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Energy Efficiency Policy: Surveying the Puzzles

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Abstract

Promoting energy efficiency (EE) has become a leading policy response to greenhouse gas emissions, energy dependence, and the cost of new generators and transmission lines. Such policies present numerous puzzles. Electricity prices below marginal production costs could warrant EE policies if EE and energy are substitutes, but they will not be substitutes if the energy price is sufficiently high. Using EE savings to meet renewable energy requirements can dramatically increase the marginal cost of electricity. Rejecting "rationality" of consumer energy choices raises doubts regarding cost–benefit analysis when demand curves may not reveal willingness to pay. Decoupling to guarantee constant profit regardless of use contradicts findings that incentive-based mechanisms outperform cost-of-service regulation. Regulators may implement EE policies to exercise buyer-side market power against generators, increasing consumer welfare but reducing overall economic performance. Encouraging utilities to take over potentially competitive EE contradicts policies to separate competitive from monopoly enterprises.

Key Words: energy efficiency, energy policy, decoupling, monopsony, vertical integration

JEL Classification Numbers: Q48, L94, L51

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Energy Efficiency Policy: Surveying the Puzzles

Timothy J. Brennan*

Introduction

Energy efficiency (EE) is among the most intensely discussed and widely implemented targets in the realms of energy and environmental policy. It refers, in essence, to an output-to-input ratio—getting the same level of service or, more contentiously, an equivalent quality-adjusted level of service, from a smaller quantity of energy consumed. Examples include getting the same heating from a high-efficiency furnace or the same cooling from an energy-efficient air conditioner or heater. Quality issues come into play in some cases, such as when one attempts to get the same level of automotive transportation using less gasoline or the same amount of light from a compact fluorescent light bulb (CFL).

EE is not coincident with economic efficiency. That distinction follows from its nature as a physical measure independent of any comparison of the marginal benefit of increased efficiency with its cost. Nevertheless, the interest in EE is not divorced from economic considerations. Across many energy uses, the scientific consensus is that the increased concentration of carbon dioxide from burning fossil fuels will lead to global warming and climate change, if it has not already done so (Min et al. 2011). If the effects of carbon burning are unpriced, subsidizing EE could be justified as a second-best response, but only if EE and energy use are substitutes, which as we will see is generally not the case if energy prices are sufficiently high. With regard to oil, used almost exclusively for transportation and heating in the United States, many see reliance on imports constitutes a threat to national security that may result in network externalities that EE policies could mitigate (Parry et al. 2007).

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With regard to electricity, the greenhouse effect concerns and "not in my back yard" (NIMBY) attitudes toward new generation and transmission construction suggest negative externalities associated with energy use that promoting more energy-efficient lighting and appliances could mitigate. In addition, the costs of generating electricity can vary enormously over the year. Because electricity cannot be stored, the capacity to provide power during the relatively few (less than 1 percent) peak demand hours of the year must be in place for the entire year, making cost during those critical peak hours as much as 50–100 times baseload prices. Absent meters and monitoring technologies to facilitate the real-time pricing of electricity, time-averaged pricing will lead to excessive use during these peak hours and too little use off-peak (Brennan 2004), leading to expensive new capacity and exacerbating the NIMBY effect.

As this suggests, EE plays a significant role in policies regarding the electricity infrastructure. Electricity is particularly inviting as a target, not only because a substantial fraction of energy use goes toward electricity generation, but because the wire infrastructure—local distribution and long-distance transmission—continues to be regulated even as much of the wholesale generation, and to a lesser extent, the retail sale of electricity, has been opened to competition. As we will see, the existence of a structure for setting the prices and terms of electricity delivery plays a particular role in providing a convenient institutional venue through which to design and implement EE policies.[1]

Such EE policies can affect the electricity infrastructure in a number of ways. An obvious effect would be to reduce the demand for new generation and transmission capacity. As we will see below, this effect could result in EE being employed by regulators to monopsonize the supply of electricity. A second effect, not directly considered here, is that EE could complement "smart grid" construction, essentially adding communications capability to the distribution and transmission grids. Among other things, a smart grid could facilitate the ability of entrepreneurs to offer energy management systems along with electricity itself. Such firms could offer lighting, heating, and cooling at reduced costs, allowing consumers to benefit from higher efficiency without having to figure out whether the long-term benefits from reduced energy expenditures are worth the short-term costs of investments in EE technologies. A third EE effect could be to encourage the use of "smart meters" to promote more efficient electricity use through real-time

[1] Of course, focusing only on electricity could distort choices where there is potential to substitute between electricity and other energy sources with adverse environmental effects, such as increasing the demand for oil heat or reducing the demand for plug-in electric cars.

pricing, although as we will see, EE policies plus real-time pricing could increase electricity use over what might occur with real-time pricing alone.

An important institutional manifestation of these policies is that incumbent utilities, which have been devoted to supplying electricity—in some cases for a century or more—are charged with the primary responsibility for implementing EE policies that reduce demand for their products. One result of this is the adoption of decoupling policies, under which the revenues and profits of utilities are set to be independent of how much electricity they deliver. This runs counter to learning in regulatory economics, which has identified numerous flaws of fixed-profit regulation, and presents yet another puzzle regarding EE policies.

A more fundamental problem is that, because the supply of EE appears to be quite competitive, regulatory economics suggests that efforts in that area should not be relegated to incumbent monopoly utilities. Prevailing opinion holds otherwise, as exemplified by the views of some in the President's Economic Recovery Advisory Board that utilities should be "engines of economic recovery" by spearheading EE technologies (President's Economic Recovery Advisory Board 2009). I explain how the choice to run EE programs through utilities is likely driven by political incentives rather than economic efficiency.

Using Maryland as an example, EE programs span a wide spectrum. At the most general, the legislature, following the lead of the governor, has adopted an "EmPower Maryland" program that promises a 15 percent reduction in electricity use by 2015, divided between utility programs and those undertaken by the Maryland Energy Administration (MEA), part of the state's executive branch (MEA 2008). The specific programs include subsidies, managed by the utilities, to promote the substitution of new, high-efficiency air conditioners, home appliances, and lighting for older, less-efficient units. Both the sticks of building code changes and the carrots of financial and marketing assistance, low-interest loans, and subsidized energy audits would increase EE in new homes and the retrofitting of existing buildings. Particular attention would be given to education and subsidized loans for consumers and small commercial enterprises, which many believe lack the expertise or access to capital to adopt EE programs that would be beneficial to them, leaving aside social benefits from mitigating negative externalities (Gillingham et al. 2009).

This review points to a number of aspects of EE policy that provide reasons to question some of the presumptions implicit in these policies. I survey half a dozen of these aspects here.[2] First, I examine whether energy use and EE are in fact substitutes. Although the possibility of a rebound effect, where EE increases energy use, has been familiar for decades, perhaps less well known is that, under very general conditions, the rebound effect must exist for sufficiently high energy prices. Next, I briefly examine how EE could exacerbate the costs of companion policies, particularly renewable use requirements. Absent either a moving baseline or a reliance on hypothetical rather than actual energy savings, allowing EE-based use reductions to satisfy a requirement that a given percentage of energy has to come from renewable sources can multiply the marginal cost of such a rule.

A third aspect of EE policy brings in currently prominent methodological controversies. Although EE policies could be justified if energy prices are too low as a result of unpriced externalities or time-averaged pricing, some advocates also believe that energy prices, specifically those of electricity, are too high. Justifying EE in these circumstances requires systematic consumer failure to invest in EE, even when the benefits from future reduced energy payments exceed the up-front cost. Among the policy puzzles presented by these mistakes is how one evaluates EE programs, or any other program, when demand curves do not reflect the underlying "real" willingness to pay. One potential policy implication is a form of decoupling that guarantees distribution utilities the same revenues and profits regardless of the amount of electricity used. As this runs counter to theoretical results regarding the inefficiency of profit guarantees, decoupling policies implicitly ask if those analyses missed something. Although utilities may fail to provide information that would lead to demand reductions when revenues are tied to use, the conditions for such failure are sufficiently implausible, suggesting that the ultimate rationale is political rather than economic.

Political economy considerations lead to the final two EE policy puzzles surveyed here. In light of the emphasis in the policy discussion on cutting electricity costs—which admittedly is contrary to goals to induce conservation—another interpretation of the view that EE could reduce spending on electricity is that it could be a tactic a regulator could use to exercise monopsony power against generators on behalf of its constituents. The debate in antitrust between

[2] Some of the following findings are in Brennan (2010a, 2010b, 2011).

whether total welfare or consumer welfare should guide merger evaluation may be in the wrong venue; this distinction may play a greater role in understanding what utility regulators do.

Finally, I ask why regulators vest utilities with the responsibility for implementing EE policies. Not only is this a possible example of the fox being asked to guard the henhouse, it more significantly contradicts concerns, reflected in both theory and practice, that regulated monopolies (electricity distribution utilities) should be kept out of competitive sectors (EE equipment and services). Such concerns led to the break-up of the (old) AT&T (American Telephone and Telegraph) in the 1980s, involving the divestiture of its regulated local telephone networks. More recently, that idea served as the basis for Federal Energy Regulatory Commission (FERC) rules to require a functional separation between the ownership of competing generation facilities and control over monopoly distribution networks. An apparent and likely rationale for involving utilities in EE is again political—doing so results in having EE programs funded by regulator-approved electricity rate increases rather than by taxes that a legislature would have to enact.

Is EE a Substitute for Energy?

For many if not most of its advocates, the goal of EE policy is to reduce energy use. It would be tempting to model this as a reduction in the demand for energy itself. However, this turns out to be inconsistent with the definition of EE—that it allows one to obtain an equivalent level of service with less energy. Unless one gets a significant amount of service from using no energy at all,[3] this implies that the gross surplus from a given amount of energy increases as EE investments increase. Such an increase is inconsistent with the demand curve falling; for some quantities of electricity, the reservation price has to increase.[4] Moreover, if the marginal effect of EE on the reservation price falls at higher levels of energy use, the demand may be expected to pivot. The effect of EE on the demand for energy has to resemble the diagram on the right in Figure 1 instead of the one on the left (P is price, Q is quantity).

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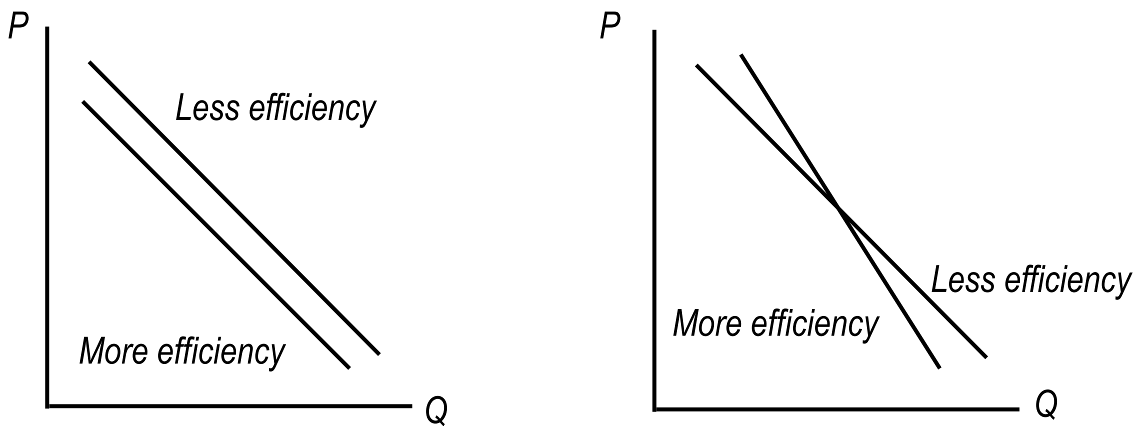
[3] I owe this qualification to Mike Waterson.

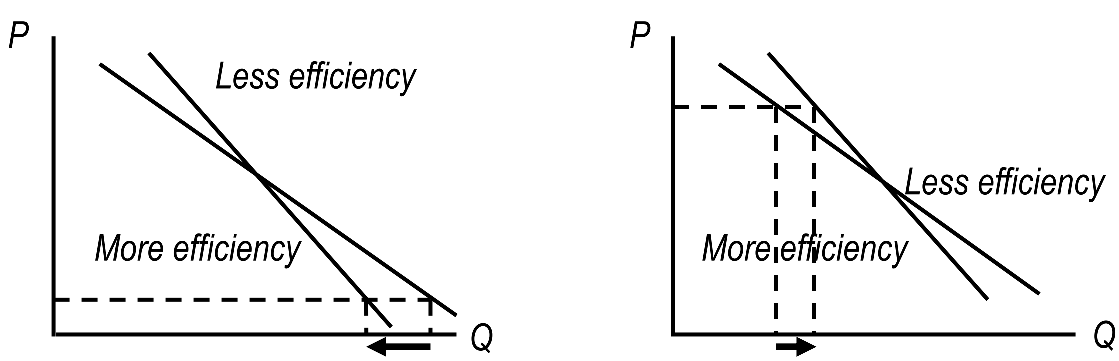
[4] See Appendix A.

Figure 1. "Wrong" and "Right" Effects of EE on Energy Demand



If prices are low, EE and energy use are substitutes in that increasing the former (by reducing its price) reduces demand for the latter. But because the demand curve for energy pivots with more EE, increasing EE will increase energy use if the price is sufficiently high. The rebound effect is not just possible, it is inevitable, rendering EE and energy use complementary as displayed in Figure 2.

Figure 2. Substitutes and Complements Depending on Price



Although a positive rebound effect is necessarily an empirical matter, depending on energy prices rather than a theoretically reasonable generalization, this result might remain a curiosity rather than an outcome with policy relevance. At prevailing prices, it is likely that EE and energy use are substitutes rather than complements, although Tierney (2011) reports evidence to the contrary. However, one policy effect bears watching. As noted above, the costs of supplying electricity during the few critical peak demand hours of the year could be many multiples of average prices. Recent policy experiments in Maryland employed critical peak prices more than 10 times the average rate (Faruqui et al. 2009). With price increases of that magnitude, the potential for prices to go above the pivot point ought not be dismissed out of hand. If real-time pricing were adopted, EE policies could increase energy use during critical peak periods over the amount that one would see without those policies.

Should EE Savings Count Toward a Renewable Requirement?

In response to climate change, a number of policies have been proposed to limit greenhouse gas emissions, particularly emissions of carbon dioxide resulting from the burning of fossil fuels to provide transportation and electricity. Among the many policy responses that have been suggested—such as carbon taxes and cap-and-trade marketable carbon emissions permit programs—are renewable portfolio standards (RPS), which would require electricity suppliers to meet demand by generating a prescribed percentage of electricity from renewable energy sources.[5] To mitigate the cost of complying with an RPS—and it is presumably costly if binding—the obligations are tradable, such that an electricity supplier that meets demand with a greater percentage of renewable energy than that required under the RPS can sell renewable energy credits to allow those for whom procuring renewable power is more expensive to meet the requirement.[6]

To further mitigate the cost of an RPS, one might allow electricity suppliers to apply reductions in energy use toward meeting an RPS. For example, a supplier facing a 20 percent RPS might need to procure only 15 percent of its energy from renewable sources if it reduces demand by 5 percent. Recent legislative proposals to address climate change would give electricity suppliers some flexibility in using energy use reductions to meet an RPS (Lenard 2009, 58–59). Be-

[5] Whether "renewable" is defined in these proposals so that it is either necessary or sufficient that net carbon emissions be zero for a fuel source to be designated renewable, or whether the definition includes assorted political influences, is ignored here. Recent proposals to impose "clean energy standards" on electricity providers suggest a broad definition, including nuclear and hydroelectric power and giving some credit for less carbon-intensive natural gas generation.

[6] Legislative proposals also included an option to make payments rather than meet the requirement, essentially capping the price of renewable energy credits and allowing more nonrenewable energy than one would get under the RPS.

cause the goal of climate policy should be to reduce greenhouse gas emissions, doing so either by switching to non-emitting fuel sources or by reducing energy use altogether should be equivalent. Allowing electricity suppliers to choose between EE and renewable sources allows them to reduce emissions using whichever method is less expensive. In effect, combining EE with an RPS is equivalent to marketable permits for using nonrenewable generation.

The baseline against which energy savings are measured plays a crucial role in determining the costs of electricity. Relative to a fixed baseline, increasing electricity supply by one unit not only increases the renewable requirement by the nominal percentage, it also forces the supplier to acquire an additional full unit of electricity from renewable sources to make up for the apparent decline in EE.[7] Whether the former or the latter is closer to the appropriate tax one would have on fossil fuel-generated electricity under a Pigovian carbon tax is beyond the scope of this paper. But the two are undeniably different. The seemingly beneficial merging of EE with an RPS has a potentially large unintended consequence.

One could avoid this consequence in two ways. One option would be to adjust the baseline to reflect the demand conditions that lead suppliers to choose a given quantity of electricity in response to demand. If weather is unusually warm, leading to a greater demand for electricity for cooling, one could increase the baseline to reflect what demand would have been absent EE investments at the higher temperatures. Thus, the increase in electricity use would not necessarily force the supplier to obtain an additional unit of electricity from renewable sources because the measured "efficiency gains" have not fallen. How this calculation would be made is far from clear.[8] An alternative would be to attribute specific hypothetical savings from EE investments and use those to meet the RPS.[9] These would not be based on actual use, and thus the actual marginal cost of increased use would be just as if the renewable standard alone were in place.

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[7] See Appendix B.

[8] This is not the only instance in which baseline measurement ambiguities complicate electricity policy. To encourage consumers to adopt real-time pricing, some have proposed programs in which consumers are paid not to use electricity (Faruqui et al. 2009). Some utilities propose that the money to cover the cost of the programs should come from selling this *demand response* in electricity capacity markets, which are mandated by grid operators to ensure that electricity supply can be kept equal to demand in order to prevent blackouts. This requires a way to measure what consumers would have used absent the payments to reduce use to calculate the capacity equivalent of demand response.

[9] I owe this suggestion to Karen Palmer.

Whether these hypothetical savings reflect actual use reductions at the margin may prove difficult to determine. One reason is the rebound effect. A second reason has to do with whether a utility's efforts caused a consumer to adopt EE or whether that consumer would have done so anyway because the benefits of the EE investment over time outweigh its up-front cost. For example, the present value of the savings from reduced electricity use for lighting may exceed the extra expense of a CFL. How the potential for consumer error or inability to make this comparison affects EE policy is the topic of the next section.

"Second Best" or Consumer Error—and if the Latter, How Do We Evaluate EE Policy?

EE policy would not be necessary if energy prices, and electricity prices in particular, equaled the sum of all relevant marginal costs. For electricity, one set of missing costs are those reflecting environmental costs in the absence of carbon taxes, cap-and-trade systems, or other policies to internalize them. Time-averaged prices fail to reflect the high variance of costs over time because of the need to recover the costs of peaking units over a very small fraction of hours during the course of a year. Even if real-time pricing were available, it might not be adopted efficiently because users do not take into account the effect that their use may have on the probability of a blackout (Brennan 2004).

If electricity prices may fail to reflect these costs and EE is a substitute for energy use and not a complement—that is, if energy prices are not already too high for the rebound effect to be dominant—too little EE is consumed. The "theory of the second best" provides a rationale for policies to encourage greater adoption of EE. It would move the economy closer to the economically efficient mix of EE and energy use that one would see if electricity were priced correctly.[10] The pollution externality could justify general subsidies for EE, and the blackout externality and the inability to charge real-time prices would be relevant for policies targeting appliances primarily at peak demand periods (e.g., air conditioners but not light bulbs).

This all follows from the second-best result that if EE and energy use are substitutes, overall economic efficiency could be improved if EE were subsidized at the margin to correct for its underutilization resulting from underpriced energy. But what if the price is too high? In Maryland, the prevailing electricity policy sentiment is that people use too much electricity, but that it

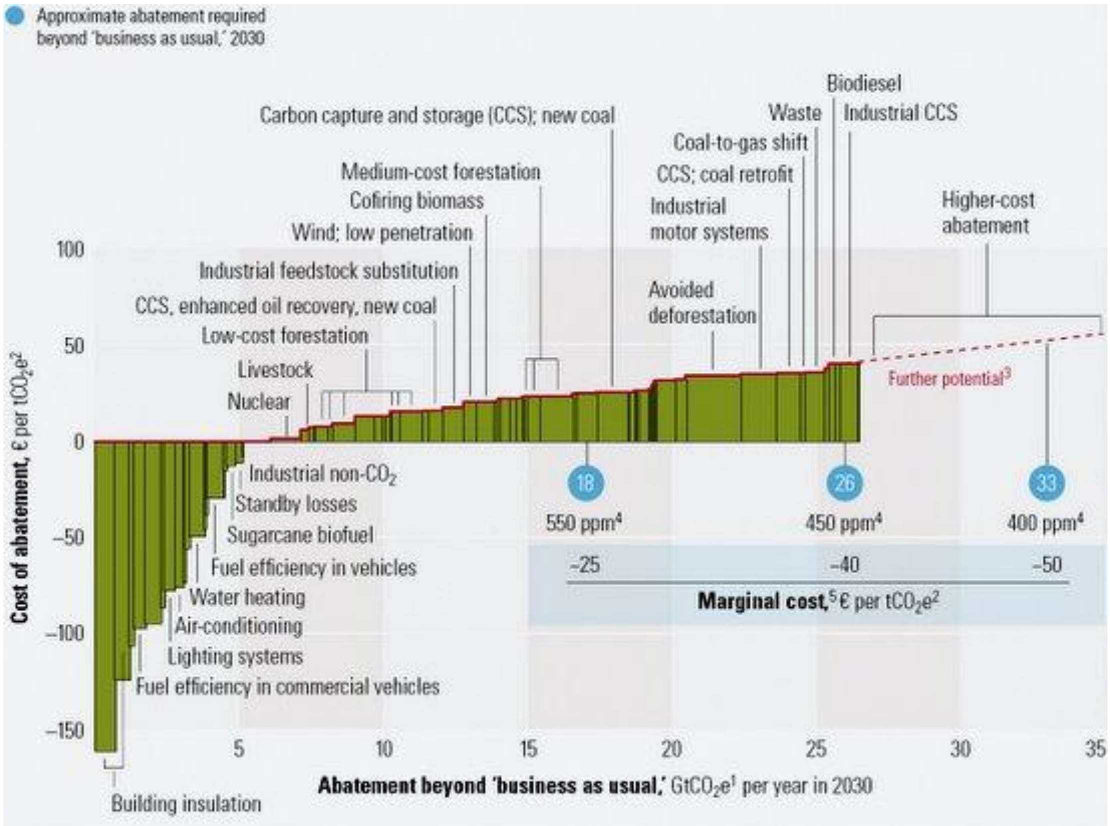
[10] Of course, if EE and energy use are complements, as they would be if energy prices were sufficiently high, one would want to tax EE.

is also too expensive.[11] If electricity is overpriced, consumers presumably overinvest in EE, and it should be taxed or discouraged by policy, not the other way around.

Reconciling policy to encourage EE and excessive energy pricing requires a belief that consumers fail to invest in EE even if it is in their own private interest to do so, without regard to environmental or reliability externalities. Questions regarding this failure go back more than three decades (Hausman 1979) and remain widely held in the policy community. A good indicator is Figure 3, a widely circulated and cited graph from McKinsey depicting a supply curve for carbon abatement based on the costs of different methods for reducing carbon dioxide emissions. The interesting aspect is not the particulars of the graph but that a substantial portion of the methods on the left side of the graph lies below the horizontal axis. Those are known in the energy policy community as "negative cost" abatement methods, as requiring them would leave the economy better off, apart from any environmental effects from carbon abatement.

[11] Although some who believe this attempt to attribute it to a lack of competition following the opening of retail markets, I am aware of little concrete evidence in that regard. After the 2006 Maryland gubernatorial election, the victor asked the state regulatory agency to investigate 72 percent increases in retail rates following the lifting of multiyear post-deregulation price ceilings, and the agency found the increases justified. Moreover, although retail service in Maryland is nominally deregulated, with entrants free to enter and set prices as they choose, the vast majority of residential customers continue to purchase electricity from the incumbent distribution utilities, and their rates remain overseen, if not explicitly regulated, by the Maryland Public Utility Commission.

Figure 3. McKinsey Carbon Abatement Supply Curve



Source: Enkvist et al. 2007, 38.

Standard economics would suggest that the negative cost portion of the supply curve reflects the cost of quality or performance shortcomings of some of those methods for reducing emissions, such as increased accident risk in more fuel-efficient cars or undesirable characteristics of light from fluorescent bulbs. However, behavioral economics—based upon the premise that people fail to act in their own self-interest because of bounded rationality or cognitive limitations—could be invoked. Gillingham et al. (2009) discuss behavioral economics rationales for EE policy but also note that there may be more conventional market failures in terms of a lack of information or an inability for homeowners to finance EE investments.

The McKinsey graph illustrates the prominence that choice failure plays in the EE policy discussion.[12] The primary policy puzzle in the EE context (and likely others) presented by the possibility of consumer choice failure involves evaluation. Generally, conventional cost–benefit methods require the willingness to pay revealed by demand curves to be the actual valuation consumers place on output. If such measures cannot be trusted, cost–benefit analyses require some measure of the "right" valuations that must inherently be introduced into the analysis from outside.

In a study of the standards instituted by California and used around the country for evaluating EE and demand-side management programs (State of California 2002), I proposed judging the effects of subsidies that induce EE adoptions by using the post-adoption valuation of EE benefits, not the allegedly mistaken pre-adoption standards (Brennan 2010a). If a marginal increase in EE adoption induces a non-marginal effect on consumer surplus because the subsidies allow consumers to overcome a putative cognitive limitation, EE policies can by that standard be beneficial, even if energy prices were too high beforehand. If no consumers would adopt a particular set of EE technologies that would be in their self-interest, a utility could be induced to do it for them if it got the same revenues from overall electricity sales regardless of the amount sold. Such revenue assurance would leave it to the utility to maximize profits by minimizing the costs of either generating electricity or supplying the EE that would give consumers the same welfare with less electricity—often referred to as "negawatts."

Whether post-adoption welfare is the correct measure or appropriate for policy remains a puzzle, as does the validity of the assumption that consumers fail to act in their own self-interest.[13] The possibility that consumers may make correct choices plays a role in the degree to which EE-related energy savings should be credited to a utility's efforts to promote it. Suppose, for example, that *N* households purchase subsidized CFLs. On the one hand, if consumers routinely make mistakes but one homeowner's adoption of EE leads neighbors to adopt it as well and to buy nonsubsidized CFLs, then the number of adopters resulting from the program exceeds

[12] A methodological assessment of consumer choice failure, on either empirical or theoretical grounds, is beyond the scope of this paper. A key theoretical concern I have with behavioral economics is whether it represents a premature admission of defeat regarding the ability of neoclassical economics to supply explanations for seemingly inexplicable, irrational, or mistaken phenomena.

[13] If consumers lack information or the ability to determine whether the benefits of a CFL over an incandescent bulb exceed its costs—a presumed inability that has led Congress to pass legislation preventing the sale of incandescent bulbs after 2014—one wonders what choices consumers can be thought to make competently.

N, resulting in what is called a "net to gross" ratio exceeding one.[14] On the other hand, if some consumers who purchased the CFLs with the subsidy would have done so without it, then the utility's program would induce fewer than *N* new adopters and the net-to-gross ratio would be less than one. In other words, the imputed benefits from utility EE programs are less than they might appear. Consumers who would have made EE investments absent subsidies because they understand the net benefits or want to contribute to the environment are known in EE policy circles as free riders—a perverse use of a generally pejorative term used to describe those who are unwilling to act in the collective interest.

Does Decoupling Help, and if so, How?

To my knowledge, no one has implemented a policy to divorce overall electricity revenues from the quantity sold. A less draconian version, known as decoupling, has been adopted in a number of states (MEA 2008, 4, 44–46; Pew Center on Global Climate Change 2011). Decoupling involves separating a distribution utility's profits and revenues from use. It does not include charging for distribution through fixed fees for customers, which would be an efficient way to recover costs if costs were not based on the quantity of electricity delivered.[15] Rather, if one customer reduces her use, the rates charged to all customers rise to keep distribution revenues intact. Unlike other regulatory policy innovations—marketable permits, price caps, spectrum auctions—decoupling did not percolate in the academic literature for years prior to implementation. Interest in it arose as a mechanism to promote energy conservation and efficiency, particularly in light of the effects of energy use on climate.

Decoupling's advocates argue that, under conventional pricing of distribution through fixed fees per kilowatt-hour delivered, utilities would lose profits if EE programs reduced electricity sales.[16] Decoupling would instead make utilities willing to participate in EE programs, participating in what many view as a national economic growth opportunity.[17] Former President Bill Clinton and President Barack Obama's representatives during the 2008 campaign have spo-

[14] For an example of the terminology here, see Summit Blue Consulting (2008, 10).

[15] If prices equal to the marginal cost of connecting an additional customer—the optimal fixed fee—do not generate sufficient revenues to cover costs, some usage-based prices would reduce the welfare cost of covering the regulated firm's expenses relative to recovering all costs through fixed fees (Brennan 2010b).

[16] For more detail on positions for and against decoupling, see Brennan (2010b).

[17] I have heard this mentioned in discussions with the President's Economic Recovery Advisory Board.

ken in favor of decoupling. On the political economy side, decoupling shifts revenue-side risk from the utilities to consumers.[18]

Decoupling has its opponents. It presents operational questions, such as when revenues and profits can be adjusted and whether it should be segregated by customer class (residential, commercial and industrial). Some high-volume industrial electricity users—many of whom have already adopted EE measures and thus stand to pay higher rates if EE becomes more widespread after decoupling—argue that making utilities' revenues and profits independent of use will discourage them from taking steps to increase their own operational efficiency and reduce their incentives to manage risks associated with variation in usage. Perhaps unexpected bedfellows with these large industrial users are state regulatory public advocates, who resist guaranteeing a utility its profits without a public right to intervene. A possibly unexpected and unintended side effect of decoupling is that divorcing utility profits from use attenuates incentives to restore service after storm-related outages.[19]

From an economic standpoint, decoupling is of interest because it challenges the central findings of regulatory economics. Since Averch and Johnson's (1962) article that founded the field nearly 50 years ago, economists have learned that fixed-profit regulation induces distortions in input use when the allowed rate of return exceeds the cost of capital. When the rate of return is correctly set equal to capital costs, the effects may be worse, as the regulated firm earns zero profits and lacks incentives to control costs.

For nearly three decades, the recommended alternative has been to divorce prices from costs through price caps (Littlechild 1983). Such prices could be adjusted over time for inflation and future profits shared through preset downward price adjustments, but prices would not be adjusted as costs change. Price caps thus give regulated firms the same incentives to innovate and cut costs as those price-taking firms face in competitive markets. Over time, prices capped over a range of services would converge to a Ramsey-like point, maximizing welfare subject to the profits the firm earns (Brennan 1989).

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[18] This reduces distribution utilities' overall profit risk unless revenues are highly correlated with costs, but because most distribution costs are fixed in the short run and independent of use per customer, this correlation does not appear likely to be significant.

[19] Although the cost of forgone usage under conventional cost recovery is significant, it may not be large relative to the cost of restorations. I owe this suggestion to Mark Case of Baltimore Gas and Electric, in response an op-ed I had in the *Baltimore Sun* noting the irony of suggestions from others that utilities face monetary penalties for slow post-outage restorations in a state that has adopted decoupling.

Decoupling challenges this consensus by taking as a premise the value in guaranteeing a distribution utility's profits. One response to this challenge is to see if the analyses supporting price cap regulation missed something. Two effects in particular may have been neglected. First, a price-capped utility would bias the information it provides, withholding that which would reduce demand (Brennan 2010b).[20] Whether utilities have unique access to information relevant to demand choices—for example, on the savings potential from CFLs or the operating costs of high-efficiency air conditioners—seems doubtful. Moreover, if a utility has to sell electricity at a time-averaged rate during peak demand periods when wholesale costs exceed the retail price, it will have an incentive to promote technologies that reduce energy use even without decoupling.

A second missed effect is that a price-capped utility would have incentives to subsidize only complements (substitutes) for electricity use when the price of electricity exceeds (is lower than) its marginal cost. This result is qualitatively consistent with the second-best responses to distorted energy prices, although the utility's private incentives to respond in this way are less than the social incentives because the utility does not capture the full marginal surplus of electricity use (Brennan 2010b). In any event, to the extent electricity prices exceed marginal cost because of usage-based delivery charges, EE advocates would find that utilities would be unwilling to subsidize EE investments that reduce use.

Neither of these economic arguments seems especially compelling. Moreover, even if profits are guaranteed, a utility has no particular incentive to invest in EE.[21] The weakness of the economic arguments suggests that the rationales for decoupling are not economic but political. Utilities are likely to be in a strong position to influence electricity policy (Stigler 1971). This is especially so as electricity policy falls within the jurisdictions of regulatory agencies rather than legislatures. State legislators may prefer to let the public service commission cover the cost of EE programs through electricity charges rather than face the political cost of enacting taxes to do so.[22] Decoupling serves to defuse utility opposition to EE programs by keeping the utilities whole. This is not necessarily a bad thing; it should be possible, in principle, to implement policies that pass a cost–benefit test in a Pareto-improving fashion. But the economics of decoupling

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[20] See Appendix C.

[21] If a decoupled utility does support EE, the effect on demand will be greater than the direct marginal effect because reducing demand will also raise price, in order to keep the utility's revenues constant. See Appendix D. I thank Ayoo Collins for suggesting this effect.

[22] Shifting the costs to the regulator to pass them in turn to the utility is also consistent with blaming the utility rather than the consumer for energy consumption deemed excessive.

strongly suggest that it is motivated by incentives in the political arena rather than the economics of supplying electricity or EE.

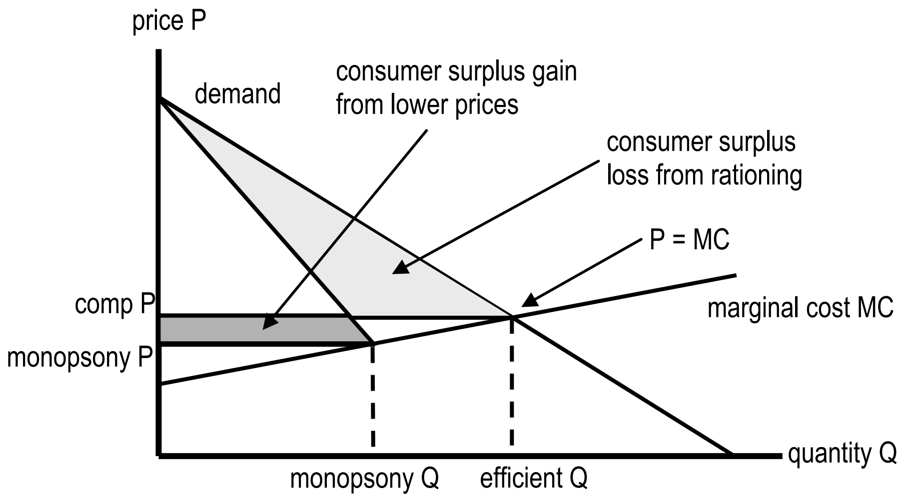
Could EE Be a Monopsony Tactic?

Much of the rhetoric regarding EE involves avoiding electricity purchases. Some of this extends to holding down electricity prices. To some degree, this is a reasonable way to characterize policies that would reduce electricity use at peak periods (e.g., through real-time pricing and demand management) to avoid having to construct generation and transmission capacity that would be used only a few hours out of the year. However, in this context and others, holding down electricity prices bears a strong resemblance to exercising monopsony power over generators.

If a regulator had the incentive and downstream market share necessary to be able to exercise market power against upstream generators, it would face a problem in implementation. Demand at the monopsony price would exceed demand at the competitive price and thus the quantity supplied under monopsony. This requires rationing. If rationing does not result in electricity being allocated to its highest-valued uses, monopsony may reduce consumer welfare rather than enhancing it, as intended.[23] A draconian example of this reverse effect, in which rationing is where each unit goes to a buyer willing to pay at least the monopsony price with equal probability, is illustrated in Figure 4, from Brennan (2011).

[23] Of course, monospony reduces total economic welfare. We return to the distinction between consumer and total welfare below.

Figure 4. Consumer Gains and Losses under Monopsony with Rationed Demand



Source: Brennan 2011.

EE can complement monopsony because it can allow the regulator to solve the rationing problem by subsidizing EE investments that reduce demand. Specifically, the derivative of consumer welfare with respect to price is negative at the competitive price (consumer welfare rises as price falls) even if consumers bear the full cost of the subsidy of EE costs necessary to increase EE penetration to reduce demand and eliminate rationing (Brennan 2011). A regulator would find it optimal to subsidize EE to some extent to reduce demand and thus price by moving supply down the supply curve.[24]

Establishing that a regulator could subsidize EE to exercise monopsony power does not mean that it would do so. The capture theory of regulation noted above suggests that the generation sector may well have more political influence on the regulator's actions than does the dispersed consumer interest. Second, if it could do so, a regulator could make consumers better off if it maximized aggregate surplus at the competitive level and extracted profits from the supplying generators through lump-sum charges or price discrimination. Even if a regulator were inclined to monopsonize, it would have to have buyer-side market power over a set of generators

[24] See Appendix E. The result holds in general only if the costs to consumers of the EE subsidy are borne in a lump-sum fashion. Distortions in other markets resulting from the need to increase taxes to raise revenues to cover the subsidy cost could make monopsony unprofitable because of rationing even at the margin at the competitive price.

in a wholesale market. As these markets span large geographic areas because of the spans and capacities of the transmission networks that support them, an individual state regulator seems unlikely to have monopsony power except in a few large states.[25]

There are other limitations as well. The supply curve for electricity is widely recognized to be highly upward sloping once baseload capacity is exhausted—the "hockey stick" metaphor is widely used. The relevant marginal cost represented by the load is long-run, however, in which prices cover the cost of the capital used to supply electricity during a limited number of peak demand hours. Regulatory efforts to drive down the cost of electricity by reducing purchases would, at least in the short run, come about largely through opportunistically denying generators their expected ability to recover capital costs. Because of the potential for regulatory opportunism, quasi-constitutional legal rules require regulators to grant firms under their jurisdictions a "just and reasonable" return, essentially to preclude a taking of the firms' capital. Although the generators are not directly regulated in an open wholesale market, it may be an open legal question whether a regulator with the ability and inclination to monopsonize could do so.

The policy puzzle presented by EE here is not so much the legal question as it is the economic question of what welfare standards are controlling. Debates regarding the degree of antitrust enforcement revolve in part around whether profits a firm or firms gain through a practice should count in the calculation of whether a practice should be permitted, or whether they should be neglected. This is generally referred to as the "total welfare vs. consumer welfare" debate. It goes back at least to Williamson's (1968) suggestion that the savings from a relatively small reduction in costs post-merger would outweigh the deadweight loss from higher prices. Cost savings would be reaped on all of the output of the merging firms, whereas the deadweight loss results only from the output forgone from the higher post-merger prices. Despite the intensity of the discussion over the last four decades, the number of antitrust cases in which a total welfare analysis would have given a result different from that of a consumer welfare analysis seems slim.[26] The rhetoric and potential for EE to drive down wholesale electricity prices suggests that

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[25] One exception may be that during peak demand periods, transmission grid congestion can create load pockets that may lie within a state and thus present at least a theoretical potential for monopsony power. FERC is currently reviewing claims that state policies in New England to encourage new generation policies are allowing the exercise of *buyer market power* in capacity markets. New England Power Generators Association v. ISO New England et al., Federal Energy Regulatory Commission, Docket EL 10-50 (March 24, 2010).

[26] Price discrimination can increase total welfare and reduce consumer welfare, but it generally is not illegal. Fowder (2010) suggests that this could be because a total welfare standard applies to price discrimination. See also Carlton and Heyer (2008).

the consumer vs. total welfare debate might be more productively framed in the regulatory context.

Should Utilities Handle EE?

A final puzzle stems from the viewpoint that incumbent regulated monopoly utilities should be the conduit through which funds are raised to pay for EE programs and the institutions that should implement them. California's manual for evaluating demand-side management programs (State of California 2002) proposes a number of tests in which the costs borne by utilities and the prices paid for the electricity they supply play a crucial role. Maryland's plan to reduce electricity use 15 percent by 2015 obliges utilities to come up with programs to achieve the "majority" of those savings (MEA 2008, 27) through a variety of EE subsidy programs involving equipment, loans, and audits of energy needs. Fox-Penner (2010, 189–202) envisions a "new paradigm" of the "Energy Services Utility," in which the incumbents sell the uses to which energy is put (lighting, heating, and cooling) rather than the energy itself. This would allow the utility to capture the benefits of EE and provide an incentive consumers may lack, especially if they are either unable or unwilling to invest to capture the benefits of EE directly.

The impetus to put utilities in the center of EE policy raises the question of whether doing so is a good idea. Utilities have spent a century or more engaged in supplying energy, not "energy services." In doing so, they have not been asked to encourage customers to buy less of what they have to sell (except on-peak, when prices have typically been below cost). To a considerable degree, having utilities implement EE policy requires them to abandon their decades-long mission to supply energy. One may also wonder whether this is asking the electricity fox to guard the efficiency henhouse.

Although the costs of changing business plans may be important, the economic policy puzzle here begins with the premise that, unlike the distribution of electricity to users, EE shows every indication of being a highly competitive enterprise. It seems almost stereotypically open to any number of entrepreneurial initiatives. There do not seem to be fixed costs—either in EE equipment or in EE-promoting programs—that preclude competition. This makes all the more compelling the question of why anyone should presume that a monopoly utility is the best provider of those programs.

Separation of regulated monopolies from competitive lines of business has been a hallmark of utility policy for decades. In the 1970s, the Department of Justice led an effort to reform the regulation of oil pipelines by mandating that they be managed independently of shippers, who could have an incentive to reduce a pipeline's capacity and drive up the prices of products shipped through it (reviewed in Mitchell [1979]). The 1980s saw the antitrust case against AT&T, leading to the divestiture of its local telephone monopolies—likely the largest policy-driven divestiture in U.S. history (Coll 1986). In the 1990s, the key event in opening wholesale electricity markets were FERC orders limiting the ability of competing generators to control the operation and to have differential access to information regarding monopoly electricity transmission grids (Brennan et al. 2002, Ch. 3).[27]

The economic basis for separating the ownership of competitive business from the control of regulated monopolies begins with the idea that diversification into competitive businesses could be a tactic by which the monopoly could reap profits nominally thwarted by regulation. The undersizing argument regarding pipelines was that owners could set the pipeline's output at the monopoly level and reap the profits through higher unregulated retail oil or petroleum product prices. A second concern has been above-cost transfer pricing: if an unregulated upstream affiliate of a regulated firm sells its inputs at inflated prices, these prices then would be passed on as a cost to be covered through higher regulated rates.

Two stories have dominated the discussion since the breakup of AT&T in the 1980s. The first, cross-subsidization, involves designating costs of providing unregulated service as costs of providing the regulated service. The effect of this is to raise regulated rates to cover these costs, reaping the profits in the cross-subsidized unregulated enterprise. This in turn can distort the unregulated market, displacing more efficient capacity at the margin and perhaps creating a credible predatory threat (Brennan 1990).

More prominent in electricity policy is discrimination. A vertically integrated owner of a regulated service could use non-price methods of discrimination, such as providing lower-quality service or delayed access to the regulated service, against unaffiliated rivals in the unregulated market (Brennan 1987; Crew et al. 2004); other observers refer to this as "sabotage" (Beard et al. 2001). The prime example in electricity would be delayed construction, lower quality, or poorer maintenance of transmission lines that competing generation companies would use to sell their products in unregulated wholesale electricity markets. This tactic gives the regulated firm an artificial competitive advantage in the unregulated markets, through which it can attain profits based

[27] The imposition of rules taking apart unified, vertically integrated utilities is why opening electricity markets and lifting regulation of wholesale (and in some states, retail) electricity prices is called *restructuring*.

on its control of the ostensibly regulated monopoly transmission grid (Brennan et al. 2002, Ch. 7).

The policy puzzle is why policies that contradict these principles and history, vesting utilities with control over competitive EE provision, are so widespread. The answer may lie with an observation above regarding decoupling. Running EE policies through utilities allows legislatures, particularly state legislatures constrained by the need to balance budgets, to avoid explicit taxation or cutting of other public services to pay for these programs. The "tax" becomes an increase in electricity rates granted to utilities to cover their costs of carrying out these services. If one believes that EE policy is desirable, channeling it through regulator commissions rather than adopting it through explicit legislation and taxation may be an acceptable tactic. A compromise to explore would be to use the regulatory process to have utilities collect funds to cover the cost of EE programs and then distribute the funds through an auction or other competitive process so entrepreneurial initiative is not stifled. As a side benefit, this would raise electricity prices that would otherwise be too low if EE policies are to be justified.[28]

Summary

Energy efficiency has become an increasingly important energy and infrastructure policy, especially as the best environmental policies, such as carbon taxes or cap-and-trade programs, become increasingly less likely. However, EE programs introduce a set of policy puzzles. Not only may greater EE increase energy use, but it also must do so if energy prices are sufficiently high, making the premise that EE substitutes for energy use an empirical question rather than a theoretical presumption. Combining EE with renewable energy standards can greatly increase the cost of the latter absent adjustments to the EE measurement baseline or using hypothetical rather than actual savings from EE deployment. Some may justify EE not with the premise that electricity is too cheap because of unpriced environmental externalities, but with consumer choice failures. That raises a question of how to do cost–benefit analysis when the data on benefits, revealed by willingness to pay, cannot be trusted if the policy requires that consumers be mistaken.

Turning to institutional responses, decoupling of distribution utility revenues and profits from use may address some omissions in the analysis of the benefits of price caps over rate-of-

[28] Prices below cost may not be necessary to justify EE policies if consumers make erroneous choices regarding EE investments, as noted above.

return regulation, but the main justification appears to be to defuse utility opposition to EE policies. EE policy could be a way for regulators to ration and reduce demand in order to exercise monopsony power over electricity suppliers, suggesting that the debate about consumer vs. total welfare as the policy standard might be more pertinent to regulation than to the antitrust settings in which it has taken place. I ended by looking at having regulated utilities play a role in competitive EE markets when doing so risks distorting the prices of both the regulated and unregulated products. The prominence of this role reinforces inferences from an analysis of decoupling and regulatory monopsony—that the politics allocating the responsibility of energy policy, and paying for it, between legislatures and regulators plays a role at least as great, if not greater, than any underlying analysis of market failures in electricity or energy.

Appendices

A. EE and Energy Use Are Complements at Sufficiently High Prices[29]

Let $w(x, e)$ be the marginal willingness to pay for the x^{th} unit of electricity, with e units of EE in place. Neglecting income effects, the total value $W(x, e)$ of that level of energy to a consumer is the area under the demand curve,

$$W(x, e) = W(0, e) + \int_0^x w(z,e)\,dz \ .$$

where $W(0, e)$ is the value consumers get with e units of EE installed when no energy is used. Because EE increases the value the consumer gets from a given quantity of energy use, $W_e(x, e) > 0$:

$$W_x(x, e) = W_e(0, e) + \int_0^x w_e(z,e)\,dz > 0.$$

Were the demand curve to fall everywhere, $w_e(x, e) < 0$ for all x. That would imply that the above expression is negative unless $W_e(0, e)$ is sufficiently large; otherwise, there must be some

[29] From Brennan (2011).

$x°$ for which $w_e(x°, e) > 0$. Moreover, if $w_{ex} < 0$, that is, if the effect of EE on the marginal value of electricity falls with the amount of electricity consumed, there exists some x^* for which $w_e = 0$, $w_e > 0$ for $x < x^*$, and $w_e < 0$ for $x > x^*$, giving the "pivot" in Figure 1.

B. Incorporating EE into a Renewable Use Requirement

First, leaving aside EE, let x be the amount of electricity produced and let r be the RPS percentage, so that rx units of electricity are produced with renewables. Let $c_r(.)$ be the cost of producing electricity with renewable sources, and let $c_f(.)$ be the cost of nonrenewables, designated here by an f for fossil fuels. The cost to the electricity sector of supplying x units of electricity, $c(x)$, is thus

$$c(x) = c_f([1 - r]x) + c_r(rx).$$

and the marginal cost c' of an additional kilowatt-hour of electricity is

$$c' = [1 - r]c_f' + rc_r' = c_f' + r[c_r' - c_f'].$$

Assuming that the RPS is binding, the marginal cost of renewable energy, $c_r' > c_f'$. The implicit tax imposed by the RPS is the difference between the actual marginal cost c' and the marginal cost were only fossil fuels used, c_f', $r[c_r' - c_f']$.

Suppose energy use reductions can be used to satisfy an RPS. Let b be the baseline from which energy reductions will be calculated. For a given quantity x of electricity supplied, the amount of renewable-source electricity required will be $rx - [b - x]$ or $[1 + r]x - b$, where rx is the nominal renewable requirement and $b - x$ is the energy savings relative to the baseline that can be applied toward meeting the RPS. The remaining amount of electricity, $x - [rx - [b - x]] = b - rx$, would be produced using nonrenewable sources. The cost of supplying x units of electricity becomes

$$c(x) = c_f(b - rx) + c_r([1 + r]x - b).$$

with marginal cost

$$c' = -rc_f' + [1 + r]c_r' = c_f' + [1 + r][c_r' - c_f'].$$

With EE incorporated into an RPS, the implicit tax on fossil fuel-generated electricity jumps from $r[c_r' - c_f']$ to $[1 + r][c_r' - c_f']$.

C. Utility Disincentives to Provide Demand-Reducing Information or to Subsidize Substitutes[30]

Assume that a regulated distribution utility with fixed costs chooses information I to maximize profits net of those costs under a capped energy price p_x

$$p_x x(p_x, I) - h(I).$$

The profit-maximizing level of information meets the condition

$$p_x x_I = h'.$$

Because $h' > 0$, $x_I > 0$. The utility will provide only information that boosts demand. However, distribution utilities typically buy electricity at cost $c(x)$ and sell at retail, giving profits (net of fixed costs) as

$$p_x x(p_x, I) - c(x(p_x, I)) - h(I).$$

The profit-maximizing level of information satisfies

$$[p_x - c']x_I = h'.$$

If prices exceed marginal cost, then the above result applies—the utility will supply only information that boosts demand. However, if the electricity price is set under conventional practice where prices are an average of low off-peak marginal costs and very high on-peak costs, then it will be sold at prices below marginal cost during peak periods, implying that the utility will want to supply information that reduces demand.

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[30] From Brennan (2010b).

Similar results hold for when a distribution utility would subsidize complements (which increase demand) or substitutes (which reduce it).

D. Enhanced Effect of EE in a Decoupled Utility

Under decoupling, distribution revenues R are held constant. Let x is electricity use and p is its price, where $p = p_w + p_d$, and e the amount of EE employed, where p_w is the wholesale price of electricity and p_d is the price of distribution. For simplicity, we assume that the individual utility's actions regarding e have no effect on p_w. With decoupling,

$$p_d x(p_w + p_d, e) = R.$$

The effect of energy efficiency on distribution price will be

$$\frac{dp_d}{de} = -\frac{p_d x_e}{p_d x_p + x},$$

making the total effect of EE on energy use

$$\frac{dx}{de} = -x_p \frac{p_d x_e}{p_d x_p + x} + x_e = \frac{-px_e x_p + x_e px_p + x_e x}{p_d x_p + x} = \frac{x_e}{1 - |\varepsilon| \frac{p_d}{p}}.$$

where $\varepsilon = px_p/x$ is the elasticity of demand for electricity. If $|\varepsilon| < p/p_d$, the denominator on the right will be positive but less than one, implying that $|dx/de| > |x_e|$. If x_e is negative, that is, more energy efficiency reduces energy use, the total reduction in energy use from of increasing energy efficiency on energy use will exceed the direct reduction because of the consequent increase in p_d. If the rebound effect dominates because the price of electricity is high—see Appendix A—decoupling will similarly enhance that positive effect on energy use because p_d will fall.

E. Regulatory Incentives To Monopsonize through Subsidizing EE[31]

Assume that the regulator is choosing the quantity of electricity, *x*, and the amount of EE, *e*, to maximize consumer welfare less the cost of EE, *h*(*e*), subject to a constraint that energy price equals marginal cost.

$$W(x, e, \lambda) = \int_0^x w(z,e)dz - w(x,e)x - h(e) + \lambda[w(x,e) - c'(x)] \; .$$

The first-order condition for electricity, *x*, is

$$\lambda[w_x(x, e) - c''(x)] = w_x(x, e)x.$$

which implies

$$\lambda = x\frac{w_x(x,e)}{w_x(x,e) - c''(x)}.$$

Because w_x is negative, c'' is nonnegative $\lambda \leq x$, with the equality holding only if $c'' = 0$, implying perfectly elastic electricity supply.

The first-order condition for EE, *e*, is

$$\int_0^x w_e(z,e)dz - h'(e) = w_e(x,e)[x - \lambda].$$

The left-hand side is the marginal value to consumers of EE—that is, its price—less *h*', the marginal cost of EE. If EE reduces use, $w_e(x, e) < 0$. Because $x > \lambda$ unless supply is perfectly elastic, the right-hand side is negative, implying a monopsonistic incentive to set the price of EE below its marginal cost.

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[31] From Brennan (2011).

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