Synapse
Energy Economics, Inc.

Costs and Benefits of Electric Utility Energy Efficiency in Massachusetts

August 2008

PREPARED FOR:
Northeast Energy Efficiency Council

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1. Introduction

Massachusetts has a long history of effective electric utility energy efficiency (EE) programs. The newly enacted Green Communities Act enables utilities to go even further, stating "electric and natural gas resource needs shall first be met through all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply."[1] Massachusetts is now poised to become the most efficient user of electricity in the country.

As we in Massachusetts are about to undertake a significant increase in the depth and breadth of our ratepayer-funded EE programs, we should endeavor to understand the likely costs and benefits of this action. The good news is that the myriad of benefits from such an increase in energy efficiency will likely come at a lower cost than previously thought.

2. Benefits of Utility EE Programs

There are a number of benefits that accrue to states that pursue energy efficiency programs. These benefits include energy and capacity cost savings, non-electric benefits such as water and heating fuel savings, avoided CO_2 costs, lower prices due to the demand-reduction-induced price effect (DRIPE), economic stimulus, job creation, risk reduction, and energy security.

Although they surely exist, some of these benefits are difficult to quantify. The benefits described in benefit-cost ratios filed by Massachusetts utilities in their 2006 Annual Reports include avoided energy and capacity costs, non-electric benefits and capacity DRIPE. Energy DRIPE will be included for the first time in the 2007 Annual Report filings. As the implementation of carbon cap-and-trade policies begin, the market costs of avoided CO_2 emissions will increasingly be included in EE benefits calculations. We also expect that the external or societal costs of CO_2 emissions will be incorporated in some instances.

Energy and Capacity Cost Savings

Avoided energy and capacity costs are the costs to an electric utility which that utility would generate, construct itself, or purchase from another source. These include both fixed and variable costs that can be directly avoided through a reduction in electricity usage. The energy component includes the variable costs, namely fuel and operating expenses, associated with the production of electricity. The capacity component includes costs associated with providing the capability to deliver energy and consists primarily of the capital costs of facilities.

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[1] Commonwealth of Massachusetts, Acts of 2008, Chapter 169, Section 21(a).

Non-Electric Benefits

Most electric efficiency measures also deliver non-electric benefits. Insulation and air sealing measures not only save on air conditioning costs in the summer months, but also save the customer money on heating fuels such as natural gas, oil, wood, propane, and other sources. High efficiency clothes washers use less water than standard, top-load models. LED exit signs and long lasting fluorescents reduce the maintenance cost of changing light bulbs.

Demand-Reduction-Induced Price Effect (DRIPE)

Reductions in the quantity of energy and capacity that customers will need in the future due to efficiency and/or demand response programs result in lower prices for electric energy and capacity in wholesale markets. Lower demand means that the wholesale markets do not need to purchase the next most expensive unit. This impact of efficiency programs on market prices is referred to as the Demand-Reduction-Induced Price Effect (DRIPE).

DRIPE estimates are very small when expressed in terms of the market prices of energy and capacity; usually amounting to reductions of a fraction of a percent in annual average prices. The impact during peak hours can be much higher, which also has a dampening impact on price volatility. These impacts are projected to dissipate over four to five years as the suppliers react to the new, lower level of energy and capacity required. However, DRIPE impacts are significant when expressed in absolute dollar terms, since very small impacts on market prices, when applied to all energy and capacity being purchased in the market, translate into large absolute dollar amounts. Moreover, consideration of DRIPE impacts can also increase the cost-effectiveness of peak-focused EE measures on the order of 15% to 20%, because the estimated absolute dollar benefits of DRIPE are being attributed to a relatively small quantity of reductions in energy.

Avoided CO_2 Costs

There are many externalities associated with the production of electricity, including the adverse impacts of emissions of SO_2, mercury, particulates, NO_x and CO_2. However, the magnitude of most of those externalities has been reduced over time, as regulations limiting emission levels have forced suppliers and buyers to consider at least a portion of potential adverse impacts in their production and use decisions. In other words, a portion of the costs of the adverse impact of most of these externalities has already been “internalized” in the price of electricity.

Carbon dioxide is the dominant externality associated with marginal electricity generation for two main reasons. First, policy makers are just starting to develop and implement regulations that will internalize the costs associated with the impacts of carbon dioxide from electricity production and other energy uses. The Regional Greenhouse Gas Initiative and anticipated future federal CO_2 regulations will internalize a portion of the "greenhouse gas externality". Second, New England avoided electric energy costs are likely to be dominated by natural gas-fired generation, which has minimal emissions of SO_2, mercury, particulates and $NO_{X,}$ but substantial emissions of

CO_2. Energy efficiency avoids generation from existing power plants as well as the need for new generating capacity. Depending on the fuel sources of the displaced generation, the avoided CO_2 emissions can range up to about 1 short ton per MWh, an emission rate typical for coal-fired power plants.

Economic Stimulus

The economic stimulus provided by energy efficiency occurs, in part, through a reduced dependence on imported fossil fuels and an increased focus on development of in-state solutions. Local resources are used to manufacture, construct or install, and operate energy efficiency technologies, thereby creating direct local jobs. As a result, energy efficiency can provide new sources of income for those who work in struggling industries. Massachusetts, in particular, is well-suited to obtain additional stimulus in the research and development of new, more efficient technologies.

Job Creation

Energy efficiency creates both direct and indirect jobs. Because the focus of the effort is not simply in manufacturing, but also in R&D, service and installation, these are well-paying, skilled positions that are not easily outsourced to other states and countries.

Direct Jobs

Direct jobs result from the use of local skilled workers in the development, manufacture, construction, installation and operation and maintenance of energy efficiency technologies.

Indirect Jobs

Indirect jobs result from development of energy efficiency technologies via several mechanisms. First, the payment of wages and purchase of goods and services in the economy results in additional job creation as workers and firms supplying goods and services to the energy efficiency industry, in turn, make purchases from the local economy. Second, as energy efficiency reduces energy bills, businesses and households gain increased discretionary income which becomes available to purchase goods and services or for investment. This drives jobs in those markets and investment areas.

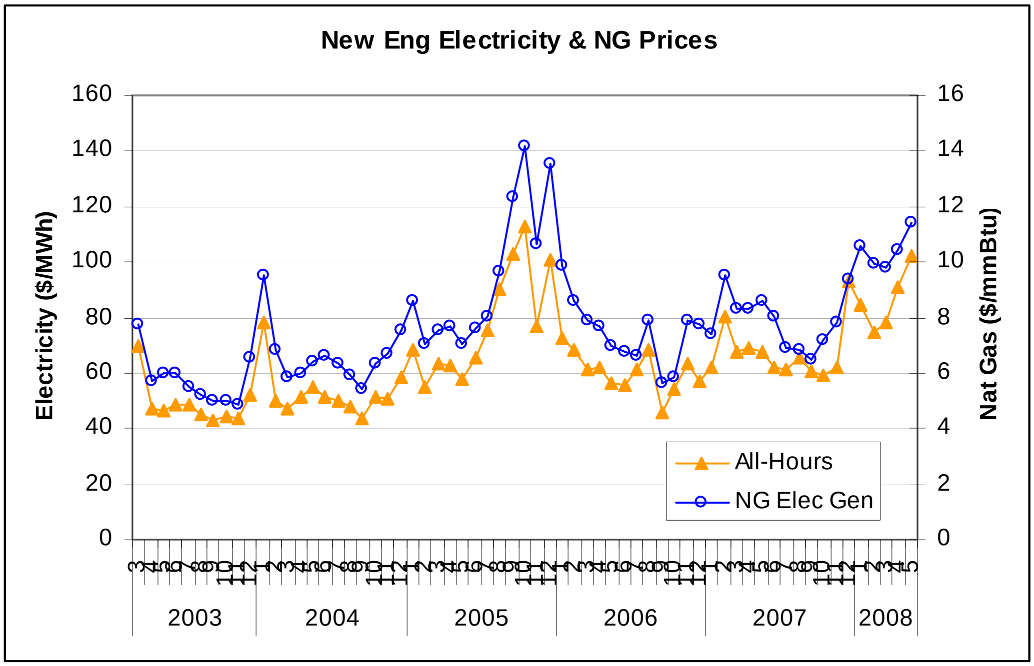
Risk Reduction

Energy efficiency reduces risks associated with fuel price volatility, unanticipated capital cost increases, more stringent regulations, fossil fuel supply shortages, and climate change.

Risk of Fuel Price Volatility

Recent increases in fuel price volatility underscore the significant benefits associated with reducing this risk. Varying demand for and supplies of natural gas and the highly volatile nature of natural gas prices have been primary drivers of more volatile electricity rates. Wholesale electric prices in New England were dependent upon the price of natural gas in 72% of the hours in 2007 and 73% of the hours in 2006[2]. Figure 1, below, shows a historical chart of New England electricity and natural gas prices, and depicts just how directly our electricity prices depend upon the price of natural gas.[3]

Figure 1. New England Electricity and Natural Gas Prices



This situation is unlikely to change in the near future, no matter which type of new supply is developed and brought into service. According to the ISO New England Scenario Analysis, natural gas will remain the marginal fuel in the New England system for more than 85% of all hours[4]. Some energy efficiency measures have a high coincidence with peak hours. Development and use of these technologies can stabilize prices on hot summer days when demand is highest and can act as a hedge against this type of risk.

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[2] 2007 Annual Markets Report. ISO New England. Section 2.4.2. June 6, 2008.

[3] Natural Gas prices for electric generation from EIA Monthly Electricity Report. All-hours wholesale LMP from ISO New England.

[4] *New England Electricity Scenario Analysis*. ISO New England. August 2, 2007. Figure 5-2.

Risk of Unanticipated Capital Cost Increases

The longer development timelines associated with conventional generation as compared to energy efficiency solutions exposes these resources to longer-term increases in the cost of labor and materials – unanticipated cost increases which increase the risk of disallowance and stranded costs. It can take more than a decade before new coal and nuclear plants are operational. Conversely, energy efficiency is more nimble and less risky, both financially and environmentally. Aggressive energy efficiency eliminates the risk associated with committing to huge investments a decade or more before they will be needed.

Risk of Fossil Fuel Supply Shortages

Other downsides faced by fossil fuel plants include longer-term supply concerns due to finite supply and transportation bottlenecks. Recent issues with transporting coal have caused some existing coal plants to buy supplies at higher prices on the spot market in order to meet electricity demand.[5] Energy efficiency is not subject to supply and transportation constraints that impact fossil fuels.

Climate Change Risks

Fossil fuel plants are often sited at sea level or along rivers because they require large amounts of cooling water. Risk factors such as sea level rise, storm surges, and drought[6], which have become more frequent due to climate change, pose concern, as do risks of thermal and other forms of pollution of marine and estuarine habitats. Implementation of energy efficiency reduces greenhouse gas emissions, which reduces the risk of adverse effects from climate change without adding other risk factors.

Energy Security

Energy efficiency reduces competition between states for fuels to support electricity production, competition between states for electricity imports, and dependence on imported oil for electricity production. Oil prices have recently spiked above $135 per barrel and will continue to rise due to a number of factors including diminishing supply, increased demand in many countries and additional costs associated with safeguarding supplies located in countries suffering from economic, social and political instability.[7] This cost increase makes increased reliance on oil unlikely. Energy efficiency can help states meet future demand increases and reduce dependence on out-of-state or overseas resources.

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[5] Some suppliers are now taking advantage of increased global demand to sell their coal for higher prices (and profit) to satisfy international rather than domestic demand

[6] Dry cooling can allow plants to operate during drought, but this adds to construction costs and decreases fuel efficiency.

[7] Oil-related defense expenditures were $137 billion in 2006 (www.setamericafree.org an organization focused on energy independence for the US. Members include James Woolsey, former CIA Director; Senator Sam Brownback; Deron Lovaas, NRDC and Robert MacFarlane, former national security advisor)

Early Adopter Recognition in National Greenhouse Gas (GHG) Reduction Schemes

Early adoption of energy efficiency policies could help states garner additional allowances (i.e., funds) as part of any national greenhouse gas programs that are enacted by Congress. Following the trend established by the Regional Greenhouse Gas Initiative (RGGI), several global warming bills being considered by Congress include provisions to auction allowances, rather than to give them away free to sources.

To date the most successful bill in the Senate, Lieberman-Warner, provided additional allowances allocations to (1) utilities and states that take early action by establishing binding greenhouse gas reduction targets, (2) utilities and states reducing greenhouse gas emissions and (3) states with more aggressive greenhouse gas reduction targets than equivalent Federal programs.

Each of these additional allocations is incremental, meaning that a state could gain additional allowances from meeting each one of these three requirements. In terms of utility allocations, the bill states that,

> "Not later than 2 years after the date of enactment of this Act, the Administrator shall allocate to owners or operators of covered facilities, in recognition of actions of the owners and operators taken since January 1, 1994, that resulted in verified and credible reductions of greenhouse gas emissions--
> (1) 5 percent of the emission allowances established for calendar year 2012;
> (2) 4 percent of the emission allowances established for calendar year 2013;
> (3) 3 percent of the emission allowances established for calendar year 2014;
> (4) 2 percent of the emission allowances established for calendar year 2015; and
> (5) 1 percent of the emission allowances established for calendar year 2016."[8]

In terms of states, the bill allocates 1% of annual allowances among states that have already adopted regulations.[9] Furthermore, the bill allocates an incremental "2 percent of the Emission Allowance Account for the year among States that have--(1) before the date of enactment of this Act, enacted statewide greenhouse gas emission reduction targets that are more stringent than the nationwide targets established under title II; and (2) by the time of an allocation under this subsection, imposed on covered facilities within the States aggregate greenhouse gas emission limitations more stringent than those imposed on covered facilities under title II."[10]

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[8] To find this language, go to www.thomas.gov, type in s2191 into the search text box, select the radio button next to "bill number" and click search. Scroll down the page and find TITLE III--ALLOCATING AND DISTRIBUTING ALLOWANCES>Subtitle C--Early Action>SEC. 3301. ALLOCATION.

[9] To find this language, go to www.thomas.gov, type in s2191 into the search text box, select the radio button next to "bill number" and click search. Scroll down the page and find TITLE III--ALLOCATING AND DISTRIBUTING ALLOWANCES>Subtitle D--States> SEC. 3401. ALLOCATION FOR ENERGY SAVINGS.

[10] To find this language, go to www.thomas.gov, type in s2191 into the search text box, select the radio button next to "bill number" and click search. Scroll down the page and find TITLE III--ALLOCATING AND

Each allowance is expected to have an initial market value in the range of $10 to $25. The proceeds from sale of the state's allowances could help states continue to invest in energy efficiency. These funds would enable states to more cost-effectively reduce their greenhouse gas emissions and promote local economic development through energy efficiency.

3. New Research on the Cost of Saved Energy

Synapse recently undertook an extensive review of numerous utility and third party EE programs from across the United States in order to explore the empirical relationship between the cost of saved energy (CSE) per kWh saved and program scale in terms of first year energy savings as a percentage of annual energy sales. In the analysis, we found that the CSE tends to decrease as energy savings increase relative to annual energy sales. This finding is contrary to the idea of an energy efficiency supply curve that is often constructed to estimate economic potential of energy efficiency measures. These supply curves generally indicate that the CSE increases as energy savings increase, much like a generation supply curve would.[11]

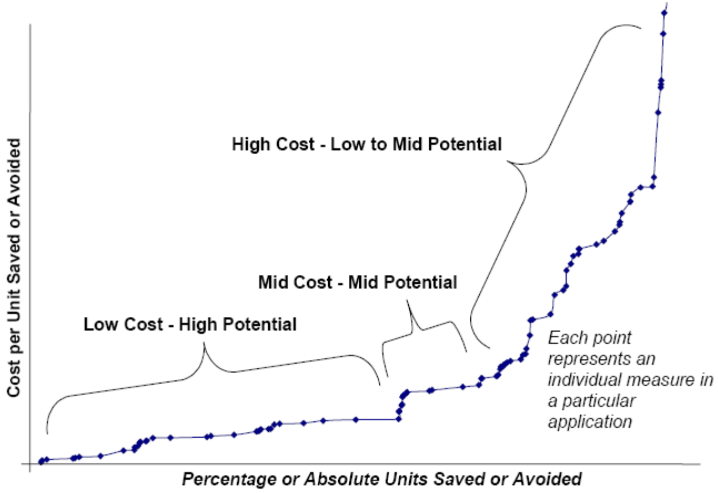
Conservation Supply Curve

A typical view expects that the CSE should increase as more of the energy savings potential is tapped. Steady-state analysis can readily arrange efficiency technologies on a "conservation supply curve" (CSC) of increasing costs per unit of saved energy so that it would appear as if increasing acquired savings would require an increase in the cost per unit savings. (See Figure 2.)

DISTRIBUTING ALLOWANCES>Subtitle D--States>SEC. 3402. ALLOCATION FOR STATES WITH PROGRAMS THAT EXCEED FEDERAL EMISSION REDUCTION TARGETS.

[11] Details of the analysis are found in Kenji Takahashi, David A. Nichols 2008. The Sustainability and Costs of Increasing Efficiency Impacts: Evidence from Experience to Date, conference paper to be presented at the 2008 Summer ACEEE conference: Synapse Energy Economics, Inc. For references and other information related to this analysis, contact Kenji Takahashi at Synapse Energy Economics (ktakahashi@synapse-energy.com)

Figure 2. Illustrative Energy-Efficiency Supply Curve



Source: XENERGY Inc. 2002. California's Secret Energy Surplus: the Potential for Energy Efficiency

Many studies develop a CSC, also known as energy-efficiency supply curves, for use in energy planning studies and policy analysis.[12] These curves are always presented with "steps" that increase as one moves along the horizontal axis from left to right (increasing energy savings). This notion of an "increasing cost supply curve for saved energy" is theoretically appealing. It reflects a logical order of prioritization of opportunities. Why would someone implement a high cost measure but not a lower cost measure?

There is no question that a CSC analysis is a useful tool for comparing the relative costs of energy efficiency measures and for understanding the aggregate potential for cost-effective energy efficiency that is available up to any given CSE level. However, CSCs are generally constructed in a manner that is limited to demonstrated and currently well-understood measures and programs. They may imply increased market share for advanced technologies, but only rarely do they reflect true technological or institutional improvement over time. In contrast, analysts of fossil fuel supply do not limit their analyses to "proven" resources, but routinely include hydrocarbon reserves that are described as "undiscovered," "possible," or "prospective."[13] Further, new power generating technologies such as integrated gasification combined cycle with carbon capture and sequestration and advanced nuclear power plants, which have never been built, are sometimes modeled in energy models such as the U.S. Energy Information

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[12] Bernow, S., M. Lazarus, and D. von Hippel. 2002. "Clean Electricity Options for the Pacific Northwest: An Assessment of Efficiency and Renewable Potentials through the Year 2020." Presentation to the NW Energy Coalition, October; Coito, F., and M. Rufo. 2002. California's Secret Energy Surplus: the Potential for Energy Efficiency. Prepared by Xenergy Inc. for the Energy Foundation and Hewlett Foundations. Burlington, Mass.: Xenergy Inc. and ; Donovan, C., R. N. Elliott, D. Hill, P. Mosenthal, S. Nadel, C. Neme, and J. Plunkett. 2003. Energy Efficiency and Renewable Energy Resource Development Potential In New York State. Prepared for the New York State Energy Research and Development Authority. Bristol, Vt.: Optimal Energy, Inc.

[13] Biewald, B. 2004. "The Shape of Things to Come: Incorporating Unproven Reserves of Efficiency Savings into Energy Models." Presentation to the East Coast Energy Group, Washington, DC. November 10.

Administration's Annual Energy Outlook. This appears to be a bias against demand-side resources in long-term energy modeling.

Further, a CSC analysis can lead to an assumption that energy efficiency programs must mimic the conservation supply curve, such that the greater their amount of savings, the greater their program cost. However, CSEs for programs or the portfolio of programs are expected to differ from CSEs for technologies that underlie CSC analysis for several reasons. Beyond the obvious fact that energy efficiency program costs[14] typically cover a substantial fraction, but not all, of efficiency's incremental costs, the program CSE fluctuates due to many factors such as year, utility, sector, type of program, and size of program. Utility efficiency programs are often composed of various measures that target each sector, including the low-income, residential, and commercial and industrial sectors. Therefore, the overall cost of saved energy for the program is always the weighted average cost of saved energy through a portfolio of various measures.

In fact, the data for actual energy efficiency programs do tell a different story from that which might be inferred from CSCs. Utility and non-utility EE programs generally include a range of measures, ranging from zero (or even negative net cost) per kWh saved up to (and in rare occasions) exceeding avoided costs. The overall cost per kWh saved for a utility program in a particular year turns out to be lower for the more ambitious programs. This could be because there are fixed costs that can be spread out over more measures or participants. On the electricity supply side, it is generally accepted that there are economies of scale in power plant construction costs (i.e., larger equipment costs less on a per MW basis) and we expect a similar effect in the administration of EE programs.

For example, a large program allows for bulk purchase of certain efficiency measures at a lower price or allows for bulk discounts for contracts with energy service companies to deliver energy savings. In other instances, large-scale programs can allocate the cost of marketing and administration of those programs over greater amount of energy savings, which would tend to reduce program cost per kWh saved as program scale increases. Also, marketing and customer education will increase customers' adoption of new technologies, which in turn will accelerate the mass production of such technologies and thus reduce price per unit in the long term. Furthermore, greater scope of programs could reduce marketing expense or provide synergistic savings.[15]

Methods

We obtained the energy savings and program cost data either from utility efficiency annual reports, directly from program administrators or staff at state energy offices or regulatory commissions. The majority of the data are from utilities in the Northeast and California, with some additional data from Washington and Iowa. Although we obtained

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[14] The costs of the utility or other program administrator including the costs for marketing, administration, program rebates, and measurement and verification of energy savings.

[15] For example, combining a lighting retrofit with a large commercial AC retrofit can reduce the size of the AC unit needed, making the retrofit both cheaper and more cost-effective.

data prior to 2000, we focused on EE data since 2000 because the recent data are more relevant to today's efficiency programs.

We estimated the levelized cost of saved energy (CSE) using a 4% real discount rate and the following formula:

Levelized CSE = (Program Costs) x (Capital Recovery Factor) / (First year kWh saved), where

Capital Recovery Factor[16] = $\frac{i(1+i)^n}{(1+i)^n - 1}$

where

i = real discount rate

n = weighted average of useful measure life (years)

The weighted average of useful lives for efficiency programs were in many cases estimated based upon reported first year and lifetime energy savings. Where no lifetime savings data were available for a specific utility or program, we used a 12-year average lifetime that has been recognized as an industry rule of thumb estimate.[17,18] For cases in which available information indicated that savings were measured at the customer level, we adjusted savings from customer to generation level to account for transmission and distribution line losses specific to each jurisdiction reported by state energy offices or regulatory commissions (e.g., approximately 8% for MA IOUs and 5% for CA IOUs).

Note that data on savings are inherently less certain than data on costs. Regular impact evaluation activities to verify savings estimates have been conducted by virtually all entities that have pursued comprehensive energy efficiency programs on a sustained basis; nevertheless, uncertainty regarding exact savings necessarily remains. Moreover, the quality of savings estimation and verification could vary from jurisdiction to jurisdiction; this is not an issue we explored for this analysis. We think it unlikely that variability in the quality of savings estimates accounts for the trends found in the analysis described below, particularly since our analytical focus is mainly on the relation of costs to the level of savings achieved within different entities' programs (as opposed to across them).

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[16] Capital recovery factor is the ratio of a uniform annual (annuity) value and the present value of the annual stream.

[17] U.S. Department of Energy and U.S. Environmental Protection Agency 2006. National Action Plan For Energy Efficiency. Washington, DC: U.S. Department of Energy and U.S. Environmental Protection Agency; Kushler, M., D. York, and P. Witte 2005. Examining the Potential for Energy Efficiency to Help Address the Natural Gas Crisis in the Midwest: Washington, DC: American Council for an Energy Efficient Economy, 2005; Bender, S., M. Messenger, and C. Rogers 2005. Funding and Savings for Energy Efficiency Programs for Program Years 2000 through 2004. Sacramento, CA: California Energy Commission.

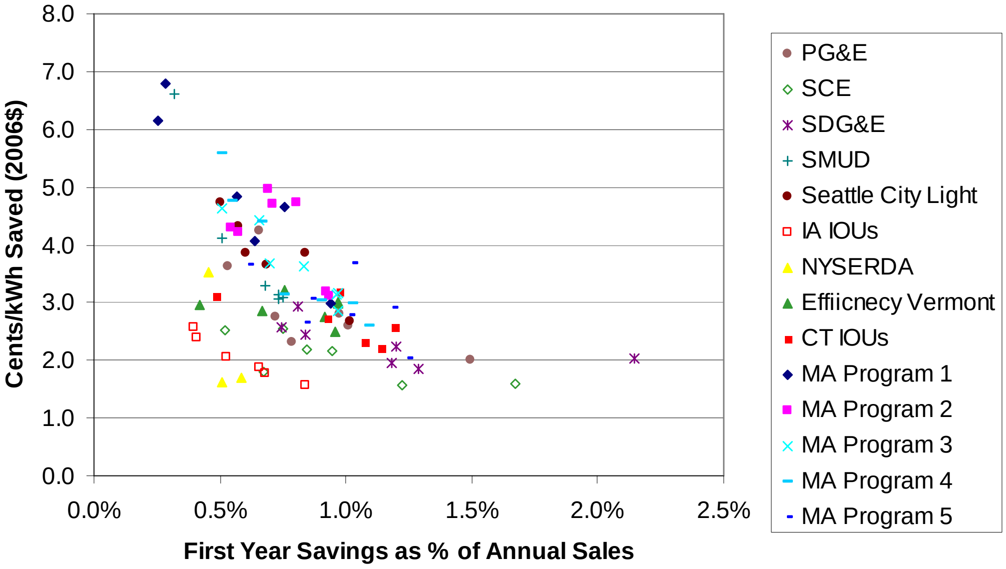
[18] For example, we used the 12 year average lifetime number to estimate lifetime savings for SMUD, Seattle City Light, and Iowa IOUs. For California IOUs' data, slightly less than half of the data we obtained have projected lifetime savings, and for the other half of the data, we used the average life of a certain program (e.g., residential, non-residential, new construction, others) to estimate the values for the same program in different years.

Energy Efficiency Program Cost Analysis across the U.S.

Figure 3 below presents program CSE and annual incremental savings (or first year savings) data as percentage of annual sales.[19] The figure represents a total of 14 datasets and about 90 data points representing utilities, a group of utilities or a state. Each data point represents a result of EE program activities in one year by one utility, a third party administrator or a group of utilities.

The vertical axis shows cents per kWh saved and the horizontal axis shows first year energy savings (also called annual incremental energy savings) as a percentage of annual energy sales. Note the first year energy savings data includes savings only attributable to one program year and excludes any savings impact from the programs implemented in the past.

Figure 3. Cost of Saved Energy



We found that the CSE ranges from about 1.5 cents to close to 7 cents per kWh saved, with the average of 2.4 cents/kWh and the median of 3 cents/kWh saved based on 90 data points. Coefficient values in Figure 4 below indicate the slopes of the linear trend lines. Negative slopes mean trend lines are declining.

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[19] The costs of efficiency programs include the costs for marketing, administration, program rebates, and measurement and verification of energy savings, and do not include contributions made by participants to purchase energy efficient products.

We then fit a linear regression trend line to each data set and examined the R-squared values and coefficients estimates. The results are presented in Figure 4. For 9 out of the 14 datasets, more than 50% of the variation in CSE could be explained by the first year savings as a percentage of annual sales. But more importantly, we found coefficient values that represent the slopes of the curves were negative for all cases. This means that the CSE was generally lower in years when program size (first year energy savings relative to annual sales) was larger.

Figure 4. Cost of Saved Energy Coefficients

Data	Coefficient	R-square
PG&E - 2000-2006	-175	0.53
SCE - 2000-2006	-77	0.55
SDG&E - 2000-2006	-51	0.40
SMUD - 2000-2006	-779	0.94
Seattle - 2000-2005	-329	0.81
Iowa IOUs - 2001-2006	-219	0.94
NYSERDA - 2004-2006	-1,300	0.61
Efficiency Vermont - 2000-2007	-31	0.08
CT IOUs - 2000-2005	-107	0.46
MA Program 1 - 2001-2006	-489	0.89
MA Program 2 - 2001-2006	-306	0.40
MA Program 3 - 2001-2006	-350	0.91
MA Program 4 - 2001-2006	-452	0.86
MA Program 5 - 2001-2006	-162	0.37

These findings are striking given that it is often argued, largely based on the idea of an upward sloping energy conservation supply curve, that the CSE would increase if the amount of energy savings increases. While there exists a possibility that the CSE might begin to increase at much higher levels of EE program savings, this evidence suggests that current program savings levels have not yet approached any such point.[20]

Possible reasons for the decreasing cost trends include: (1) economies of scale are at work (e.g., allocating marketing and administration costs over more savings, achieving lower unit costs for program inputs); (2) more economies of scope are at work at larger scale of energy savings relative to annual sales (e.g., exploiting synergies among different measures such as reducing the cost of site visits per measure by implementing multiple efficiency measures at one time); (3) administrators become more organized in designing and developing effective EE programs (including appropriate level of incentives to promote customer participation); or (4) administrators have more credibility or more resources available for quality program design and development.

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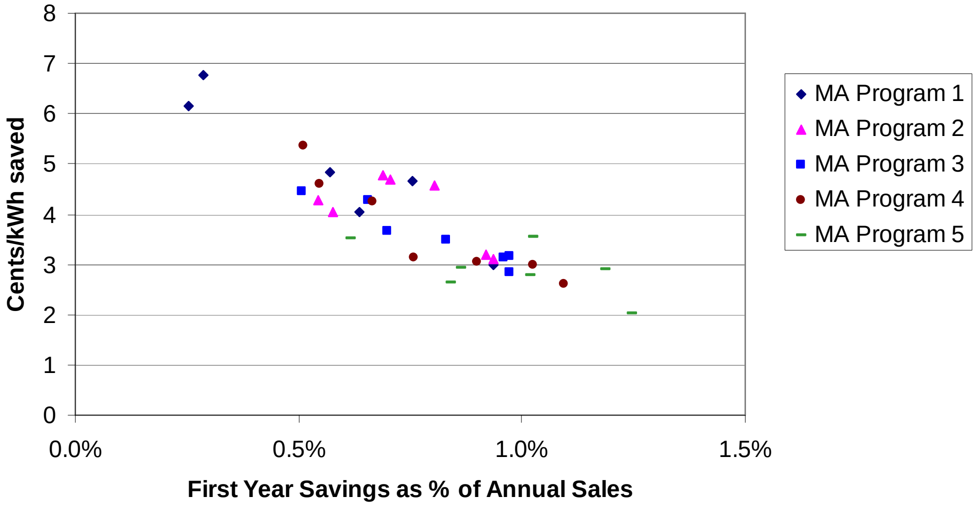
[20] Details of the analysis are found in Kenji Takahashi, David A. Nichols 2008. The Sustainability and Costs of Increasing Efficiency Impacts: Evidence from Experience to Date, conference paper presented at the 2008 Summer ACEEE conference: Synapse Energy Economics, Inc. For references and other information related to this analysis, contact Kenji Takahashi at Synapse Energy Economics (ktakahashi@synapse-energy.com)

Energy Efficiency Program Cost Analysis for Massachusetts

With the recent legislation signed into law, it is important to investigate if the data specific to Massachusetts – and the Commonwealth's particular structure, scope, and depth of programs - parallels the trend of the nationwide data. We compared the cost and energy savings for efficiency programs by all program administrators in Massachusetts and investigated the cost trend lines. The data we are using here are for years 2000 to 2006, derived both from the PARIS energy efficiency database that Massachusetts Division of Energy Resources (DOER) is maintaining and a database that the Massachusetts Department of Public Utilities (the former Department of Telecommunications & Energy or DTE) used to maintain.[21] The DOER receives the data from each program administrator each year and compiles them in PARIS database.

Figure 5 below shows the data on cost of saved energy and first year energy savings by 5 program administrators from 2003 to 2006. As indicated for the figure above on CSE for numerous programs across the nation, each data set represents the result of efficiency program activities in one year by one administrator. We found that the observed R-squared values range from 0.4 to 0.9 for Massachusetts programs as indicated in Figure 4. We also found that all of the data sets have negative or declining slopes, a similar trend as we have found in other states (Figure 4 above and 5 below).

Figure 5. Cost of Saved Energy for Massachusetts



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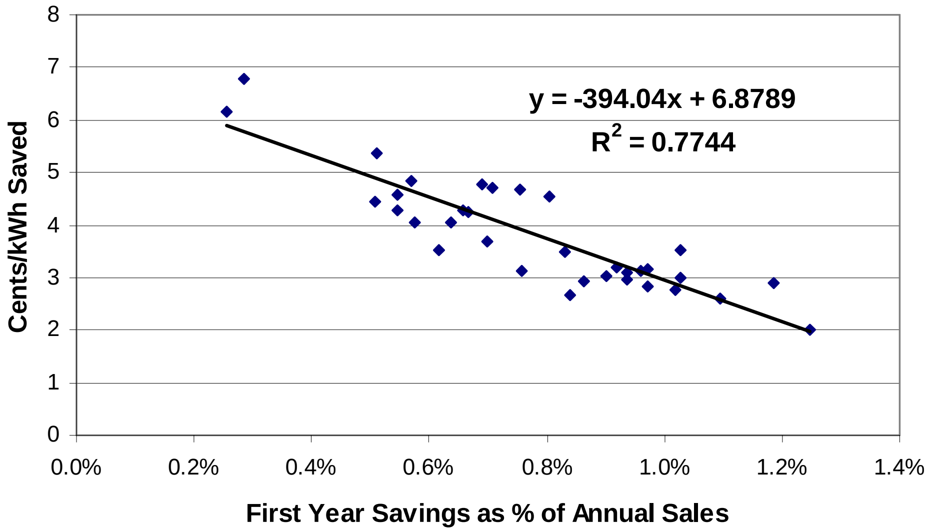
[21] Massachusetts Division of Energy Resources. 2008. "Data File for Energy Savings and Program Expenditures for Massachusetts Utilities for 2003 to 2006 (PARIS database)". (Unpublished raw data obtained from Lawrence Masland in February 2008); Massachusetts Department of Telecommunications and Energy. 2003. "Massachusetts Electric Utility Energy Efficiency Database." Unpublished raw data obtained from Gene Fry, June 2007.

Lastly we combined all of the data sets for Massachusetts programs and fit a linear regression trend curve to the combined data (See Figure 6). Again, we found a large negative correlation between CSE and program size relative to annual sales, with an observed R-squared value of 0.77. The consistency of the observed relationship across utilities is to be expected, given the similar nature and design of the programs among program administrators within the Commonwealth. We did not conduct this analysis for data across different states because the nature and designs of the programs could differ significantly state by state.

Figure 6. Cost of Saved Energy for Massachusetts, Combined



4. Conclusion

Massachusetts electric utilities are currently achieving energy efficiency program savings of about 1% of their annual energy needs with energy efficiency programs at a CSE of around 3 cents/kWh. Our data suggest that the cost of saved energy could decrease if the utilities were to increase their program scale further, perhaps up to the level of annual savings equal to 2% or 3% of annual sales. This implies that the cost effectiveness and benefits of energy efficiency programs could be even greater in the future with greater program scale.

The Green Communities Act will allow our EE program administrators to invest more in electric efficiency. Beyond all of the benefits we as ratepayers currently get from this investment, recent analysis described in this paper indicates that we should expect to pay less per kWh saved as these programs expand than previously thought.