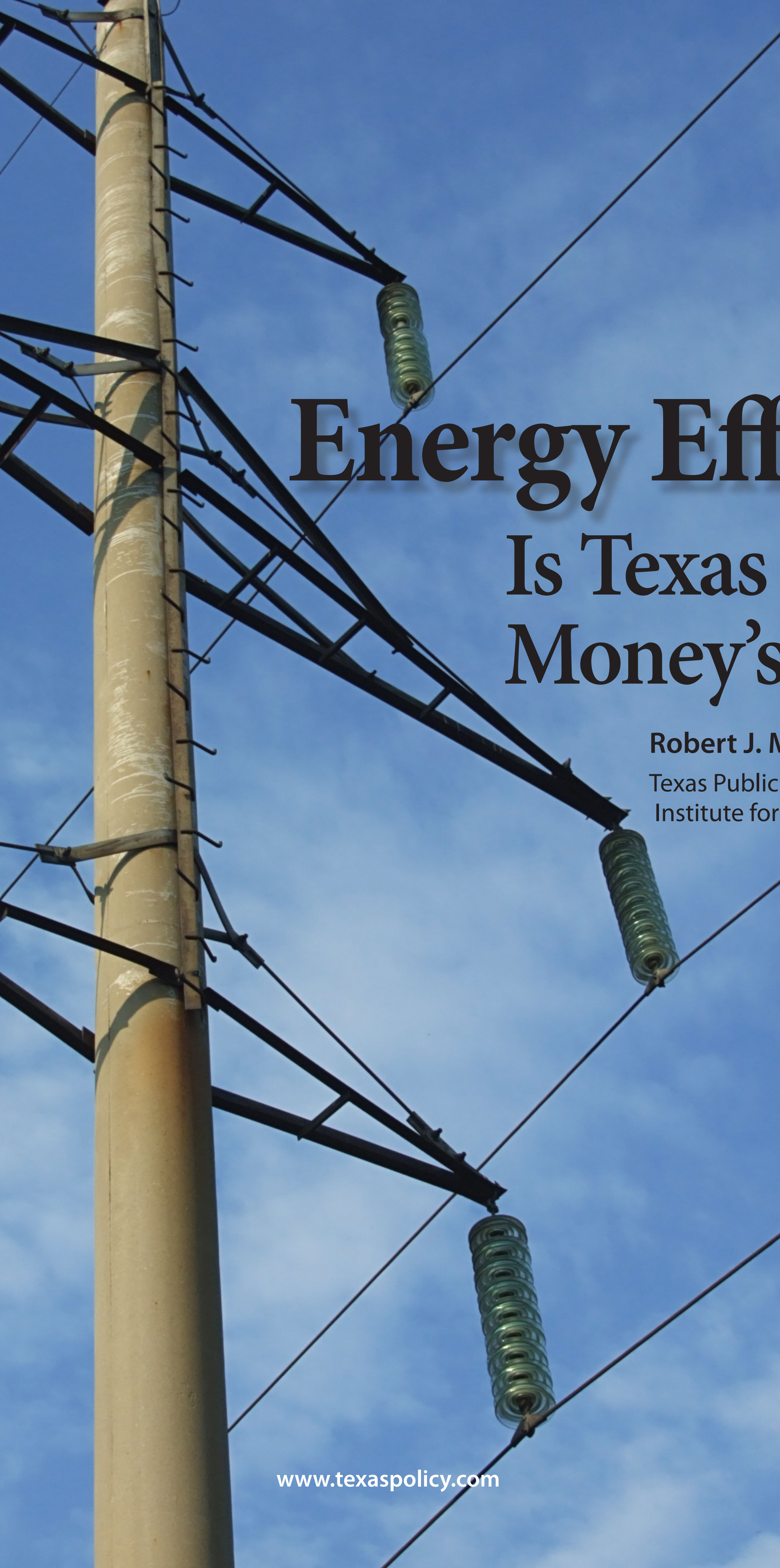

Energy Efficiency:
Is Texas Getting Its Money's Worth?

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When reasonable assumptions are applied to the Public Utility Commission's data, the potential returns of Texas' energy efficiency program range from 86.3 percent to -11.3 percent. There is simply no way, given the existing data and the methodology employed by the PUCT, to properly determine the efficiency—or inefficiency—of the state's energy efficiency program.

Executive Summary

Since 2002, Texas consumers have paid $591.1 million to support the state's energy efficiency program. The 2009 costs totaled $104.8 million, and the program's estimated cost for 2010 is $114.8 million.

A proposal before the Public Utility Commission of Texas (PUCT) raising the state's energy efficiency goals would dramatically increase these costs. Estimates show the average annual cost of the proposal over the first four years to be $297 million, with a total cost to Texas electricity customers during that span of $1.2 billion. Beginning in 2015 the estimated annual cost would climb to $462 million. A separate proposal to cap the costs would limit the costs to $229 million annually.

Are Texans getting their money's worth for this program?

Energy efficiency has traditionally been about making energy less expensive to use. The public benefit of energy efficiency is that we are able to use more, less-expensive energy that in turn produces greater economic growth.

However, today's government-mandated energy efficiency programs are generally designed to *decrease* energy use. And, as described below, they often do this by *increasing* the cost of energy.

As this paper makes clear, the claimed returns from Texas' government-mandated energy efficiency program are highly speculative. It is even quite possible that those returns are negative, i.e., that the energy efficiency programs are not energy efficient because the full costs of the programs are ignored while the benefits are overvalued.

For instance, the full costs of a project are the sum of those for the utility's incentives and administration of the program, and those incurred by the customer who makes the subsidized efficiency investment. An investment that is made by the customer and incentivized by the utility may still fail to pass a cost-benefit test. For instance, an investment whose actual cost is $110 might save future power costs of $100, and allow the utility to give the user $50 (the incentive percentage allowed for residential and small commercial customers). The user happily pays the remaining $60 to save $100 on its power costs. Under the PUCT's calculations, the utility reports that its $50 investment has passed the test by saving $100 of power. Society, however, has spent $110 in order to buy only $100 of power savings.

Additionally, the benefit side of the PUCT's calculations assumes a value for capacity saving which is difficult to reconcile with the actual cost of being able to obtain capacity under the institutional conditions that prevail in Texas. Thus absent further information, the PUCT's evaluation methods virtually guarantee that program benefits will be overstated and costs will be understated. Attaching reasonable values to these amounts can under some assumptions turn seemingly glowing estimates of the program's benefits into losses that are ultimately borne by ratepayers.

Without the appropriate data and methodology, any enthusiastic claims of energy efficiency for the Texas program, i.e., reducing the amount of energy used without raising its costs, are little more than conjectures. This study reinforces this conclusion. When reasonable assumptions are applied to the PUCT's data, the potential returns range from 86.3 percent to -11.3 percent. There is simply no way, given the existing data and the methodology employed by the PUCT, to properly determine the efficiency—or inefficiency—of the state's energy efficiency program.

It is quite possible that the returns of the program are negative. If so, legislative or agency increases to the state's energy efficiency goals will result in a subsequent decrease in economic growth.

Whatever the cost-effectiveness of energy efficiency programs similar to Texas' might be when located in another state, they will probably be less efficient in Texas' competitive markets. Texas' program is poorly designed to work within the successful framework of the restructured market in which it has been implemented. It is like trying to fit a square peg in a round hole.

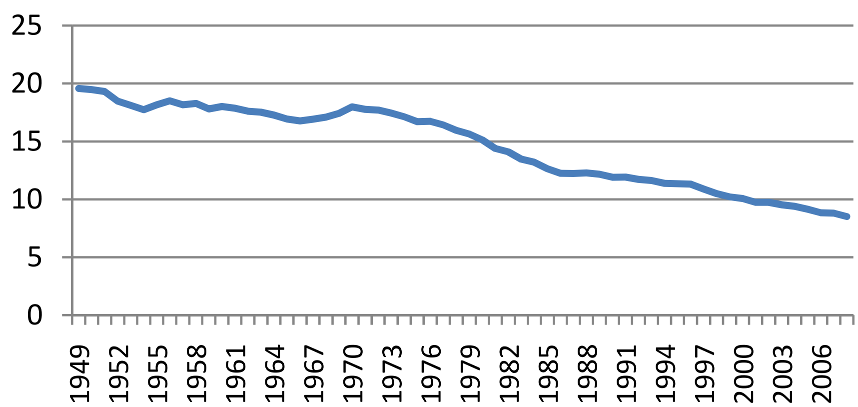
What is Energy Efficiency?

Efficiency in electricity use has occupied a curious intellectual and policy niche. Experts of almost all political persuasions generally agree that, at least in theory, competitive markets offer incentives to behave in economically efficient ways—to put scarce resources to their most valuable uses, and to invest and innovate so that we can best cope with likely future scarcities.*

Along those lines, it is clear that energy efficiency has greatly benefitted society and has been a key part of economic growth throughout the world, especially since the advent of the industrial revolution. And most of these gains from energy effi-

Figure 1: Energy Consumption per Real Dollar of GDP

(Thousand BTU per Chained [2000] Dollar)



Sources: U.S. Energy Information Administration

* There is evidence that inventive activity moves toward activities in which it can make the greatest contributions to the saving of costs. See Richard Newell et al, "The Induced Innovation Hypothesis and Energy-Saving Technical Change," *Quarterly Journal of Economics* 114 (Aug. 1999) 941-975.

> The reason energy efficiency has been so successful is because it has been market-driven.

ciency have obviously come prior to today's government-mandated energy efficiency programs.

The reason energy efficiency has been so successful is because it has been market-driven. In other words, the natural workings of society—without the assistance of government—have led to fewer units of cheaper energy being used in any particular effort, system, or activity.

The end results of energy efficiency are two-fold. First, it has resulted in fewer units of energy needed to produce the same unit of output. This is referred to as energy intensity or economic efficiency. **Figure 1** demonstrates this. It shows that the BTUs needed to produce one dollar of U.S. Gross Domestic Product (GDP) decreased 56.46 percent from 1949 to 2008.

Second, not only has energy efficiency led to more output from the same amount of energy previously used, it has led to the use of more energy to produce even greater output.

The effects of energy efficiency can be seen in the popularity of coal in 13th century London. Why was coal so popular? Because it was cheaper and more efficient than wood from the King's forests. So while the nobles didn't like the coal soot falling on their fineries, the general population of London was warmer and wealthier as a result.

Energy efficiency has traditionally been about making energy less expensive to use. The public benefit of energy efficiency is that we are able to use more, less-expensive energy that in turn produces greater economic growth.

However, today's government-mandated energy efficiency programs are generally designed to *decrease* energy use. And, as described below, they often do this by *increasing* the cost of energy. This could well be the case in Texas. If so, legislative or administrative changes designed to increase the state's energy efficiency goals will result in a subsequent decrease in economic growth.

Energy Efficiency Policy in Texas Today

Since 2002, Texas consumers have paid $591.06 million to support the state's energy efficiency program. The 2009 costs totaled $104.8 million, and the estimated cost of the program for 2010 is $114.8 million.

Are Texans getting their money's worth for this program?

The success of Texas' current policy toward energy efficiency must be examined in the context of its uniquely successful restructuring of its electricity market. The effort has resulted in highly competitive wholesale and retail electricity markets. End-users of all sizes have at their disposal a large number of competitive 'retail' suppliers, who offer a wide menu of pricing and risk choices. At the same time the state's retailers can contract with a large number of generation owners for the power supplies that they will distribute, or they can choose buy or sell energy in short-term markets. The Electricity Reliability Council of Texas (ERCOT) dispatches most of the state's generating capacity reliably, and the construction of new powerplants has kept up with demand for power.

Texas' basic restructuring statute, known as Senate Bill (SB) 7, became law in May 1999. In addition to establishing the institutions that underlie the new markets, SB 7 set a "Goal for Energy Efficiency" applicable to all Transmission and Distribution Utilities (TDUs) in ERCOT.[1]

Implementation of the goal would bring annual reports from utilities to the Public Utility Commission of Texas (PUCT) on their success in meeting numerical measures of those goals. As retail competition evolved, SB 7's program would come to subsume utilities not in ERCOT, including El Paso Electric Company and Entergy Texas.*

In 2007, House Bill (HB) 3693 required each utility under PUCT jurisdiction to institute efficiency and demand-side management (DSM) programs sufficient to offset 10 percent of its 2007 growth in the peak load (sometimes referred to as "demand" or "peak demand") of residential and commercial customers. The percentage would grow to 15 percent of 2008 peak demand growth by Dec. 31, 2008, and 20 percent by Dec. 31, 2009.† The demand reductions are to come from utility-initiated "Standard Offer Programs" (SOPs) applicable to individual classes (e.g., residential and small commercial) of customers, and from "market transformation programs" (MTPs) aimed at reducing market barriers for energy efficient technologies and practices. The PUCT also required each utility to offer an SOP for "Hard-to-Reach" customers, described as residential users with annual household income at or below 200 percent of the federal poverty level. Under its SOP a utility can offer rebates to contractors who provide energy-saving equipment (insulation and appliance swapouts) or services (e.g., duct cleaning and sealing), as well as other programs. There are limits on funds that utilities may spend on the programs, but none has yet reached them.‡ Subject to PUCT approval, utilities can recover their expenses on these programs and collect them from all of their ratepayers. HB 3693 also specified that the PUCT conduct a utility-funded study on the future potential of energy efficiency. The study, performed by metering and consulting firm Itron, would among other things determine whether improvements in efficiency could lower annual demand growth by 30 percent in 2010 and 50 percent in 2015.[2]

The PUCT recently proposed rule amendments to dramatically increase the scopes and targets of its efficiency programs. Specifically, in 2012 utilities would be required to cut annual demand growth over the past year by 30 percent. In 2013, the mandated reduction would be the larger of 40 percent of annual demand growth or 0.7 percent of peak load. For 2014 and each year after it would be the larger of 50 percent of demand growth or 1.0 percent of peak load.

Table 1 shows several estimates of the cost of proposals before the PUCT. The first three rows estimate the cost of the proposal mentioned above. The average annual cost of the proposal over the first four years is $297 million. The four year total cost of the proposal on average is $1.18 billion, an increase of $728 million over the existing program. Beginning in 2015 the average annual cost would be $462 million. It is estimated that consumers would directly pay about $257.1 million of this annual cost, while commercial users would pay approximately $204.9 million.§

Supporters of the proposal, such as the American Council for an Energy-Efficient Economy (ACEEE), claimed that Itron had shown that these goals were feasible, and that the costs of achieving them were reasonable relative to the saving in generation and energy costs that would be achieved.[3] Others, including EUMMOT, the utility companies' marketers' association, pointed to what they claimed would be massive increases in costs stemming from the seemingly reasonable figures in the proposal.

* PUCT Substantive Rules §25.181. Municipal and co-operative utilities are largely beyond the reach of state law. Large systems such as those in Austin and San Antonio, however, have instituted their own efficiency programs.

† PUCT Substantive Rules § 25.181 and § 25.183, implementing Public Utility Regulatory Act § 39.905. Demand and energy growth are calculated on the basis of the past five years' averages.

‡ Funding in 2008 could not be over 175 percent of the 2007 figure, and funding in 2009 could not be over 250 percent of 2007.

§ These numbers are derived from calculations in the REP Coalition filing in PUCT Project 37623.

Table 1: Estimates of Proposals Pending at the PUCT (in $ millions)

	2012	2013	2014	2015	Totals
EUMMOT Low Scenario	$106	$181	$219	$361	$867
EUMMOT High Scenario	$150	$311	$383	$681	$1,525
REP Coalition	$200	$287	$344	$344*	$1,175
Capped Proposal†	$172	$229	$229	$229	$859

Sources: Filings in PUCT Project 37623[4]

For the three largest systems, required demand reductions between 2012 and 2014 would have increased from 277 to 390 percent of their previous requirements, a figure they claimed would be unconscionably high for consumers and violate legal constraints on allowable size of energy efficiency budgets.[5] Even efficiency advocates noted that Texas had already made progress, in part as a result of market forces rather than regulation. The ACEEE found the state 22nd in efficiency per capita in 2006, highly ranked on demand-side management, and fourth in overall savings from energy efficiency. Despite these achievements (largely achieved in the absence of regulatory compulsion), ACEEE sees much room for further improvement.[6]

Does Government-Mandated Energy Efficiency Work in a Competitive Market?

For the last century or so, electricity markets in the U.S. have been operated as government-mandated monopolies. While the deregulation movement of the 1990s began to make some changes in this, only Texas can claim competitive, price deregulated wholesale and retail markets. The ACEEE figures show that competition and energy efficiency can coexist, quite possibly to the benefit of both.

As one example, the South Texas Nuclear Project is a two-unit power plant notorious for its cost overruns. Of course, many of these cost overruns were caused by the federal and state regulatory apparatus—and its manipulation by opponents of nuclear energy. But the cause of the overruns is not important here. What is important is that prior to the advent of competition, every consumer whose utility had chosen to purchase power from the South Texas Project had no choice but to bear a portion of these overruns.

The South Texas Project has applied to build the first new nuclear power plants in the U.S. in nearly three decades. But unlike consumers from the 1980s, today's consumers won't be taking on the risk of cost overruns. In fact, they won't be taking any risks at all. Once the new nuclear plants are complete, the price of the electricity sold from the plants will be determined by market forces. If the price is higher than the cost of the electricity, the plants will be profitable. If not, the plants will lose money. But it is the investors—not consumers—who will bear that risk.

* The Rep Coalition estimate ran only through 2014. The 2014 number is replicated here for 2015 for the purpose of comparison.

† The capped proposal would limit the cost increases to 150 percent and 200 percent of the 2010 costs in 2012 and 2013, respectively.

In the first instance, the two units were built by investors who bore very little price risk on their investment. Cost, while important, was secondary to ensuring that the cost was recovered through the rate-of-return price calculations at the PUCT. But for these new units, investors will bear all of the price risk. Therefore, cost becomes all important to the investors—the same companies/people that are building the units. This raises the question: Which units will have been constructed in the most energy and cost efficient manner, i.e., which units will produce electricity at the lowest possible cost? The answer is self evident.

The structure and the incentives of Texas' government-mandated energy efficiency program are very different. The costs of a typical efficiency program are borne, at least in its earlier years, by ratepayers who pay surcharges to fund incentive payments that will lower the demand and energy costs of other ratepayers. If events unfold as planned, those ratepayers will escape paying for future generation investments that would have otherwise been necessary to meet load growth. However, this reasoning presupposes a utility system which is under traditional cost-of-service regulation. A vertically integrated utility without efficiency programs would need to build additional generation to meet load growth, and its costs would be factored into ratepayers' bills. Assuming that the efficiency programs work as intended, ratepayers can be certain of getting the lower rates that result from investments that the utility does not have to make.

Transmission and Distribution (T&D) utilities in Texas, however, operate very differently. They no longer own generation and are not responsible for constructing it to meet anticipated load growth. Instead, generators are built by unregulated entities. They compete to form contracts with retail electric providers, who themselves compete for the business of final consumers. The generators sell some of their energy into short-term markets such as those for balancing and ancillary services, and retailers obtain their residual supplies at prices determined in those markets. Efficiency programs in Texas do not operate under a "regulatory compact," where consumers who pay for the programs have assurance that they will enjoy the future savings from avoided generation investments. Generators are built by entities that are not under cost-of-service regulation, and their incomes depend on their abilities to form long-term contracts and strategize in short-term markets. Ratepayers do not pay for their losses, but also have no entitlements to their profits.

The rationale for a competitive generation market is that producers will innovate and compete for wholesale customers, which drives down profits and prices. As competitive retailers buy and resell that power, consumers' rates will probably fall. But that drop in rates is no longer the certainty that it would have been if the same generation had been built under regulation. Market conditions can leave consumers paying more or less than the costs of that generation, and generation owners taking the corresponding profits or losses. In the long term the outcome will likely be superior to that of a fully regulated system, but there is no guarantee that the consumers who paid the efficiency surcharges will reap commensurate savings in their bills.

As this paper makes clear, the claimed returns from Texas' government-mandated energy efficiency programs are highly speculative. It is even quite possible that those returns are negative, i.e., that the energy efficiency programs are not economically efficient. But whatever the outcomes of mandated efficiency programs elsewhere, it is clear that they will be even less efficient in Texas' competitive markets. Texas' program is poorly designed to work with the market structure in which it has been implemented. It is like trying to fit a square peg in a round hole.

Are "Market Failures" and "Market Barriers" Really Barriers to Energy Efficiency?

An articulate fringe of scholars and consultants argues that the American economy can save much more energy than it currently does, and that doing this offers high returns to businesses that take advantage of the opportunities. A typical recent statement of this view comes from consulting firm McKinsey & Company. McKinsey reported that by 2020 the U.S. could reduce annual energy consumption by 23 percent by deploying currently economic technologies and implementing effective conservation policies. McKinsey claims that its recommendations are sound investments that more than cover their cost of capital, and one would normally see businesses taking these opportunities and pocketing the profits. Their explanation for such seemingly irrational behavior centers on certain market "failures" or "barriers" that discourage businesses from making the necessary purchases and commitments.[7] Similarly, the ACEEE (financed by pro-conservation organizations and financially interested businesses) offers a similar promise on its home page. It claims there are cost-effective policies that could reduce 2020 U.S. energy consumption to 93 percent of its 2002 value. Absent these policies, consumption in that year will be 130 percent of its 2002 level.[8] When the PUCT suggests mandatory programs to reduce demand for energy, it is implicitly aligning itself with these viewpoints. Our question is whether that alignment is justified.

"Market failure" is the economist's term for a situation in which prices do not "work," i.e., they could encourage households and businesses to make inefficient choices. In theory, and possibly in practice, market failure could serve as a rationale for governmental interventions such as the efficiency programs under study here. Here the most important market failures are those that involve "externalities" of electricity production and consumption. Advocates of intervention basically claim that market prices do not measure the full costs of electricity (including pollution, resource dependencies, etc.). If true, policies such as incentive payments for efficient appliances and construction that reduce power consumption could in principle remedy the market failure. Likewise, "rebounds" that might undo the effects of an efficiency program by inducing consumption of more energy are sometimes viewed as market failures, but they more likely tell us that markets are functioning well. Finally, some "failures" are not failures at all, but are rather evidence that policy makers have preferences that differ from those of the public in whose name they make policies.

The claimed returns from most government-mandated energy efficiency programs are highly speculative.

"Market barriers" stand alongside market failures as possible obstacles to efficiency, a variety of phenomena with a common element: they lead people to purchase lower levels of efficiency than some believe are in their best interests. One set of barriers stems from regulation, which often misprices electricity (at average rather than marginal cost) and thereby discourages some economically warranted investments in efficiency by users. Other alleged barriers reflect misunderstandings about markets. In a popular example, a building owner may pay the power bills for all of its tenants from a single meter, or tenants may be separately metered and pay their own bills. Efficiency advocates see the first arrangement as a source of economic inefficiency, but such is not necessarily the case because property markets capitalize the values of saved electricity into the prices of buildings. The hesitance of consumers to purchase efficient appliances or building designs have also been seen as market barriers, but choosing to adjust over a longer horizon is often more economically efficient than quick adjustment.

Barriers are not market failures and are not necessarily rationales for government intervention. A current situation attacked as energy inefficient by critics could well be the most economically efficient solution available given technology and other factors existing at the time—and no amount of government intervention can change that fact. The following sections examine issues related to "market barriers" where advocates of energy efficiency often call for government intervention.

The Knowledge Problem

In some instances characterized as market barriers the issue is less efficiency than it is paternalism. A well-documented barrier to efficiency is consumers' alleged inability to properly calculate the present values of their future savings from purchasing efficient appliances, which provides a rationale for mandating more energy-efficient designs. If the premium on (e.g.) an energy-efficient refrigerator pays for itself in lower power bills over a short period, interventionists argue that design mandates that force consumers to purchase efficiency are really in the consumers' best interests. In reality, the economics of option values shows that choosing a less efficient refrigerator can often be a more rational decision than choosing a more efficient one. Unless it is made by flipping a coin, a person's decision on an efficiency investment (an Energy Star refrigerator or a less miserly one) requires a forecast of energy prices. However, official (and unofficial) forecasts of energy prices are often far off the mark, and efficiency mandates may only be worth their costs if those prices turn out to be high.

Some forecasts are better than others, and some magnitudes (near-term weather) are easier to forecast than others (GDP in 2024). The reality is that if a decision has future consequences, one cannot avoid making a forecast. It can be the output of an elaborate computer model, a survey of professionals, or an unquantifiable but strongly held gut feeling. But more information is not necessarily better. For four decades the U.S. Department of Energy has constructed ever more complex models to predict demands, supplies and prices. The most recent version of its National Energy Modeling System (NEMS) forecasts literally hundreds of numbers, with 3,500 pages of documentation. That model's predictive abilities have, if anything, fallen with time, and similar models have done no better.[9*] Undoubtedly this reflects our thin knowledge of important facts and our occasional neglect of basic economics.

For instance, changed policies can substantially alter market conditions and render earlier predictions worthless. Concern over dwindling gas supplies ended with a 1985 Federal Energy Regulatory Commission order that decontrolled prices and spurred extensive and successful exploration efforts. Likewise, models cannot predict new technologies such as hydraulic fracturing of gas shales, which over the past three years has raised the lifespan of America's gas reserves from decades to centuries.

This lack of foreknowledge by both consumers and experts shows that attempts to justify governmental intervention to achieve greater electrical efficiency should be carefully scrutinized. Those who claim benefits from intervention often fail to acknowledge the benefits of allowing consumers to make their own choices. Consumers will sometimes make mistakes, but so will a government agency that makes choices for them, particularly if the government's employees do not directly bear the costs of their

[*] From the 1960s through the 1980s, such models consistently overestimated both U.S. and world energy consumption by factors ranging from 10 to 200 percent.

errors. People make more complex and far-reaching choices about financing homes and cars than about energy-efficient appliances, yet most peoples' presumption is that government's role in the former two should be largely restricted to providing information and protection against fraud. On both economic and philosophical grounds, the burden of proof should rest with those who favor efficiency-related interventions in markets for energy.

Costs of Adjustment

Consumers (and businesses) do not respond to price changes overnight. The costs of information and adjustment make such delays rational, but some energy efficiency advocates see them as evidence of inefficiency and possible market barriers. Most consumers will only learn about a higher electricity price (or a lower one) when they see it registered on their bills. Detailed reading of a higher bill is necessary for one to distinguish whether it reflects a higher price per kwh or higher consumption at the same price. Even if the per kWh price is higher this month, delayed response may rational. Most utility bills automatically pass through fuel costs, whose fluctuations may not mean permanent change.

Purchasing energy efficiency seems like a good way for consumers to lessen the problems caused by rising and volatile prices, but in reality it has a cost. Assume that the long-term trend of energy prices is generally upward, with a relatively slow average growth rate and substantial random deviations (both upward and downward) every year. This fact would not deter investment in energy efficiency, assuming that if price turns out low and efficiency has little value the investor can costlessly withdraw his funds and put them into a safe alternative. Unfortunately many energy efficiency investments are in large part irreversible—if the next few years of prices turn out low, someone who bought an energy-efficient refrigerator takes losses because he cannot recover his funds and

Barriers are not market failures and are not necessarily rationals for government intervention.

transfer them elsewhere. Irreversibility and randomness of prices mean that there is an "option value" if an investment can be deferred until some uncertainty has resolved itself.

Assume that a low energy price next year means that prices over the future will be lower (on average) than if price is high next year. Investing immediately means taking a long-term loss if price is low next year, relative to the longer-term gains if next year's price is high. If I have the option to delay the investment a year I will learn whether prices farther into the future are more or less likely to remain high. If both this year's and next year's prices turn out high, I can invest more confidently in efficiency with that information, because under economically plausible conditions, these facts tell me that energy prices over the longer future will also be high. If next year's price turns out low, I will be able to avoid the loss I would have taken on an immediate efficiency investment and can instead keep my funds in the alternative investment.

Looked at from today, an investment in efficiency produces returns in two ways. First, if made immediately it produces an income (energy cost savings) stream, which could be either high or low. Second, if I make the investment immediately I lose a valuable option to delay it a year until some uncertainty is resolved. If the resolution is adverse for the efficiency investment (i.e., energy prices are low) I can put my funds elsewhere, and if it resolves itself favorably (energy prices are high), I invest a year later and earn high returns with certainty. The option to defer an investment allows a person to earn higher returns because he can avoid being locked into an unfavorable situation. The expected energy saving from buying the efficient refrigerator today will have to be greater than otherwise to induce me to give up the option to delay investing. This is, however, equivalent to saying that irreversibility and option value make my required return on an immediate investment in efficiency higher than if the option value does not exist.* If the refrigerator does not earn me a high enough return in saved energy, I will choose not to buy it today. Plausible data and assumptions allow us to calculate the critical "hurdle" return that will induce immediate purchase. One set of data for refrigerators shows that this rate is approximately 2.5 times higher than the interest rate that should be used to discount future costs and benefits if we disregard irreversibility and option value, i.e., if the best reversible alternative investment yields 10 percent, the actual return on a more efficient refrigerator must be at least 25 percent.†

Delays in investment that reflect option value are economically efficient. Once an irreversible investment has been made, most or all of the resources embodied in it cannot be recovered and used to create value elsewhere. An option to delay investment makes us more certain that the outcome will be productive, creating economic benefits that are likely to outweigh the saving from any decrease in energy consumption that an earlier investment would have produced. Mandatory efficiency standards in effect require people to make premature investments that have a higher probability of not covering their costs. Just as importantly, those standards will in part be based on government price forecasts whose record of accuracy has been minimal.‡

Yet even once a consumer concludes that price is higher for the long term, there are additional adjustment costs to be considered. The first is for information about possible adaptations. One faced with a higher power price can change energy sources (gas in applications that heat), purchase more efficient electric appliances, or adjust consumption of non-electrical goods (users of electric heating can purchase insulation or heavier clothing). The second cost is that of a quick changeover. Because appliances are durable, slow adjustment may be best. The consumer does not aim to minimize the cost of power used, but rather to minimize the total (present value) cost of the services—cooking, dishwashing, etc.—that power produces. Choosing when to make the changeover from old appliances to new requires balancing the costs of continuing to operate the former against the capital and operating costs of the latter. A regulation requiring more energy-efficient appliance designs does not change the basic logic of this decision, but could result in either an advance or delay of the changeover date, depending on details about its cost and energy consumption.

* An introduction to the algebra of option value appears in Robert Michaels, *Transactions and Strategies: Economics for Management* (Cengage Learning, 2010) 481-483.

† Metcalf and Rosenthal, Op. Cit., 528 estimate an annual decline in refrigeration costs between 1978 and 1993 of 4.4 percent per year. 1.6 percent of that was decreases in the price of refrigerators, and the remaining 2.8 percent was due to greater energy efficiency.

‡ There are other economic models that suggest the rationality of deferring investments in energy efficiency. Sutherland (*Op. Cit*., 26) relies on a capital asset pricing model. In that model, investments in energy efficiency are but one of many that can be in someone's portfolio, and the correlation of energy cost savings with market returns will mean that efficiency investments will only be made if their returns are substantially above market levels. Metcalf and Rosenthal (p. 524) point out a possible problem with this approach, namely that stock prices are negatively correlated with most energy prices, in which case efficiency investments should be made, even if their rates of return are below those of the market.

Capitalization and Construction

Owners of buildings have incentives to maintain them and make investments that increase their values. Some of these investments conserve energy (double-glazed windows, compact fluorescents in hallways) and others use it. The advent of inexpensive air conditioning in the mid-twentieth century made retrofits by owners of older buildings a commercial necessity if they were to compete for tenants against newer ones. Both the energy-using and energy-saving measures carry returns that owners can see as increases in the market value of their properties. The properties are sources of long-lived income streams, whose annual values increase as a result of these investments are made in them. Air conditioning increases net income because tenants are willing to pay more, and conservation retrofits do likewise by reducing operating costs.

There is abundant evidence that economically efficient energy-saving investments more than recover their costs as increases in the values of buildings while unimproved structures sell at discounts.[*] Home prices increase by an average of $10 to $25 for every $1 decrease in energy bills.[†] However, some efficiency-related investments will and should go unmade because they do not return enough savings to cover their costs, including interest (see below). If made, they would be a waste of the world's scarce resources. Assertions that landlords will not make efficiency investments in buildings they do not occupy are really claims that tenants have no sensitivity to rents.[‡] Energy efficiency advocates sometimes favor policies to further increase

The methods chosen to evaluate the benefits of the state's efficiency programs are such that any conclusions made using them are of little value for policy purposes.

investments in the efficiency of buildings by claiming that their "true" returns to society (for example, better public health due to reduced pollution from power generation) are greater than the savings to owners. But the search for widespread benefits is rarely matched by equal efforts to account for all costs.

It is Impossible to Determine Whether Texas' Energy Efficiency Program is Cost-Effective

There are frequent claims that programs operated under the state's existing energy efficiency rules are cost-effective. Their presumed success from 2001-2009 is used to provide justification for new legislation and rules that will increase efficiency and benefit the public. In reality, available data provide no such justification. While data that would allow such a determination may be available, it is not currently collected, and what data is available is insufficient for drawing any useful conclusions. Even if such data were available, the methods chosen by the PUCT to

[*] Texas Comptroller of Public Accounts, "The Home Energy Efficiency Report 2008," 15. 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," University of California Energy Institute CSEM Working Paper No. 192, Aug. 2009.

[†] Ruth Johnson and David Kaserman, "Housing Market Capitalization of Energy-Saving Durable Good Investments," *Economic Inquiry* 21 (July 1983) 374-386; Rick Nevin and Gregory Watson, "Evidence of Rational Market Valuations for Home Energy Efficiency," *The Appraisal Journal* 66 (Oct. 1998) 401-409.

[‡] For one type of property, energy-saving investments are not associated with occupancy by the owner. Sutherland (*Op. Cit.* at 15) cites federal surveys showing that the percentage of commercial rental buildings with shell conservation features was the same (66%) for those that were absentee-owned as for those that were partially occupied by their owners.

evaluate the benefits of its efficiency programs are such that any conclusions made using them would be of little value for policy purposes.

There are a number of generally accepted methods that regulatory agencies use to evaluate the outcomes of their demand-side management (DSM) and efficiency programs. The so-called Total Resource Cost (TRC) test is probably the closest in principle to a correct balance of costs and benefits, because it ideally measures both sides of that equation. Its disregard of transfers from payers of higher bills as incidental may be strictly correct as economics, but it can also disregard the political realities of how the burden of providing efficiency is to be allocated. Hence other tests such as the Ratepayer Impact Measure (RIM) evaluate such programs favorably to the extent that there are no losers who will suffer higher bills as a result of the policy. The RIM test has less economic logic than the TRC test, and measures that pass the latter often do not pass the former. In nearly all states, however, TRC or RIM is the policy test of choice.

In Texas this is otherwise. Texas is almost alone among the states in using a "Program Administrator Cost Test" (PACT) to evaluate its efficiency programs (here the program administrator is the utility itself). The California Standard Practice Manual, used as a reference in many other jurisdictions, sees essential flaws in the PACT.[10] Benefits of a program or project under PACT are, as in Texas, the avoided supply costs of energy and capacity. Instead of being the total of opportunities that society foregoes, however, costs under PACT are only the administrative costs incurred by the administrator (again, the utility), incentives paid to the customers, and possible increased supply costs for periods in which load is increased.[*] The California Manual is explicit about the weakness of such a program: "By defining device costs exclusively in terms of costs incurred by the administrator, the [PACT] results reflect only a portion of the full costs of the resource."[11] In short, Texas uses an incorrect test to evaluate its efficiency program, and its bias is entirely in one direction—toward acceptance of projects because their costs are uniformly understated.

The result of this is that, taken at face value, the figures produced in support of the state's energy efficiency program are remarkable. Producing Oncor's goal amounts summed over the eight years would have cost the utility $1.151 billion using the PUCT's assumed figures for avoided cost. The company, however, more than met its demand reduction goal, nearly met its energy reduction goal, and did so at a cost of only $346.9 million. The cost it incurred to achieve these outcomes was only 30 percent of its cost of building the same amount of capacity and producing the same amount of energy. Seven of the remaining eight utilities spent even smaller percentages of that cost. The utilities as a group achieved a weighted average of $2.44 in net savings, and none got less than $1.76. On the surface, efficiency looks like a great bargain. Going deeper, the outcomes may be less favorable than at first glance.

Given the PUCT's calculation methods—what it includes and excludes, it appears quite possible that some costs of the programs have been understated or some benefits overstated. Table 1 shows the extreme variability of possible returns when corrections are applied to the program data.

[*] Texas gives little consideration to the latter. If an efficiency program leads some customer to use less electricity but switch to some other fuel for its energy needs, the latter is not considered as a cost of the program.

Table 2: Net Savings of Texas' Energy Efficiency Program Under Various Corrections to the Data

Net Savings per Dollar Spent as Reported	Net Savings if: 33% Free Riders 0% Customer Cost 100% Capacity Value	Net Savings if: 33% Free Riders 25% Customer Cost 100% Capacity Value	Net Savings if: 67% Free Riders 25% Customer Cost 100% Capacity Value	Net Savings if: 33% Free Riders 25% Customer Cost 0% Capacity Value	Net Savings if: 50% Free Riders 25% Customer Cost 0% Capacity Value	Net Savings if: 50% Free Riders 25% Customer Cost 50% Capacity Value
244.22%	137.40%	86.30%	-7.00%	18.40%	-11.30%	14.20%

Source: Authors' calculations

Free Riders

The benefits of the state's energy efficiency program may be overstated by a failure to consider free riding. Assume that $1 of utility expenditures produces $2 of gross benefits, i.e., the net return on a dollar spent is another dollar, or 100 percent. A 33 percent free rider rate, plausible in light of California survey data[12*] and the Itron report,[13] means that the dollar actually buys only $1.33 of benefits, because the other 67 cents of them (33 percent of the total) would have occurred absent the program.[†] Assuming a 33 percent free rider rate, the second column on the second page of Table 3 shows that the statewide weighted average return on a dollar of incentive payments (over the lifespan of the program) falls from 249 percent to 133 percent, i.e., a dollar spent returns its own value plus $1.33 in benefits.[‡] (Other assumptions in the headings are discussed below.) The weighted average of benefit/cost percentages falls substantially but to a level that still appears to indicate success.

Customer Costs

Free riding is not the only factor that can bias the calculation. There are certain transaction costs borne by customers that should be included among the total costs of the program. If an incentive payment induces a customer to invest in an energy-saving project that would not have been undertaken absent the payment, the customer's expense is a cost of the program. The program takes resources from other valuable uses and diverts them to projects that are only undertaken because of incentive payments.[§] Before making any decision, a prospective participant bears the costs of informing himself about a project's existence, estimating its benefits to him, and choosing among and negotiating with competing contractors. The contractors likewise bear costs of publicizing themselves and administering their duties under the program. Costs of search and negotiation are also borne by both program participants and contractors who ultimately decide not to go beyond shopping and negotiation.

[*] The California Energy Commission's Database for Energy Efficiency Resources (DEER) includes summaries of virtually all free rider estimates made in the state prior to 2008.

[†] This is equivalent to saying that $2 of benefits actually costs $1.50 rather than $1.

[‡] The 100 percent difference between these and the figures on the Table reflects return of the principal used to make the incentive payments.

[§] This of course does not imply that such projects should never be undertaken, since those costs must be balanced against the benefits of saved capacity and energy. Isser (*Op. Cit.*, 57) uses unavailable New York data showing a co-funding ratio (i.e., multiple of the subsidy spent by the customer) of 2.74 for commercial customers and 1.99 for residential. Only some (probably) small percentage of these amounts will be associated with customer spending that only took place because incentive payments were offered.

There is a ceiling of 10 percent of total budget on utilities' costs of administering the program. Aggregating over all utilities over the life of the programs, these costs have been in practice taken up 8.9 percent of total budget. The actual transactions take place between contractors and businesses or homeowners, who in most instances find each other (e.g., via advertising) and agree on a price. The utility then handles the paperwork and measures and verifies the transaction's savings. These costs are lumped into utility expenditures on **Table 2**.

Transactions come in greatly differing sizes. As a representative example, AEP Central's 2008 Commercial and Industrial Standard Offer Program allocated $644,400 in funds (net of administrative cost) to 61 participants, for a per-transaction amount of $10,564. The corresponding figures for the 6,054 customers in its Residential and Small Commercial Standard Offer Program were $2,330,700 for incentives and $385 per customer. $980,400 was paid to 1,320 Hard to Reach participants, an average of $743 per customer.[14] Absent evidence to the contrary, assume that an additional 25 percent of incentive payments were spent by customers in transaction-related costs, including costs borne by those who ultimately did not engage in any transactions.[*]

Table 2 shows the effects of adding Customer Costs equal to 25 percent of the amounts spent by utilities.[†] The third column of Table 2 shows that including these costs and continuing to assume 33 percent free riders drives net benefits of the programs to 86.3 percent of the average dollar spent. Accounting for these two costs drives the raw 244 percent net return down to approximately one-third of its level. The benefits can be sensitive to alternative assumptions about free riding. The fourth column in Table 2 asks what happens if 67 percent of dollars spent on the programs go to free riders, while other assumptions of the third column continue to hold. (The California free-rider surveys have estimated similar percentages for programs aimed at businesses and building contractors.) The statewide net returns on a dollar of incentive payments now become negative, at -7.0 percent. Calculations for the individual utilities suggest other policy implications. For example, of the nine utilities, only CenterPoint and TNMP show positive returns under these assumptions. Considering the likely importance of free riders in the calculation of program benefits, it is odd that the PUCT has shown little interest in estimating their numbers.

Capacity Factors[‡]

The PUCT's measure of savings from its efficiency programs is the present value (with a ten-year horizon) of a gas-fired plant and the associated energy output that are rendered unnecessary by incentive payments. Under conditions that prevail in Texas, however, there are reasons to question full inclusion of the capital cost of an unbuilt generator in the savings. The inclusion is questionable because it does not consider alternatives whose cost is likely to be much lower than the cost of building the generator. A marginal generator such as a small gas-fired unit will run for only a few hours of the year, and only on peak days. On the supply side, if power is available from a large number

[*] There are no easily available figures on overall transaction costs in the economy. Wallis and North estimate that in 1970 the "transaction sector" accounted for 46 percent of Gross National Product. This definition, however, includes costs of financial and related services that do not apply in our case. John Wallis and Douglass North, "Should Transaction Costs be Subtracted from Gross National Product," *Journal of Economic History* 88 (Sept. 1988) 651-654.

[†] Utilities' administrative costs are already included in their expense figures.

[‡] This usage differs from the usual definition of capacity factor, which is a measure of the fraction of the time that a facility is actually used to capacity. The definition in the text is instead about the actual value of new capacity relative to its costs, given the alternatives that are available through markets or demand-side programs.

of sources, such as the many generation owners in ERCOT's competitive market, the benefits of the efficiency program should not include the saving of the full cost of unbuilt capacity, because energy will likely be available in the market at competitive prices when it is needed. Note, however, that even if the capacity has no value, the efficiency program may still produce savings in the form of energy that no longer needs to be generated or purchased.

On the demand side, developments in load management can also reduce or eliminate the capacity value of the saved generator, which will run only at extreme peaks. If other techniques or institutions are in place to shave these peaks the generator will be unneeded. Many such institutions exist or are on the horizon. Interruptible rates for large customers lower the value of seldom-used peaking generators because those customers can reliably cut their consumption when the need arises.*

Similarly, in Texas a growing number of large power consumers are under a program known as Loads Acting As Resources (LaaRs), standing ready to cut their consumption on short notice when requested to do so.[15] The future will likely see important developments in load management as smart meters are installed on the premises of virtually all end-users of power in Texas. The meters are expected to improve reliability and reduce operating costs, and some of them will also become parts of "Home Area Networks" (HAN) that will allow small users to better control their consumption. Changes in rate designs may further incentivize those customers by increasing their costs at system peaks and decreasing them when system load is low.

The capacity value of the generator that is "saved" under the PUCT's calculations may in fact be considerably less than its cost if there are accessible markets, economical load management, or other alternatives that could replace it. The energy saved by consumer investments in efficiency, however, is genuine—generation owners (and the end-users of energy they produce) will not need to consume the fuel and incur other costs they would have had to pay absent those investments. If the only real benefit of incentive payments is reduced energy production, the costs and benefits of Texas' efficiency program will be quite different. The fifth column of Table 2 shows the consequences of counting only energy saved ("0% Capacity Value") as a benefit and assigning no value to capacity. For the utilities as a group, as noted above, assuming 33 percent free riders, 25 percent customer costs, and assigning full value to capacity yields a net return of 86.3 percent on the average program dollar. Assuming the same free rider and customer cost percentages, but assigning a zero value to capacity reduces the net return to 18.6 percent.

The PUCT's omission of free riders, disregard of customer transaction costs, and questionable inclusion of the full value of saved capacity all have the same qualitative effects—to raise the calculated returns on incentive payments to levels in the realm of the astronomical. Including what may be reasonable values for those three factors reduces the returns on program spending to levels which are no more than commensurate with returns on relatively risky investments.

Critical Configurations of Cost Factors

The final two columns of the table illustrate the sensitivity of outcomes to assumptions about costs that the PUCT does not consider (also see Appendix 2). For example, the sixth column estimates the effects of 50 percent free riders, along with 25 percent customer costs and zero capacity value. A 17 percentage point increase in free riders changes the algebraic sign of the

* It is well known that the economically efficient rate design for interruptible customers generally includes only an energy charge and none for capacity.

There is simply no way, given the existing data and the methodology employed by the PUCT, to properly determine the efficiency—or inefficiency—of the state's energy efficiency program.

net returns (relative to 33 percent free riding), moving it from 18.4 percent to -11.3 percent. (Again, only two utilities earn positive returns.) The seventh column modifies the sixth by maintaining its assumptions of 50 percent free riders and 25 percent customer costs, but raises the capacity value of generation from zero to 50 percent. Doing so turns the former negative program-wide net returns per dollar (-11.3 percent) to a positive 14.2 percent.

Conclusion

Nowhere in utilities' annual reports to the PUCT is it possible to estimate how frequently the real returns on the subsidized investments are negative, nor how often they are positive. To our knowledge, neither the PUCT nor any utility has ever produced a survey of costs incurred by customers in making these investments. On the other side are customers who did not need a subsidy to induce them to make their investments in efficiency. Some would do so without the program, and others might strategically wait for subsidies that they in reality did not need. The best available results are probably those from the 2008 Itron survey, and they show over half of the efficiency investments that would have been made in a "base" incentives case would have occurred "naturally."[16] Without such data, any enthusiastic claims of energy efficiency, i.e., reducing the cost of energy use, are little more than conjectures.

This study reinforces this conclusion. When reasonable assumptions are applied to the PUCT's data, the potential returns range from 86.3 percent to -11.3 percent. There is simply no way, given the existing data and the methodology employed by the PUCT, to properly determine the efficiency—or inefficiency—of the state's energy efficiency program.

The PUCT has been at the forefront of state regulators who are trying to introduce competition and market choices into almost all aspects of electricity. Yet its efficiency program does not provide information about when interventions cease to be warranted and markets should be relied upon.

The PUCT is now in process of evaluating a massive increase in the scope of the program, and its evaluation materials are seriously inadequate absent estimates of capacity value, free ridership and consumer costs. Estimates of capacity value are integral parts of most utilities' planning procedures, but the Commission has yet to request reports on its real worth to them and ratepayers. Commissions like California's have performed extended research on free ridership and customer costs, but to our knowledge the PUCT has yet to venture into these areas, or to authorize utilities to perform their own research. The records of individual transactions that take place (and some that do not take place) under Standard Offers and Market Transformation Programs contain data of great value for estimating these critical factors. The proposals in this docket are likely to triple program budgets over the next three years and produce commensurate increases in consumer bills. The PUCT should not use the existing record to justify the additional costs it intends to impose on ratepayers. It must engage in further research that accurately accounts for the full costs and benefits of its programs before doing so. ✩

Endnotes

[1] Texas Public Utilities Code § 39.905.

[2] Itron, *Assessment of the Feasible and Achievable Levels of Electricity Savings from Investor Owned Utilities in Texas: 2009-2018* (23 Dec. 2008) ES-1. (Subsequently referenced as Itron Report).

[3] Electric Utility Marketing Managers of Texas; The REP Coalition; Chairman Smitherman Memo.

[4] Comments of the American Council for an Energy Efficient Economy, PUCT Docket 37623 (Filed 12 Mar. 2010) 2.

[5] Initial Comments of Electrical Utility Marketing Managers of Texas, PUCT Docket 37623 (Filed 15 Mar. 2010).

[6] R. Neal Elliott et al, "Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas' Growing Electricity Needs," ACEEE Report E073 (Mar. 2007).

[7] McKinsey Global Energy and Materials, *Unlocking Energy Efficiency in the U.S. Economy*, Exec. Sum., iv–xi.

[8] ACEEE's Energy Policy Program.

[9] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook Retrospective Review, Evaluation of Projections in Past Editions 1982-2006 (Sept. 2009). Vaclav Smil, "Perils of Long-Range Energy Forecasting: Perils of Looking Far Ahead," *Technological Forecasting and Social Change* 65 (2000) 262.

[10] California Energy Commission, *California Standard Practice Manual, Economic Analysis of Demand-Side Programs and Projects* (Oct. 2001) Ch. 5.

[11] California Energy Commission, 24.

[12] The California Energy Commission's Database for Energy Efficiency Resources (DEER), "NTG Lit Review Summary" (10 Oct. 2008).

[13] Itron, Inc., "Assessment of the Feasible and Achievable Levels of Electricity Savings from Investor Owned Utilities in Texas: 2009-2018" (23 Dec. 2008) 7-29 through 7-31.

[14] AEP 2009 Efficiency Report, 32.

[15] Grayson Heffner et al, "Loads Providing Ancillary Services: Review of International Experience," Lawrence Berkeley National Laboratory, LBNL 62701 (May 2007).

[16] Itron, Inc., 8-8 and 8-10.

Appendix 1: Projected and Actual Demand and Energy Reductions, 2002-09, by Utility

	Projected Peak Demand Reduction (MW)	Actual Peak Demand Reduction (MW)	Difference	Projected Energy Saved (MWh)	Actual Energy Saved (MWh)	Difference	Amount Spent
AEP Central	109	90	-19	322,943	263,136	-59,806	$52,901,392
AEP North	15	16	1	47,986	55,476	7,489	$9,792,835
CenterPoint	258	355	97	689,385	796,576	107,192	$109,203,802
El Paso	14	11	-3	52,527	40,102	-12,425	$7,201,577
Entergy	53	49	-5	184,039	129,563	-54,476	$29,531,920
Oncor	678	734	56	1,965,885	1,858,120	-107,765	$346,929,018
Swepco	29	26	-3	83,359	95,998	12,639	$14,370,746
SPS	21	24	2	96,215	76,209	-20,006	$13,604,834
TNMP	21	21	0	59,721	47,273	-12,448	$7,527,074
TOTALS	**1199**	**1326**	**127**	**3,502,060**	**3,362,454**	**-139,606**	**$591,063,198**

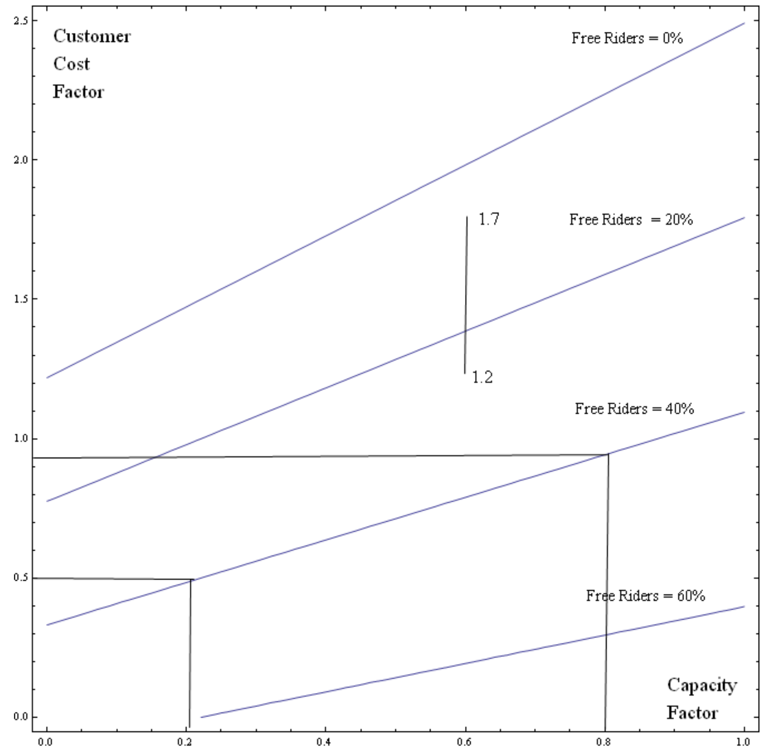
Appendix 2: Examining the Dependence of Returns on Definitions and Assumptions

It is easy to estimate the effects of alternative changes in the free riders, customer costs and capacity factors, but we can generalize beyond particular examples like those discussed above. Further, because estimates of these numbers often depend on definitions and assumptions chosen by the researcher, we might often want to work with ranges (confidence intervals) within which we expect the figure of interest to lie. Figures 1 through 3 provide a graphical method of examining the interactions among the three factors. The data behind them are statewide figures for the entire duration of the program, but the graphics in those figures can just as easily (and perhaps should be) generated for individual utilities and years.

Figure 1: Combinations of Capacity Factor and Customer Cost Factor that separate regions of positive and negative returns on incentive payments, under alternative assumptions about free rider percentages. For example, If 60 percent of funds go to free riders, only combinations of Capacity and Customer Cost Factors in the small region below the "Free Riders=60%" line yield positive returns. If 0 percent of funds go to free riders, all combinations of Customer Cost Factor and Capacity Factor in the large region below the "Free Riders = 0%" line yield positive returns [Based on Aggregated PUCT-jurisdictional utility data, 2002-2009]

The horizontal and vertical axes of Figure 1 measure Capacity Factors and Customer Cost Factors. A capacity factor must lie between zero and one, i.e., capacity gets its full value (1) or no value (zero). The lower bound of a Customer Cost Factor is zero, but in principle there is no upper limit. A factor of 0 indicates that customers bear no cost above their incentive payments, a factor of 0.25 indicates that their costs are 25 percent of incentives, so that the full cost of the program is 1.25 times the value of its incentive payments. A Customer Cost Factor of 1 means that the total cost is twice the amount of incentive payments, and higher Factors are certainly imaginable.

Figure 1



A higher Capacity Factor raises the return on a dollar spent in the program, and a higher Customer Cost Factor lowers the return on a dollar. Each line in figure 1 shows (for a given percentage of free riders) the combinations of Capacity and Customer Cost Factors at which the net return on a dollar of incentive payments is zero. For example, if there are 40 percent free riders the "Free Riders = 40%" line shows that the program breaks even with a Customer Cost Factor of approximately 0.5 and a Capacity Factor of 0.2. It also breaks even if both are higher, for example if the Customer Cost Factor is 0.9 and the Capacity Factor is 0.8. A higher Customer Cost Factor by itself would mean lower returns on the program, and a higher Capacity Factor would mean that the value of saved investment in capacity is greater. At the upper end of the line these balanced as they are at the lower end, and the net effect is again zero. We conclude that combinations of Capacity and Customer Cost Factors that lie below the "Free Riders = 40%" line are consistent with positive returns on a dollar of incentive payments, and combinations above that line mean negative returns—if customer costs are high enough, any winning program can become a losing one.

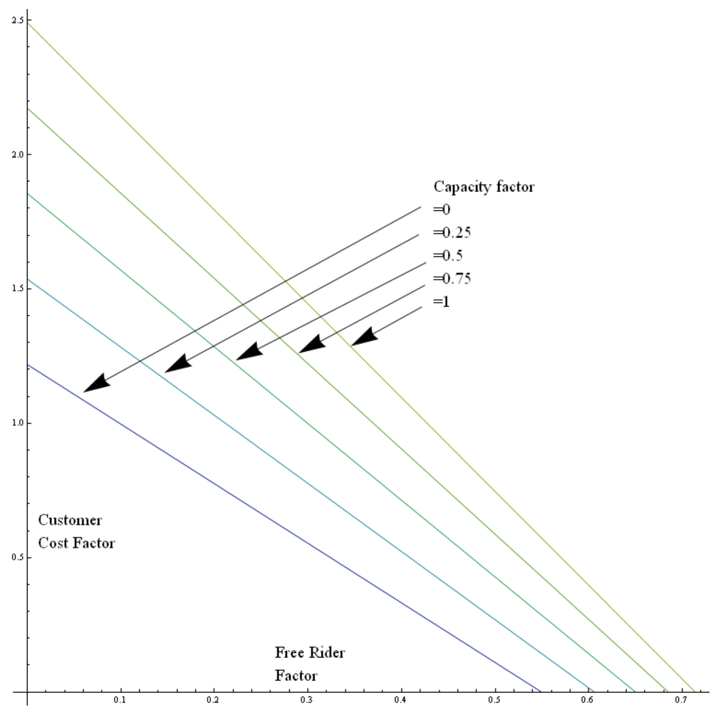
The ranges of Customer Cost and Capacity Factors at which the program breaks even will also depend on what is assumed about Free Riders, our third factor of interest. Since we are limited to two dimensions, Figure 1 contains lines that correspond to different assumptions about Free Rider percentages. A higher line corresponds to a lower percentage of them, which taken by itself will raise the returns on a dollar of incentive payments for a given combination of Customer Cost and Capacity Factors, and possibly turn it from negative to positive. Thus if there are only 20 percent rather than 40 percent free riders, a smaller percentage of the funds go to people who would have invested in efficiency absent the program, and a larger range of Capacity / Customer Cost Factor combinations is consistent with positive returns on the incentive payments.

A graph like Figure 1 then allows us to estimate the consequences of alternative estimates of factors that are intrinsically difficult to estimate. For example, assume that we are reasonably certain that our estimates of an 0.8 Capacity Factor and a 20 percent Free Rider Factor are close to correct, but that there is a wide range of uncertainty about the Customer Cost

Factor. If research shows that it might take on any value in a range from 1.2 to 1.6 with equal probabilities, the fact that most of the line linking those points lies in the area of negative returns might lead us to conclude that there is a high likelihood that the program will not deliver on its promised savings.

Figure 2: Combinations of Free Rider Factor and Customer Cost Factor that separate regions of positive and negative returns on incentive payments, under alternative assumptions about Capacity Factors. For example, If the Capacity Factor =1, i.e. a MW of capacity takes on the full value assumed by the PUCT, 60 percent of funds go to free riders, all combinations of Customer Cost and Free Rider Factors below the "Capacity Factor=1" line yield positive returns. If the Capacity Factor = 0, i.e., only energy is saved, then only those combinations of Free Rider and Customer Cost Factors below the "Capacity Factor = 0" line yield positive returns on incentive payments. [Based on Aggregated PUCT-jurisdictional utility data, 2002-2009]

Figure 2



Figures 2 and 3 provide alternative pictures of the situation, using the same data as Figure 1. The axes of Figure 2 measure the Free Rider Factor (limited to the range between zero and one) and the Customer Cost Factor, as discussed above. Holding the Capacity Factor constant, the lines again show combinations of those two factors along which a dollar spent on incentive payments just breaks even. Here, unlike in Figure 1, the two Factors affect returns in the same direction—a higher Free Rider Factor means a lower return, all else equal, and so does a higher Customer Cost Factor. If the former is large and the latter small, their combined effects might be the same as happens when the latter is large and the former small. With a Capacity Factor of zero, a Free Rider Factor (i.e., percentage) above 0.55 (55 %) will imply a negative return, even if the Customer Cost Factor is zero. The same holds for a Customer Cost Factor over 1.2, even if there are no free riders at all. Intermediate combinations of the two along the downsloping line labeled "Capacity Factor = 0" are also on the boundary between positive and negative returns. Analogous to Figure 1, a higher Capacity Factor such as along the line "Capacity Factor = 1" means that a larger range of combinations of Customer Cost and Free Rider Factors are consistent with positive returns on a dollar of incentive payments. This is so because higher capacity factors mean that the program creates more value in capacity and the same value in energy.

Figure 3: Combinations of Free Rider Factor and Capacity Factor that separate regions of positive and negative returns on incentive payments, under alternative assumptions about Customer Cost Factor. For example, If the Customer Cost Factor =0, i.e. Incentive payments cover all costs of efficiency measures, all points to the left of the "Customer Cost Factor = 0" line yield positive returns, and those to its right yield negative ones. If the Customer Cost Factor = 2, i.e. incentive payments cover only 1/3 of relevant total customer costs, only the small area to the left of the "Customer Cost Factor =2.0 line yields positive returns. Note at (per the text), "customer costs" do not include all expenses by customers in connection with the program. [Based on Aggregated PUCT jurisdictional utility data, 2002-2009].

Figure 3

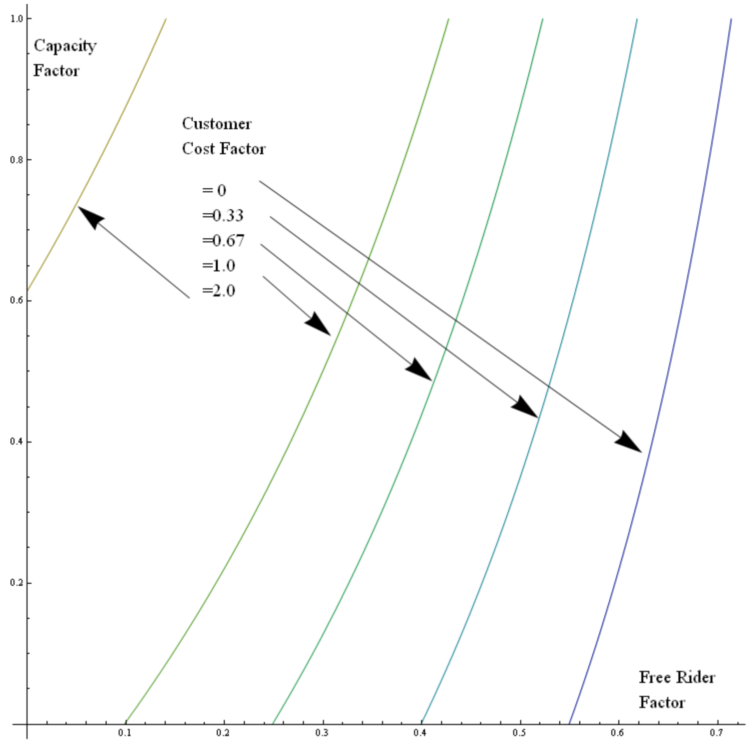


Figure 3 provides the final combination of variables that determine whether incentive payments break even. There the axes measure Free Rider and Capacity Factors, both restricted to values between zero and 1. Now the lines corresponding to different Customer Cost Factors are upward sloping—holding that factor constant, a program may break even with a high Capacity Factor (indicating that its saved investment is more valuable) and a high Free Rider Factor (indicating that more of the funds are wasted), and it could also break even with a low capacity factor and low free ridership. Areas to the left of the lines represent combinations of the two that yield a breakeven on the incentive payments. The area is greater, the lower is the Customer Cost Factor.

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