Ohio's Energy Efficiency Resource Standard: Where Are the Real Savings?

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Abstract

Ohio's energy efficiency resource standard (EERS) requires regulated utilities to meet a schedule of reductions (above federal requirements) in customer energy consumption that cumulate to 22 percent by 2025. Utilities are to comply with these purely political requirements by devising programs whose costs are recoverable in rates. All utilities have been in compliance since 2009, but that compliance means little because nearly all the savings have come from utility-offered discounts on energy-saving light bulbs. Available data show that the majority of claimed savings come from transfers by other ratepayers to "free riders" who did not require subsidies to induce purchases. Data indicate that energy use reductions net of free ridership are already falling short of EERS requirements. The shortfalls will probably grow in the future as cost-effective savings opportunities (that must exceed federal standards) diminish while the costs of compliance rise.

JEL codes: K2, L4, Q2, Q4

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Contents

CHAPTER I

THE ECONOMICS OF ENERGY EFFICIENCY

I. Introduction

A. Regulation and Efficiency in Electricity

Electricity has long been regulated comprehensively, with state and federal oversight of its technologies, markets, operations, planning, and profitability. The importance of electricity policy grew as the energy crises of the 1970s unfolded and new policies came into being. Some were variants of more general regulation, as when the US Environmental Protection Agency applied rules for "criteria pollutants" (e.g., oxides of nitrogen and sulfur) to both power plants and industrial sites with similar boilers. Other aspects of electricity were singled out for special treatment.

From the outset regulatory ratemaking had allowed the representation of consumer interests, a role that expanded in the 1970s with the introduction of integrated resource planning (IRP). IRP brought together utilities, consumers, environmentalists, and others to account for both demand and supply in determining a least-cost regional resource mix. Ohio did not explicitly introduce IRP, but its regulators continued to determine the suitability of new utility facilities for cost recovery from ratepayers. Other regulations further constrain utilities' investment choices. Most importantly for my purposes, utilities in 30 states are subject to renewable portfolio standards (RPSs) that require them to obtain power from such sources as wind and solar generators. Twenty-four more states have energy efficiency resource standards (EERSs) that typically specify annual energy savings requirements and often operate alongside RPSs.[1] Ohio's EERS, effective in 2009, requires annual percentage reductions in energy consumption and peak

[1] Definitional differences make comparison and description difficult. Some states, for example, have renewable power "goals" for future dates that carry no penalties for noncompliance. All states with an EERS also have an RPS. See Jenny Heeter and Lori Bird, "Including Alternative Resources in State Renewable Portfolio Standards: Current Design and Implementation Experience," *Energy Policy* 61 (October 2013): 1388–99.

loads for each of the state's regulated utilities. The annual reductions in energy consumption relative to a statutory baseline, if met, would total 22 percent by 2025. The EERS went into effect alongside the separate renewable energy goals in the state's 2008 RPS.

These energy efficiency regulations can take many forms and can be directed at either producers or consumers of power. For example, a technology requirement might specify allowable design characteristics of electric motors. Another regulation might require that certain power consumers succeed in saving certain quantities of electricity. Yet another might specify penalties for consumers who fail to reduce power use by some amount specified by law. Ohio's EERS requires the state's regulated utilities to institute programs of their choice that will result in lower energy consumption.

There is not, however, any obvious rationale for EERSs. The Public Utilities Commission of Ohio (PUCO) requires that every utility's program be cost-effective as a whole. An economist usually expects that self-interested consumers (whether households or businesses) will adopt cost-effective programs on their own, helped along by profit-seeking entrepreneurs. One possibility remains: unique and strong barriers may stand in the way of economically rational choices by users, and a properly designed and implemented EERS could lower these barriers. If so, we must examine (1) whether such barriers exist in Ohio and (2) whether an EERS can bring about efficient choices that will not otherwise be made.

B. Plan of This Study

The goals of this study are to discuss the economic logic of energy efficiency programs in general, to examine their costs and benefits, and to evaluate Ohio's EERS in light of economic theory and available data. This chapter starts with a general discussion of economic efficiency and energy efficiency, and important distinctions between them. Chapter 2 presents data on electricity supply, demand, and regulation in Ohio, including a summary of EERS legislation and PUCO rules for implementing it. Chapter 3 introduces the data that utilities must submit as evidence of compliance and outlines the benefit-cost tests used. It also provides a discussion of the important problems associated with "free riders," those who receive incentive payments from a program but would have participated if they had not been paid. Chapter 4 examines a typical utility's compliance in more detail, beginning with its selection of programs and a prospective benefit-cost analysis. It then discusses the claims of savings that the utility submits as evidence of compliance.

Ohio is among a distinct minority of states that use gross data rather than net data that have been adjusted to eliminate free riders. Corrected by using estimates of free riders in other states, the results of some important benefit-cost tests in Ohio turn out to be net costs rather than the benefits claimed. In addition to the free rider problem, utilities' required annual reports to PUCO generally show that 80 percent or more of estimated energy savings come from discounts on energy-efficient lightbulbs, most of which are purchased by free riders. Chapter 5 combines theory and data to examine whether Ohio's EERS is meeting expectations that existed when it became law. In particular, I discuss the illogic of Ohio's odd requirement that counts energy savings for compliance only if they exceed federal standards. Some supporters of EERSs now acknowledge that they may not be sustainable for the long term, while others continue to claim that a plethora of energy-saving opportunities remain to be exploited. Sustainability may be even more elusive. Some (but definitely not all) of the utilities' consultants even question whether the state can meet the law's 22 percent savings goal for 2025. Ohio exemplifies a political difficulty that will almost surely be seen in other states with EERS-like programs. The problem is that

Ohio's EERS program has done more than put rules in place. It has also created a choice process and a coalition of interest groups that will make the more onerous provisions of state Senate Bill 221 (discussed in chapter 2) difficult to alter, although changes in the state's energy situation (e.g., shale gas) may provide a countervailing force.

II. Efficiency and Information

A. Energy Efficiency and Economic Efficiency

Elementary physics defines engine A as more energy efficient than engine B if, for example, it uses less fuel to move a certain weight a certain distance. Algebraically, energy efficiency is the percentage of energy in the fuel that is converted to useful work. But what if engine A is platinum and engine B is steel? A conclusion that A is preferable rests on an unstated assumption that only fuel is scarce; that is, that the large amounts of labor and equipment that produced the platinum are irrelevant. In reality, they could have produced other desirable goods. Build the platinum engine and these workers and equipment will be unavailable to make other goods; build the steel engine and some of those goods can come into being.

The platinum engine will probably go unbuilt because it is economically inefficient. A given bundle of resources—such as labor, machinery, and energy—is used in a more economically efficient way if it produces a more valuable set of outputs, measured at market prices. Distinguishing economic efficiency from energy efficiency can improve our understanding of electricity policy. The oft-heard claim that "the cheapest power plant is the one you don't build" disregards the benefits of the electricity it would have produced. "The cheapest school is the one you don't build" only makes sense if education has a low value in students' future productivity relative to the cost of building and operating the school.[2] The concept of economic efficiency reminds us that all productive resources are scarce in varying degrees.

B. Prices and Information

We know that supply and demand determine prices, but less often do we recognize that supply and demand are also determined by expectations of the future. In March, halfway between last year's and this year's corn harvests, holders of corn are selling from their inventories in hopes of profiting before the fall harvest. Assume that today one weather forecaster unexpectedly predicts a disastrous drought between now and harvest time, while all the others maintain their belief that weather will be normal. With only one outlier forecast, only a few people hold on to corn they would otherwise have put on the market but, as time passes, more forecasters come to predict drought. Less corn comes to market as holders expect to profit from the high prices they now anticipate at harvest time. A growing expectation of high prices causes today's cash prices ("spot" prices) to rise. If the harvest turns out to be poor, rising prices today are early warnings that corn is becoming scarcer, and users will reduce their corn purchases in response. Today's prices are determined by the expectations of market participants about future supply and demand. Of course, if the drought does not materialize and the harvest is normal, those who released corn from their holdings in the interim will prosper. Prices and markets look forward. Because prices inform buyers and sellers in advance, they can take fuller advantage of good news and gain time to mitigate the effects of bad news.

In a market economy, no central institution sets prices. Rather, prices adjust as the result of production and purchase decisions made by self-interested sellers and buyers in response to

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[2] This example is from Timothy Brennan, "The Challenges of Climate for Energy Markets" (RFF DP 09-32, Resources for the Future, September 2009), 3, http://www.rff.org/RFF/Documents/RFF-DP-09-32.pdf.

market prices. Buyers and sellers act on their information, and the net impact of their transactions changes market price and makes it a more accurate indicator of underlying scarcity. The market price contains the information of all the market participants. The alternative to allowing a market to determine prices is empowering the government to do so, and the government would have to set prices on the basis of more limited information than is available to buyers and sellers as a whole. Government rulemaking on energy production and use can outperform private choices only if we assume that its centralized forecasts are superior to those of market participants whose information is continuously incorporated in prices. As discussed below, however, situations might exist in which government decision-making will produce superior outcomes. Advocates have claimed that some energy efficiency policies fit that theory.

On the surface, energy commodities are unlike farm products, because new crops appear annually while oil and gas are said to be finite or nonrenewable. In the context of a short period, a particular deposit, and a fixed extraction technology, finiteness may have relevance. History, however, suggests a type of renewability. In reality, energy may be more usefully viewed as renewable, because rising prices encourage new production from existing properties and improved extraction techniques such as hydraulic fracturing. Rising prices make all these activities potentially more profitable.[3] As with farm crops, rising energy prices motivate users to economize and falling prices motivate them to use energy more intensively. Higher prices stimulate production of substitutes that range from wood stoves to flannel shirts and promise rewards to inventors and innovators who facilitate adjustment to changed prices. If markets,

[3] Renewability is in the eye of the beholder. California's Kern River oil field was discovered in 1899 and produced relatively small amounts for the next 40 years. According to a 1942 estimate, 54 million recoverable barrels remained. In the next 44 years it produced 736 million barrels, with an expectation that 970 million were yet to come. By 2007 the field's operator announced cumulative production of 2 billion barrels, with another 480 million recoverable. Leonardo Maugeri, "Another Century of Oil: Getting More from Current Reserves," *Scientific American*, August 2009, 47.

market prices, and intermediaries improve peoples' abilities to forecast and adjust, assertions that consumer incompetence rationalizes mandatory efficiency lose some of their force. They may not, however, lose all their force, as noted in the following sections.

III. Market Failure

A. External Costs and Benefits

The economic theory of a perfectly competitive market describes an abstract system in which all transactions that can benefit both buyers and sellers take place at a uniform market-clearing price. Some situations, however, could provide rationales for government efficiency policies. A voluntary exchange benefits both buyer and seller, and possibly other parties as well. If others gain (lose), the transaction is said to create an external benefit (cost). External costs provide a possible rationale for environmental policy. A power plant's emissions may be harmful in the aggregate while injuring each individual in the community by a small amount. If the cost of additional harm exceeds the value of additional electricity, there may be a case for regulating emissions.

One possible regulatory regime is a cap and trade system like the EPA's rules on oxides of nitrogen and sulfur.[4] After the EPA sets a ceiling on total emissions and allocates rights to pollute the ceiling amount, polluters may buy and sell these rights among themselves. Those who can reduce emissions at low cost can sell their rights to others whose reduction costs are greater, allowing more power to be produced while total emissions are still capped. Cap and trade controls emissions directly rather than by, for example, regulating

[4] Recent court decisions have put the future of cap and trade systems in doubt, but for reasons unconnected with their economic benefits. See North Carolina v. EPA, 531 F.3d 896 (D.C. Cir. 2008) and New Jersey v. EPA, 517 F.3d 574 (D.C. Cir. 2008).

allowable power plant technologies. It allows polluters to profit by introducing innovative ways to reduce the pollutant rather than simply assuming that the government knows best which methods they should use.

This logic sheds light on the likely economic inefficiency of most state policies on renewable power and energy efficiency. A compact fluorescent (CFL) bulb consumes less energy than an incandescent bulb, but an EERS policy that compels the use of the former (or subsidizes its purchase) limits users' motivations to innovate in ways that best suit their individual situations. Likewise, a requirement that power be produced by specific types of renewable generators diminishes incentives to devise innovative pollution control methods because it does not target emissions directly. An EERS or RPS implicitly assumes that the government knows the best ways to reduce power consumption or control pollution, and that any policies it enacts will be undistorted by politics.

B. "Market Barriers" to Energy Efficiency

Economists sometimes encounter behavior that appears inconsistent with the commonly held assumption that people act rationally to advance their interests. For example, a 2009 McKinsey & Company report concluded that American businesses could reap huge profits and save energy by investing in proven technologies. McKinsey estimated that 10 years of expenditures with a present value of $520 billion would save a present value of $1.3 trillion in energy costs.[5] Inexplicably, large businesses with access to capital appear to be walking away from investments in efficiency. The external costs and benefits discussed above were outcomes of rational choices by self-interested producers and consumers; the McKinsey study

[5] McKinsey & Company, *Unlocking Energy Efficiency in the U.S. Economy* (July 2009), 14. For readers unfamiliar with finance, present values are described in the text below.

illustrates so-called market barriers that impose avoidable costs on a decision maker. A different choice with the same cost would have left that person better off, but this choice was not made. Causes might include erroneous calculations, disregard of relevant information, and misinterpretation or disregard of the consequences of a correct calculation. If market barriers are relevant, some experts argue that consumers will benefit from seemingly coercive policies that prohibit them from making economically inefficient choices. Others have found little evidence for consumer irrationality and instead conclude that regulators are in reality objecting to consumer preferences that differ from their own.[6]

In electricity four broad types of market barriers have been alleged. The first are inherent in its technology and regulatory institutions, which can combine to price power at economically inefficient rates. Such factors can include a lack of metering capability that can set time-varying prices, or political constraints that prohibit regulators from instituting efficient rate structures. The second set of barriers exists in markets that interact with power markets. For example, some experts believe that commonly used contract terms in construction and housing markets do not provide people with adequate incentives to invest in energy efficiency. A third barrier is high information cost that may leave nonspecialist consumers incapable of making rational choices. This barrier overlaps with a possible fourth one: that people may not have the ability to compare the opportunity costs of present sacrifices (higher costs of more efficient appliances) with the benefits of lower future power bills.

However, many other markets also exhibit barriers that limit consumers' decision-making abilities, and they are not regulated heavily or at all. Some people believe that electricity should be singled out because of its economic importance or because its highly developed regulatory

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[6] Ted Gayer and W. Kip Viscusi, "Overriding Consumer Preferences with Energy Regulations," *Journal of Regulatory Economics* 43 (2013): 248–64.

regime may facilitate accurate policy targeting. On the other hand, buyers may make mistakes, but so can a government that is choosing on their behalf. Further, electricity users have demonstrated abilities in other markets. If they generally reason well when shopping for home mortgages, why would they make poor choices in appliances? One can come up with reasons (e.g., more is at stake with the mortgage), but little research compares consumer skills across markets.

C. Regulation as a Barrier

There is some irony in the fact that rules mandating energy efficiency are made by the same regulators who earlier developed inefficient policies that warranted remediation. When metering technologies did not exist to track real-time power use, regulators often allocated the costs of serving different customer classes by political rather than economic criteria. Today's metering technology often makes it possible to charge customers of all types time-varying rates based on marginal cost that are economically efficient. Few jurisdictions have mandated such rates for residential customers, despite the fact that as a group those users would pay the same amount under time-varying and flat rate structures.[7] Further, with time-varying rates, utilities' investment requirements will be lower because they will require less peaking generation. On the other hand, changes in today's inefficient rate designs may not be worth the cost. One authoritative study found that if all US power consumers had smart meters and paid time-varying rates, the nation would save only about $2.4 billion per year in avoided generator investments (approximately 2 percent of the total) and $600 million in operating costs.[8]

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[7] This reasoning rests on an assumption that regulators enforce revenue neutrality, in which the utility's total receipts stay the same regardless of the details of rate design.

[8] Ahmad Faruqui et al., "The Power of Five Percent: How Dynamic Pricing Can Save $35 Billion in Electricity Costs" (Cambridge, MA: Brattle Group, May 16, 2007), 5, http://www.brattle.com/_documents/UploadLibrary/Upload574.pdf. The text examines only the possible saving from accurate metering and efficient pricing. In reality, smart meters can help economize on other operational (outage detection) and administrative (meter reading) costs.

D. Contractual and Institutional Barriers

A contract that benefits both parties results from negotiations that allow them to construct mutually acceptable sets of rights and responsibilities. Improved energy efficiency may be a benefit, but the parties may find that the most valuable arrangement they can construct treats energy in ways that appear inefficient if viewed in isolation. Apartment buildings are often master metered, with the owner paying for all the power the tenants use and recovering the cost as an unitemized component of rent. With individual meters, tenants pay for only their own power use, but these meters are costly to install and monitor. If tenants consume similar quantities of power, master metering reduces costs with little loss in economic efficiency. If tenants' patterns of power consumption differ greatly (e.g., because some prefer warmer or cooler ambient temperatures), a landlord is more likely to install meters in individual apartments. Regulations that prohibit master metering have been proposed to induce lower consumption by tenants, but the object should be efficient use rather than simply lower use.

E. Capitalization and Construction

Building owners have strong incentives to maintain their properties and to make investments that support or increase their value. Some such investments economize on energy use (double-glazed windows), while others (installing air conditioning in older buildings) increase value. Regulators and other experts have proposed restrictions on building designs in the belief that contractors and future occupants are shortsighted, despite abundant evidence that efficient energy-saving investments increase building values by more than their costs while unimproved structures sell at discounts.[9] Home prices increase by an average of $10 to $25 for every $1 decrease in energy bills.[10] Arguments that home builders profit at buyers' expense by installing too little energy efficiency stand on a weak foundation. Such reasoning appears to assume that (1) contractors systematically deemphasize energy savings that consumers are willing to pay for, (2) consumers accept inferior designs because contractors do not compete for their business, and (3) consumers do not understand that markets capitalize efficiency into prices that will raise the resale values of homes.[11] All three of these premises are doubtful at best, but advocates sometimes claim them as justifications for compulsory efficiency.

F. Information Costs

Efficiency requirements are often introduced with a claim that future energy prices will rise to make them cost-effective, even if they are not so today. The implied claim is that government is a better predictor than private parties and that its forecasts help reduce market barriers by decreasing uncertainty that might make people reluctant to commit funds to efficiency investments. Complexity alone, however, does not ensure that government will predict more accurately. Forecasts in the US Department of Energy's Annual Energy Outlook have not

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[9] This is an ideal illustration of Gayer and Viscusi's reasoning about conflicts between market participants and regulators. Gayer and Viscusi, "Energy Regulations"; Texas Comptroller of Public Accounts, *The Home Energy Efficiency Report 2008*, 15, http://www.window.state.tx.us/specialrpt/hb3070/96-1350_Home_Energy_Eff_HB3070.pdf. In the San Francisco area, newer "green" buildings enjoy selling prices 16 percent higher than similar structures and charge rents 6 percent higher. Peter Eichholtz et al., "Doing Well by Doing Good? Green Office Buildings" (Working Paper No. 192, University of California, Berkeley, Energy Institute, Center for Study of Energy Markets, August 2009).

[10] Ruth Johnson and David Kaserman, "Housing Market Capitalization of Energy-Saving Durable Good Investments," *Economic Inquiry* 21 (July 1983): 374–86; Rick Nevin and Gregory Watson, "Evidence of Rational Market Valuations for Home Energy Efficiency," *Appraisal Journal* 66 (October 1998): 401–9.

[11] Trends in home heating contradict such claims. Considerably cheaper furnaces are available, but energy-efficient heat pumps now dominate the heating of new homes in all price ranges. See Ronald J. Sutherland, "Market Barriers to Energy Efficiency Investments," *Energy Journal* 12, no. 3 (1991), 24.

become more accurate despite steadily increasing detail in the model that generates them.[12] There will always be unpredictable changes in policy and technology, as happened when the recent development of hydraulic fracturing massively expanded the base of accessible hydrocarbons and reduced their prices. We can criticize both private and government forecasts, but there is an important difference: Government forecasts often become the basis for efficiency policies that constrain private choices. Mandated efficiency standards can prevent people who do not believe in the forecast from undertaking transactions they think will benefit them.

Governments may not be ideal forecasters, but they may have a useful role to play in publicizing reliable information that citizens can act upon as they choose. This "public good" property of informing citizens may make government the provider of choice for such data. For example, a person who wants to tabulate power consumption by appliances might not be able to sell enough copies of his report to warrant doing the research.[13] In this case, the government's cost of disseminating this information could be very low, for example using Energy Guide stickers attached to appliances. Markets, however, often also produce useful information despite the fact that participants do not receive payments that reflect its full value. The futures price of natural gas emerges from the interactions of traders who do not profit from the information they create, but it predicts near-term gas prices better than the Department of Energy's models.

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[12] See US Department of Energy, Energy Information Administration, *Annual Energy Outlook Retrospective Review, Evaluation of Projections in Past Editions 1982–2006* (September 2009). From the 1960s through the 1980s, such models consistently overestimated both US and world energy consumption by factors ranging from 10 to 200 percent; "long-range energy forecasters have missed every important shift of the past two generations." Vaclav Smil, "Perils of Long-Range Energy Forecasting: Perils of Looking Far Ahead," *Technological Forecasting and Social Change* 65, no. 2 (2000): 262.

[13] The text is greatly simplified because the intent is only to introduce the "public goods" and "free rider" concepts. There are numerous intellectual property protections, all imperfect, but in cases like Hollywood movies the protection is strong enough to make production of DVDs profitable. The nonprofit magazine *Consumer Reports* has produced data on aspects of consumer goods quality for decades.

G. Comparing the Present and the Future

One potential economic argument for mandated energy efficiency was a byproduct of research on consumer choice. A number of studies claim to have shown that consumers cannot usefully estimate the present value of future savings generated by a more efficient appliance. To address this problem, a consumer must evaluate the return on an investment. The investment is the price premium of a more efficient appliance, and the return is the difference in energy bills that it generates over the years. In economics, this is a standard calculation of present values and rates of return. Using typical numbers on price premiums and energy savings, researchers have calculated rates of return of 20 percent or more, sometimes as high as 40 percent.[14] A consumer who buys a less efficient model forgoes these returns. Why this happens is unclear, since the more energy-efficient appliance would be worth buying even if the purchaser had to pay credit card interest rates on it. Further, there is little uncertainty. The government-mandated Energy Guide discussed above allows easy calculation of savings from a more efficient appliance.

If consumers choose inefficient appliances when efficient ones are rational, those who favor intervention may have a case: forcing the purchase of efficient appliances by disallowing the sale of inefficient ones may leave consumers better off, assuming that the appliances are otherwise identical.[15] But this example contains paradoxes. If people buy inefficient appliances because they cannot estimate the savings, we expect that more education would increase the likelihood of purchasing an efficient one. However, the data say otherwise, and the same

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[14] Jerry Hausman, "Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables," *Bell Journal of Economics* 10, no. 1 (1979): 33–57.

[15] Gayer and Viscusi note that a proposed change in home laundry equipment generated favorable benefit-cost analyses. Gayer and Viscusi, "Energy Regulations," 260. Surveys, however, showed strong rejection of the proposal because the new rules effectively outlawed convenient top-loading models.

comparison holds between people with high and low incomes.[16] But unlike purchasers of inefficient appliances, home and auto buyers as groups respond so rationally to interest rates that swings in their purchases generate economy-wide business cycles.[17] The appliance data could be an anomaly that is peculiarly hard to explain.[18]

IV. Summary

As will be seen, Ohio's policies touch on almost every aspect of energy efficiency and economic efficiency discussed above. Economic efficiency, however, critically depends on market prices and expectations of their future values. The concept asks how something can be accomplished with the smallest forgone value of resources, and market prices render the alternatives comparable. Prices help us distinguish resources that are scarce from those that are abundant; in the process, they direct resources to their most valuable uses.

Mandatory energy efficiency policies are often justified as remedies for *market failure*, a term that is often indiscriminately applied whenever real markets fall short of theoretical ideals. In a complex world, there may be problems in diagnosing market failures and comparing the costs of remedying them with the costs of leaving them untreated. In all cases we should note that government officials who make the policies may have objectives quite unlike those of an efficiency-minded economist who understands that energy is just one of many costly resources. An insistence that energy use always decline (as specified in Ohio's rules) may also yield

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[16] Henry Ruderman et al., "The Behavior of the Market for Energy Efficiency in Residential Appliances Including Heating and Cooling Equipment," *Energy Journal* 8, no. 1 (1988): 100–24.
[17] N. Gregory Mankiw, "Consumer Durables and the Real Interest Rate," *Review of Economics and Statistics* 67 (August 1985): 353–62.
[18] One explanation is based on option value, where rational purchase behavior can lead to patterns of choice such as those for appliances but not most other financial and real assets. This topic is beyond the scope of this paper. See Gilbert Metcalf and Donald Rosenthal, "The 'New' View of Investment Decisions and Public Policy Analysis: An Application to Green Lights and Cold Refrigerators," *Journal of Policy Analysis and Management* 14 (1995): 517–31.

economic inefficiency. All these facts bear on Ohio's policies, as the following chapters show in more detail.

Although human abilities to process information are limited, some of the proposals for achieving economic efficiency involve reducing the spectrum of choices available to the private sector. The implicit rationale is often that people have such great difficulty analyzing choices about energy efficiency that they cannot or will not make rational decisions. Forcing consumers to abide by decisions made for them by experts, however, carries its own costs. The experts may have their own interests and can make mistakes if they use the same imperfect information as everyone else. Many market barriers have been deemed worthy of policy attention without serious consideration of the cost of alleviating them and the risks of making policy on the basis of inadequate or erroneous information.

CHAPTER 2

OHIO'S EFFICIENCY POLICIES

I. Introduction

In August 2007, Ohio governor Ted Strickland's "Energy, Jobs and Progress" plan included proposals to change the basic structure of regulation and facilitate the growth of energy efficiency and renewable power. Support for legislation that embodied the plan was thoroughly bipartisan. The state senate passed Senate Bill (SB) 221 unanimously on October 31, 2007, and the state house of representatives passed its final version on April 22, 2008, with one dissenting vote. The law became effective on July 30, 2008, and the Public Utilities Commission of Ohio (PUCO) began rulemakings that extended through 2013 and have since been reopened. SB 221 was devoted primarily to alternative energy and efficiency.[19] Its alternative energy portfolio standard (AEPS) resembled the renewable portfolio standards (RPSs) of 29 other states. The AEPS required utilities to generate or purchase specified quotas of power (actually percentages of load) from renewable sources. SB 221 also introduced an energy efficiency resource standard (EERS) that required utilities to achieve annual percentage reductions (relative to a three-year baseline) in customers' energy consumption and peak load. As of late 2013, EERS programs had been enacted in 25 states. Different sequences of annual requirements make interstate comparisons difficult, but Ohio's average energy and peak reduction requirements are among the highest.[20]

This chapter summarizes relevant aspects of the EERS and describes the utilities and markets it affects. I find that whatever the reductions in energy use and peak loads, SB 221

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[19] Ohio Revised Code (ORC) 4928.64–.65. The minor provisions included (1) "net metering" rules for end-users who self-generated a fraction of their power use, a topic of growing importance with home installations of photovoltaics; (2) criteria for "solar-ready schools"; (3) guidance on policies toward "advanced energy" sources that include "clean coal" technologies, fuel cells, fossil fuel generation enhancements that emit no additional carbon, and demand-side management as detailed in ORC 4928.01; and (4) rules on greenhouse gas emissions reporting.

[20] American Council for an Energy-Efficient Economy, *2013 State Energy Efficiency Resource Standards* (July 2013).

virtually guarantees needlessly high costs to attain the law's requirements, which means economic inefficiency. I describe how a utility sets its compliance strategy with the consensus of a "collaborative" of interested parties and how it subsequently demonstrates its compliance with the law's requirements. As necessary background, I briefly summarize Ohio's electricity industry, with data on utilities' loads and resources that will help explain the practices and difficulties the companies encounter as they attempt to achieve compliance with SB 221.

II. Standards and Compliance

A. SB 221

SB 221 sets uniform timetables for each of Ohio's regulated utilities to accomplish (1) annual minimum percentage reductions in energy use by their customers and (2) annual minimum percentage reductions in peak demand on their systems.[21] Municipal and cooperative utilities are not subject to the law. The energy use reductions shown in table 2-1 are heavily backloaded. They begin in 2009 at a modest 0.3 percent decrease and rise to 1 percent in 2014. Instead of declining (to reflect less-abundant opportunities or higher costs of compliance), required reductions remain at 1 percent through 2018 and then rise to 2 percent each year from 2019 through 2024. By the end of 2025, cumulative savings must equal at least 22 percent. Table 2-2 shows required peak demand reductions. Except for the first year (2009), they are at least 0.75 percent through 2018. For subsequent years, SB 221 requires that standing legislative committees meet to make recommendations on future reductions to the Ohio General Assembly.

[21] Unless otherwise indicated all data and quotations in this section are from SB 221, as codified at ORC 4928.

Table 2-1. Timetable for Minimum Efficiency-Based Energy Reductions under Senate Bill 221

Year	Minimum reduction (%)
2009	0.3
2010	0.5
2011	0.7
2012	0.8
2013	0.9
2014–2018 annual	1.0
2019–2024 annual	2.0
2025	Cumulative 22

Source: Ohio Revised Code 4928.66.

Table 2-2. Timetable for Minimum Annual Peak Demand Reductions under Senate Bill 221

Year	Peak reduction (%)
2009	1.0
2010–2018	0.75
2019 and after	to be legislated

Source: Ohio Revised Code 4928.66.

SB 221 restricts eligible efficiency measures to demand-response programs, cost-effective smart grid investments, customer-sited programs that include combined heat and power (CHP) systems, and transmission improvements that reduce line losses. The annual baselines for calculating compliance amounts are average loads and average peak demands over the preceding three years. PUCO may change either baseline to adjust for new economic growth, and SB 221 specifies that they be "normalized for changes in numbers of customers, sales, weather, peak demand, and other appropriate factors so that the compliance measurement is not unduly influenced by factors outside the [utility's] control." So far, the matter has not become contentious. SB 221 further specifies that PUCO can change a utility's benchmark if it determines that achievement is impossible "due to regulatory, economic, or technological reasons beyond [the utility's] reasonable control," a situation yet to occur.[22]

B. Compliance

A utility submits an annual report to PUCO that describes its previously approved programs and their anticipated and actual results. If PUCO finds the utility to be out of compliance, it must

[22] ORC 4828.01 and 4928.64.

assess a forfeiture (paid to Ohio's Advanced Energy Fund) equal to either $10,000 for each noncompliant day over the reporting period or the market value of one renewable energy credit for each noncompliant megawatt-hour (MWh). Large mercantile customers are allowed to devise their own savings plans, since they are typically users who have already undertaken the sorts of measures (e.g., lightbulb replacement) aimed at smaller customers. If PUCO approves a large customer's plan, its utility may count the savings for compliance.

A regulated utility whose customers succeed in reducing their consumption may face a problem of insufficient revenue. In Ohio and other states, fixed costs of transmission and distribution are prorated among customers, most of whom pay constant rates per kilowatt-hour (kWh) that include fixed costs. In response, some state regulatory commissions have instituted decoupling procedures that adjust rates to maintain a utility's revenue and leave it with an adequate return on capital. SB 221 promises to implement decoupling that "reasonably aligns the interests of the utility and of its customers in favor of those programs." Three of Ohio's four utility companies currently have decoupling in effect and the other (Dayton Power & Light) has other avenues for recovery.[23] Under PUCO's rules, the EERS offers utilities the opportunity to apply for a shared savings performance incentive. A utility receives 5 percent of net benefits if it achieves the year's EERS target and an increasing amount up to 13 percent for attaining 115 percent of its target.[24]

Although this report concentrates on the EERS, a brief description of SB 221's alternative energy resource standard (AERS) is in order. The standard covers advanced energy

[23] Ohio State Senate, Public Utilities Committee, October 30, 2013 (testimony of Kim Bojko, Ohio Manufacturers Association), 8–9, http://www.ohiogreenstrategies.com/documents/omapaneltestimony.pdf.
[24] Ohio State Senate, Public Utilities Committee, October 30, 2013 (testimony of J. Richard Hornby on behalf of Ohio Manufacturers Association), 8–9, http://www.ohiogreenstrategies.com/documents/omapaneltestimony.pdf.

resources and renewable energy resources placed in service after January 1, 1999.[25] By 2025, 25 percent of all delivered power must comply with the AERS. Renewable generators (including wind, solar, and biomass) must produce at least half of the 2025 amount (12.5 percent of load) while following a timetable of required percentages. By 2025, at least 0.5 percent of Ohio's total energy must be solar. Constitutional issues may arise from quotas specifying that half of all renewable energy be produced in Ohio and the remainder by resources whose output was delivered into the state.[26] Alternative technologies include clean coal, advanced nuclear power, fuel cells, distributed generation, and solid waste conversion. There is no timetable for generation from these technologies; rather, there is a blanket requirement that they total at least 12.5 percent of load by 2025. As with the EERS, a noncompliant utility will be penalized. There are no indications in the record of how any EERS or AERS requirement was set and no background documents on the costs and benefits of alternative requirements.

III. Utility Planning and Reporting

A. Programs and Benchmarks

Every three years, each utility must submit its program portfolio plan for the next three years of compliance to PUCO.[27] The first two were due on January 1, 2010, and April 15, 2013, and are publicly available. A plan begins with estimates of three possible levels of savings. The first and most general is an "assessment of potential" of all programs that might succeed, using only technological standards of feasibility. For unclear reasons, the utility must estimate these savings on the assumption that all qualified ratepayers participate, regardless of cost. The second level

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[25] Advanced and renewable sources are enumerated at ORC 4928.64 and 4828.01(A)(35).
[26] ORC 4828.64(B)(3).
[27] All legal provisions discussed in this paragraph are found in OAC 4901: 1–10. It refers to regulated companies as "distribution utilities."

uses a total resource cost (TRC) test to estimate the cost-effectiveness of the technologically possible programs deemed most likely to succeed. Described in detail in chapter 3, that test compares estimated benefits of each program with the most valuable set of opportunities forgone. As a third step the utility ranks each program that has survived the previous two screens by its "achievable potential," factoring in barriers to customer adoption. Beyond the market barriers listed in the previous chapter, the utility must consider "financial, political, regulatory [and] attitudinal barriers."[28] We discuss the content and problems of potential studies in more detail in chapter 5.

SB 221's energy and peak reduction requirements are minimum standards. In particular, utilities must offer energy savings when doing so is more cost-effective than supplying power.[29] Energy reductions over SB 221's percentages can be banked to satisfy future requirements. Peak reductions cannot be banked because they may depend on factors (such as weather) that are beyond the utility's control. Interruptible loads, however, qualify as demand response when calculating peak reduction, whether or not an interruption actually takes place.

PUCO's "Green Rules" to implement SB 221 encourage but do not require utilities to coordinate with interest groups ("stakeholders") in formulating their proposals.[30] These so-called collaboratives can serve two functions. First, data their members provide may improve the quality of a utility's application and its likely feasibility. Second, a utility may be better off settling its differences with interest groups under the cloak of a collaborative if the

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[28] The Green Rules discussed below mention 13 factors to be considered in the final selection. Some are only distantly related to economics, such as potential for "broad participation among customer classes" and "non-energy benefits" that include carbon reduction and participation by people of low socioeconomic status.
[29] OAC 4901: 1-39-04(A). The question of how to compare the relative efficiencies of additional sales with over-quota reductions has not yet arisen.
[30] As will be seen in chapter 3, in 2009, Dayton Power & Light reached a settlement with regulators and regulatory intervenors specifying that the company was to initiate a collaborative.

alternative is regulatory intervention or litigation.[31] PUCO entertains objections up to 60 days after submission, at which point it must accept, reject, or modify the application. Upon acceptance, the utility may apply to recover the costs of the program in an energy efficiency and peak demand reduction cost recovery (EE/PDR) rider, which is typically approved with little delay.[32] The rider can also recover revenues that the utility will lose from decreased sales, a step toward full decoupling of its costs and revenues. A utility may also file for a shared savings plan.

B. Verification

Each April 15, the utility must file a compliance status report that includes a performance assessment. It must include an evaluation, measurement, and verification report by an independent program evaluator hired by the utility (typically a specialist consulting firm) whose work is directed by PUCO staff. In practice, the evaluator is typically retained through both the planning and evaluation processes. The commission can choose to hold a hearing on the status report and must do so if it has recommended a forfeiture for noncompliance. The annual report verifies compliance and may include alterations to the utility's original plan if agreed upon by the utility and PUCO. The annual report process does not review the utility's original benefit-cost projections or make retrospective calculations.

Nonresidential mercantile users who consume more than 700,000 kWh per year receive special attention in verification. PUCO assumes that such large businesses have strong

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[31] AEP's initial collaborative contained representatives of at least 27 organizations. See *Direct Testimony of Jon Williams*, Docket Nos. 09-1089 and 09-1090 EL-POR (November 12, 2009), 8–9. Collaboratives cannot make binding decisions based on members' votes. There are no official record-keeping requirements, but some utilities have made public the minutes of collaborative meetings.

[32] This applies to all utilities but Duke, which recovers its costs as part of an ongoing "Save-a-Watt" program.

competitive reasons to save energy cost-effectively and that they have already participated in such standardized activities as lightbulb swap-outs. A mercantile customer may devise an idiosyncratic proposal to improve energy efficiency. The customer and its utility may then apply to PUCO for permission to include the savings in the utility's compliance plan baseline. If the commission approves, the customer is exempted from payment of the utility's EE/PDR rider.

IV. Electricity in Ohio

A. Utilities and Their Regulation

Ohio's retail consumers (end-users) purchase from a mix of corporate (investor-owned) utilities, municipal utilities (municipals), and rural electricity cooperatives (co-ops). PUCO regulates corporate rates, service, and investments but has no corresponding powers over municipals and co-ops, which are governed by appointed or elected local boards. Until recently, each corporate utility was a territorial monopoly, either vertically integrated into generation or otherwise holding contractual rights sufficient to fulfill its service obligations. Its counterparties were other utilities marketing their excess generation or independent power producers (IPPs)—standalone generators that do not directly serve end-users.

Changes in federal law and regulation have obligated corporate utilities (but not municipals or co-ops) to allow competing energy marketers to use their transmission and transact with them at cost-based rates. These marketers cannot serve end-users unless state law permits, as it now does in Ohio.[33] There and elsewhere, a complex transition process separated regulated from unregulated utility activities and compensated the companies for transitional losses that might result from competition. In Ohio and some other states, the transition included divestitures of utility-owned

[33] Ohio's unregulated municipals and co-ops could offer their customers competitive options, but none has yet chosen to do so.

generators. If these units fetched prices too low to keep the utility financially whole, end-use customers would be responsible for the difference. Customers who preferred other suppliers faced non-bypassable charges to amortize these “stranded” costs. With unbundled service, they pay distinct bills to their competitive provider of energy and to their utility for transmission, reliability, and stranded costs. Some of Ohio’s divestitures took the form of generator sales to utility-owned (“affiliated”) power marketers whose rates were now set by competition.

B. Sales and Revenues

Table 2-3 summarizes the organization of electricity in Ohio in 2012. Power delivered by corporate utilities accounted for 92.8 percent of the state’s total. Municipals and co-ops delivered the remaining 3.8 percent and 3.4 percent, often using the lines of corporate systems to move the power to their city gates. The effects of restructuring show up in unbundled corporate utility deliveries from nonutility generators and marketers, which were 33.3 percent of total deliveries. Marketing affiliates of utilities provided most (81.6 percent) of those unbundled deliveries, and other suppliers made up the remainder. As markets grow and competitive suppliers take root in Ohio, there are reasons to expect that unbundled service will increase and service from utility affiliates will shrink.[34]

Table 2-4 shows that the load mixes of the distribution utilities vary considerably for both bundled and unbundled service. These differences will probably affect compliance with SB 221. For example, Dayton Power & Light delivered a total of 18.303 gigawatt-hours (GWh), 5.848 as bundled utility service and approximately 12.455 unbundled from affiliate DPL Energy

[34] The unbundled figures for 2012 are also low because at the time American Electric Power, the state’s largest system, was in transition. The company was shifting bundled (regulated) distribution into its Ohio Power unit, while its new affiliate AEP Energy had no industrial customers and only a handful of others. Since 36.7 percent of Ohio Power’s deliveries were industrial, it appears that AEP’s territory will soon see substantial marketer penetration.

Resources, marketers affiliated with other utilities, and unaffiliated marketers.[35] Residential service comprises 57.2 percent of the company's total (bundled + unbundled) load while industrials are 17.7 percent. By contrast, AEP (Ohio Power) delivers only 39.6 percent of its total kWh to residential users, while industrial loads are 35.3 percent of its total deliveries, nearly twice Dayton's percentage.

Table 2-3. Gigawatt-Hours Sold in Ohio by Supplier Type, 2012

Type	GWh sold
Corporate (bundled)	134.809
Corporate (unbundled, affiliated marketer)	62.702
Corporate (unbundled, unaffiliated marketer)	11.550
Total corporate	207.061
Municipal	8.502
Cooperative	7.620
TOTAL	223.183

Source: US Energy Information Administration Form EIA-861, 2012.

[35] This is an approximation because we do not know the geographic patterns of affiliated and unaffiliated marketers seeking business in the service territories of other utilities. A utility's affiliate marketer can sell outside its parent's territory.

Table 2-4. 2012 Revenues and Gigawatt-Hour Sales of Utilities in the Jurisdiction of the Public Utilities Commission of Ohio

Utility	Residential			Commercial			Industrial			TOTAL		
	Revenue ($ mil.)	Sales (GWh)	Sales/ total	Revenue ($ mil.)	Sales (GWh)	Sales/ total	Revenue ($ mil.)	Sales (GWh)	Sales/ total	Revenue ($ mil.)	Sales (GWh)	Revenue ($/KWh)
Bundled service												
Cleveland Electric Illum. Co.	154.0	1,327.4	0.4631	96.4	800.7	0.2793	40.1	738.5	0.2576	290.5	2,867	0.101
Dayton Power & Light Co.	562.7	4,122.3	0.7049	155.7	1,501.1	0.2567	21.1	224.7	0.0384	739.5	5,848	0.126
Duke Energy Ohio Inc.	462.4	4,347.4	0.7277	140.4	1,394.6	0.2334	18.7	232.2	0.0389	621.5	5,974	0.104
Ohio Edison Co.	363.4	3,198.1	0.5430	106.3	1,006.8	0.1710	98.1	1,684.3	0.2860	567.8	5,889	0.096
Ohio Power Co.	1,532.1	12,413.6	0.4018	768.9	7,131.1	0.2308	649.4	11,352.4	0.3674	2,950.4	30,897	0.095
Toledo Edison Co.	97.0	831.0	0.3246	34.9	292.2	0.1141	63.1	1,437.0	0.5613	195.0	2,560	0.076
TOTAL	**3,171.6**	**26,239.8**	**0.4856**	**1,302.6**	**12,126.5**	**0.2244**	**890.5**	**15,669.1**	**0.2900**	**5,364.7**	**54,035.4**	**0.099**
Unbundled service												
First Energy Solutions	828.3	13,631.2	0.2884	1,074.3	19,618.6	0.4150	676.9	14,020.1	0.2966	2,579.5	47,270	0.055
AEP Energy	20.2	315.5	0.2459	54.9	967.8	0.7541	0.0	0.0	0.0000	75.1	1,283	0.059
DPL Energy Resources	42.3	6,360.9	0.5107	193.2	3,075.9	0.2470	177.3	3,018.5	0.2423	412.8	12,455	0.033
Duke Energy Retail	72.8	11,961.1	0.6578	190.1	3,667.3	0.2017	100.3	2,554.0	0.1405	363.2	18,182	0.020
TOTAL	**963.6**	**32,268.7**	**0.4075**	**1,512.5**	**27,329.6**	**0.3451**	**954.5**	**19,592.6**	**0.2474**	**3,430.6**	**79,190.9**	**0.043**
Bundled + unbundled service, by company												
AEP Energy	1,552.3	12,729.1	0.3956	823.8	8,098.9	0.2517	649.4	11,352.4	0.3528	3,025.5	32,180.4	0.094
Dayton Power & Light Co.	605.0	10,483.2	0.5727	348.9	4,577.0	0.2501	198.4	3,243.2	0.1772	1,152.3	18,303.4	0.063
Duke Energy Ohio Inc.	535.2	16,308.5	0.6751	330.5	5,061.9	0.2095	119.0	2,786.2	0.1153	984.7	24,156.6	0.041
First Energy Solutions	1,442.7	18,987.7	0.3241	1,311.9	21,718.3	0.3707	878.2	17,879.9	0.3052	3,632.8	58,585.9	0.062
TOTAL (all)	**4,135.2**	**58,508.5**	**0.4392**	**2,815.1**	**39,456.1**	**0.2962**	**1,845.0**	**35,261.7**	**0.2647**	**8,795.3**	**133,226.3**	**0.066**

C. Compliance and Efficiency

Differences in customer mix suggest that SB 221's consequences will differ among utilities, but the details will depend on the costs and availability of new energy reduction opportunities in their territories. In principle, decoupling and revenue adjustment leave a utility indifferent to selling energy or efficiency; thus, utility revenues will be constant however much or little efficiency the company sells.

SB 221 carries other risks and opportunities. A utility that does not meet the annual goals may incur penalties that it cannot pass on to customers, but above-plan energy savings may allow it to collect incentive payments from its ratepayers. As discussed in chapter 4, all utilities have thus far used CFL bulb programs for most of their compliance requirements, but PUCO rules may soon make it impossible to continue these programs. Similarly, the range of industrial customer opportunities may have already diminished because many of them made their own efficiency investments before the implementation of SB 221. They do, however, have additional opportunities in nonstandard mercantile activities that can count toward their utility's compliance.

The seeming simplicity of SB 221 is at odds with economic efficiency, as noted in the earlier discussion of its arbitrary percentage reduction requirements and the arbitrary timing of these reductions. But even if assuming that these amounts have rational foundations, the heterogeneity of utilities and their loads would almost certainly ensure that the law's equal reduction requirements for all would result in an inefficient outcome. Ohio could realize the benefits of statewide objectives at lower cost if it did not require the same results from each utility. The logic is the same as that behind cap and trade (discussed in chapter 1). If an EERS operated analogously to cap and trade, a utility could choose the cheapest way to comply; for example, whether to undertake a program in its own territory or fund a less costly one elsewhere that delivers the same reduction. Allowing utilities to trade opportunities would result in lower statewide costs of compliance. The potential gains of replacing SB 221 with this system are certain, but their size will depend on how the statewide distribution of efficiency opportunities differs from its distribution over individual utility territories.[36]

V. Summary and Conclusions

The bipartisan support for SB 221's provisions at the time of enactment is unsurprising. First, it came before the shale gas revolution (in which Ohio is becoming a major producer), when resource depletion and deliverability were common concerns. Second, it came when climate change was higher on the list of public priorities, carrying the hope that efficiency policies could support the state's industries while preparing it for carbon controls. Third, the bill's advocates promised that Ohio could regain its position among the states as an industrial power, but with green and efficient jobs this time around. Together, these factors appealed to enough voters that it was easy to ignore the details of the law. The legislature provided no foundation for the bill's quantitative requirements or details of its enforcement. SB 221 is heavy with numbers that are clearly the outcome of politics. How else can one explain the uniform objectives for all utilities, the equal split between the numerical implementation of the EERS and the AERS, and the near-equal split in the AERS between requirements for renewable generation and requirements for resources whose technologies do not yet exist?

[36] In principle efficiency would be even further improved if Ohio utilities were able to invest in projects outside the state, but obstacles similar to those encountered in markets for renewable energy credits would probably arise—most importantly, verification of operability, savings, and deliverability. Politics alone would probably make such an expansion of program scope impossible, particularly because one oft-stated rationale for the EERS is that it will create employment opportunities in Ohio.

On the surface, compliance is simple. The utility submits a three-year plan of programs and budgets that will meet SB 221's requirements. It then reports annually to PUCO, which (with one exception thus far) has allowed the inclusion of program costs in rates. The utility chooses its programs with the help of a collaborative of interest group members and a consultant (environmental rather than economic) who analyzes costs and benefits at the time the three-year plan goes to PUCO and again in the utility's annual reports. Those reports emphasize benefit-cost analyses of individual projects, as measured by tests described in the next chapter. None of the consultant reports have yet considered possible inefficiencies in the overall EERS requirement or the scheduling of compliance. Finally, there are no required analyses of any links between the utility's expenditures and such concrete (and often measurable) goals as environmental quality improvement.

CHAPTER 3

ESTIMATING COSTS AND BENEFITS

I. Introduction

Analyzing the costs and benefits of an investment project is conceptually easy and empirically problematic. A typical analysis examines the expected future stream of net income the investment will produce and applies a discount factor related to the project's riskiness and the investor's cost of capital. The present value of the stream (alternatively, the rate of return on investment) is a measure of its profitability. Testing the robustness of these conclusions under different assumptions can provide additional insight into the sensitivity of the calculation and the worth of the project. Regardless of who puts up the funds, any energy efficiency project is amenable to a similar investment analysis. This chapter covers relevant theoretical and empirical aspects of benefit-cost calculations for programs aimed at reducing energy use.

All the problems in traditional investment analysis turn up in the analysis of energy efficiency, which also carries some of its own issues. I examine controversies over which (and whose) benefits and costs to include. Different calculations can show costs and benefits from viewpoints that include those of the utility, the regulatory agency, ratepayers, and the overall economy. As an example, assume that an efficiency program subsidizes an industrial power consumer's purchase of a motor that consumes less power, which raises the consumer's profits and cuts its electric bill. A similar power consumer that bought its own motor (possibly because there was no program at the time) enjoys the same benefits but at a higher cost because it is also paying for the utility's efficiency program. An economist looking at environmental outcomes that affect the entire population might neglect these distributional consequences and evaluate the program's desirability simply by adding up all the benefits and netting them against costs.

Another approach is to accept the subsidization program only if it produces no losers; that is, if each ratepayer's benefits are so great that no one pays a higher bill. These two examples are the bases of two commonly applied benefit-cost analyses. The results of the first, a total resource cost (TRC) test, often differ greatly from those of the second, known as a ratepayer impact measure (RIM) test.

Some other aspects of efficiency programs have few analogs in ordinary business. Reduced power production could entail reduced pollution, which would lengthen the lives of Ohio residents and those in nearby states. Here a benefit-cost test must account for the benefits of increased lifespan, which gives rise to complex questions about the value of saved or extended lives. Some aspects of Ohio policies treat Ohioans as special. For example, the state's renewable portfolio standard requires that half of its renewable power requirement come from in-state sources, even if providers outside the state can do the job more cheaply. Other apparent benefits—such as lower regional prices for generating capacity—may not be benefits at all, as will be discussed in chapter 4.

One further difficulty seldom shows up in ordinary investments. The so-called "free rider" problem is virtually endemic in benefit-cost analyses of electrical efficiency. A program (e.g., a subsidy to purchasers of energy-efficient lightbulbs) often appears more successful if it attracts more participants, but some of those may be free riding. Absent the program they would have purchased efficient bulbs on their own, but if they participate they will receive payments that originate in the utility bills of others, who may or may not be participants in the program. There are many conceptual and empirical difficulties in estimating free ridership, as will be discussed below. It is possible, however, to say with some confidence that in some Ohio cases free riding is so pervasive that its presence transforms superficially beneficial programs into failures. Most state regulatory commissions incorporate (or at least discuss) free rider estimates in their evaluations. PUCO, however, disregards free riders and treats total participation as its measure of success.

II. Elements of Benefit-Cost Tests

A. Program Administrator Cost Test

I first consider the program administrator cost (PAC) test, sometimes called the utility cost test, which looks at costs and benefits from the relatively narrow perspective of the sponsoring utility.[37] Costs include the program's incentive and administrative expenses, and benefits include the value of unproduced energy that the program saves and the present value of deferred generation investments.[38] As shown in table 3-1, the PAC test does not examine costs that the customer alone must bear; for example, outlay on a new appliance that is eligible for a rebate. Because the test covers only utility-related costs and not those borne by others, it is likely to overstate a program's net benefits. PUCO allows utilities to use PAC results only as supplementary data in program applications, on the grounds that they may provide valuable information about the distributional consequences of a policy.[39]

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[37] Other benefit-cost tests sometimes appear in utilities' reports for comparison purposes. A counterpart to the PAC test known as the participant cost test examines only costs borne by an enrollee in the program. Algebraic formulations of all these tests, including the RIM test, appear in *In the Matter of Protocols for the Measurement and Verification of Energy Efficiency, Finding and Order,* PUCO, Case No. 09-512-GB-UNC (October 15, 2009), 4, 5 ("PUCO, 09-512-GB-UNC").

[39] The most generally accepted classification of programs and benefit-cost calculations appears in California Public Utilities Commission, *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects*, October 2001, http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF.

[39] The commission specifies that the TRC test must be used for overall program evaluation. See PUCO, 09-512-GB-UNC, Appendix C, 3.

Table 3-1. Costs and Benefits in Program Administrator Cost and Total Resource Cost Calculations

Type of cost	Total resource cost test	Program administrator cost test
Administrative costs	cost	cost
Avoided costs of power	benefit	benefit
Capital (measure) costs	cost	cost
Incentives paid	not considered	cost
Increased supply costs	cost	cost
Participant costs	cost	not considered
Tax credits	benefit	not considered

Source: California Public Utilities Commission, "Clarification of Several Cost Concepts in CPUC Demand-Side Cost-Effectiveness Tests," 1, accessed December 1, 2014, http://www.cpuc.ca.gov/NR/rdonlyres/58129C08-C0EC-4C0F-926C-327F1A710537/0/ClarificationofSeveralCostConceptsinCPUCDemandSideCostEffectivenessTestsFinal.pdf.

B. Total Resource Cost Test

In economics the opportunity cost of any action is the most valuable alternative forgone, measured at market prices. Opportunity cost is the foundation of the TRC test. A person who will buy a $4,000 air conditioning system only if he receives $500 or more as an incentive need pay only $3,500 (or less) from his own resources. If the air conditioner is produced, the community forgoes $4,000 of valuable goods and services because the resources (worker time, metal, etc.) employed to build it must be bid away from other uses. No matter who pays what percentage of the price, the unit's cost remains $4,000, which is the cost used in the TRC test.[40] Because the TRC test is conceptually correct (assuming it is performed competently), a comparison of its results with a project's benefits will be economically valid. TRC results, however, may be politically unacceptable because the test does not by itself identify who enjoys the benefits and who bears the costs. Ratepayers whose premises are not cooled by the air conditioner are the ultimate source of the purchaser's incentive payment.

[40] In practice the TRC test often disregards relevant costs that are difficult to measure or that entail forgone opportunities but not monetary outlays. The buyer's cost of the new air conditioner includes the opportunity costs of time spent acquiring information, negotiating with the installer, and handling rebate-related paperwork, none of which are generally included in TRC calculations. I return to this topic later in the chapter.

C. Which Costs for Which Tests?

Table 3-1 provides a summary of data types considered in the PAC and TRC tests. Some costs are straightforwardly included in both, such as administrative costs, measure costs (of equipment promoted and distributed by the program, such as energy-efficient bulbs), and increased supply costs (which are incurred rarely, e.g., for fuel switching). Benefits in both tests include the avoided costs of power supply (both fuel and deferral of generation investments). Incentives paid by the utility are a cost in the PAC test, intended to analyze the program from the utility's viewpoint. The TRC test does not consider them, because the amount paid is a transfer; that is, ratepayer-supplied funds that pay the incentives equal the amount paid out to participants. The society's total resources are unchanged but not their distribution among its members, which the TRC test treats as immaterial. Returning to the table, participant cost is the cost that utility customers incur through their participation; for example, the price of a new air conditioner less any scrap value of the old one. Since it entails no outlays by the utility, participant cost is excluded from PAC but included in TRC. A federal (but not a state) tax credit is considered a benefit in the TRC test (it goes to the consumer but does not account for forgone uses of federal revenue) but is excluded from the PAC test because it does not flow through the utility.

The treatment of tax credits depends in part on the policymaker's perspective. The TRC test treats a tax credit as a benefit. The consumer enjoys a higher disposable income, the utility is unaffected, and the test does not consider the alternative uses of government revenue (including some other redistribution). If the tax credit comes from a federal program, the test from a national standpoint should properly net the tax payment and disbursement to zero. As administered in Ohio and other states, the TRC test is intended to be state-centric. The same tax credit would be neither a cost nor a benefit in the PAC (utility cost) test because it does not flow through the utility.

D. Free Riders and the Ratepayer Impact Measure Test

The TRC test lacks concern for the income distribution and fails to make obvious the possibility that some participants can gain at the expense of nonparticipants. Free riding is a possible distributional consequence of the TRC test, and its existence cannot change the test's outcome. Ethical and political considerations may be relevant. Many people probably prefer that transfers to free riders from others in the population be minimal because there are no obvious reasons why free riders are more deserving than those who funded the payments to them.[41] Ratepayers and regulators might prefer information about the size and direction of wealth transfers among ratepayers, but the TRC test is agnostic toward them.

The ratepayer impact measure (RIM) or ratepayer benefit test goes to a different (but possibly valid) extreme. A program only passes the RIM test if all ratepayers are better off, including those who do not receive incentives. Correct use of the RIM test requires more detailed consideration than a TRC test of costs and benefits that go forward in time. Because the test entails a present value calculation, it must account for nonsynchronous payments and benefits. Assume that a program begins in year 1 with payments from other ratepayers to adopters of some technology that, in fact, succeeds in saving electricity. Assume that the savings start in year 2 and continue indefinitely. Had the program not existed, new power plants would have been required in year 5, but it cuts power use by so much that the plants are not needed until year 10. Nonadopters are worse off in the early years because of their initial payment to adopters. The

[41] California's *Standard Practice Manual* does not mention free riding, despite estimates of large numbers of free riders on the state's programs (see below).

deferred generation investment, however, benefits nonadopters over the period of deferral. If that amount is large enough, its present value (forward from year 1) can exceed that of the initial amount that they gave to adopters. If so, both participants and nonparticipants may enjoy discounted positive net benefits.

E. Discounting Future Costs and Benefits

Because the savings and costs of a program like an EERS extend into the future, it is necessary to account for the opportunity costs of capital and compare the program's returns with alternatives. PUCO specifies that utilities discount their costs and returns by their individual weighted average of debt and equity capital costs (WACC).[42] These methods are difficult to extend to programs like EERS because of regulations affecting utility investment practices and the guaranteed recovery of prudent investments. A significant proportion of the funds are being supplied by ratepayers who have little choice about doing so rather than by investors seeking to maximize their returns. In addition, some ratepayers will receive benefits that are worth less than the costs that EERS imposes on them, and the payments of some will be transferred as benefits to others. The fact that customers are compelled to pay for individually and socially uncertain benefits while regulation shelters utilities from risk strongly suggests that consumer benefits and costs should be evaluated using a higher discount rate than applies to the utility.[43]

Ohio utilities, like those in most other states with efficiency programs, must perform TRC calculations that apply the same discount factors to both utilities and their customers. If

[42] Finding and Order, PUCO, 09-512-GE-UNC, Appendix C, 6.
[43] Relatively few economists have addressed the questions of differences between utility and consumer discount rates that reflect things such as different preferences rather than market failures. See, however, Eric Hirst, "Definitions and Tradeoffs: Cost-Effectiveness of Utility DSM Programs" (paper presented at ACEEE 1992), 8.94, http://aceee.org/files/proceedings/1992/data/papers/SS92_Panel8_Paper11.pdf.

utility and consumer discount rates differ, however, a proper calculation would reduce the consumer benefits (discount them at a higher rate) to account for the different risk positions of consumers and the utility. Ohio's rules seem to exhibit some confusion about benefit-cost tests. For all but one of these tests, the same discount rates must apply to both utilities and their customers. The exception is the utility cost test, for which PUCO requires that the costs and benefits of commercial and industrial users be discounted by utility WACC, but those of residential consumers by the interest rate on a two-year US Treasury bond. The difference is contrary to the above discussion, since PUCO is applying the lower Treasury interest rates to small customers rather than large ones. More important, the difference is incomprehensible as stated. By definition, all customer costs are excluded from the utility cost test.[44]

III. Free Riders and Customer Costs

A. Estimating Free Riders

Free riders turn up in many public programs. One widely cited study claimed that most of the funds expended in the US government's 2009 "Cash for Clunkers" program went to free riders. The survey data purportedly show that the program was responsible for only 125,000 of the 690,000 new vehicles subsidized during its existence; that is, most beneficiaries were free riders.[45] Both that study and those of efficiency programs share some problems in sampling and elicitation of truthful answers, but there are no foolproof alternatives.

There have been numerous attempts to estimate free riding in energy efficiency programs, often by utilities faced with compliance requirements. Unfortunately, a comprehensive

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[44] See California Public Utilities Commission, *Standard Practice Manual*, 23. The source refers to this as the program administrator cost test.

[45] Press release by Edmunds.com, October 28, 2009, http://www.edmunds.com/help/about/press/159446/article.html. Edmunds is an automotive industry consulting firm.

summary of such estimates has yet to be compiled. Absent such a database, I examine California and Texas, both of which have yielded substantial amounts of data on programs affecting both households and businesses. My first source is the California Energy Commission (CEC), a state government agency that requires benefit-cost calculations and estimates of free riding for all approved utility-sponsored programs but has not endorsed any criteria for separating acceptable from unacceptable research designs. Its Database for Energy Efficiency Resources (DEER) includes summaries of virtually all free rider estimates through 2008 for 16 types of programs.[46] Table 3-2 shows the number of different free rider estimates available for each type of program and the median percentage of free riders for each.[47] Most free rider estimates for residential and commercial equipment purchases, construction, and retrofits are in the 25–50 percent range.

Table 3-2. California Free Rider Percentage Estimates, 2008

Type of program	Number of programs	Median free rider (%)
Residential compact fluorescent (CFL)	10	66
Residential HVAC replacement	6	40
Residential Energy Star appliances	5	31
Residential new construction rebates	1	26
Multifamily appliance and CFL rebates	8	81
Residential energy audits	4	20
Home appliance recycling	2	47
Other direct residential installations	1	27
Commercial/industrial direct installations	12	20
Nonresidential audits	3	74
Commercial new construction	3	24
Industrial new construction	3	41
Misc. nonresidential retrofits	1	17
Misc. nonresidential custom incentives	2	51

Source: California Energy Commission, Database for Energy Efficiency Resources, 2013, various files.

[46] Enter DEER at http://www.energy.ca.gov/deer/ (requires registration). The table entries are from DEER Excel file "NTG Lit Review Summary 2008-10-10." Updates and estimates for more recent programs are not yet available.
[47] Using a median helps eliminate the influence of outlying observations. In some cases, distinct programs with different administrators are aggregated into one estimate; in some others, an administrator may have produced multiple estimates. Where data were given as ranges, midpoints were used for calculation of the median. The reader should bear in mind that DEER does not standardize for numerous important factors that might create differing free rider percentages (most importantly, the liberality of incentive payments), and many of the raw survey data are not public.

The two highest free rider percentages in table 3-2 are for compact fluorescent lighting in residential and multifamily dwellings: 66 percent and 81 percent, respectively. Given that landlords spend more on lighting than homeowners and probably are more aware of programs, the high percentage of free riders is unsurprising. A consulting firm's analysis of data from the Public Utility Commission of Texas drew a more definitive conclusion. Itron's 2008 report said that the saturation of consumer knowledge about CFL bulbs warranted a decrease in utilities' efforts to market them. The report further noted "the tendency for CFL lamps to quickly become the dominant source of savings in the residential sector once these measures become eligible for rebates or other promotions as part of utility programs."[48] The next chapter shows that Ohio's utilities all rely heavily on CFL bulbs for compliance with efficiency mandates, but PUCO requires no estimates of free riding.

Estimates of free riding for Texas share some characteristics with California's estimates. The Itron report included scenarios of efficiency growth (cumulative savings in capacity and energy) under alternative assumptions about incentive payments. It noted that under existing programs, incentive payments accounted for approximately a third of total costs. Using these and other data, Itron estimated that approximately half of all incremental savings in each year from 2009 through 2018 will come from transactions that would have occurred without the incentives.[49] Free ridership is the percentage of natural transactions that make use of incentives that were not needed. Itron found that 50 percent of all transactions in a typical program (i.e., the "unnatural" ones) require incentives if they are to materialize. Roughly half of the natural transactions (25 percent of the total) also use them. Free riders thus account for an average 33

[48] Itron, *Assessment of the Feasible and Achievable Electricity Savings from Investor-Owned Electric Utilities in Texas, 2009–2018* (December 23, 2008), 7-8–7-10.
[49] Itron, *Electricity Savings*, 7-1–7-6. The Itron study does not mention spillovers.

percent of all program participation that entails incentive payments. This is the equivalent of a 33 percent tax on subsidized transactions that were not needed to improve efficiency. Unfortunately, transactions by free riders cannot be identified in advance.

Energy efficiency programs can lead to further strategic and rent-seeking behaviors that impose additional costs. A business that would not have participated in a program without the subsidy may expend additional resources as it attempts to qualify for subsidized benefits. For example, it might incur the costs of rebuilding a plant before its normal replacement date because the new design qualifies for the program while the old one did not. Time can be used in other ways. A user who would normally have taken quick advantage of an unsubsidized opportunity could find it more remunerative to wait until a program comes into existence or goes into effect. Some California consultants offer to help their clients select from among the state's many efficiency programs and find the most profitable details of the chosen plan.[50]

Efficiency programs can also be credited with successes for which they were not responsible. Some of a program's gross savings may result from incremental nonprogram actions by participants that became convenient when their program participation began (e.g., following up the installation of a subsidized capital good with complementary but unsubsidized equipment). Some believe that additional savings are possible and sometimes occur when nonparticipants are somehow induced to act efficiently when they become aware of a program's existence. Such so-called spillovers are counterparts of free riding, and there is little reason for

[50] As one of several examples, MRW & Associates of Oakland, California, advises municipal government clients that it will help them "[shape] renewable energy and energy efficiency programs to meet regulatory requirements and take full advantage of available incentives." "Municipal Advisory Services," MRW & Associates, accessed November 24, 2014, http://www.mrwassoc.com/expertise-municipal.php. A cofounder of this firm is currently chairman of the California Energy Commission. Robert B. Weisenmiller biography, California Energy Commission, accessed November 24, 2014, http://www.energy.ca.gov/commissioners/weisenmiller.html.

confidence in available estimates of their size.[51] California's rules explicitly exclude the use of nonparticipant spillovers in utilities' compliance reports, but the California Public Utilities Commission has directed its staff to study their measurement and possible contributions to compliance.[52] As will be seen in the next chapter, Ohio is one of the few states that does not require estimation of free riders and instead uses gross figures to calculate compliance and determine utilities' rewards for complying.

B. Customer Costs and Valuations

1. Heterogeneous consumers. If all consumers eligible to participate in an efficiency program are in all relevant ways identical, the rational choice for all will be either to participate or not to participate. There are many possible explanations if some subset of that population joins and the remainder does not when universal participation is optimal. As noted in chapter 1, the explanations might include the cost of obtaining information about the choices, difficulties in accurately estimating costs and benefits of the choices, constraints on borrowing and lending, and irrationally high discount rates.

Even if we disregard these differences, heterogeneous preferences among households (and possibly businesses) are a potentially important source of behavior that deserves more attention from policy experts. In economics, a person's valuation of some good is the highest price that the person will voluntarily pay for it. The person will refuse an asking price that exceeds this valuation, which is determined by the best available alternative. It might be the

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[51] This is a counterpart of the problem of estimating free riders with surveys. Someone who is happy with the program or wishes to please the interviewer might exaggerate how its existence has induced additional efforts to use power efficiently.
[52] Cadmus Group, *Compact Fluorescent Lamps Market Effects Final Report* (prepared for California Public Utilities Commission, April 12, 2010).

price for that item posted by another seller or the cost of a bundle of other goods that leaves the person as well-off as the good in question. The consumer's benefits are defined as the difference between valuation and the price actually paid. If individuals have dissimilar valuations of an efficiency program's output (e.g., quality of light from an economical bulb), those with low willingness to pay will rationally choose not to participate. Leaving such consumers with no alternatives to the efficient bulb makes them worse off. Less obviously, having a third party subsidize the consumer's purchase of the bulb can also produce an economic loss for the community.

2. An example. Assume at the outset that a consumer (Jones) currently uses an energy-inefficient bulb and values its light at $20.[53] The bulb sells for $5 and the local regulated utility charges $10 (i.e., marginal cost) for the necessary power.[54] Jones's net benefits are $\$20 - \$5 - \$10 = \$5$. Next, assume that a more efficient new bulb that produces the same quality of light becomes available. Its market price is $7 and its power costs $6. Now Jones's net benefits are $20 – $7 – $6 = $7. He voluntarily buys the new bulb because it gives him $7 rather than $5 in net benefits.

Next, assume a different new bulb that produces a quality of light that Jones finds so unattractive that it is only worth $12 to him. At the same price of $7 for a new bulb and the same $6 power bill as before, he rejects it, since his net benefits are now $12– $7 – $6 = –$1. If the old bulb is still available, Jones will stay with it because his net benefits are $5 instead of a loss. If the new bulb is the only one available, Jones is inescapably worse off in terms of his personal preferences.

[53] This example was devised by economist Carl Danner, "California's Green Gaffe," *Public Utilities Fortnightly*, November 2007, 56–59.
[54] This example is intended to make a simple point, not to portray all relevant elements of reality.

Now introduce an efficiency program in which some ratepayer (Smith, who is not interested in buying a new bulb) pays for Jones's bulb on her utility bill. Jones still values the inferior-quality light at $12 and must still pay $6 for power, but if he chooses the new bulb his outlay on it will be zero. His net benefits are $12 – 0 – $6 = $6. Because this exceeds the $5 net benefit of the old bulb, he voluntarily uses the new one, even if the old one is still available. Our difficulty is that Smith paid $7 to get the new bulb manufactured. If her other benefits from the program are zero, she has taken a loss of $7. The balance is Jones's $6 of net benefits less $7 in cost for involuntary benefactor Smith. The efficiency program leaves the community $1 worse off under a TRC test, and it fails to pass a RIM test because Smith has lost $7. The fact that Jones takes the offer of a new bulb even when the old one remains available at the old price does not force a conclusion that the efficiency program is cost-effective. If we mistakenly assume that Jones values light from the new bulb at $20 (as is typically done in efficiency analyses), a TRC test will recommend the new bulb. Jones, however, chooses not to buy it because its harsh light makes him subjectively worse off.

By the normal standards of economics, a benefit-cost calculation must take into account the new bulb's lower quality light as viewed by Jones. Unfortunately, estimating the valuations that different consumers place on such attributes is probably an insoluble research problem, even if we neglect privacy issues. We are not even certain whether our example is a rare one or a common one. For some efficiency programs, the analysis is easier because consumer preferences regarding performance can safely be assumed to be identical. In economics we say that a more energy-efficient electric motor that can perform the same industrial work as the one it replaces is producing the same electric services. Here engineering tests allow numerical measures of, for example, a bulb's output in lumens—but not consumer satisfaction from different bulbs.

The example further assumed that the new bulb entailed no extraordinary cost for the customer (e.g., replacement of conventional sockets). TRC calculations must in fact account for the customer cost as measured by utility records, which is most often the purchase and installation price of the new equipment. Individual consumers may incur other adjustment costs, and these costs will differ among them. Clear examples include the time cost of informing oneself about alternatives, putting the job out for bids, and negotiating with a contractor; modifications necessary to accept the new technology in a nonstandard environment; and lost production when new equipment is installed because routines must change. Few, if any, studies have attempted to evaluate these costs, the associated risk factors, and their differences among potential adopters of efficient equipment.[55] These costs do not constitute a market barrier to efficiency as defined in chapter 1, and they provide no clear rationale for funding public programs intended to reduce such costs.

IV. Summary and Conclusions

A regulated utility's energy efficiency program has some properties in common with an ordinary capital investment. It entails an outlay at the start that will produce a long-lived stream of returns; in this case lower energy use and deferral of generation investments. Some state regulatory commissions treat these investments symmetrically with generation as part of least-cost planning. However, there will generally be differences in the identities of the beneficiaries and the ratepayers who fund the programs, who also have little choice but to supply the funds as part of their electric bills. These differences have given rise to several commonly used tests to

[55] If consumers' valuations are inherently subjective and different, some costs may also be viewed similarly. A consumer clearly bears costs if he must alter a familiar daily routine purely to adjust to a new energy-efficient appliance that regulators left him no choice but to buy.

compare costs and benefits. The theoretically correct TRC test does its job without considering the identities of payers and beneficiaries, a politically problematic simplification. The "no losers" RIM test accounts for the difficulty, but in practice the bulk of efficiency programs, including Ohio's, fail it by substantial margins.

Almost all efficiency programs are plagued by the problem of estimating their true marginal effects, because some participants who receive funding for efficiency measures would almost surely have put them in place absent the funding. There are no standardized ways to estimate free riders, and utilities reporting on their programs may have reasons for bias. Samples from California and Texas show few programs with under 25 percent free riders, and mass programs for CFL bulbs have estimated free-riding rates as high as 80 percent. Customer participation costs and possible quality differences in the outputs of efficiency programs can make economically inefficient programs appear superficially efficient. Most utility regulators are well aware of these problems and attempt to factor them into the analyses of utility programs.[56] PUCO, however, explicitly refuses to identify and quantify free riders in any of its utilities' programs. In consequence, seemingly effective utility programs may actually save less energy than SB 221 requires, and the returns on the associated investments will be seriously overstated.

[56] ACEEE, *A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs* (February 2012), Appendix B, table B-4.

CHAPTER 4

COMPLIANCE REPORTS AND FREE RIDERS

I. Introduction

SB 221 requires that each utility submit an application to PUCO every third year detailing its EERS compliance plans for the next three years. It must describe programs in detail and set budgets intended to achieve compliance with annual targets for both energy and peak load reductions. The utility may consult with its collaborative, but the collaborative may not impose its members' preferences on the company. The collaborative's views, however, are strategically important because cooperation minimizes the likelihood that members will intervene on their organization's behalf before PUCO to modify the utility's plan. The utility must produce annual compliance reports whose components have been specified under PUCO's Green Rules. It must also select a consultant for evaluation, measurement, and verification (EM&V) of each year's report. The utility may petition PUCO to allow recovery of program costs before it submits its annual report.

Experience with applications and reporting has been limited, but some inferences are possible. Utilities' first plans were due in 2008–2009 and have yielded three compliance reports for each utility. All utilities filed their second plans in 2012–2013 and have made their first compliance filings. With one exception involving an initial report, every utility has maintained compliance with both energy and peak reduction requirements. Thus far, utilities' annual claimed savings have generally been several times the compliance amounts, and the excess can be banked for future compliance. Overachievement at this stage is likely rational because compliance includes only improvements that exceed those required under federal regulations. With the passage of time, the regulations will become more stringent and opportunities for compliance will decline.

The next section examines a typical utility's plans and reports, using forms that are comparable with those used by other utilities. Dayton Power & Light's (DP&L's) initial three-year compliance plan covers 2009 through 2011, and its second covers 2012 (the most recent data as of this writing). Like the state's other utilities (with one minor exception), DP&L has easily achieved compliance in each of the first four years of the EERS. Although one might expect innovation as utilities devise methods for achieving future compliance, DP&L introduced no new programs for its 2012–2014 cycle. With the exception of some new AEP programs, utilities' plans were little changed. The costs of the programs are currently rather modest relative to claimed savings, but there are reasons for concern about future compliance as annual targets rise.

The sustainability of reductions depends on opportunities for compliance. Compliance currently depends heavily on the achievement of lighting-related goals for both households and commercial and industrial (C/I) customers (see data from all utilities in table 4-3). The bulk of the savings for all utilities comes from subsidization of CFL bulbs and some other lighting programs. Bulbs, however, will probably not suffice over the longer term because of upcoming changes in the stringency of federal standards, which serve as minimum acceptable levels for compliance. What will replace them for compliance is unclear, and the issue will become more urgent as annual required EERS percentage savings increase. On the other hand, Ohio's savings figures are overestimates because, unlike most other state regulators, PUCO measures compliance by gross savings inclusive of free riders.

II. Compliance Reports

A. Budgets and Performance Measures

DP&L's experience between 2009 and 2012 is representative of EERS programs, budgets, and estimates of success.[57] Shortly after SB 221 became law, the company initiated a general rate case at PUCO that included programs for EERS compliance.[58] During the proceeding, representatives of various interests objected to aspects of the EERS and other portions of DP&L's filing. Regarding the EERS, interveners objected to the company's not having hired an EM&V consultant, to some elements of its cost filings, and to the fact that it had not organized a collaborative as the other utilities had. Ultimately, DP&L signed a stipulation agreeing to hire a consultant and initiate a collaborative.[59]

A utility's first step is to work with its consultant (DP&L's is the Cadmus Group of Portland, Oregon) to estimate three levels of potential efficiency improvement and compare them with EERS requirements. (I discuss these in more detail in chapter 5.) The utility next works with its consultant, its collaborative, and customer-level personnel on benefit-cost calculations that will determine the details of its next three years of programs. Along with demographic and economic data, the utility must account for changes in federal standards, because under PUCO rules (not stated in SB 221) a saved MWh counts for compliance only if it exceeds those standards. Estimates of power savings and their costs come from the state's *Technical Reference*

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[57] DP&L, *Notice of Filing Portfolio Status Report*, Case No. 10-0303-EL-POR (March 12, 2010); DP&L, *2012 Energy Efficiency and Demand Reduction/Response Portfolio Status Report*, Case No. 13-1140-EL-POR, May 15, 2013 ("DP&L 2012 Report").

[58] *In the Matter of Dayton Power & Light for Approval of the Electric Security Plan*, Case No. 08-1094-EL-SSO, Vol. I, Chapter 2 (October 10, 2008). A general rate case sets rates for various customer classes and a rate of return on capital on the basis of expected costs of service. Rate cases in Ohio and elsewhere now include both supply costs and demand management initiatives, of which EERS is one.

[59] *In the Matter of the Application of Dayton Power & Light*, Case No. 09-1986-EL-POR, Stipulation and Recommendation (March 22, 2011), 3. As noted above, collaboratives are not mentioned in SB 221 but the stipulation required that DP&L form one.

Manual, a document constructed for PUCO by the nonprofit Vermont Energy Investment Corporation (VEIC).[60] Data from the manual are also inputs into the TRC benefit-cost calculations that determine which programs will be included in the final plan.[61] The company's consultant audits and evaluates each year's program results using a mix of expert sources, industry knowledge, and statistical tests.[62] Reports from all utilities are sent to PUCO, whose own contracted independent evaluator (currently Evergreen Economics of Portland, Oregon) assesses and compares the reports. Regarding DP&L's 2010 report, the independent evaluator concluded, "We have a high level of confidence in the evaluation findings included in the 2010 evaluation report."[63]

B. DP&L Data

Table 4-1 presents data for 2009 and 2012 on energy savings, peak reduction, and expenses by program and customer type.[64] The bulk of the data covers residential and C/I users. Also included are educational programs (e.g., one in which students received conservation kits that included CFL bulbs) and the results of measures taken by large and self-funded mercantile

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[60] VEIC, *State of Ohio Energy Efficiency Technical Reference Manual* (draft, August 6, 2010). As yet there is no finalized version of the manual. All states with extensive conservation and efficiency programs have their own technical reference manuals which are individually particularized (e.g., for weather).
[61] DP&L's 2009 program proposals appear in *DP&L Electric Security Plan, Book 2, Customer Conservation and Energy Management Programs*, PUCO, Case No. 08-1094-EL-SSO (October 10, 2008), 4–35 ("DP&L 2009 Electric Security Plan"). They were revised and incorporated in Cadmus Group, *Dayton Power & Light 2010–2012 Evaluation, Measurement and Verification Plans* (July 14, 2010). (Cited as Cadmus 2010–2012 Evaluation.) The 2013 programs are outlined in Cadmus Group, *Dayton Power and Light 2013–2013 Portfolio Plan* (April 15, 2013), submitted as attachment to *Application of the Dayton Power and Light Company for Approval of Its Energy Efficiency and Peak Reduction Program Portfolio Plan*, PUCO, Case No. 13-833-EL-POR.
[62] Cadmus Group, *Dayton Power and Light, 2009 Evaluation, Measurement, and Verification*, exhibit 1 to DPL 2009 Report ("Cadmus 2009 Evaluation"). In somewhat confusing terminology, the utility submits its ex ante data, which the consultant changes into ex post figures if necessary.
[63] PUCO, Case No. 12-0665-EL-UNC, Evergreen Economics, "Report of the Ohio Independent Evaluator" (April 29, 2012), 31 ("Evergreen Economics 2011 Report").
[64] All figures in this section are from DP&L 2009 Electric Security Plan, 2-4–2-9; and DP&L 2012 Report, 1-6, 2-4, and 2-6.

customers (described in the previous chapter). Demand response savings of 125 MW in 2009 in the Pennsylvania–New Jersey–Maryland Interconnection (PJM) market consist of generation commitments bid into that regional market and not directly usable to serve DP&L's customers. They are independent of any funding of other EERS programs.[65] Finally, start-up costs are one-time expenditures in 2009.

Table 4-1. Dayton Power & Light Efficiency Program Savings for 2009 and 2012

Program purpose	2009 spending ($ mil.)	% of total	2009 energy saving (GWh)	2009 demand cut (MW)	2012 spending ($ mil.)	% of total	2012 energy saving (GWh)	2012 demand cut (MW)
Residential	4.15	54.3	92.9	9.7	6.73	44.72	91.9	12.6
Compact fluorescent bulbs	2.63		85.2	6.5	3.07		80.7	9.7
HVAC rebates	1.06		3.1	2.8	1.75		7.0	2.2
Low income	0.03		0	0	1.01		0.9	0.2
Commercial/industrial	1.64	21.44	23.3	6.1	6.04	40.10	84.5	16.1
Prescriptive rebates	1.37		20.7	5.8	4.39		71.5	13.7
Custom rebates	0.26		2.6	0.3	1.66		13.0	2.3
Education	0.65	8.50	0	0	0.82	5.40	4.5	0.3
Mercantile	0.08	1.00	0	35	0.80	5.30	5.5	23.4
PJM* demand response	0.57	7.40	0	125	0.67	4.50	0	0
Start-up cost	0.58	7.60		N/A	N/A	N/A		
TOTAL	7.65		115.2	176.5	15.05		186.5	52.4

* PJM stands for Pennsylvania–New Jersey–Maryland Interconnection.

Source: Dayton Power & Light, 2009 Energy Efficiency and Demand Reduction/Response Portfolio Status Report (March 12, 2010), 2-4, 2-7, and 2-9; Dayton Power & Light, 2012 Energy Efficiency and Demand Reduction/Response Portfolio Status Report (May 15, 2013), 1-6, 2-4, and 2-6.

To calculate 2009 direct spending per GWh of energy and MW of peak load saved, it is best to subtract mercantile, PJM, education, and startup costs from the $7.65 million total, as

[65] For additional discussion, see *Comments of the Dayton Power and Light Company on Appendix B of Commission Entry*, PUCO, Case No. 09-512-GE-UNC (July 15, 2009), 3. It is unclear why the 2009 data show expenditures but no demand reductions.

these are not directly related to improved customer efficiency.[66] Energy saved after these adjustments rose from 115.2 GWh in 2009 to 181.0 in 2012 (57.1 percent), and peak reduction (with adjustments) increased from 16.5 MW to 29.0 MW (75.8 percent).[67] In both years these figures exceeded the law's requirements and the excess was banked. The overall average program cost of saving 1 GWh rose from $50,100 in 2009 to $75,000 in 2012, up 49.7 percent. The cost of a MW peak reduction increased from $349,600 to $468,200, up 33.9 percent.[68] In the next chapter I discuss the possibility that these cost increases are early indicators of diminishing opportunities for further efficiency improvements.

The allocation of funds among customer classes changed between 2009 and 2012. In 2009, DP&L's residential expenditures were 71.6 percent of total residential and C/I funding, a figure that had fallen to 52.7 percent by 2012. The cost per MWh of residential energy reduction rose from $44,700 in 2009 to $73,200 in 2012 (63.8 percent), while the corresponding C/I figures were $70,400 to $71,500 (1.3 percent).[69] Neither DP&L nor its consultant have attempted to explain these changes in spending allocations or the reason for the near-constant cost of energy reductions for C/I customers. DP&L's spending on residential and C/I programs rose by 130 percent over the four years, balanced between administration and incentives. The former were 39 percent of the total in 2009 and 41 percent in 2012. DP&L provides no explanation for why experience and program size have not driven down the per-unit costs of administration.

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[66] DP&L chose to recognize any education-related savings from 2009 expenses as occurring in 2010. The 2012 calculation assumes that the effects of education spending in that year took place then.
[67] Note that all 2009 DP&L figures are annualized to take account of the fact that different programs in its package began operation at different times of the year.
[68] To simplify the text, I am not considering the small inflation taking place at the time. Between 2009 and 2012 the producer price index increased by 1.7 percent per year.
[69] DP&L's expense per residential peak MW reduction rose from $427,800 to $534,100 (24.8 percent), while that for C/I customers rose from $268,900 to $375,200 (39.5 percent).

C. Benefit-Cost Tests

Applied to DP&L, the PUCO-authorized total resource cost test generally finds that the benefits of individual programs outweigh their costs. The results are also generally insensitive to measurement details and assumptions that utilities and consultants discuss in their evaluations.[70] For example, applying the TRC test to DP&L's entire portfolio of efficiency programs and using three alternative datasets produced benefit-cost ratios of 2.35, 2.61, and 3.04.[71] Results of a TRC test may have the greatest value as guides to programs that should be modified or eliminated. DP&L's 2012 report, for example, uses a TRC calculation as partial justification for its decision to phase out its HVAC tune-up program.[72]

The ratepayer impact measure described in chapter 3 is a benefit-cost statistic that considers the well-being of beneficiaries, the costs borne by nonbeneficiaries, and the present values of those benefits and costs. Even if a TRC test shows aggregate benefits exceeding aggregate costs, a RIM that is less than 1 in value means that benefits to the average ratepayer fall short of costs. EERS reports to PUCO show that every program of every utility in every available year has a RIM value below 1, most commonly between 0.4 and 0.6. The TRC test is conceptually appropriate for a benefit-cost analysis, but a favorable outcome may not benefit everyone. If a program passes the TRC test and fails the RIM test, in principle the beneficiaries could be taxed an amount sufficient to compensate the losers, while the beneficiaries would remain better off by a smaller margin. Not surprisingly, such a redistribution has yet to be proposed and would probably be impossible to implement.

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[70] Minor differences in the data can sometimes be the difference between compliance and fines for noncompliance. However, this issue has arisen only once in Ohio.

[71] DP&L 2009 Electric Security Plan, 1–4. The three datasets were DP&L's raw results (ex ante), those results as modified by Cadmus (ex post), and results using data from VEIC, *Technical Reference Manual*.

[72] DP&L 2012 Report, 3–24.

III. The Importance of Lighting for Compliance

A. Residential and Other Customers

1. Residential. Table 4-2 illustrates a point that is already well known but whose importance may be underappreciated: energy savings by residential participants in the EERS are overwhelmingly due to lighting.[73] The $1.97 million DP&L spent on CFL bulb incentives in 2009 yielded an 85.200 GWh drop in energy consumption, 91.7 percent of which resulted from its residential programs. The $2.50 million spent in 2012 saved 80.7 GWh, 88 percent of that total. Incentive costs per GWh saved were $23,100 in 2009 and $31,000 in 2012, a 35 percent increase.[74] Neither DP&L nor Cadmus provides an explanation for the increase.

Table 4-2. Dayton Power & Light Filed and Actual Savings, Incentives, and Marketing

PANEL A: 2009

Category	Filed savings (GWh)	Actual savings (GWh)	Filed incentives ($ thousands)	Actual incentives ($ thousands)	Filed mkt'g & admin. ($ thousands)	Actual mkt'g & admin. ($ thousands)
Residential lighting	23.58	85.21	1,203	1,976	794	653
Residential other	6.57	5.79	1,783	719	859	795
Nonresidential prescriptive lighting	N/A	17.81	N/A	842	N/A	N/A
Nonresidential prescriptive other	N/A	2.64	N/A	261	N/A	N/A
Nonresidential custom lighting	N/A	0.32	N/A	317	N/A	N/A
Nonresidential custom other	N/A	0.61		606	N/A	N/A
Total actual		112.38		4721		
Total lighting		103.34		3135		
% of total		91.956%		66.405%		

[73] Some minor residential programs are not shown in detail on the table.
[74] DP&L 2009 Electric Security Plan, 2-9 and 3-1; and DP&L 2012 Report, 1-6 and 3-1. Peak demand savings attributable to lighting were 6.5 MW in 2009 and 9.7 MW in 2012.

PANEL B: 2012

Category	Filed savings (GWh)	Actual savings (GWh)	Filed incentives ($thousands)	Actual incentives ($ thousands)	Filed mkt'g & admin. ($ thousands)	Actual mkt'g & admin. ($ thousands)
Residential lighting	28.6	80.68	1,787	2,486	1,179	574
Residential other	11.31	11.29	2,965	2217	1703	1440
Nonresidential prescriptive lighting	N/A	61.6	N/A	3102	N/A	N/A
Nonresidential prescriptive other	N/A	9.95	N/A	621	N/A	N/A
Nonresidential custom lighting	N/A	5.67	N/A	316	N/A	N/A
Nonresidential custom other	N/A	7.32	N/A	852	N/A	N/A
Mercantile programs lighting		2.31		270		
Mercantile programs other		3.2		375		
Total actual		182.02		10,239		
Total lighting		150.26		6,174		
% of total		82.551%		60.299%		

Source: Dayton Power & Light, 2009 Energy Efficiency and Demand Reduction/Response Portfolio Status Report (March 12, 2010), 2-4, 2-7, and 2-9; Dayton Power & Light, 2012 Energy Efficiency and Demand Reduction/Response Portfolio Status Report (May 15, 2013), 1-6, 2-4, and 2-6.

Note: Figures for 2009 do not include education, mercantile, start-up, and EM&V (evaluation, verification, and measurement). Those for 2012 do not include mercantile, education, and EM&V. Panel B data did not separate mercantile incentives for lighting from others. Lighting was assumed to be the same percentage of incentive payments as its share of energy savings.

There are anomalies in both the 2009 and 2012 data. DP&L's plans for those years indicate that savings in residential lighting programs, when combined with savings from all other programs, would have just brought the company into compliance. DP&L's 2009 plan forecast the sale of 501,663 bulbs of various types, incentive costs of $1.20 million, and marketing and administrative costs of $794,000.[75] Its estimated energy savings would have been 23,580 MWh,

[75] DP&L 2009 Electric Security Plan, Book 2, Ch. 2, Energy Efficiency and Demand Response, 15. Energy savings were based on data from California's DEER program, discussed in chapter 3.

with an average incentive of $2.40 per bulb.[76] By contrast, its 2009 report to PUCO showed sales of 1,512,783 bulbs and savings of 85,210 MWh, 261 percent over plan. Paradoxically, it accomplished this reduction with incentives of $1.97 million, only 64 percent above plan rather than the 200 percent one might have expected. The numbers in DP&L's 2012 report are similar. In 2008, DP&L projected sales of 608,570 bulbs in 2012, a figure it never modified. Its planned incentive costs of $1.78 million were to have produced a 28,600 MWh reduction in energy use at a per-bulb subsidy of $2.94.[77] Again, reality was very different, with sales of 1,763,652 bulbs for a saving of 80,680 MWh, 180 percent over plan. Actual incentives were $2.50 million, 39.7 percent over plan, but they nevertheless supported nearly triple the anticipated number of bulb sales and nearly twice the plan's energy savings. Neither DP&L nor Cadmus has attempted to explain the massive differences between forecast and actual amounts.[78] Cadmus's discussion was primarily about refining its estimates of hours of use per bulb and other technical documentation, both of which can, at most, explain only minor discrepancies between estimated and actual data.[79]

2. Commercial/industrial prescriptive programs. The dominance of lighting in residential efficiency is clear from summary data. Less obvious is its dominance in commercial and industrial programs, which can be found only after a close look. Under DP&L's 2009 plan, its prescriptive C/I rebates for standardized equipment and applications installations were expected

[76] DP&L 2009 Electric Security Plan, Book 3, Working Paper WPG-1.1. It was derived from results of a company residential survey, which appears to have covered no more than 300 customers. That incentive times the number of bulbs equals the total incentive figure.
[77] DP&L 2009 Electric Security Plan, Book 2, Ch. 2, Energy Efficiency and Demand Response, 15. Actual average discount per bulb in 2012, year 4 of the program, was $1.48, an unexplained 40 percent decrease from the 2009 discount.
[78] DP&L's only explanation is that "keys to the program's success included offering customers a wide variety of CFL choices as well as a broad, and convenient, retail distribution network." DP&L 2009 Electric Security Plan, 3-1.
[79] Cadmus 2009 Evaluation, 14 and table 11; Cadmus Group, *Evaluation, Measurement and Verification Report* (May 15, 2013), filed with DP&L 2012 Report, 10–16. See also Evergreen Economics 2011 Report, vol. 1, 10-16t (April 21, 2013).

to save 20,450 MWh of energy, of which only 4,090 (20 percent) would be lighting-related.[80] The actual outcome was a saving of 20,690 MWh, 17,810 (86.1 percent) of which came from lighting.[81] Lighting rebates were $842,000, 76.4 percent of total prescriptive incentives paid. DP&L's 2012 filed estimates and actual results show similarly substantial differences. The company planned for 32,860 MWh of energy saving but actually saved 71,550, 86.1 percent of which was lighting-related.[82] Between 2009 and 2012, incentive costs per saved MWh rose by 23.6 percent. Neither the company nor its consultant offered an explanation for the massive discrepancies between planned and actual amounts, or for their persistence over the period.

3. Custom and mercantile rebates. Custom rebates tailored to individual customers were virtually nonexistent in 2009, but by 2012 accounted for 12,990 MWh of saved energy, 5,670 of which was lighting-related.[83] Likewise, mercantile programs were minimal in 2009, but by 2012 PUCO had approved 10 such projects entailing $644,000 in incentives. Claimed savings were 5,510 MWh of energy, 2,310 of them lighting-related.[84]

B. The Dominance of Lighting

Table 4-3 shows that in 2009 approximately 92 percent of DP&L's energy savings came from lighting-related programs and that those programs accounted for approximately 66 percent of the

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[80] DP&L 2009 Electric Security Plan, Book 4, Working Paper WPG-1.10a. If controls are defined as lighting, the figure rises to 7.45 MWh.
[81] DP&L 2009 Electric Security Plan, 2-9 and 4-3; DP&L 2012 Report, 1-6 and 4-3. Peak demand savings attributable to prescriptive lighting rose from 4.88 MW in 2009 to 11.88 MW in 2012. Corresponding percentages using Cadmus ex post modified figures were 87.6 percent of total energy kWh and 89.9 percent of total peak kW. (Cadmus 2009 Evaluation, 4-3). Lighting also contributed 4.88 MW (84.3 percent) of the 5.8 MW prescriptive peak reduction.
[82] DP&L 2009 Electric Security Plan, 4-3. The remainder are primarily HVAC and motors.
[83] DP&L 2012 Report, 4-15.
[84] The projects are listed in DP&L 2012 Report, 4-24. Data on lighting were taken from individual project applications. Table 4-2 does not cover educational programs.

company's incentive payments. By 2012, lighting was responsible for 83 percent of load reductions and 60 percent of incentive payments. Table 4-3 shows that all Ohio's other utilities have been similarly dependent on lighting for compliance over the four years.[85] Nearly all figures are above 60 percent, and more than half are above 80 percent.

Table 4-3. Percentages of Energy Saved by Lighting Programs

Utility		2010 (%)	2011 (%)
AEP	residential	88	54*
AEP	nonresidential	82	66
Dayton Power & Light	residential	89	85
Dayton Power & Light	nonresidential	85	56
Duke Energy Ohio	residential	88	80
Duke Energy Ohio	nonresidential	74	67
First Energy**	residential	82***	87
First Energy**	nonresidential		71

* Does not include up to 24 percent savings from behavioral programs.
** All three First Energy operating companies are aggregated in the company report.
*** Residential and nonresidential customers were aggregated in the 2010 filing.

Source: Evergreen Economics Inc., *Report of the Ohio Independent Evaluator, 2009 and 2010 Ohio Efficiency Programs*, vol. 1, Main Report (August 29, 2012); *Report of the Ohio Independent Evaluator, 2011* (April 29, 2013), various pages.

The lighting data strongly suggest that the EERS is probably not sustainable in its current form. With minor exceptions, Ohio's rules specify that only efficiency improvements over and above those specified by federal law count for compliance. Before 2014, several commonly used incandescent bulb wattages were not yet covered by federal standards, and thus CFL bulbs were more economical than bulbs whose sale was still legal. The federal Energy Independence and Security Act of 2007 (EISA) mandated efficiency increases on all bulbs produced after January

[85] Evergreen Economics Inc., *Report of the Ohio Independent Evaluator, 2009 and 2010 Ohio Efficiency Programs*, vol. 1, Main Report (August 29, 2012) ("Evergreen Economics 2009 and 2010 Report"); and Evergreen Economics 2011 Report, various pages.

1, 2014. The change, in effect, makes CFL bulbs the federal standard and presumably ineligible for the EERS.

Discussions of possible future problems in using bulbs for compliance have been relatively infrequent. Duke Energy Ohio's 2013 application claims to have de-rated the benefits of its program based on changes in federal lighting regulation, but it appears to be alone among the utilities in doing this.[86] DP&L's latest application includes plans to continue its CFL lighting program, under assumptions about federal policy that cannot be determined. It is not clear what utilities will do (or what they should do) if they can no longer use today's CFL bulbs to comply with the EERS. None of their 2013 applications details a shift toward other existing programs for compliance. These applications also mention very few new programs that might make up the CFL gap or position the companies to meet the higher EERS percentages set to begin in 2015. DP&L and the FirstEnergy companies propose only relatively minor modifications to existing programs. AEP proposes six programs. One is a "behavior change" policy intended to make residential customers more aware of their consumption. AEP's other measures are for commercial and industrial users and will have a minor effect over the next three years.[87]

IV. Free Riders and Spillovers

A. Free Riders and Compliance

As noted in the previous chapter, evaluating the net benefits of any energy efficiency program requires estimating the portion of the program's benefits going to free riders who would have

[86] *Duke Energy Ohio, Inc.'s Application for Energy Efficiency and Peak Demand Reduction Portfolio of Programs*, PUCO, Case No. 13-0431-EL-POR (April 15, 2013), 20.
[87] AEP Ohio, *2012 to 2014 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan*, vol. 1 (November 29, 2011), 71, 98, 108, 113, 120, 126.

taken action and paid for it themselves absent the program. The 2008 California data show a median free ridership of 66 percent for residential CFL bulbs and 47 percent for appliance recycling.[88] The 2010 household market penetration of CFL bulbs in Ohio was slightly below that of California. Such comparisons, however, do not necessarily show that knowledge of the bulbs' existence and prices (more germane to free riding) was more widespread in California.[89] DP&L reports 85,210 MWh in its 2009 residential CFL lighting program.[90] If 66 percent of the bulbs were sold to free riders, the program's actual savings would be the remainder used by new participants (0.34 × 85,210 MWh = 28,971 MWh), which is only 66 percent of that program's 43,919 MWh compliance goal. DP&L's report gives a total energy reduction from all other programs of 115,279 MWh – 85,210 MWh = 30,069 MWh. Adding the CFL savings net of free riders to this figure gives 59,040 MWh. If more than 50 percent of non-CFL participants free ride, the company will have failed to meet its energy goal on a net basis.[91] DP&L's 2009 residential CFL program sold 1,512,713 bulbs in 2009 at an average discount of $1.30 per bulb.[92] Again, netting out an assumed 66 percent free rider factor, this equals $3.83 per bulb sold to non–free riders. More than 71 percent of bulbs sold in the program were 60 watt-equivalent CFL bulbs with 2014 retail unit prices that ranged from $2.19 to $2.47.[93] Although exact figures have not been calculated, it appears that Ohio's other utilities performed similarly if their free rider percentages were similar to DP&L's.

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[88] DEER, "NTG Lit Review Summary."
[89] US Department of Energy, *CFL Market Profile September 2010*, 19, 26.
[90] DP&L 2009 Electric Security Plan, 2-4.
[91] It thus becomes important for analysts to estimate the percentage of free riding in mercantile programs, because these customers are large businesses that will probably be more aware of the benefits of investing in efficiency and more strongly motivated by profit considerations.
[92] DP&L 2009 Electric Security Plan, 3-3. This equals total incentives ($1,974,578) divided by the number of bulbs (1,512,713).
[93] These prices were taken from Home Depot's website.

B. Net and Gross Savings

Few, if any, arguments have been made in favor of gross savings (inclusive of free riders) as a measure of compliance. In particular, PUCO's 2009 order on measurement and verification was devoid of rationales.[94] After noting that most commentators agreed with its provisional recommendation to use gross savings, the commission settled on it without further discussion.[95] It did say that it would consider net savings after accumulating experience with the programs, but this has yet to happen. The program's independent evaluator has produced two reports, both of which discuss the questionable logic of gross measures. The second report included some discussion of how to detect and estimate free riders.

Reaction at PUCO to these reports was strong and nearly unanimous in favor of retaining gross compliance measures. Some advocates of gross measurement simply appealed to precedent and to the fact that some of Ohio's neighbor states used gross savings. Others asserted without evidence that net savings alone would understate effectiveness and that a full accounting required estimation of spillovers, which are defined as nonparticipants who chose to take the program's action (buy the bulbs) without receiving incentive payments after observing the benefits that participants were enjoying.[96] At least one utility argued against estimation on the grounds that regulators want to see what actually occurred rather than calculations that require additional assumptions and the ability to retrospectively evaluate consumers' states of mind.[97] There are indeed difficulties in estimating free riders and spillovers, but the relevant question is

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[94] PUCO, 09-512-GE-UNC (June 24, 2009), 5, 6.
[95] The Ohio Consumers' Counsel has noted that PUCO uses net savings as a standard for evaluating gas utility programs. See Comments of the Ohio Consumers' Counsel, Case No. 09-512-GE-UNC (July 24, 2009), 3.
[96] Reply Comments of Ohio Edison Company *et al*., PUCO Case No. 13-1027-EL-UNC (January 14, 2014), 2.
[97] Reply Comments of the Dayton Power & Light Company, PUCO Case No.13-1027-EL-UNC, 2. There is no record of PUCO having made such a claim.

whether excluding both is superior to acknowledging problems in estimates that use them.[98] In reality, experience with such estimates is accumulating, comparability is improving, and an increasing number of states are using or considering net savings.[99] Finally, several parties argued against net savings on the grounds that substituting them for gross savings would further raise compliance costs and consumer bills.[100]

These arguments in favor of gross savings are all questionable at best. The treatment of savings in ratemaking, however, gives utilities strong reason to support a gross definition. PUCO allows the adjustment of rates to recover the distribution revenues a utility loses as a result of energy efficiency programs. The utility, however, does not have a right to revenue recovery when a customer chooses to, for example, purchase energy-saving equipment in the absence of a program. Thus any program participant, free rider or not, offers a utility the possibility (not certainty) of lost revenue recovery that would not be possible outside the program. Insufficient utility revenues as a result of independent customer conservation or free riding may warrant a proceeding of their own that covers matters beyond those relevant for energy efficiency programs.[101] The net-gross controversy may also apply to utilities' shared savings programs.

If our goal is to evaluate the effectiveness of a program, the only plausible standard is some measure of return on investment. Energy savings from a CFL bulb purchased by a free rider who would have bought it with or without the program cannot possibly be treated as a

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[98] Ohio Power and AEP both submitted copies of unpublished (non-peer-reviewed) working papers that detailed some of the difficulties in estimating free riders and spillovers. Those papers nevertheless acknowledged the importance of these estimates in program evaluation.
[99] See references in chapter 3; also State and Local Energy Efficiency Action Network, *Energy Efficiency Program Impact Evaluation Guide* (US Department of Energy DOE/EE-0829, 2012).
[100] Reply Comments of Industrial Energy Users–Ohio, PUCO 13-1027-EL-UNC (January 28, 2014), 5; Reply Comments of Ohio Edison Company et al., PUCO 13-1027-EL-UNC (January 28, 2014), 7.
[101] Reply Comments of the Environmental Law and Policy Center, PUCO 13-1027-EL-UNC (January 28, 2014), 4. Cadmus Group, *DPL 2012 Evaluation, Measurement and Verification Report* (May 2013), 10 ("Cadmus 2012 Evaluation").

return on investment in the program. If that person later learns of the program and belatedly receives funds through it, his purchase of the bulb cannot possibly be attributed to the program's existence. The free rider who already knew about the program is no different, because the program's existence does not determine his purchase decision.

C. Free Riding at PUCO

PUCO's 2009 basic order specified the use of gross savings, with an expectation of revisiting the issue in the near future. It appears that utilities initially expected a changeover to net measures and were preparing for it. Dayton Power & Light's consultants at the Cadmus Group promised to be responsive to the company's request for proposals, one of whose aims was to calculate net and gross savings.[102] Evergreen Economics, PUCO's independent evaluator, has thus far produced two reports. In both reports it discussed the net-gross controversy, and in the second it proposed methods to estimate free riding.[103] Looking at utilities' appliance programs, Evergreen asked about the importance of rebates in the purchase decision.[104] Its 2013 report formulated questions that would produce a "program influence score" to more accurately characterize free riding. Although Evergreen claimed that its estimations were tentative, it calculated a substantial number of free rider percentages in the 50 percent and over range.[105]

Utility consultants may be paying less attention to free riding as time passes, despite the indirect evidence for it that appears in their reports. For example, Cadmus's 2010 surveys for DP&L indicated that 93 percent of respondents were familiar with CFL bulbs, 93 percent were satisfied with them, and 76 percent of homes visited by surveyors had one or more installed.

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102 Cadmus 2010–2012 Evaluation, 1, 10.
103 Evergreen Economics 2009 and 2010 Report, 64, 73; Evergreen Economics 2011 Report, 71, 90–98.
104 Evergreen Economics 2009 and 2010 Report, 64; Evergreen Economics 2011 Report, 71.
105 Evergreen 2011 Report, 90–101.

Further, the biggest increase in CFL bulb use occurred in 2009, the first year of DP&L's program.[106] A 2012 survey found that the average DP&L household had purchased 25 CFL bulbs over the past four years.[107] Similarly, Cadmus's study of DP&L's 2010 HVAC replacement program found that a substantial number of respondents chose to take rebates from multiple sources, although in many cases their equipment was in good repair.[108]

In later years, the matter becomes less important. "Free rider" does not appear in the text of DP&L's 2012 report.[109] Regarding possible free ridership in another program, Cadmus noted that "a net-to-gross (i.e., free rider) analysis was not in the scope of our evaluation."[110] Elsewhere Cadmus claimed that its "methodology for calculating free ridership is explored in greater detail in Appendix C"; the appendix actually covers an unrelated topic.[111] A definition in the report's glossary assures us that whatever the relevance of free riders, Cadmus chose to assume that they do not exist:

> Free ridership is the percent of participants who would have taken the same action/installed the same measure in the absence of the program. Cadmus assumed the net-to-gross ratio to be 1.0 for the 2010 analysis.[112]

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[106] Cadmus Group, *2010 Evaluation, Measurement and Verification Report* (March 15, 2011), 12–13 ("Cadmus 2010 Evaluation").
[107] Cadmus 2012 Evaluation, 10.
[108] "We asked survey respondents if they applied for, were going to apply for, or had received any other rebates along with the DP&L rebate. As indicated in Figure 25, federal tax incentives were mentioned in roughly one-third of the responses (38 percent). This was a surprising statistic considering that the 2010 federal tax incentive for central A/C and air source heat pumps could approach $1,500. We asked interviewees who were planning on, had applied for, or had received a federal tax incentive how much they had or were planning on receiving. 85 percent indicated the full $1,500, and the remaining 15 percent were not sure." See Cadmus 2010 Evaluation, 77.
[109] I have not found any estimates of free ridership in other utilities' reports, although Duke claims to measure them in other states.
[110] Cadmus 2012 Report, 123. I cannot find a reference to scope in their work.
[111] Ibid., 78.
[112] Ibid., 178.

V. Summary and Conclusions

The seeming accuracy and thoroughness of utility and consultant reports probably deter many observers from asking about their relevance. At this stage of the program, mandated annual energy reductions are relatively small and seemingly inexpensive. If easy opportunities are disappearing as federal standards tighten, Ohio's utilities may be buying time by substantially overcomplying with early annual requirements using relatively inexpensive CFL programs. A detailed examination of data from their reports shows that 80 percent or more of claimed savings come from lighting, and there will be no obvious ways to replace lighting for compliance as standards rise.

To further complicate matters, PUCO has chosen to delay its promised investigation into free riding and is allowing utilities to report gross data for compliance. The EERS can be economically justified (if at all) only by a showing that its requirements have induced efficiency investments that households and businesses would not have made in its absence. The concerns over mounting costs that are already public can become stronger only if PUCO chooses to require net improvements in efficiency. For now, Ohio's political climate favors disinterest from almost all sides in these seemingly obscure comparisons, and the few stakeholders who favor net measures have made little progress. As compliance becomes more difficult and more expensive, the sustainability of any program will become the overarching question. In the next chapter I examine several possible futures for the EERS in the light of research by utilities and others, who are learning that the seemingly limitless pool of energy-saving opportunities that motivated SB 221 is being depleted at a surprisingly high rate.

CHAPTER 5

CONCLUSIONS: EFFICIENCY PAST, PRESENT, AND FUTURE

I. Introduction

Ohio's energy efficiency resource standards were among several laws beginning in 2001 that aimed to change the state's electricity markets for the indefinite future. The laws restructured utilities by mandating generation divestitures, changed their regulation by introducing efficiency considerations, and offered customers new choices by introducing retail competition. Enacted by a near-unanimous legislature, SB 221 promised benefits for almost all important interests at low cost because increases in efficiency would result in lower electric bills. Things are turning out somewhat differently. This chapter begins with a discussion of how the rationales for energy efficiency policy discussed in earlier chapters might have been operative in Ohio, if indeed the state ever needed such a policy. The general public's benefits from SB 221 are difficult to find, while the increases in power costs are becoming obvious. The language underlying the EERS and its implementation virtually guaranteed an imbalance between costs and benefits. Its quantitative standards were at best distantly linked to the economic realities of the power industry. One well-known consequence of the economic theory of regulation did occur: Ohio's policies protected concentrated incumbent interests (particularly utilities and environmentalists) as they threw costs and risks onto poorly organized consumer interests.

The chapter continues with a discussion of inefficiencies inherent in the law and its implementation. Some could have been eliminated or alleviated in legislation and others in subsequent PUCO rulemakings. Although the EERS has been in effect for only five years, evidence of its benefits has yet to materialize. Particularly missing are benefits that might stem from state requirements that exceed federal levels. Over a longer horizon, some important interests have expressed doubts about the standard's sustainability. Energy efficiency advocates have often claimed that their policy is inexpensive and a nearly inexhaustible source of public benefits. In more recent EERS proceedings, however, both utilities and environmental interests appear to be converging toward a consensus that Ohio's actual efficiency potential (in excess of federal requirements) may not allow it to meet SB 221's timetables, even at substantial cost. I discuss recent legislation to end or substantially modify the EERS, followed with a summary of my findings and the likely consequences for Ohio.

II. Does Ohio Need the EERS?

A. Before and after SB 221

Before SB 221's implementation, Ohio was neither a leader nor a laggard in energy efficiency. In 2008, Ohio scored 21st among the states on a weighted average of policies of interest to the American Council for an Energy-Efficient Economy (ACEEE), an organization of environmentalists and efficiency-related businesses. It was 24th in efficiency expenditures as a percentage of utility revenue (0.2 percent). Annual savings as a percentage of electricity sales were indistinguishable from zero.[113] There is no evidence that the modest set of programs in existence before SB 221 had either advantaged or disadvantaged Ohio businesses relative to other states.

Statistically, SB 221 raised Ohio's relative standing. ACEEE's measures of efficiency are imperfect, but they do allow interstate comparisons. By 2012, Ohio ranked 13th in ACEEE's overall index of energy efficiency, which includes energy sources other than electricity; ninth in

[113] ACEEE, *2008 Energy Efficiency Scorecard*, 5, 8, and 10 (2009). Before SB 221, Ohio utilities could initiate their own programs with the approval of PUCO, but most were small and simple measures such as CFL lighting discounts. ACEEE generally refers to these as "efficiency" rather than "reduction" standards.

net savings from efficiency programs; and ninth in incremental savings from efficiency in 2011 (the latest year available).[114] ACEEE also credited Ohio with weakening the links between utility sales and profits as it moved toward revenue decoupling and for the shared savings incentives of SB 221. It did criticize the law's 3 percent spending cap and the "exit ramp" provision that allows PUCO to reduce annual requirements if it judges that utility finances have been adversely affected. Whatever the state's rank in spending, however, the important question is whether Ohio's households and businesses are getting their money's worth.

B. What Benefits for Ohio?

1. Predicting its macroeconomic effects. SB 221 became law in part on the basis of improbable claims. Interest groups made assertions about how their desired provisions would benefit Ohio, what they would actually cost, and how the benefits would be distributed. Other parties were interested in creating inefficiencies that would lower net benefits; for example, possibly unconstitutional in-state renewable power purchase requirements. Efficiency advocates produced little evidence that SB 221's timetable was achievable at a reasonable cost, and the timetable itself was a product of negotiation that took place within legislative deadlines and was constrained by inadequate information. A representative of industrial power users said that the timetable was "set by statute without the slightest reference to any science, empirical or otherwise."[115] Despite the heterogeneity of Ohio's generation and loads (see table 2-4), SB 221 disregarded any differences in utilities' abilities to originate and implement efficiency measures. Instead, each utility was to devise programs whose outcomes would be the same regardless of

[114] ACEEE, *2013 Energy Efficiency Scorecard*, 22, 27, 31, 35, and 113 (2014). Note that the EERS applies only to regulated corporate utilities; thus, roughly 10 percent of the state's economic activities are not included in the calculations.
[115] Ohio State Senate, Public Utilities Committee, April 9, 2013 (testimony of David Boehm, Ohio Energy Group).

local characteristics.[116] There is no record of proposals that could have reduced compliance costs by allowing utilities to trade opportunities. An overcompliant utility is, however, permitted to bank its overages for future compliance.

At the legislature, optimists admitted that the EERS could raise the price of delivered power. With little or no data, they argued that energy use reductions would nevertheless allow Ohioans to use fewer kWh to produce the same "electric services" (i.e., useful work) as before and thus enjoy lower bills. As early as 1994, ACEEE outlined policies it claimed would allow continued economic growth while lowering 2010 energy consumption to 90 percent of consumption in 1992, all "without reducing services or standards of living."[117] By 2013, ACEEE's arguments about cost had come to rely less on energy efficiency and more on price suppression within PJM (discussed in detail below).[118] SB 221's opponents did not produce their first numerical estimates of its effects until 2011, using a computable general equilibrium model to find adverse effects on employment and production in Ohio.[119] ACEEE subsequently used a similar model to find benefits from the EERS and efficiency policies in general.[120]

It should hardly surprise a reader that the same research method can produce different results with different data and assumptions. But here research by both proponents and opponents fails some basic plausibility screens, the first of which is the overall amount. Ohio's gross

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[116] These loads were defined as transmission and distribution customers. A customer who obtained these services from a utility's distribution affiliate was legally indistinguishable from one who purchased from an independent generator and used the utility's lines only for delivery. Municipal and cooperative utilities that used utility lines for delivery of their power supplies remained exempt from the EERS.

[117] Skip Laitner et al., *Energy Efficiency as an Investment in Ohio's Economic Future* (ACEEE, November 1994), v.

[118] Ohio State Senate, Public Utilities Committee, Review of Ohio Senate Bill 221, April 23, 2013 (submission of R. Neal Elliott, ACEEE, on behalf of Ohio Manufacturers Association).

[119] See Beacon Hill Institute and American Tradition Institute, *The Cost and Economic Impact of Ohio's Alternative Energy Portfolio Standard* (April 2011), 4. This document does not explicitly mention the EERS, but there is no obvious reason to reject the use of the same methods that the report used to evaluate the AERS.

[120] Max Neubauer et al., *Ohio's Energy Efficiency Resource Standard: Impacts on the Ohio Wholesale Electricity Market and Benefits to the State*, ACEEE Report E138 (April 2013).

domestic product in 2011 was $484 billion.[121] Many of its components are imputations and estimates with measurement errors. By contrast, in 2014, utilities' direct expenditures on the EERS were $256.6 million, to which should be added customer costs and regulatory adjustments of utility revenues. On the other hand, substantial funds are transferred to free riders, who would have participated in any case. Put simply, even if the full costs of efficiency programs considerably exceed utilities' direct spending on them, the effects on the far larger Ohio economy will be extremely hard to identify and measure, be they net costs or benefits.[122]

2. Employment and markets in Ohio. If the EERS has relevant effects, they will likely be in individual markets. The two most plausible venues are markets for labor and markets for efficiency-related equipment and services. Reasoning that links the EERS with job creation is unclear at best and illogical in the context of many standard economic models.[123] One politically popular scenario argues that increased spending on efficiency by utilities expands employment in firms that produce efficiency-related equipment and services, and with it the state's overall level of employment. If the net effect is to increase employment, the source of the new workers goes unstated. Unemployment is often unpleasant, but it is a consequence of necessary adjustments in well-functioning markets. Vacancies come and go while workers transition between employers and into and out of the labor force. If a supplier of efficiency-related equipment expands because a utility complying with the EERS buys more from it, the new job slots are in no obvious way special. The people filling them are likely to come from other jobs. Except in extreme and

[121] Ohio Policy Research and Strategic Planning Office, *Gross Domestic Product from Ohio* (August 2012), 4.
[122] For useful summaries of the measurement difficulties (and evidence that some efficiency programs are cost-effective), see Kenneth Gillingham et al., "Energy Efficiency Policies: A Retrospective Examination," *Annual Review of Environment and Resources* 31 (2006): 161–92; and David Loughran and Jonathan Kulick, "Demand-Side Management and Energy Efficiency in the United States," *Energy Journal* 25 (2004): 19–43.
[123] Robert J. Michaels, "National Renewable Portfolio Standard: Smart Policy or Misguided Gesture?," *Energy Law Journal* 29, no. 1, 2008): 79–119.

largely theoretical situations, there are no massive aggregations of long-term unemployed people today like those that were seen in the Great Depression of the 1930s.

In today's economy, absent the EERS households and businesses would have spent funds elsewhere instead of hoarding them, creating employment in other industries. A regulation that requires consumers to buy efficiency instead of other desirable things is the equivalent of a tax that leaves them with less command over other goods, whose production and employment must of necessity shrink. Even if we believe that a local "stimulus" can have benign wider consequences, there are no obvious reasons to expect that renewable or more efficient power is a superior vehicle with which to deliver the stimulus. Ohio cannot by itself challenge the ever-expanding geography of markets.[124] The simple fact that Ohio now requires reductions in energy use does not necessarily mean that workers and owners of Ohio businesses will benefit. Worldwide competition means that Ohio consumers and businesses have little choice but to strike the best bargains they can, whether in or outside of Ohio.

3. Distribution of costs and benefits. An EERS program whose benefits exceed costs (in present value) will pass a total resource cost test, but their distribution can also be a matter of concern. Economists are ill-prepared and usually reluctant to weigh political factors or serve as ethical arbiters. A desire for objectivity ideally leads them to concentrate on measurable totals rather than their distributions. Nearly all Ohio's EERS programs thus far have passed TRC tests. If all ratepayers received benefits and incurred costs proportional to their bills, they would probably support the standard almost unanimously. The actual distributions of costs and benefits, however, are quite different. As of 2013, 98 percent of the FirstEnergy companies' business

[124] Such attempts at challenges may include in-state purchase requirements as discussed earlier.

customers were not participating in the EERS and, disregarding CFL bulbs, only 7 percent of household customers were participating.[125] Some individual beneficiaries enjoy substantial gains, while costs are diffused into small amounts borne by millions of ratepayers. If the EERS grows and the distribution of benefits remains largely the same, continuation of the programs in their present forms may become politically difficult. Worse, future options for small consumers may be few. Ultimately, as federal standards tighten utilities will have to phase out such important programs as CFL bulbs and recyclable appliances; replacement programs that will save as much as those two probably are not on the horizon.

There are other reasons to question the equity of EERS programs. The financial situation of a particular ratepayer (e.g., a credit rating that makes it costly to borrow) may lead that person to choose nonparticipation in an EERS program that a different ratepayer would choose to join. Both, however, will pay unavoidable bills for benefits accruing to only one of them. Likewise, before the EERS, some ratepayers chose to invest in efficiency on their own and bore the full cost. They will nevertheless also pay to subsidize the purchases of those who chose to delay their participation.[126]

4. Environmental improvement. However imperfect its execution, the US Environmental Protection Agency must generally perform a benefit-cost analysis before issuing most new regulations. Broadly, the agency places dollar values on harm to health and other pollution-related damages, then bases the rule on the value of the harm and the cost of mitigating it.[127]

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[125] "Revisiting Ohio's Energy Efficiency Mandates," Ohio State Senate, Public Utilities Committee, April 9, 2013 (testimony of Leila L. Vespoli), 6–7.
[126] There are no known records of users who postponed efficiency investments while waiting for a program to be announced. Such behavior, however, is hardly beyond reason.
[127] Legally, the EPA is not allowed to consider mitigation cost, but in practice there is no way to avoid accounting for that cost in the rulemaking.

There may be reasons to disagree with the EPA's findings in particular cases, but an economist would have few difficulties accepting these principles in the abstract. Without further analysis, advocates of SB 221 were satisfied with the claim that passage was warranted because using less power reduces pollution. At no point in the legislative process was there an attempt by any interested party to weigh the costs and benefits as the EPA does, or to consider (as the EPA also must) alternatives to the proposed rule.

All Ohio corporate utilities are members of PJM, whose regional high-voltage power markets extend from New Jersey to Chicago. If the EERS leads to lower power consumption in Ohio, there is no reason to expect an Ohio generator to reduce its output and thus its emissions over the state. Some Ohio customers may be gone, but under federal regulations that generator is guaranteed transmission access to one of the largest markets in the world. (Under PJM rules, it is often required to submit bids.) Likewise, within broad limits, power from a non-Ohio generator can easily substitute for power that would have been produced by an Ohio power plant. In any case, if Ohio generators produce less power and out-of-state production is unchanged, the benefits of Ohio's policy will be enjoyed by residents of other states, who will get cleaner air without having to pay for it. Even as a matter of theory, the EERS is likely to be an inferior policy tool for coping with both ordinary pollutants, such as those already federally regulated, and carbon emissions, which may be on their way to regulation.[128]

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[128] Economic theorists have recently shown that under fairly general economic assumptions, an efficiency requirement such as the EERS is inferior to taxes or other pricing interventions as an instrument of environmental policy. In particular, using a combination of energy efficiency and emissions controls is approximately three times as costly as a tax on carbon itself. Ian Parry et al., "Are Energy Efficiency Standards Justified?," *Journal of Environmental Economics and Management* 67 (March 2014): 104–25.

C. Why Go beyond Federal Policy?

Under PUCO rules, an EERS program is good for compliance only to the extent that its energy savings exceed those required by federal policy. Neither SB 221 nor PUCO has yet set forth a coherent rationale for this choice. Advocates have supported this rule with claims that some other states have similar standards, but this is in no sense a valid economic reason.[129] For example, a federal standard for power consumption by some appliance must generally be supported by a benefit-cost analysis, however imperfect, before it can become a regulation. The fact that the benefits of some standard exceed its costs in no way implies that a more stringent one is even better. As of this writing, no interested party has performed a study on the cost-effectiveness of exceeding federal standards.

Evaluation problems are compounded by the fact that rising federal standards can turn last year's benefits into this year's costs. The most important example thus far occurred at the end of 2013, when a higher federal standard eliminated 40-watt and 60-watt incandescent bulbs as a benchmark for savings. All Ohio utilities have depended on bulb replacement programs for (over)compliance since 2009, but this change will probably create problems. Lighting constitutes the largest percentage of both residential and C/I savings; the reach of other existing programs (e.g., air conditioner tune-ups) is more limited, and no utility has proposed new programs that are likely to make up for the bulb deficit. Banked credits for overcompliance have given the utilities a temporary respite, but the future of compliance is uncertain. Some environmental or economic changes in Ohio might rationalize its unilateral adoption of a stronger standard, but the state's post-2008 history probably counsels otherwise. The most likely reason for change has been the

[129] As noted previously, advocates have claimed that more-stringent efficiency regulations will decrease electric bills by more than they increase power prices. Even if we believe this, there must be some point at which this difference is reversed.

development of shale-borne gas and oil, which promises a long era of lower fuel prices. If so, the investments to make are those that productively use the new fuels rather than those that deal with a scarcity that no longer exists.

D. Are Lower Prices Elsewhere a Benefit?

If the price of generation fuel falls, power consumers benefit as market forces pressure utilities or other retailers to lower energy prices. Electricity bills will not fall in proportion to the fuel savings, because ratepayers must ultimately also pay the fixed costs of generation and transmission. Ohio utilities and competitive retailers obtain the power supplies they distribute to end-users through self-generation, bilateral exchanges, and participation in PJM's markets.[130] EERS supporters claim that the standard confers benefits on Ohio end-users beyond increased local efficiency, because a decrease in their state's PJM purchases will suppress regional prices. Estimating the price impact of Ohio's policy requires certain assumptions, some of which are difficult to rationalize or verify. By one such calculation, the effect of the EERS on PJM demand was a $333 million reduction in annual sales.[131] Since Ohio makes up approximately 20 percent of total PJM load, the consequence for the state was a saving of approximately $66 million in costs in 2012. Assuming prices are roughly uniform over the PJM footprint, we can conclude that 80 percent of the rate suppression benefits of Ohio's policies went to users in other states. The effect of suppression is to reduce the typical Ohio household's bill (750 kWh/month) by $4.38 per year.[132]

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[130] Generation divestitures and the growth of retail competition do not materially affect the reasoning in the text.
[131] Neubauer et al., *Ohio's Energy Efficiency Resource Standard*, 6–7.
[132] Ohio State Senate, Public Utilities Committee, February 19, 2014 (prepared testimony of Jonathan A. Lesser on behalf of Industrial Energy Users—Ohio), 18–20. More recent PJM capacity market auctions have exhibited significantly higher prices that correspondingly lower these putative economic benefits.

Some testimonies claim to have estimated substantial benefits for Ohio ($1.3 billion total between now and 2020) if more of its demand response and efficiency resources are bid into PJM's capacity market, where they will also reduce prices.[133] It has been suggested that PUCO order distribution utilities to bid all their demand response and efficiency resources into PJM's capacity market to obtain the most price suppression there.[134] A utility or other power producer may not want to bid all these resources into PJM if it believes they may be of use in its own load management, or if resources that are expected to become available in the future do not materialize. There are also some legal questions about who "owns" demand response and what it means to own it. An attorney for industrial customers opined that "the logic of the theory suggests that it is possible to reduce Paul's electric bill by robbing Peter to pay Paul's electric bill."[135] Figures like the capacity value above should be viewed in light of the fact that they come from studies whose scope is intentionally narrow and that disregard certain costs. For example, ACEEE chose not to include direct costs of participation to customers because it wanted "to keep the focus . . . specifically on the implications . . . of having energy efficiency programs."[136]

[133] Neubauer et al., *Ohio's Energy Efficiency Resource Standard*, testimony of R. Neal Elliott.
[134] Perhaps more importantly, the PJM capacity market is an artifact of regulation whose prices are heavily influenced by regulatory practice. These payments would not exist (or be collectively available) absent a capacity market. As a counterexample, generators in Texas sell most of their output under confidential contracts with competitive retailers, payments for which are bilateral and invisible to the system operators. A small amount of the power (usually 5 percent to 10 percent) trades in a spot "balancing" market, which operates solely to clear payments. See Andrew N. Kleit and Robert J. Michaels, "Reforming Texas Electricity Markets: If You Buy the Power, Why Pay for the Power Plant?," *Regulation* 36 (Summer 2013): 32–35.
[135] Ohio State Senate, Public Utilities Committee, April 9, 2013 (testimony of Sam Randazzo on behalf of Industrial Energy Users–Ohio).
[136] Neubauer et al., *Ohio's Energy Efficiency Resource Standard*, 2.

III. Is the EERS Sustainable?

A. How Cheap Are Negawatts?

Power has a cost, and so does energy efficiency. In industry parlance, the counterpart of a produced megawatt is a saved "negawatt." The costs of both are measured by the most valuable alternative forgone when a production (or nonproduction) decision is made. Common sense and economics tell us to use the lowest-cost sources first for both megawatts and negawatts. Ohio is an early illustration of a critical policy question: What happens to the cost of an additional negawatt as opportunities are more fully exploited? Potential negawatts may be the analog of a finite deposit of ores of varying richness whose marginal costs rise as production cumulates. Alternatively, new technologies might reduce these costs so that lower grade ores (more expensive negawatts) can be efficiently put to use.

As energy efficiency has become a policy choice, numerous studies claim to have found that in important applications the cost of a megawatt saved is well below the cost of a megawatt produced. McKinsey & Company's paradigmatic 2009 study claims that by 2020 the United States could reduce nontransportation energy consumption by 23 percent. Its authors calculated that a $520 billion up-front investment could eliminate a present value of $1.2 trillion in waste.[137] In Ohio, SB 221 was rationalized as a tool for recovering otherwise wasted energy, as measured by such interests as ACEEE and environmentalists. Few, if any, researchers attempted to explain why large businesses with adequate access to capital often preferred nonenergy investments to those that advocates claimed would bring higher returns. Implicitly, the efficiency advocates had somehow found out that negawatts were more profitable than many other investments by businesses. There are, however, no available explanations of how the

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[137] McKinsey & Company, *Unlocking Energy Efficiency*.

experts had learned about the risks and returns of alternative investments and the competitive strategies of energy users.

B. Which Programs to Use

SB 221 in effect required utilities to conduct experiments, with the help of collaboratives of experts, to determine how much might be saved and where the savings might be hidden. It is possible that the newness of SB 221 can explain why utilities' 2008–2009 plans consisted almost entirely of programs that had been tried and proven elsewhere. As previously noted, the bulk of energy savings came from CFL programs that turned utilities into discount marketers of CFL bulbs. TRC tests showed that the programs were cost-effective and high percentages of small customers obtained some benefits through them. These beneficiaries, however, included many program participants who were free riders. Their continued existence has been an inconvenient fact that many interested parties would prefer not to mention (or at least to deemphasize), despite general acknowledgment that gross benefits (calculated inclusive of free riders) were serious overestimates of effectiveness.

These issues have been complicated by the fact that all utilities' budgets and forecast savings for CFL programs have been greatly at variance with their results. For example, DP&L's annual fillings all contain budgets whose energy reductions are expected to comply with SB 221's requirements. Expected savings for residential CFL bulbs and other programs are itemized in some detail. In reality these budgets and projections have resulted in massive overcompliance. DP&L's planned 2009 energy reduction from residential CFL bulbs was 23.6 MWh; the actual amount was 85.2 MWh, 260 percent higher. The discrepancy cannot be attributed to the novelty of the EERS, since the corresponding 2012 figures were 28.6 MWh, 80.7 MWh, and 182 percent.[138] It seems clear that DP&L wanted to bank its early savings in anticipation of the scarcer opportunities likely to follow the incandescent bulb phase-out.

C. Are There Limits to Energy Efficiency?

Ohio's implementation rules specify a relatively rigorous triennial process. Each utility, with the help of its consultants and collaborative, first examines its overall potential for energy savings. It then uses a stepwise procedure to identify feasible programs and ultimately choose those that, in total, will best meet SB 221's upcoming requirements. Because efficiency is at issue, plans must consider such economic factors as prices of alternative energy sources. Ohio's rules specify that savings must exceed those under federal standards, so the utility and its advisors must also account for the likely effects of predictable changes in those standards. The process uses many different information sources and forecasts, and a utility may also avail itself of knowledge and advice from outsiders, such as those in its collaborative. The entire process seems well-suited for forecasts of three years and longer.

The first step is to estimate three variants of potential for efficiency. The broadest of these is *technical potential*, which assumes that all technically feasible reductions are implemented regardless of their costs or market barriers. *Economic potential* is a subset of technical potential that refers only to measures that meet cost-effectiveness criteria. *Achievable potential* is the portion of long-run economic potential assumed to be feasible after accounting for customer awareness, market barriers, and the likely costs of energy reductions.[139] Table 5-1 presents DP&L's estimates of these potentials in 2010 and 2012. The differences reflect new information and revisions—

[138] DP&L 2009 Electric Security Plan, 2-4; DP&L 2012 Report, 2-4. For conciseness, I have used facts and data from the DP&L proceedings. Those of other utilities are broadly similar, particularly regarding overachievement of CFL goals.
[139] *DP&L 2013–2015 Portfolio Plan*, Case No. 13-833-EL-POR (April 15, 2013), 21, 26.

including baseline potentials, assumptions about avoided costs (fuel prices), data on efficiency changes already achieved, and changes in federal codes. The company then evaluates a final group of possible program elements.[140] In the three years since DP&L's first plan, every relevant figure on table 5-1 has declined, some significantly. In particular, residential potential fell by 33 percent and commercial by 41 percent, both primarily as a result of changes in lighting standards. Technical potential savings for the system fell from 65 percent to 55 percent of the baseline, and economic potential savings fell from 17 percent to 12 percent of technical potential.

Table 5-1. Economic and Technical Potential Savings Estimated for Dayton Power & Light, 2010 and 2012

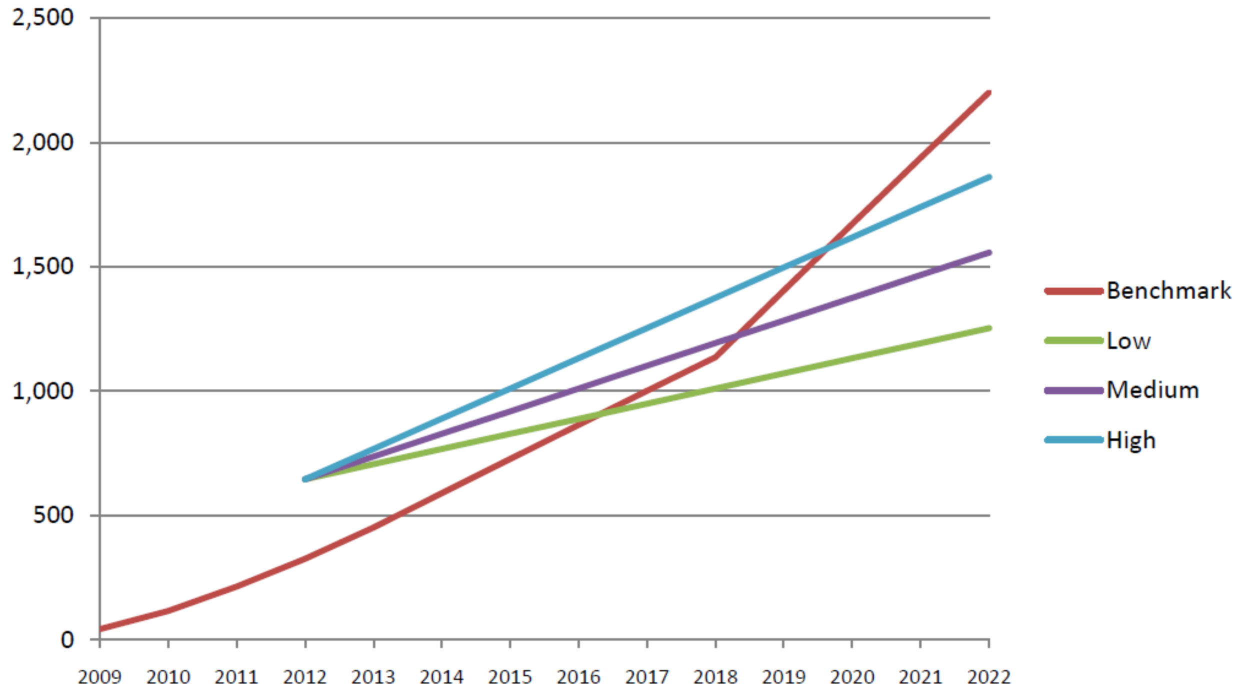
	Baseline (GWh)		Economic potential		Economic as % of technical		Technical potential as % of baseline	
	2012	2010	2012	2010	2012	2010	2012	2010
Residential	5,288	5,867	801	1,203	15	21	47	54
Commercial	3,945	4,391	314	810	8	18	48	77
Industrial	3,643	3,458	403	372	11	11	99	9
TOTAL	12,876	13,716	1,518	2,385	12	17	55	65

Sources: Cadmus Group, *Dayton Power & Light 2010–2012 Evaluation, Measurement and Verification Plans* (July 14, 2010).

The second round of three-year plans for all the utilities was noteworthy (see chapter 4) for the small number and volume of new programs introduced by the utilities as a group. DP&L introduced no new programs and proposed only minor improvements to existing ones, again intending to meet its compliance requirements primarily with lightbulbs. The newer programs included some whose outcomes were potentially quite uncertain, such as AEP's introduction of behavioral methods to raise consumer consciousness. The collaborative process allows almost anyone to propose a program, but few cost-effective proposals have been forthcoming.

140 Ibid., 23.

Figure 5-1. Dayton Power & Light Low, Medium, and High Achievable Scenarios Relative to Benchmarks Required for Compliance



Source: *DP&L 2013–2015 Portfolio Plan*, Case No. 13-833-EL-POR (April 15, 2013), 30.
Note: The y-axis units are cumulative gigawatt-hours saved.

Over the longer term, the utilities' problems become more challenging. Because achievable potential depends on future developments in markets, policies, and technologies, there is no consensus on a quantitative measure. Accordingly, DP&L produced high, medium, and low estimates for the remaining years of the EERS. Figure 5-1 shows the company's cumulative energy savings in the three scenarios between 2013 and 2022. They are superimposed on the benchmark line that shows SB 221's cumulative energy savings requirements. DP&L summarized its prognosis:

> As depicted above, potential savings have declined due to the success of current energy programs and the increased baselines driven by changes in codes and standards. As a result, meeting future Ohio benchmarks will become increasingly challenging based on the current data from the market potential study. Taking the medium achievable scenario and assuming that potential savings are captured in a linear fashion, targets would be achieved through 2018. However, beyond 2018, as the incremental energy benchmark

target increases to 2% per year, achieving the benchmarks will become increasingly challenging.[141]

First Energy Corporation's 2012 Market Potential Study reached similarly pessimistic conclusions for all three of the holding company's utilities. Ohio Edison could achieve 12.7 percent efficiency savings in 2026 under base case assumptions and 16.8 percent under high case assumptions, both well short of SB 221's 22 percent requirement. The corresponding figures for Toledo Edison were 11.1 percent and 13.1 percent, and for Cleveland Electric Illuminating, they were 14.1 percent and 16.3 percent. First Energy's consultants agreed with ACEEE's 2009 conclusion that "a suite of innovative energy efficiency policies will need to contribute 10% of the EERS targets (i.e., just under half of the required MWh) in order to satisfy the state's savings goal of 22% by 2025."[142] ACEEE's innovative policies included, among others, industrial initiatives, building code changes, workforce development, and expanded demand management, none of which were analyzed in any detail.[143]

IV. Conclusions

A. How Permanent Will SB 221 Be?

In February 2013, Republicans in the state senate introduced SB 58, in part in reaction to the ways SB 221 had been administered and in part because of a popular acknowledgment that Ohio's economy was changing with a large increase in shale gas and oil production. If Ohio were suddenly energy-rich, the premises underlying SB 221 would require serious reexamination. Ohio could, according to advocates, reclaim its former title as a major industrial power, but only if its

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[141] Ibid., 30.
[142] Black and Veatch, Market Potential Study: Energy Savings and Demand Reduction for Ohio Edison, Toledo Edison, and The Illuminating Company, PUCO Docket No. 12-2192-EL-POR (June 22, 2012), Appendix D, 137.
[143] ACEEE et al., *Shaping Ohio's Energy Future: Energy Efficiency Works* (Report No. E092, March 2009), iii. The report also noted possibilities for extracting more than the 10 percent expected savings from ongoing utility programs.

entrepreneurs were no longer distracted by policies that were reactions to energy scarcities that were no longer so acute. SB 58 was the subject of seven months of hearings before legislative committees. Supporters claimed substantial support for the bill, but in December, for unclear reasons, its sponsors canceled a committee vote on it and SB 58 was dropped from the agenda.

Energy efficiency remained a salient issue, and in March 2014 state senate Republicans introduced SB 310. Instead of effectively repealing the RPS and the EERS, SB 310 would implement a two-year freeze on both requirements.[144] The bill also included provisions for formal reconsideration, by establishing a 21-member Energy Mandates Study Committee tasked with performing two benefit-cost analyses. The first would study continuation of the freeze, and the second would examine the consequences of reinstituting SB 221's 2014 requirements and those that would have been in effect for subsequent years. In June 2014, Governor John Kasich signed SB 310 into law. As of August 2014 the law has produced no significant legislative or regulatory developments.

B. Ohio in a Broader Context

An economist looking at the sweep of federal and state energy interventions since the 1970s must do so with mixed emotions. Economists rightly had foundational reasons to reject the price-freezing and micromanagement of energy markets that characterized the 1970s and 1980s, whose only effects were to worsen existing inefficiencies and shortages. Their work in freeing natural gas markets in the mid-1980s flew in the face of near-universal opposition, but in the end it brought the nation centuries worth of shale gas. The performance of economists at the nexus of energy and environmental policy has been far more ambiguous. Their theories have correctly

[144] SB 310 contained some other provisions of interest, including a requirement that PUCO adopt rules outlining how it would require disclosure of the costs of the standards on consumer bills.

recommended efficient ways to cope with some pollutants (the EPA's once-active trading programs for oxides of nitrogen and sulfur) and questioned the causes and consequences of renewable power. If the EERS had a rationale, it was as an antidote to market failure, which supposedly led to underinvestment in efficient technologies. However, economists performed no rigorous studies of SB 221 that might have substantially changed its content. Studies by interest groups were for the most part applications of modeling that failed to capture either changes in energy markets or important details of Ohio's institutions.

In efficiency policy, the proper job of economists is to bring to the forefront the questions that Ohio's politicians have chosen to ignore or have answered incorrectly. An odd coalition of lobbyists arose that included environmentalists, businesses seeking special treatment, and thoughtless onlookers who wanted to show their concern, all while most economists stood aside. A near-unanimous legislature enacted SB 221, complete with requirements and timelines that had no economic basis. Even enthusiastic EERS supporters at ACEEE acknowledged that without new and costly programs, Ohio would achieve little more than half of the law's 2025 goal. Now the consequences are unfolding and will continue to unfold, whether the state chooses to keep SB 310 in effect or return to SB 221's compliance schedule. Those consequences range from wealth redistribution to economic inefficiencies that result from overly high efficiency standards to shrinkage of energy-saving opportunities that many understand but few have said much about. An unpleasant encounter with economic reality is unfolding for Ohio's citizens and businesses; this study is an attempt to give them an understanding of its shape and size.