fetuses, when people eat fish from contaminated waters (Brennan et al., 2002, 161–62). More recently, an additional air pollution concern associated with electricity generation—emissions of carbon dioxide leading to an increase in the likelihood and severity of global climate change—has become more prominent.

Air effects are not the only environmental harms associated with electricity generation. Electricity generation generally requires copious amounts of water, as most forms of large-scale electricity generation (other than wind and combustion turbines) involve heating water to create the steam that drives turbines to produce power. Water is also used to cool the plumbing and machinery involved in generation. The conversion of surface or groundwater to steam and the return of warm water to lakes and streams can harm aquatic habitats. Nuclear power raises unique concerns associated with the risks of radioactive emissions following plant failures and, over the longer term, the disposal of radioactive waste fuels and materials from decommissioned plants. Wind power, although free of air and water effects, is associated with adverse effects such as noise, flickering light, the deaths of migrating birds and local bats, and in some celebrated cases, the degradation of otherwise desirable views (Rosenberg, 2008, 640–41).

All sources are not equal when it comes to emissions. As alluded to above, electricity is generated using a wide variety of fuels; coal, natural gas, hydroelectric dams, nuclear reactors, wind, and other biofuels are the leading sources of energy. The wide variety of fuels and technologies arises because of differences in location; for example, not every electricity user is near a river amenable to damning for hydropower or a site with reliable wind currents. Further, some types of electricity, most notably nuclear and coal, are characterized by high fixed costs relative to fuel and operating costs, making them relatively economical for continuous baseload operation. Natural gas combustion turbines, on the other hand, can be produced at smaller scales and designed to come on and off in response to variations in demand.

In addition, each of these fuels has a different pollution profile, although one often finds considerable variation within fuel types as well. Coal is often regarded as the dirtiest, but emissions can be controlled through the use of low-sulfur coal, scrubbers to remove emissions of SO_2 and other technologies to remove emissions of nitrogen oxides or mercury. Still in the prototype stage are technologies to capture carbon dioxide emissions from coal and natural gas plants and store them underground so they do not exacerbate atmospheric greenhouse effects. In addition, the production of coal, particularly strip mining, raises environmental concerns.[2] Natural gas is typically cleaner than coal, though with variation among the different gas generation methods. For example, combined cycle plants produce more electricity for a given level of heat and thus have lower emissions per kilowatt-hour compared to boilers or simple gas turbines.[3] Moreover, natural gas (methane) in the

[2] Coal mining also raises the possibility of other potential market failures. In particular, miners may not be informed of the risks, such as mine accidents and post-mining respiratory diseases, and they may not be compensated for such accidents or diseases. Although important, these risks to miners can, at least in principle, be addressed through safety standards and information programs.

[3] U.S. Environmental Protection Agency, Natural Gas, http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html (last accessed November 16, 2011).