COMMONWEALTH OF MASSACHUSETTS

OFFICE OF CONSUMER AFFAIRS AND BUSINESS REGULATION

DIVISION OF ENERGY RESOURCES

DOER Report: 1998 Energy Efficiency Activities

An Annual Report to the Great and General Court on The Extent to Which Energy Markets Are Meeting the Statewide Energy Efficiency Goals

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Winter 2000

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EXECUTIVE SUMMARY

The Commonwealth of Massachusetts requires that the customers of electric distribution companies contribute a portion of their electricity charges to activities that reduce the consumption of electricity. Enacted as part of the Electric Industry Restructuring Act (St. 1997, c. 164, "the Act"), the policy recognizes that energy efficiency investments reduce the overall cost of electricity without reducing comfort or convenience, lower the emission of harmful air pollutants, create jobs and stimulate the economy. The investments provide for the installation of high efficiency lighting, motors, air conditioners and appliances; the construction of high efficiency homes and commercial buildings; and more.

The Act also requires that DOER submit an annual report to the Legislature regarding the extent to which energy markets are meeting the statewide energy efficiency goals. This report is DOER's review and analysis of 1998 ratepayer-funded program achievements and the development of competitive markets for energy efficiency products and services, and their contribution to the statewide energy efficiency goals. DOER's major findings are as follows:

1998 Program Participants Saved Money

Customers who participated in 1998's energy efficiency offerings saved a total of $19 million on their electricity bills. For the productive lifetime that the energy efficiency equipment remains in place – an average period of ten to fifteen years – total savings grow to approximately $265 million. These savings were in addition to those realized and mandated through electric deregulation. Average annual savings for low-income participants were 13%. All other residential participants saved an estimated 6%. In addition, the average commercial participant's bill dropped 6%, and the average industrial participant's bill was reduced by over 7%.

Energy Efficiency is Cheaper Than Buying Electricity

1998 ratepayer-funded energy efficiency programs will save a projected 3.4 billion kilowatt-hours of electricity for participating customers over the lifetime of the energy efficiency measures. With 1998 ratepayer-funded energy efficiency expenditures totaling $99.3 million, plus $22.7 million in participant costs, this translates to an estimated average cost for conserved energy of 3.6¢/kWh – 60% less expensive than the projected average retail electricity price over the same period of 9.6¢/kWh.

Improving Air Quality in Massachusetts and the Region

The installation of energy efficiency measures in 1998 will play an important role in reducing nitrogen oxide (the primary cause of smog formation) and sulfur dioxide (a main contributor to acid rain) emissions at least until stricter emission regulations for power plants go into effect, and until new, cleaner gas-fired combined cycle generating units dominate the supply mix. Even more important will be the role of energy efficiency in reducing carbon dioxide (known to change global climate) which is neither regulated nor subject to direct pollution control.

INCREASING JOBS IN THE COMMONWEALTH

DOER's estimates that 1998 ratepayer-funded investments in energy efficiency will lead to 815 new jobs in Massachusetts, resulting in $30 million in associated employment income over the next decade. These jobs will be concentrated in the areas of manufacturing (notably machinery and electrical equipment), as well as wholesale/retail trade, and business services (including design and engineering services).

1998 ENERGY EFFICIENCY PROGRAMS WERE COST-EFFECTIVE

Energy efficiency programs were cost-effective according to methodologies approved by the Department of Telecommunications and Energy. By a ratio of 1.8 to 1, statewide benefits to all electric ratepayers from 1998 energy efficiency programs outweighed total program costs. These benefits included avoided wholesale electricity, distribution, and transmission costs that would otherwise have been passed on to customers absent the energy efficiency programs. The cost-effectiveness ratio of these programs increases to more than 1.8 when other non-energy and environmental benefits of the programs are considered.

LOW-INCOME FUNDING LEVELS WERE CONSISTENT WITH THE ACT

Over 12,900 low-income customers received $8.3 million in energy efficiency products and services, including refrigerator replacement programs and a range of services to weatherize homes. Savings from these programs resulted in an average electricity bill reduction of $62 for participating low-income customers in 1998.

ALL CUSTOMER CLASSES WERE SERVED EQUITABLY

Energy efficiency funds were equitably allocated among customer classes according to collections from customers and low-income funding requirements under the Act. Collections to fund energy efficiency activities were 3% from low-income customers, 27% from residential (non low-income), and 70% from C&I customers, while expenditures for these customer classes were 8%, 24%, and 68%, respectively. Residential (non L/I) and C&I expenditures were proportional to collections from these classes after accounting for their contributions to fund low-income energy efficiency programs.

PROGRAMS ARE BALANCING SHORT AND LONG TERM SAVINGS

1998 program activities provided participating customers with substantial immediate savings as well as savings over the period of time that the higher efficiency equipment remains in place. These programs also contributed to changing energy efficiency markets on a permanent basis, thus benefiting *all* customers. New Construction programs, for example, targeted not only participating builders and their customers, but other key market players (e.g., architects, designers, and builder organizations) to promote energy efficient building practice. These strategies help to promote better building practices by changing building code requirements.

1998 WAS A TRANSITIONAL YEAR

A total of $137.5 million was collected from ratepayers during 1998, representing 3.4% of distribution companies' 1998 revenues. Total expenditures for the year amounted to $99.3 million, or about 72% of the $137.5 million collected from ratepayers. The under-spending was due to: 1) the new funding levels mandated by the Act, and the ramp-up time needed to implement new programs, 2) a portion of funds were committed to energy efficiency projects at the end of 1998 but were not yet expended, and 3) the difficulties of implementing coordinated programs across distribution companies. Unexpended amounts (including accrued interest) were carried forward to 1999 program budgets.

CHANGES IN THE COMPETITIVE MARKET FOR ENERGY EFFICIENCY SERVICES

Up until 1998, the competitive energy efficiency market in Massachusetts included a wide range of market players that provided energy efficiency products and services to customers either directly or through ratepayer-funded programs. These market players have each played a unique role in working towards eliminating barriers that consumers confront when making decisions to invest in energy efficiency opportunities. In 1998, a new market player – competitive retail suppliers – began offering a range of energy services to large C&I customers as a bundled product with electricity commodity. At this time, it is too early to know the extent to which energy efficiency services provided by competitive retail suppliers will eliminate barriers that these customers face when investing in energy efficiency, and the degree to which ratepayer-funded programs reduce these barriers. Furthermore, it is unclear at this time whether competitive retail suppliers will ultimately offer energy efficiency services to other customer classes – namely small C&I and residential customers.

SUMMARY

DOER anticipates that because 1998 was a transitional year, energy efficiency investments in 1999 will be higher, and program activities will likely produce greater savings and benefits for customers. DOER will continue to monitor the ratepayer-funded energy efficiency program activities to ensure they are consistent with the statewide goals and are helping to facilitate the development of competitive energy efficiency markets.

I. Introduction

A. Legislative Background

The Massachusetts Electric Restructuring Act (St. 1997, c. 164), or "the Act," created the framework to fundamentally change the electric utility industry in Massachusetts. In particular, the Act mandated changes that allow competitive retail suppliers to provide electric generation services to all classes of Massachusetts electricity customer. Further, under the Act, prices for electricity generation will ultimately no longer be set under state regulation. Rather, generation prices will be determined by competitive market forces. These changes are expected to provide substantial, additional economic and environmental benefits to the electric ratepayers of the Commonwealth. Some of these benefits are already becoming visible, as previously reported by DOER.[1]

Within the framework created by the Act, the Massachusetts Legislature reiterated the Commonwealth's policy on energy efficiency and other public purpose activities. In general, the Legislature has held that ratepayers will continue to support energy efficiency services and other public purpose activities that will not be fully provided through market forces. This policy recognizes that it is imprudent to assume that market forces will automatically, immediately and/or fully meet the need for these public purpose activities. Therefore, the Legislature created a special fund to ensure continued ratepayer funding for energy efficiency programs. Funding is mandated over the period 1998 to 2002 at a level of 3.3 mills[2]/kWh in 1998, ramping down to 2.5 mills/kWh in 2002. In addition, the Act established permanent funding for low-income programs, in recognition that markets may never fully deliver energy efficiency benefits to these customers.

Creating a fully competitive energy efficiency market that delivers services to all customers is an objective of the Act. During the 5-year transitional funding period mandated by the Act, competitive energy markets have the opportunity to deliver energy efficient products and services to customers, with decreasing or no reliance

Transforming Energy Efficiency Markets. Strategies to transform markets include increasing the f energy efficient products and services to customers, such as through ratepayer-funded energy efficiency programs or through competitive energy efficiency service companies. Other strategies target manufacturers, retailers, builders and architects, to encourage them to develop, sell or design energy efficiency equipment and systems. As a result of these strategies, energy efficiency products and services can become *normal practice* in appropriate applications, and are sustained over time. Additionally, these strategies focus on stimulating consumer demand by fostering confidence in the effectiveness and quality of high efficiency technologies. In many cases, market transformation strategies also provide financial assistance to help overcome the higher cost of these technologies. Because there are a multitude of strategies and market players working toward the transformation of energy efficiency markets, the process is complex and takes time.

[1] See Division of Energy Resource's 1998 Market Monitor Report, which includes information on 1998 cost savings to customers as a result of the Act.

[2] A mill is one-tenth of a cent or one-hundredth of a dollar. For definitions of this and other terms throughout this report, please refer to Appendix H: *Glossary of Terms.*

on ratepayer funding. Achieving this objective, however, requires that markets for energy efficiency products and services be transformed.

B. Division of Energy Resources' Mandate

Under the Act, DOER is assigned several new, major responsibilities regarding energy efficiency activities. First, DOER was given the task of overseeing energy efficiency activities in the state. This task involves three distinct components: a) the development of statewide energy efficiency goals, b) the oversight of electric ratepayer-funded energy efficiency activities,[3] and c) the filing of annual reports to the Legislature regarding the extent to which energy markets are meeting the statewide energy efficiency goals. The second major responsibility assigned to DOER by the Legislature is to assess in year 2001 whether ratepayer funding for energy efficiency activities should continue, and if so, for whom and at what levels.

1. Oversight of Massachusetts Energy Efficiency Activities. DOER has been charged to oversee the performance of energy efficiency programs offered by Massachusetts electric distribution companies. Under this charge, DOER has pursued three separate and concurrent activities:

a) ***Development of Statewide Energy Efficiency Goals*** -- DOER developed statewide energy efficiency goals through an extensive process involving key stakeholders (see Section III of this report). Energy efficiency program administrators use these goals to guide development of their energy efficiency plans. DOER also uses these same goals as the basis for reviewing those plans. Finally, the goals provide the framework for DOER's annual reports to the Legislature on the extent to which energy markets meet statewide goals and objectives.

b) ***Review of Energy Efficiency Plans*** -- The oversight of electric ratepayer-funded energy efficiency activities requires DOER to review distribution company energy efficiency plans in order to ensure consistency with the statewide energy efficiency goals and objectives, and to issue its opinion to the Department of Telecommunications and Energy (DTE). This includes determining whether a distribution company's energy efficiency plan is cost-effective according to DTE cost-effectiveness methodology.[4] DOER also periodically monitors the

[3] As directed by the Legislature in the Act, DOER has promulgated regulations 225 CMR 11.00 (and supporting guidelines) regarding its oversight of electric ratepayer-funded energy efficiency activities. The Massachusetts Register published these regulations in September 1999.

[4] The Act directs DTE to define cost-effectiveness and then review electric distribution company (and municipal aggregator) energy efficiency plans to ensure that the programs are cost-effective and utilize competitive procurement processes to the fullest extent practicable. DTE shall serve as the adjudicator when distribution company or municipal aggregator energy efficiency plans are contested by one or more parties, including DOER. In those instances, DTE will decide the cases based on its own rules and policies and compliance with statewide energy efficiency goals, as identified and articulated by DOER.

implementation of energy efficiency plans to ensure progress toward statewide energy efficiency goals.

c) ***Annual Report to the Legislature.*** DOER also carries responsibility for reporting annually to the Legislature on the extent to which the energy markets are meeting the Commonwealth's energy efficiency goals and objectives. This report, the first of five such progress reports to cover the years from 1998 to 2002, describes progress against those goals and objectives. Specifically, it reports on the operation of electric ratepayer-funded energy efficiency programs (those administered by electric distribution companies[5]), and the extent to which these programs have furthered the development of a competitive market for energy efficiency.

2. DOER's 2001 Energy Efficiency Report to the Legislature. DOER is directed by the Act to recommend whether or not ratepayer funding for energy efficiency programs should continue beyond 2002. If DOER recommends that funding should be continued, it will specify for what customer sectors, and at what funding levels. This report will be provided to the Legislature, accompanied with any proposed legislation, in the fall of 2001. This task requires DOER to establish the extent to which:

a) *competitive markets are working* – Are competitive energy markets providing a full range of energy efficient products and services to all Massachusetts customer classes?
b) *market barriers to energy efficiency still exist* – Do market barriers to energy efficiency still impede the ability of homeowners and businesses to make investments in energy efficiency? In particular, the report will examine whether certain customer classes face greater market barriers to investing in energy efficiency relative to other customer classes.
c) *related economic and environmental goals are being met* – Do investments in energy efficiency bring the savings to homeowners and competitive benefits to Massachusetts businesses that the Legislature assumed in creating the public benefits charge? Conclusions on this and other points will be supported by DOER's findings in both prior annual progress reports analyses and supplementary analyses.

C. Overview of the 1998 Energy Efficiency Report

This report, as mandated by the Restructuring Act, summarizes the extent to which energy markets are meeting statewide energy efficiency goals during 1998. Its also sets forth a framework of indicators against which market progress can be monitored annually. Specifically, the report lays out the 1998 performance of statewide energy efficiency programs against several goals and objectives. It begins to develop a

[5] This report addresses electric utility ratepayer-funded energy efficiency activities, and does not cover energy efficiency activities of municipal power and light companies or natural gas distribution companies.

framework for the further discussion of the transition to a competitive energy efficiency market. Under the latter objective, DOER attempts to describe the energy efficiency industry in Massachusetts as it existed in 1998, and to identify the role that different kinds of competitive energy efficiency market actors play in providing energy efficiency products and services to customers. This analysis includes reporting on the development of energy efficiency services being provided by competitive electricity suppliers and how these activities may help to transform markets for energy efficiency products and services.

The remainder of this annual report is organized as follows:

Section II provides background information regarding electricity consumption and energy efficiency in Massachusetts.

Section III presents the statewide energy efficiency goals and supporting objectives, including a description of the process used to develop the goals and objectives. This section also addresses the contributions of the 1998 electric ratepayer-funded energy efficiency activities to the overall statewide goal regarding economic and environmental impacts.

Section IV explains the contributions of the 1998 electric ratepayer-funded energy efficiency activities to the program cost-effectiveness and customer class allocation objectives, and identifies the associated measures of progress.

Section V describes the contributions of energy efficiency activities to the statewide objectives of balancing immediate and long-term savings for customers, and identifies the associated measures of progress.

Section VI covers the critical objective regarding the development of competitive energy efficiency markets in Massachusetts.

Finally, **Section VII** summarizes the insights drawn from the review of 1998 experience, and future plans for DOER to monitor the development of competitive energy efficiency markets.

The Appendices provide additional depth and supporting information on several of the objectives, as well as further detail on 1998 activities.

II. Electricity Consumption and Energy Efficiency in Massachusetts

A. Massachusetts Electricity Consumption

Electricity is an integral part of virtually every activity in the daily lives of Massachusetts customers. Electricity heats, cools and lights homes, schools, hospitals and businesses, and powers computers and industrial processes. In 1998, the total amount of electricity sold to Massachusetts' customers by investor-owned electric distribution companies[6] was 41,895 million kWh, as shown in **Table 1**.

Table 1: 1998 Electricity Consumption by Customer Sector and Major End-Uses

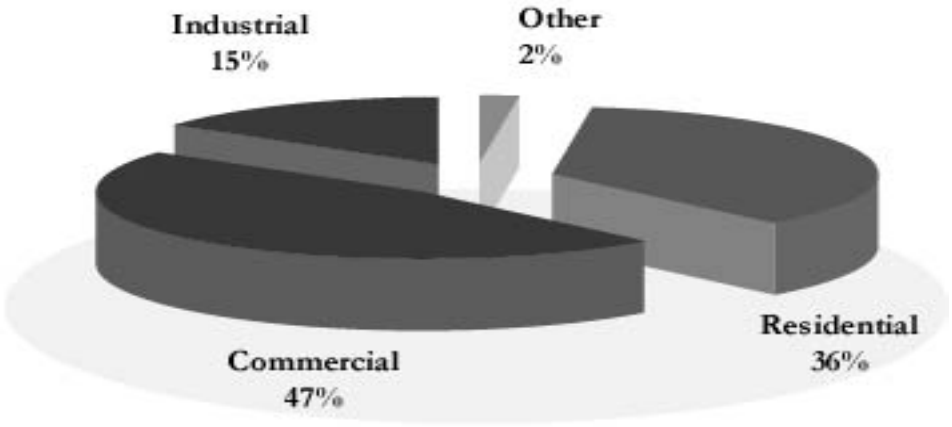
Customer Sector	Electricity Consumption (million kWhs)	Percent of Total	Major Customer Sub sectors	Major End-Uses
Residential	13,992	33%	Single-family and multi-family homes, and apartment buildings.	Space heating and cooling, water heating, venting, refrigeration, lighting, household appliances.
Commercial	20,012	48%	Business, health, educational, and engineering services, retail trade (including food and general merchandise stores), and state government.	Lighting, heating, ventilation, and air conditioning (HVAC) systems, motors and refrigeration.
Industrial	7,603	18%	Manufacturing, including industrial machinery and equipment, electronic equipment, instruments, printing and publishing, and fabricated metals.	Lighting, heating, ventilation and air conditioning (HVAC) systems, motors, boilers, air compressors and process equipment.
Other	288	7%	Street lighting	Traffic lights and street lamps.
TOTAL	41,895	100%		

Source: 1999 Massachusetts Electric Distribution Companies FERC Form 1

[6] The Act exempts municipal electric companies from key provisions regarding mandated energy efficiency funding. Therefore, these figures and all electricity consumption and expenditure data for Massachusetts in this report, are specific to investor-owned electric distribution companies, and do not include municipal electric companies in the state.

The total revenue generated by these sales was $4 billion, of which residential, commercial and industrial end-uses accounted for $1.47 billion (36%), $1.88 billion (47%), and $616 million (15%), respectively, as shown in **Figure 1:** *1998 Electric Distribution Company Revenues.*

Figure 1: 1998 Electric Distribution Company Revenues
Total Revenues = $4.041 billion



Source: MA distribution company 1999 FERC Form 1

B. What is Energy Efficiency?

The DTE defines energy efficiency as "the implementation of an action, policy or measure which entails the application of the least amount of energy required to produce a desired or given output and includes demand-side management and energy conservation measures."[7] Improvements in energy efficiency include replacing energy-using equipment, such as lights, motors, air conditioners, and appliances with more efficient electrical equipment. Virtually every energy end-use could benefit from more efficient technology than what is in general use today. While higher efficiency equipment is often more expensive than standard technology, over time the savings achieved through reduced electricity use and longer lasting equipment covers the higher purchase cost – what is referred to as the payback period. Increased energy efficiency is also realized through changes in practices such as turning off lights or lowering thermostats in unused spaces.

C. Historical Electric Ratepayer-funded Energy Efficiency Activities in Massachusetts

[7] Department of Telecommunications and Energy, Docket 96-100 Definitions

For the past decade, electric ratepayer-funded energy efficiency programs have been a core element of the Commonwealth's energy efficiency policies. Efficiency programs were originally instituted as an alternative path for investor-owned electric utilities to avoid the construction of new generating plants during the late 1980s and early 1990s. This strategy was known as *integrated resource management,* which required that regulated utilities compare the cost-effectiveness of new generation against the cost-effectiveness of reducing energy consumption through energy efficiency measures, and then pursue the least-cost alternative. These energy efficiency, or demand-side management programs (DSM)[8], made economic sense for several reasons. First, DSM programs provided *direct* benefit to the customers who *participated* in them in the form of direct energy savings and lower bills, as well as property improvement due to the installation of high efficient equipment in homes, businesses and facilities. At the same time, savings also accrued to *all* of the electric utility's customers in the form of *system benefits*. For example, these programs reduced electricity demand, therefore postponing the need to build new power plants and avoiding the need for additional transmission lines and transformers. Energy efficiency programs have also traditionally included load management programs that shift energy use during peak demand periods, further reducing capacity demand and increasing system reliability, and therefore benefiting all customers.

In addition to energy savings benefits, energy efficiency programs have provided non-energy and other resource benefits. Non-energy benefits include the creation of employment in the state, increased economic activity stimulated by energy cost savings resulting from energy efficiency investments, increased electric system reliability, and reduced air pollutant emissions. Moreover, because energy efficiency investments help reduce costs for participating customers, they help reduce costs associated with late electricity bill payments, carrying costs, bad debt expenses, and termination and reconnection charges – costs that would otherwise be shared by *all* customers. Finally, other resource benefits include savings to customers in the form of reduced natural gas and water bills. For example, the investment in an energy efficient clothes washer will not only reduce electricity costs for the customer, but will also reduce water use and thus, if applicable, the gas used to heat the customer's hot water for washing clothes.

During the 1990s, energy efficiency programs in Massachusetts secured significant economic and environmental benefits that the market, acting alone, would not have captured. For example, over the five-year period 1994-1998, ratepayer-funded energy efficiency programs resulted in electricity savings totaling over 17,585 million kWh over the lifetime of the efficiency measures that were installed. These savings were achieved at a total cost of $675.4 million (in $1998).[9] This translates to a cost for conserved electricity of 3.8¢/kWh over the five-year period.

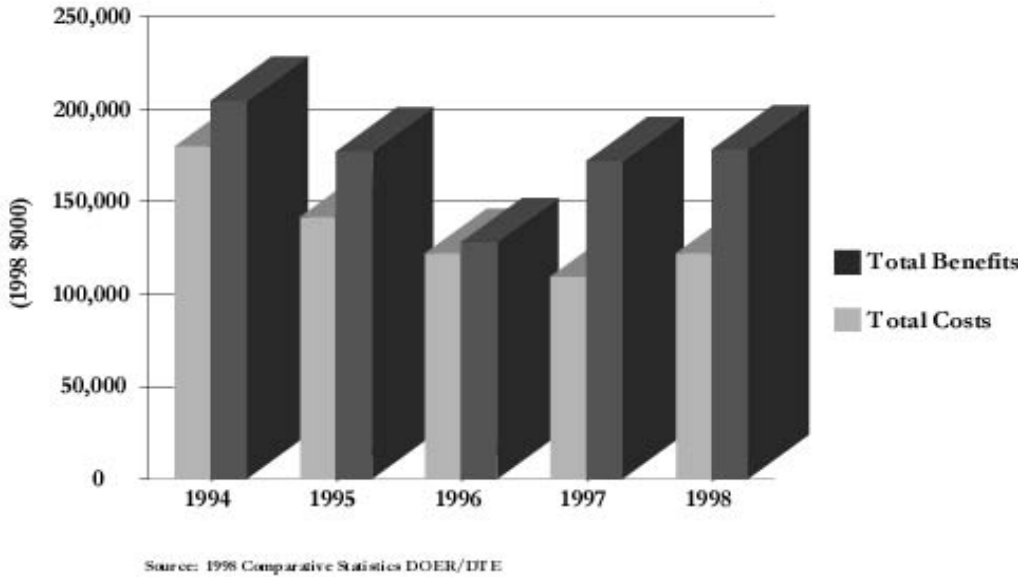
[8] Demand-side Management refers to energy efficiency or load management programs funded by electric ratepayers that are implemented to increase the efficiency of energy use by end users or alter energy consumption usage patterns. Throughout this report, DOER uses the term "energy efficiency" instead of DSM, although the two terms are typically used interchangeably.

[9] This total cost includes program expenditures (funded through the ratepayer energy efficiency charge) as well as participant costs. Participant costs are the investment a customer makes in an energy efficiency project *over and above* what is funded by ratepayer funded energy efficiency programs.

During this same five-year period, the total benefit realized by all customers from these programs was $860 million. Comparing these benefits to total costs of $675.4 million yields a benefit-cost ratio for these programs of 1.3 to 1.0. The calculation of benefits associated with these programs includes the costs that were avoided by the electric utilities as a result of the reduced demand for electricity due to the installation of energy efficiency measures. Without these energy efficiency programs, costs associated with that additional electrical demand would have been passed on to all utility customers through higher electricity rates.

Figure 2: *Historical Comparison of Costs and Benefits* shows the relationship of costs and benefits to customers over the period 1994-1998. In each program year, the total benefits achieved through energy efficiency programs have exceeded the total costs to deliver those programs. In each year, therefore, these investments have been a cost-effective investment for ratepayers (see Section IV.A for further discussion of cost-effectiveness).

Figure 2: Historical Comparison of Costs and Benefits 1994-1998



Source: 1998 Comparative Statistics DOER/DTE

D. Today's Rationale for Ratepayer-Funded Energy Efficiency Activities

The passage of the Restructuring Act in 1997 began a period of fundamental change in the infrastructure of the electricity industry. The divestiture of generating facilities from investor-owned utilities moved decisions about constructing new facilities from regulators and utilities to the competitive market. As a result, the historical basis for ratepayer-funded energy efficiency activities as a tool in integrated resource management is less relevant.

Nevertheless, many of the benefits historically associated with energy efficiency programs, as discussed earlier, remain largely in place in the restructured electricity market. These benefits are summarized as follows:

- direct electricity cost savings for all customers that participate in the programs;
- reducing the need for additional transmission lines or distribution wires and transformers which avoids costs for *all* electricity customers;
- reducing production costs and increasing productivity for Massachusetts businesses and employers in the state as a result of lower electricity costs;
- providing non-energy and environmental benefits, as well as other resource benefits;
- reducing the need for imported electricity and imported fuel to generate electricity, thus reducing the economic drain caused by energy expenditures leaving the state; and
- encouraging local energy efficiency industries to grow in Massachusetts to service state customers as well as export their services.

Finally, while energy efficiency within the framework of IRM is less relevant today, the avoidance of wholesale electricity costs as a result of decreased demand for electricity continues to generally apply during the transition period to a fully competitive electricity market. After this transition period, a more theoretical benefit of energy efficiency programs is the impact they may have on lowering market-clearing prices for all customers, particularly at peaking periods when the spot market plays a more significant role in setting prices. In this new market, electricity from power plants will be procured in order of increasing bids. The market-clearing price paid to all bidding power plant owners will be set by the last, highest bid when the demand for electricity is met (e.g., in a particular hour). When energy efficiency programs lower demand for electricity, especially peak demand, they may displace the need for generation from this last bidder. In that case, the next highest bidder is the one tapped to set the market-clearing price. By eliminating the need for the last, highest bid, a lower clearing price is paid to all generators. This lower clearing price is passed on to all customers, thus reducing electricity costs relative to what they would have been without the efficiency programs. This phenomenon has been documented in several simulation-based studies of a restructured electricity industry.[10]

In Massachusetts, however, the impact of this phenomenon will likely be deferred until after the standard offer lapses in 2004. After the standard offer lapses, the spot market will play a larger role in the pricing of peak electricity and thus overall prices will be more sensitive to demand reductions.

[10] Centolella P., and J. Parmelee. "The Structure of Competitive Power Markets." Science Applications International Corp. Final Report for U.S. Department of Energy Policy Office. January 1997

III. Statewide Energy Efficiency Goals and Objectives

A. Development of Goals and Objectives

During 1999, DOER developed a set of statewide energy efficiency goals and objectives to guide its oversight of Massachusetts' electric ratepayer-funded energy efficiency activities. These goals and objectives, as shown in Table 2, were developed in consultation with the industry stakeholders identified in Appendix B.[11] The goals and objectives provide guidance to energy efficiency program administrators in designing their programs, and enable DOER to review energy efficiency plans for consistency with those goals and objectives. Further, in light of the guidance provided by these goals and objectives, DOER is also able to determine the extent to which ratepayer funded energy efficiency programs are fulfilling them.

The overall statewide energy efficiency goal and its supporting objectives largely came from key provisions of the Restructuring Act. In addition, these statements of direction and intent benefited from extensive public comment through a series of DOER-sponsored stakeholder workshops held over a period of six months in 1999. Finally, although the statewide goals were not finalized until 1999, DOER has chosen to report 1998 energy efficiency activities within this framework for two reasons. First, these goals and objectives are consistent with general policy principles developed in DTE's 96-100 energy efficiency plan guidelines and subsequent settlement agreements with distribution companies on their energy efficiency plans. Second, DOER felt it was appropriate to issue this first annual report within the framework of these goals in order to provide a consistent and comparative framework for future annual reports.

[11] During the stakeholder process to develop goals, a total of ten goals were developed. For the purposes of this report to the Legislature, DOER has consolidated the ten statewide energy efficiency goals to one overall goal and four broader objectives in order to present 1998 energy efficiency activities in a more understandable format.

Table 2: Massachusetts Energy Efficiency Goals

OVERALL STATEWIDE ENERGY EFFICIENCY GOAL:
Protect the environment and strengthen the economy by increasing the efficiency of energy use.
ENERGY EFFICIENCY OPERATIONAL GOALS:
Reduce the use of electricity cost-effectively (as defined by the DTE).
Ensure that energy efficiency funds are allocated to low-income customers consistent with the requirements of the Act, and allocated equitably to other customer classes.
ENERGY EFFICIENCY PROGRAMMATIC GOALS:
Reduce customer energy costs by balancing short-run and long-run savings from energy efficiency programs.
Support the development of competitive markets for energy efficiency products and services

The overall goal requires that energy efficiency activities must contribute to the environmental health and economic well being of the Commonwealth. This goal is intended to ensure that energy efficiency is seen clearly as a means to an end, and not as an end in and of itself. In other words, the overriding goal is to strengthen the economy by reducing electricity costs to customers, increasing employment and income in the state, and to protect the environment by reducing the emissions of harmful air pollutants that otherwise would be emitted. Within this goal are several measures that can be used to track progress. These are further developed in Sections III.

The ***operational objectives*** for ratepayer-funded energy efficiency programs are largely mandatory requirements of the Act. First, the Act requires that the energy efficiency programs be cost-effective according to a methodology approved by DTE. Second, the Act requires that funding levels for low-income programs be the greater of 0.25 mills[12]/kWh or 20% of the energy efficiency funding level for residential programs. A subset of this objective is to ensure equitable allocation of energy efficiency funds to other customer classes, namely residential (non low-income) and commercial and industrial (C&I), where expenditures by customer class are consistent with customer class collections.

The ***programmatic objectives*** include a combination of objectives set forth both explicitly and implicitly by the Act, together with long-standing state energy efficiency policies. These objectives require that energy efficiency programs be designed so that they provide both immediate as well as long-term electricity cost reductions to customers. In addition, programs should be designed to support the development of competitive markets for energy efficiency products and services.

[12] A mill is one-tenth of a cent or one-thousandth of a dollar. For definitions of this and other terms throughout this report, please refer to Appendix H: *Glossary of Terms.*

The following sections are organized around the contributions that 1998 electric ratepayer-funded energy efficiency activities made to the overall goal and the four specific supporting objectives.

B. Overall Statewide Energy Efficiency Goal

In 1998, energy efficiency activities produced numerous direct and indirect economic and environmental benefits for Massachusetts. Energy efficiency programs reduced consumers' energy costs, boosting disposable income for residential and commercial consumers, and increased productivity and profit for businesses while reducing the environmental impacts associated with electricity consumption. Each of the two subsets of this overall goal – economic benefits and environmental benefits – is examined separately in the following pages.

1. Economic Benefits

Energy efficiency actions can result in several forms of direct and indirect savings. These savings accrue directly to customers that participated in the energy efficiency programs, and indirectly to the electric power system overall as well as the Massachusetts economy. These benefits are realized both in the short-run and over time.

Table 3: *Summary of Economic Impacts Due to 1998 Ratepayer-funded Energy Efficiency Activities* summarizes the specific economic impacts of the 1998 energy efficiency programs in terms of total bill savings for customers who participated in the programs, net employment, and associated earnings from energy efficiency expenditures.[13] These impacts are discussed in the following paragraphs.

[13] The employment and associated earnings impacts provided in Table 3 are based on the following three components: (1) the *increase* in economic activity as a result of expenditures on efficiency programs, (2) the *decrease* in economic activity as a result of decreased expenditures on electricity supply, and (3) the *increase* in economic activity as consumers *increase* their spending for other goods and services, to the extent that efficiency programs reduce consumers' overall costs, and these savings are available for other spending. Please refer to Appendix C for a full description of the model and supporting assumptions.

Table 3: Summary of Economic Impacts Due to 1998 Ratepayer-funded Energy Efficiency Activities

A. Bill Impacts	
Energy Savings	
Total Participant Annual Energy Savings	$19.2 million
Total Participant Lifetime Energy Savings	$265 million
Estimated Average Cost for Conserved Energy	3.6¢/kWh
Capacity Savings	
Total Participant Annual Capacity Savings	$0.4 million
Interruptible Service Credit Payments	$3.8 million
B. Employment Impacts	
Net Employment	815 jobs
Income from Net Employment	$30 million

Source: DOER, E^{3}AS (Energy, Economic, and Environmental Analysis System) Model. See Appendices C-D

1.1 Electricity Savings and Bill Reductions

As reported in DOER's 1998 Market Monitor report, restructuring the Massachusetts electric industry has substantially reduced costs for customers. Nonetheless, in 1998 Massachusetts' consumers continue to face relatively high average electricity rates compared to other states.[14] Energy efficiency provides consumers with an opportunity to further reduce their bills by reducing the total electricity they use. This can be achieved through energy and/or capacity savings.

Energy savings represent the electricity savings available immediately to customers in the form of bills lowered because fewer kilowatt-hours were used. *Capacity* savings represent the impact that the energy efficiency programs have on reducing demand on the electricity system during very high or "peak" periods, when the cost of electricity is more expensive. Both energy and capacity savings can be described in two ways – first, *annual* savings, that accrue in the year that energy efficiency measures were installed. Second, *lifetime* savings reflect the customer's savings over the entire period during which the energy conservation measures remain in place. DOER's analysis shows that energy efficiency activities resulting from 1998 program offerings provided positive economic impact in all of these categories.

[14] The average electricity rate for Massachusetts customers in 1998 was 9.5¢ per kWh compared to the national average of 6.8¢ per kWh.

Table 4: *Energy and Capacity Savings from 1998 Programs* shows the impact of the 1998 programs on electricity savings, in terms of both energy and capacity savings.[15]

Table 4: Energy and Capacity Savings from 1998 Programs

Type of Savings	1998 Savings
Energy Savings	
Annual	263 million kWh
Lifetime	3,417 million kWh
Capacity Savings	
Annual	125,501 KW

Energy Savings. The estimated total *annual* energy savings in 1998 were 263 million kWh. This amount translates roughly to the annual electricity use of 39,000 households[16], or a city the size of Cambridge. These savings resulted in annual bill reductions totaling over $19 million for participating customers.

Table 5: *1998 Electricity Bill Impacts for Participating Customers* provides a summary of the average annual bill impact per participant for specific customer classes as a result of the energy savings (these do not reflect capacity savings). Customers were able to realize savings of between 6% to 13% on their total annual electricity bills. For all customers who participated in 1998 programs,[17] annual energy savings totaled over $19 million.

[15] All information in this report regarding savings, program expenditures, bill impacts etc. is aggregated across all Massachusetts electric distribution companies. For information specific to a distribution company, contact DOER.

[16] This assumes an average electricity use of 600 kWh per month per household.

[17] The participation rates in Table 5 represent participation in the energy efficiency programs only for 1998. Participation to date (i.e., since inception of the programs) is 67% for residential (including low-income), 20% for commercial and 43% for industrial customers. Also note that for the low-income customer class, the number of Total Customers and thus Percent of Customers Served In 1998 reflects only low-income customers on a discounted low-income electricity rate, and not the number of low-income customers defined by 175% of Federal Poverty Line (as directed by the Act). DOER roughly estimates, based on 1990 census data, that the number of customers at the 175% of FPL in 1998 was 391,400. Based on this value, the percent of low-income customers served in 1998 was 3.3%. These values assume all customers at the 175% of FPL were customers of record.

Table 5: Electricity Bill Impacts for Participating Customers

Customer Class	Total Customers	Number of Participating Customers	Percent of Customers Served in 1998	Annual Bill Reduction per Participating Customer	Reduction as a Percent of Total Average Annual Bill
Low-income	166,744	12,946	8%	$63	13%
Residential	1,893,440	132,795	7%	$42	6%
Commercial	237,843	3,241	1%	$2,521	6%
Industrial	9,278	634	7%	$7,173	7%

Source: DOER Bill Impact Analysis, DOER/DTE Comparative Statistics of 1998 Ratepayer-Funded Energy Efficiency Activities

Furthermore, for the productive lifetime that the energy efficiency equipment remains in place – an average of 10-15 years – total savings grow to approximately $265 million for participating customers. These savings are in addition to those realized and mandated through electric deregulation.

Hanover Household

Ellen Robinson of Hanover participated in Eastern Edison's Residential Efficiency Services Program in 1998. The energy efficiency services provided in her home included the installation of efficient lighting, low-flow showerheads, faucet aerators, air sealing, insulation, and ventilation measures. Ms. Robinson was provided $1,206 in customer rebates, and she contributed an additional $92 for a total cost of $1,298. Annual savings from energy efficiency measures are estimated to be 7,397 kWh, and lifetime savings from these measures are estimated to be 157,400 kWh. These translate to $670 in annual savings and over $14,000 over the life of the measures

Another way to quantify the impact of energy savings from 1998 energy efficiency programs is to compare the costs of those programs and the energy they save over time, with the cost of providing the electricity that would otherwise have been needed. Projected lifetime energy savings from 1998 programs will result in 3,417 million kWh for a total investment of $122 million.[18] This translates to an estimated average cost for conserved energy of 3.6¢/kWh – 60% less expensive than the projected total average retail electricity price over the same period of 9.6¢/kWh.[19]

[18] This $122 million includes 1998 energy efficiency expenditures (funded through the ratepayer energy efficiency charge) of $99.3 million, plus participant costs of $22.7 million.

[19] Source: DOER Energy 2020 Model. This average retail electricity price reflects prices over the average productive life of the energy efficiency measures installed in 1998, and includes all components of electricity price (e.g., generation, transmission, distribution and customer charges).

Capacity Savings. The energy efficiency programs also resulted in *capacity* (or demand) savings. The 1998 program activities resulted in annual capacity savings of 125,501 kilowatts (kW). This is equivalent to the combined peak load of communities the size of Danvers and Holyoke. More than half of these savings was attributable to load management programs. These load management programs were primarily C&I interruptible service programs, in which large C&I customers agreed to reduce their electricity load when called upon by their distribution company during capacity shortage or emergency situations. In 1998, participating C&I customers received $3.8 million in interruptible service credits. In order to maximize the benefits of these interruptible credits, distribution companies encouraged participating customers to apply the credit payments to investments in energy efficiency at the customers' facility.

The Cooperative Interruptible Service (CIS) Program

Massachusetts Electric offered a monthly credit to C&I customers in exchange for their agreement to reduce electricity load when called upon by the distribution company. Two notification periods were available: one-hour notice and previous business day notice. Bonuses and penalties to the basic credit were used to enforce customer performance. In 1998, 79 customers participated in the CIS program, and were credited over $2 million for providing a total of 31,021 kW of electricity demand available for reduction. Actual interruptions occurred on three days during the year, when all 79 customers were called upon to reduce their loads. This program is currently closed.

In addition, over 40,000 kW, or a third of the total capacity savings, provided direct bill savings for certain participating customers – specifically those that have a demand charge component on their electricity bill, such as medium and large C&I customers. DOER estimates these savings to be roughly $400,000. These capacity savings will persist over the productive life of the energy efficiency measures installed in 1998, thus benefiting the participants over the long-term.

These annual and lifetime capacity savings also benefit other customers indirectly. In the short-term, capacity reductions such as those achieved through load management programs reduced the cost of peak load electricity during constrained periods, thus reducing the higher cost for electricity that would have been shared by all customers. Over the longer term, capacity savings help to reduce wholesale electricity costs as well as displace or prolong the need for additional transmission lines and transformer costs, which would otherwise be paid for by all customers. These benefits are typically referred to as "system benefits" of energy efficiency programs, because they accrue to the entire electricity system (e.g., all customers) as opposed to only those customers that participated in the energy efficiency programs.

1.2 Economic Development Impacts

The economic development impacts of 1998 energy efficiency program activities are visible in several forms. These include job creation in the energy efficiency industry and other industries in Massachusetts, and direct savings to C&I customers and associated opportunities for capital reinvestment and/or competitive improvements.

Over the past decade, ratepayer-funded energy efficiency activities in Massachusetts have helped local energy efficiency industries to grow. It has been estimated that the industry employs at least 20,000 people in over 750 service and manufacturing companies, producing annual revenues of $1.5 to $2 billion.[20] Although ratepayer-funded programs do not account for all of this employment, they contribute significantly to this business growth.

Springfield Meat Packer

Hatfield Quality Meats, a Pennsylvania-based company, opened a new facility in Springfield Massachusetts to process and pack high-end pork products. In 1998, the company participated in Western Massachusetts Electric's economic development program, which included the installation of efficient lighting, process, air compressors, air dryers and insulation. The customer received rebates in the amount of $8,925, and is estimated to reduce its electricity bill by $12,000 annually, or $250,000 over the lifetime of the energy efficiency measures installed.

To examine the employment impacts of 1998 energy efficiency program investments; DOER used the E^{3}AS (Energy, Economic and Environmental Analysis System) software, as described in Appendix C. The model generated estimates of the economic impact associated with the 1998 energy efficiency programs. Because the model did not recognize all the benefits of energy efficiency,[21] its estimates of 1998 employment impacts from energy efficiency are conservative. Nonetheless, DOER estimates that 1998 ratepayer funded programs will provide a net increase in state employment of approximately 815 jobs over the next decade, most of which will develop in the near-term. This net employment increase represents additional statewide income of $30 million. These jobs will be concentrated in the areas of manufacturing (notably machinery and electrical equipment), as well as wholesale/retail trade, and business services (including design and engineering services).

1998 energy efficiency programs also targeted specific economic development projects.

Fitchburg Medical Center

As part of Fitchburg, Gas & Electric's small commercial retrofit program, North Central Kidney Center in Fitchburg was provided with $7,755 in rebates in 1998 to install efficient lighting including T-8 lamps and electronic ballasts. The estimated annual electricity savings were 28,143 kWh, providing annual savings of nearly $2,800 to the customer. Over the lifetime of the efficient lighting installed, the project and facilities. DOER's analysis also did not consider other non-monetary benefits from energy efficiency, which are largely non-quantifiable, yet worth noting. These include: reducing reliance on energy imports, hedging against future oil price increases or shocks, preventing strain on gas and oil transportation and storage systems, and improving electric system reliability.

savings are 422,145 kWh and over $40,800 in savings to the customer.

[20] *The Energy Efficiency Industry and the Massachusetts Economy*. Massachusetts Energy Efficiency Council, 1992.

[21] For example, the model does not estimate the benefits associated with avoided gas, oil and water consumption or increased business productivity and the potential for reinvestment in improved equipment

Through these projects, energy efficiency services were provided in 1998 to over 2,500 small commercial customers, resulting in annual savings of 52 million kWh.

2. Environmental Benefits

The overall statewide energy efficiency goal acknowledges the detrimental environmental affect that electricity generation has on the environment. By reducing electricity consumption, energy efficiency reduces emissions caused by fossil fuel combustion. In 1998, almost 55% of all electricity generation in the New England region was from fossil-fueled generation plants. Among the environmental consequences of energy-related emissions are acid rain, the formation of stratospheric ozone or smog, and climate change, or global warming.

2.1 Environmental Impacts of Energy Efficiency

All Massachusetts generating facilities are regulated for five criteria pollutants under the Clean Air Act (CAA) and Clean Air Act Amendments. In addition, although global warming and its precursor greenhouse gases are not regulated, many audiences are increasingly concerned about atmospheric concentrations greenhouse gases. Further background on the emissions associated with electricity generation and their environmental and health effects are included in Appendix F.

Clean Air Act -- The combustion of fossil fuels to generate electricity produces nitrogen oxides, sulfur dioxides, ozone, particulate matter, and carbon monoxide. These five "criteria air pollutants" (in addition to lead) all have serious health implications, and are still present in Massachusetts at levels that represent health risks. The most significant health implications of electricity generation are caused by emissions of nitrogen oxides (NO_X) and sulfur dioxide (SO_2).

Nitrogen Oxides. Massachusetts is classified as being in non-attainment of federal ozone standards. Ground-level ozone is the principal component of smog and is formed by the chemical reaction of NO_X and volatile organic compounds (VOCs). According to the EPA, in 1998 regional electricity generation produced over 69,000 tons of NO_X, of which 54% or 37,600 tons were produced by Massachusetts generating plants.

Sulfur Dioxide. SO_2 is a main component of acid rain and a major contributor of soot. In 1998, New England electricity plants generated over 270,000 tons of SO_2, of which 56% or 151,000 tons were produced by Massachusetts's plants.

Global Warming -- Increasingly, attention is being given to the threat of global climate change from emissions of heat-trapping carbon dioxide, the primary byproduct of fossil fuel combustion. Climate change has the potential to cause abnormal weather patterns, rises in sea level, and economic disruptions. The science of climate change has become more certain, particularly with the release of the Intergovernmental Panel of Climate Change Second Assessment Report, which concluded, "the balance of evidence suggests a discernible human influence on global climate," as a result of greenhouse gas emissions, primarily CO_2.[22]

Carbon Dioxide. In 1998, New England electricity generating plants produced an estimated 42 million tons of CO_2 emissions. Of this amount, 58% was produced from Massachusetts' plants, or 24.4 million tons. While the planned introduction of cleaner, natural gas fired generation in the region and more stringent federal Clean Air Act requirements will substantially reduce NOx and SO_2 emissions, these generation technologies will continue to emit significant quantities of CO_2, absent the introduction of cost-effective CO_2 emission control equipment.

Other Environmental Benefits – Energy efficiency directly and indirectly reduces other environmental effects associated with energy consumption. These effects may include reduced water and land pollution from fuel mining and extraction activities, reduced effect on aquatic populations and water quality through the operation of water intake systems, thermal discharges, and solid and toxic chemical discharges into water bodies. Moreover, land impacts of energy-related solid waste disposal can include problems associated with the disposal of potentially hazardous ash, solid wastes from pollution control technologies, and high and low-level radioactive waste produced from nuclear generating facilities.[23]

[22] Intergovernmental Panel on Climate Change, *Second Assessment Report,* 1996.
[23] B. Biewald, et. al., *Societal Benefits of Energy Efficiency In New England,* Tellus Institute, 1995.

2.2 Emission Reductions from Energy Efficiency

DOER analyzed the impact of ratepayer-funded energy efficiency programs had on emissions of NO_X, SO_2 and CO_2 over the life of the energy conservation measures installed in 1998. The E^3AS model was used to develop estimates of the emission reductions associated with 1998 energy efficiency programs. Estimates of emission reductions are shown in **Table 6:** *Impact of 1998 Energy Efficiency Programs on Reducing Electric Power Plant Emissions (see next page).* The values in Table 6 reflect emission reductions in 1998 due to the installation of energy efficiency measures in that year, as well as emission reductions over the lifetime of the measures installed in 1998.

Table 6: Impact of 1998 Energy Efficiency Programs on Reducing Electric Power Plant Emissions

Pollutant	Environmental/Health Impacts	1998 Regional Emissions (tons)	Emission Reductions 1998 (tons)	Emission Reductions Over Lifetime (tons)
Nitrogen Oxides (NO_X)	Smog, acid rain, lung damage, respiratory system illnesses	69,000	340	1,335
Sulfur Dioxide (SO_2)	Acid rain, damage to trees and lakes, lung damage, respiratory system illnesses	270,000	535	1,795
Carbon Dioxide (CO_2)	Climate change, abnormal weather patterns, rise in sea level, increases in temperature	42,000,000	220,000	1,950,000

The 1998 NO_X emission reductions are equivalent to roughly the annual emissions of 25,700 passenger cars. The annual SO_2 emission reductions of 535 tons is equivalent to avoiding the burning of 22,000 tons of bituminous coal, the primary type of coal burned for electricity generation. The 220,000 tons of reduced CO_2 emissions is equivalent to 9% of the reduction that Massachusetts electric generating plants would have to make from 1990 CO2 emissions levels in order to meet the Kyoto Protocol.

It is important to note that while the 1998 energy efficiency activities provided direct environmental benefits to Massachusetts customers, the extent to which these activities reduced emissions *generated in Massachusetts* is difficult to determine. This is due to the regional nature of the New England electricity system. Because electricity in Massachusetts is obtained from the regional grid, it is not possible to trace reduced electricity use in Massachusetts to reductions in the operation and emissions of any particular Massachusetts generating facilities. Instead, emissions reductions from energy efficiency benefit the region overall rather than any specific state. At the same time, because other New England states support publicly funded energy efficiency programs that also reduce regional emissions, Massachusetts' air quality reaps benefits from regional energy efficiency investments as well as from those made in Massachusetts. Energy efficiency can play a role in reducing emissions of these criteria pollutants, especially in the short-term prior to the implementation of tighter NO_X and SO_2 controls

expected by 2003 and 2004. Over the mid- and longer-term, however, new combined cycle natural gas generation facilities are coming on-line throughout New England,[24] concurrent with the implementation of tighter emissions controls for both NO_X and SO_2. These two trends will result in an electrical generating system that emits substantially less NO_X and SO_2 in 2010 than it will in 2000.[25] As a result of these changes, each kWh of electricity displaced by energy efficiency in 2010 will avoid fewer tons of pollutants than will the same kWh avoided in 1998. Over time, then, the NO_X and SO_2 emissions reductions associated with energy efficiency will become less, as the overall electrical generation system becomes cleaner. It is important to point out, however, that these same two trends will have less effect on emissions of CO_2, which is neither regulated nor for which there are currently cost-effective controls.

C. Summary: Progress Towards the Overall Statewide Goal

Economic Impacts: DOER's economic analysis concludes that net gains were made as a result of 1998 ratepayer funded energy efficiency activities, including net gains in employment and earnings. Furthermore, customers who participated in the energy efficiency programs reduced their annual bills, and will continue to have lower bills over the lifetime of the conservation measures installed in their facility or home (relative to what they would have paid absent the energy efficiency investments). This essentially increased customers' discretionary spending, with corresponding benefits to the state economy. Thus, the activities were beneficial not only to participating customers, but also to the state as a whole.

Environmental Impacts: Currently, there are many strategies – both regulatory and market-based -- underway to combat the air quality effects of electricity generation. These include federal regulations such as the Clean Air Act and CAA Amendments, regional efforts directed by the Northeast States Coordinated Air Use Management (NESCAUM), market-based programs such as tradable allowances for SO_2 and NO_X, as well as voluntary programs that promote energy efficiency and renewable energy. While electric ratepayer-funded energy efficiency programs in Massachusetts represent only a piece of this larger effort to reduce air pollution, these programs nonetheless play an important role in improving Massachusetts air quality and the health of its citizens. DOER concludes that 1998 energy efficiency activities contributed to protecting the environment by improving air quality in the state and region. Further, DOER concludes that the lifetime emissions reductions associated with 1998 energy efficiency programs will continue to make a significant contribution to air quality improvements and CO_2

[24] DOER's Market Monitor Report in September 1999 noted that over 30,000 MW of new generation was proposed, the bulk of it being natural gas.

[25] DOER's E^3AS analysis reflects these changes in the forecasted regional portfolio of electric generation sources in New England over the next decade, as described in Appendix C.

emissions reductions for years to come, thus helping Massachusetts and New England meet climate change and CO_2 reduction goals.

IV. Program Cost-Effectiveness and Customer Class Allocation of Funds

The 1998 electric ratepayer-funded energy efficiency activities contributed to the operational objectives regarding program cost-effectiveness and equitable allocation of funds to customer classes. These objectives are addressed in turn.

A. The Cost-Effectiveness Objective

The Act requires that energy efficiency programs supported by ratepayer funds be cost-effective as defined by the Department of Telecommunications and Energy (DTE). In order to determine whether and to what extent energy efficiency programs are cost-effective, both program administrators and DTE regulators compare the benefits of a program to the costs of that program, and calculate a benefit-cost ratio. A program with a benefit-cost ratio of 1.0 or over is considered to be cost-effective.

There are several ways to calculate cost-effectiveness. In 1998, the majority of distribution companies applied the *electric system test* to determine whether energy efficiency programs were cost-effective.[26] The electric system test specifically considered benefits and costs to the electric system as a result of the energy efficiency programs, and was used to ensure that electric ratepayers received net benefits from the energy efficiency programs they funded. Benefits included avoided wholesale electricity costs, as well as avoided transmission and distribution costs to the distribution company that otherwise would be passed on to ratepayers. These "system" benefits also included contributions that load management programs made to maintain system reliability during capacity shortage or emergency situations. The denominator of the cost-effectiveness ratio was simply the annual energy efficiency program costs funded by ratepayers. In 1998, the statewide benefits to the electric system outweighed costs to ratepayers by a ratio of 1.8 to 1, as shown in **Table 7:** *Cost-Effectiveness of 1998 Energy Efficiency Programs*.

[26] In 1998, the DTE did not require that a single type of cost-effectiveness test be used to screen energy efficiency programs. Rather, distribution companies used a number of cost-effectiveness tests to screen their programs, including an electric system test, a societal test, and a total resource cost test. Only sufficient data was provided to DOER by distribution companies to support the electric system test. As of the writing of this report, DTE is in the process of developing standard cost-effectiveness guidelines (Docket 98-100) that will apply to all distribution companies for program activities in the years 2000-2002.

Table 7: Cost-effectiveness of 1998 Energy Efficiency Programs

Customer Sector	Benefits (millions)	Cost (millions)	Net Benefit (millions)	Benefit/Cost Ratio
Low Income	$10	$8	$2	1.3
Residential (non L/I)	$27	$24	$3	1.1
C&I	$141	$67	$74	2.1
TOTAL	$178	$99	$79	1.8

The C&I programs were almost two times more cost-effective than residential programs. This reflects the fact that economies of scale tend to favor C&I customers, as their costs to purchase and install energy efficiency measures are less per unit over the larger scale of most C&I projects.

In addition, C&I customers utilize electricity for a greater proportion of each 24-hour period than do residential customers, and therefore see greater savings because energy conservation measures are in use more frequently. For these reasons, greater benefits accrued to C&I customers.

Total Program Costs in 1998. In 1998, total funds collected from all customers were $137.5 million, while $99.3 million were actually expended, as shown in Table 7. The difference in the amount collected versus the amount expended is attributable to several factors, including 1) the new funding levels mandated by the Act, and the ramp-up time needed to implement new programs, 2) a portion of funds were committed to energy efficiency projects at the end of 1998 but were not yet expended, and 3) the difficulties of implementing coordinated programs across distribution companies. Unexpended funds, plus interest, were carried forward to 1999 program budgets for customer classes on an equitable basis.

B. The Customer Class Allocation Objective

The Act directs DOER to ensure that ratepayer funding for energy efficiency activities is equitably allocated among customer classes. The extent to which funds were equitably allocated to customer classes is also influenced by specific requirements set forth in the Act regarding low-income customers. The

Low Income Energy Efficiency Services

Over 12,900 low-income customers were served with $8.3 million in energy efficiency activities during 1998. These programs resulted in estimated annual bill reductions of $62 per participating customer. Services provided included customer home energy audits, education about the customers' electric bills, replacement of high energy-use refrigerators, and installation of energy conservation measures such as compact fluorescent lighting. These programs also provided wall and ceiling insulation and programmable thermostats to electric space heat customers. All measures were provided at no cost to low-income customers. As directed by the Act, the low-income programs were largely administered and delivered by the low-income Weatherization Assistance Program and fuel assistance program network and coordinated closely with gas utilities.

Legislature specifically directed low-income program funding levels to be the greater of 0.25 mills/kWh (based upon total kWhs sold), or 20% of energy efficiency funds collected from all residential customers, and that this charge would continue beyond 2002 without further legislative action. In mandating the continuation of the low-income charge, the Legislature acknowledged that competitive markets will not successfully or completely serve these customers, and therefore this customer group can especially

Low-Income Multi-Family Program

In 1998, Com/Energy provided energy efficiency services to Tripp Towers in New Bedford as part of its Low-income Multi-family program. The energy efficient measures installed included super-efficient refrigerator and energy efficiency lighting retrofits. The program provided estimated annual savings of 154,000 kWh, or $15,000 per year. Over time, these measures will save almost 2 million kWh and $225,000 for low-income families

benefit from ratepayer-funded energy efficiency programs.

In evaluating success at meeting the overall customer allocation objective, DOER examined the level of collections for each customer class compared to the expenditures made on behalf of each customer class and the low-income funding requirements of the Act.

Collections From Customer Classes. Funds were collected from each electric customer at the mill rate (3.3 mills per kWh) specified in the Act, based upon each customer's total electricity consumption in kWh. The collections from each customer category (as a percent of total collections) is reported in the first section of **Table 8:** *1998 Energy Efficiency Fund Collections and Expenditures.* Collections from C&I customers provided the greatest portion of the energy efficiency funding, at 70%. Non- low-income residential customers provided the second largest portion, at 27%, followed by Low-income customers at 3%.[27]

[27] 1998 customer class collections are calculated as: March-December 1998 sales by customer class times 3.3 mills/kWh plus conservation charge collections from Jan-Feb 1998 for each customer class. The latter part of this formula reflects energy efficiency charge collections in place prior to the Act, and varies by company.
Note that the 3% value for the low-income class reflects collections from only low-income customers on the discounted low-income electricity rate, and not all low-income customers defined by 175% of the Federal Poverty Line (as directed by the Act). DOER roughly estimates based on 1990 census data that the number of customers at 175% of the FPL in 1998 was 19% of total residential customers. Based on this value, collections from low-income customers in 1998 would have been 6% of total collections in Column A of Table 8 (instead of 3%). This assumes that all customers at the 175% of FPL were customers of record.

Table 8: 1998 Collections and Allocation of Expenditures by Customer Class

Customer Class	Collections		Allocations	
	A. All Customer Classes	B. Residential (non L/I) and C&I	C. All Customer Classes	D. Residential (non L/I) and C&I
Low Income	3%	n/a	8%	n/a
Residential (non L/I)	27%	28%	24%	27%
C&I	70%	72%	68%	73%

Expenditures for Customer Classes. Expenditures represent those investments of program collections in the energy efficiency programs. In light of the market barriers faced by low-income customers, the Act requires funding for the low-income sector that is *above* what these customers contribute to the energy efficiency fund. As a result, collections from the residential (non low-income) and C&I classes are greater than the energy efficiency expenditures for these classes, as demonstrated in columns A and C of Table 8.

To evaluate the level of collections compared to expenditures for the residential (non-low-income) and C&I classes, however, it is necessary to adjust collections for the amounts that were *contributions made by these customer sectors to support the low-income funding*. Once that adjustment has been made, the energy efficiency expenditures for these two customer sectors can be seen as equitable: the collections are roughly equivalent to expenditures, as demonstrated in columns B and D of Table 8.

This analysis shows that in 1998, residential (non-L/I) and C&I expenditures were generally proportional to their respective collections of 28% and 72%, after their respective contributions to low-income program funding were made.

As noted earlier in this section, not all energy efficiency funds collected in 1998 were expended. Of the total $137.5 million collected, $99.3 million was expended. In order to ensure that funds continue to be equitably allocated, the unexpended 1998 funds (plus accrued interest) were carried forward to the 1999 program year, and allocated to the same customer class to which they were allocated in 1998.

C. Summary: Progress on Cost-effectiveness and Customer Class Allocation Objectives

Program Cost-Effectiveness Objective: DOER concludes that the cost-effectiveness of 1998 programs was generally consistent with the DTE requirements. However, as of the writing of this report, the DTE has approved only preliminary 1998 energy savings estimates filed by some of the distribution companies. It is anticipated that final 1998 estimates will be filed and approved by DTE in year 2000, at which time energy savings data will be updated with final estimates and reconciled accordingly. Any substantial

changes to the cost-effectiveness reported herein will be updated in DOER's 1999 annual report to the Legislature. In the past, however, such adjustments have not materially altered near-term savings projections and thus DOER expects that only minor adjustments to the 1998 findings of cost-effectiveness will occur.

Customer Class Allocation Objective: Based on the broad customer class sectors presented in Table 8, DOER concludes that energy efficiency funds were equitably allocated in 1998. In the future, however, DOER anticipates analyzing the allocation of funds among more specific customer segments, such as small versus medium and large C&I customers, institutional facilities (e.g., hospitals, schools, and government buildings), and possibly rental versus owner-occupied office space and housing. Analyses of more specific customer segments will help inform how and whether energy efficiency funds are reaching these segments. Such analyses will assist DOER in assessing what barriers these customers face to investing in energy efficiency, and whether ratepayer funding is needed beyond 2002 to assist specific customer segments in making these investments.

V. Balancing Short-run and Long-run Savings for Customers

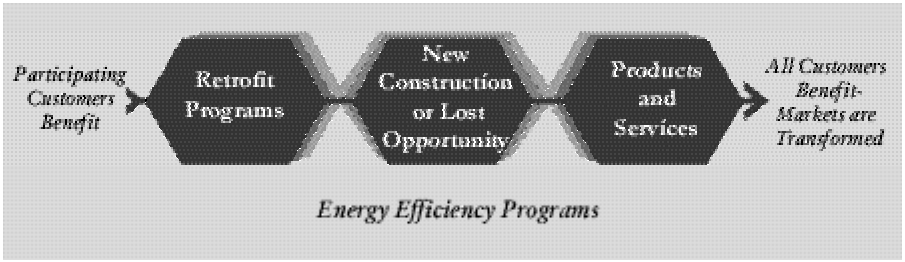
A. Background on the Balanced Savings Objective

Ratepayer-funded energy efficiency programs are intended to serve two fundamental purposes: to provide immediate and long-term savings for *participating* customers, while also laying a broader foundation for future savings for *all* customers through the development of a competitive energy efficiency market. This latter objective suggests that today's programs need to be deliberately designed to tackle the market barriers that stand in the way of the competitive market's offerings of energy efficiency products and services to all classes of customers. **Appendix G:** *Common Barriers to Investing in Energy Efficiency* describes a number of price-related and structural barriers, including incomplete information, poor access to both capital and high efficiency equipment, split incentives in third party situations such as lease, rental or other property management arrangements, and so forth.

Removing existing barriers to the use of energy efficient products and services helps to change – or transform – those markets so that they can indeed support a more fully competitive market in the future. Thus, "market transformation" is not a label that uniquely identifies certain energy efficiency program at the exclusion of others. Rather, market transformation *is an objective* that all energy efficiency programs have the potential to achieve, to at least some extent. Some programs are designed to accomplish specific changes in markets. Other programs may have effects on markets without necessarily targeting those effects as a program objective.

In this framework, market transformation may be thought of as a continuum along which energy efficiency program designs fall. The major types of energy efficiency programs offered in 1998 were Retrofit programs, New Construction (or Lost-opportunity) programs, and Products & Services programs. These program strategies fell along this market transformation continuum, as shown in **Figure 3:** *Market Transformation Continuum*, the following pages, and discussed below.

Figure 3: Market Transformation Continuum



B. 1998 Energy Efficiency Program Offerings

1. Retrofit Programs

> ***In-Home Services Programs***
> A number of distribution companies offered in-home services in 1998. These programs provide comprehensive, whole-house retrofit services and education to residential customers with historically high levels of electricity consumption (e.g., 12,000 kWh per year). Eligible customers receive an energy audit, education on energy savings opportunities, direct installation (free of charge) of low cost efficiency measures and 75% discounts on the installation of major (higher cost) conservation measures.

At one end of the market transformation spectrum are Retrofit programs (referred to as "In-home Services for the residential sector). These programs are designed primarily to provide immediate energy savings and cost reductions to participating customers beginning upon installation and continuing over the lifetime of the conservation measures in their home or facility. They target existing facilities or homes with functioning, but older, less efficient equipment, and offer rebates to encourage replacement of the outdated equipment with higher efficiency products. Rebates are designed to buy down the equipment cost to an acceptable payback period for the customer, usually less than five years. In 1998, retrofit programs were a cornerstone of program offerings, and comprised the largest portion of energy efficiency expenditures.

> ***Transforming the T-8 Ballast Market***
> A good example of a retrofit program market impact in Massachusetts is the transformation of the electronic ballast market for C&I lighting in the early 1990s. As a result of collective action by many electric utility retrofit programs, the technology and distribution channels for electronic ballasts were improved to the point where this technology has become standard practice and rebates are no longer needed. Thus, ratepayer lighting retrofit programs not only delivered savings to participating customers, but they also transformed the market for the higher efficiency equipment, thereby making this technology widely available and affordable to all customers.

Retrofit programs may have affects on transforming markets, whether near-term or more permanent. In targeting a particular technology or practice, facility managers and trades people are introduced to the new product and are more willing to use the product elsewhere without ratepayer subsidies. Manufacturers are provided with a large, stable market and are willing to produce for the market.

The risk of retrofit program strategies is low relative to other program strategies. Because these programs often focus on proven technologies and practices, they virtually guarantee savings to the customers, and involve a limited number of actors (usually only the vendor providing services to the customer). Although they may impact all customers, they primarily affect program participants.

Boston Department Store

Filene's Department Store in Boston's Downtown Crossing replaced a number of old chillers in its buildings with new high efficient chillers, and upgraded and installed additional air conditioning capacity. The total project cost was over $225,000, of which the customer received a rebate for half the cost through Boston Edison's C&I Retrofit program. The energy efficiency improvements provided annual savings of 1.2 million annual kWh and associated cost savings to the department store of $110,000 per year. These savings will continue every year that the energy efficient equipment remains in place, thus providing substantial cost savings over the long-term.

2. New Construction/Lost Opportunity Programs

The next largest portion of funding in 1998 was spent on Lost Opportunity/New Construction programs. These programs focus on encouraging investment in higher energy efficiency at the time of a naturally-occurring market event, such as construction of a new home or building, major expansion, renovation or remodeling, or replacement of failed equipment. [28] New Construction/Lost Opportunity programs are located roughly in the middle of the market transformation continuum shown in Figure 4. They are similar to Retrofit programs in that they use rebates to induce customers to upgrade equipment that provides immediate and long-term savings to the participants.

Leominster Food Processor

Nasoya Foods is a manufacturer of soy milk and tofu products, with facilities located in Leominster, and more recently in Ayer. When Nasoya was renovating their new facility in Ayer, Massachusetts Electric Company provided technical assistance and customer rebates for energy efficient refrigeration systems and efficient plant lighting and motor systems through Mass Electric's Design 2000 energy efficiency program. Nasoya was provided $227,000 in customer rebates, saving over 607,000 kWh in electricity per year. This amounts to an estimated $42,800 in annual savings and $642,200 over the lifetime of the measures installed.

[28] The use of the term "lost opportunity" refers to the opportunity to invest in energy efficiency that would otherwise be lost during a naturally-occurring market event, such as the new construction or renovation of a building.

Lost Opportunity/New Construction Programs differ from most Retrofit programs because they also specifically focus on changing key market players – including architects, designers, and builders – in order to upgrade standard building practice and to raise building codes and standards. Thus, all customers benefit over the long-term in addition to the savings realized by program participants.

Upgrading The Commercial Building Code

An important component of new construction programs is that they help to transform energy efficiency markets by promoting the upgrading of the commercial building code in Massachusetts (CMR 780). In 1998, the Massachusetts Board of Building Regulations and Standards (BBRS) began work on upgrading the commercial code with the goal of revising the code by mid-1999. Ratepayer-funded energy efficiency activities supported the process of upgrading the commercial building code by providing technical information to BBRS and developing commercial building profiles of energy efficiency performance and baselines for design, construction and operation practices.

3. Products & Services Programs

At the other end of the market transformation continuum are programs that are primarily designed to change a technology or service market so that it ultimately delivers energy efficiency products to *all* customers in the long-run, not just to those customers that participated in the programs. Products & Services programs are typically coordinated statewide or regionally. Like Retrofit and New Construction/Lost Opportunity programs, they employ customer rebates for selected high efficient equipment to motivate customers to opt for higher efficiency equipment, and thus yield immediate savings to participating customers. However, the Products & Services programs primarily target the full range of market players – including manufacturers, retail suppliers, architects, engineers, builders, as well as consumers – in order to eliminate barriers across the entire spectrum of the market chain that impede the commercialization of high efficiency equipment.

Residential Products & Services

These programs include the statewide/regional TumbleWash/ENERGY STAR™ Appliances programs. In 1998, numerous Massachusetts electric and gas distribution companies collaborated in a regional initiative for high efficiency clothes washers, facilitated by Northeast Energy Efficiency Partnerships (NEEP). In 1998, the program provided a high visibility television advertising campaign, as well as information and labels for retailers to identify models of appliances that met the ENERGY STAR efficiency guidelines. These guidelines require that ENERGY STAR appliances be at least 11% more energy efficient than required by the Federal Appliance Standards. For the TumbleWash program, a $100 rebate was offered in recognition of the market barrier posed by higher initial costs for the high efficiency washers.

Because Products & Services programs rely on changing the behavior of many market actors, there is a higher perceived risk relative to Retrofit and Lost Opportunity programs. However, at the same time, the potential for substantial and sustainable long-run savings is greater than for other programs because changing markets over time increases the leveraging of considerable private investment in energy efficiency in the longer term. For example, Products & Services programs typically include training for trade allies. The trained trade allies become more comfortable with the technical requirements of high efficiency equipment and thus are willing to recommend these products to all of their customers, and not just to program participants. Thus, the benefits of Products & Services programs accrue to all customers, and not only the program participants.

4. Educational Programs

While all 1998 programs had an educational component to them, some programs focused exclusively on increasing customer awareness of energy efficiency and encouraged targeted audiences to act on the basis of this awareness. These programs included school education programs, home energy audit software programs, and university and trade school education. See Appendix E: *Overview of 1998 Energy Efficiency Programs by Customer Class* for more information on these programs.

Home Energy Auditing Software

A key educational program offered in 1998 was the *EnergySmart* auditing software. Developed by Nexus Energy Software, Inc., the software allows residential customers to analyze energy use in their own homes. The energy efficiency topics included typical appliance energy use, energy savings opportunities, associated costs and benefits, and other information. *EnergySmart* is available in CD-ROM format or can be downloaded directly off of distribution companies' web sites. Some versions allow access to an "Account Link" feature through which residential customers can download their monthly electric energy consumption and cost information.

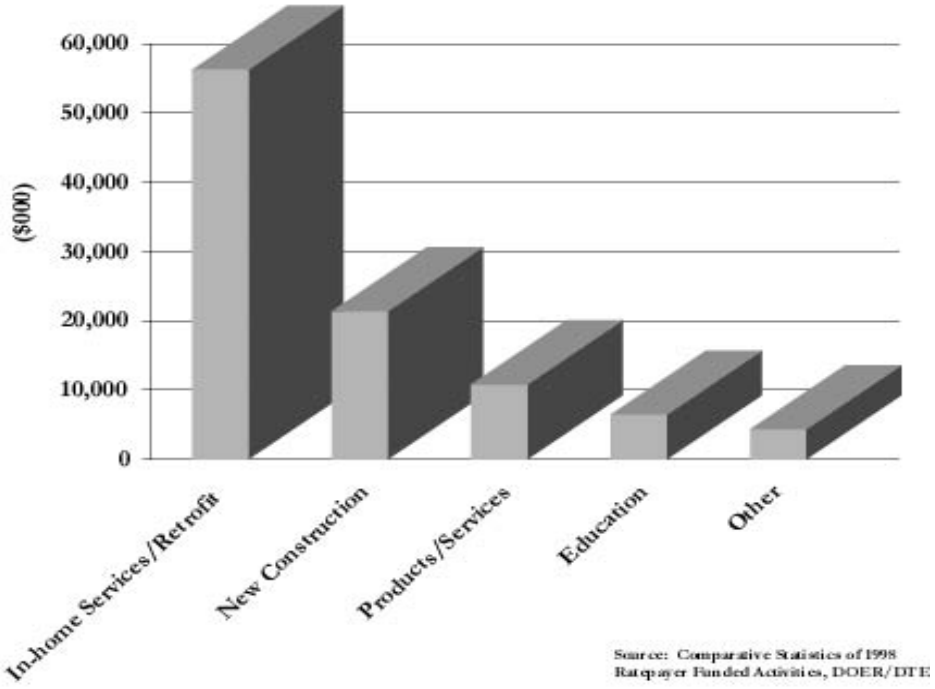
These educational programs would most appropriately fit on the far right of the market transformation continuum because they attempt to target all customers. However, in reality it is virtually impossible to measure their impact on transforming markets, and therefore DOER has elected not to include these programs in Figure 4.

5. Other Programs

In 1998, a number of distribution companies offered load management programs, which primarily constitute the "Other" program category. These programs mostly funded C&I interruptible service programs, in which large C&I customers were paid credits if they agreed to reduce their electricity load when called upon by their distribution company during capacity shortage or emergency situations. In 1998, participating C&I customers received $3.8 million in interruptible service credits, thus providing them immediate "savings." Because these programs also helped to maintain system reliability, they benefited all customers in 1998 as well.

Figure 4: *1998 Allocation of Expenditure by Program Type* summarizes program spending by the types of programs discussed above. In 1998, investments in Retrofit programs represented 57% of all program expenditures, while New Construction/Lost Opportunity programs represented about 22% of total expenditures. Funding for Products & Services was substantially less, at 11%. Educational programs represented 7% of total expenditures and Other program investments were about 4% of the total.

Figure 4. 1998 Allocation of Expenditures by Program Type



C. 1998 Program Expenditures and Savings by Customer Class

Table 9: *Summary of 1998 Program Activity* summarizes the expenditures made by distribution companies to design and implement qualifying energy efficiency programs for different customer groups. These expenditures are further broken down by program type. Finally, annual and lifetime savings attributable to each program category are also summarized. The figures show that:

- 68% of the total 1998 expenditure on energy efficiency programs was directed toward C&I customers.
- Savings from C&I programs constitute 77% of the total energy saved through 1998 programs.
- Retrofit and Lost Opportunity programs predominated for C&I customers.
- Low-income program services focused entirely on in-home services.

- The largest fraction of programming for non-low-income residential customers was targeted to Products & Services programs, followed by In-home Services.
- Savings to residential customers are primarily attributable to In-home Services and Products & Services.

Note that expenditures reported in Table 9 include *all* 1998 energy efficiency expenditures, including administration, marketing, program implementation, program evaluation and performance incentives paid to the distribution companies. A breakdown of program expenditures by cost categories is provided in Figure 6 in Section VI.B.4.

Table 9: Summary of 1998 Program Activity

Customer Sector	Program Expenditures (Millions of $)	% of Total Program Expenditures	Annual Savings (million kWh)	Lifetime Savings (million kWh)	% of Total Lifetime Savings
Low Income					
In-home Services	$8.3	8.4%	11	151	4.4%
Subtotal	$8.3	8.4%	11	151	4.4%
Residential (non L/I)					
In-home Services	$7.1	7.1%	24	282	8.2%
New Construction	$2.7	2.7%	9	105	3.1%
Products and Services	$9.4	9.5%	21	225	6.6%
Information & Education	$4.3	4.3%	2	15	4%
Other	$.4	0.4%	0	0	0%
Subtotal	$23.9	24%	56	627	18.3%
C&I					
Retrofit	$41.0	41.3%	140	1,681	49.2%
New Construction	$18.7	18.8%	47	837	24.5%
Products & Services	$1.4	1.4%	1	10	0.3%
Information & Education	$0.1	0.1%	n/a	n/a	0%
Other	$6.0	6%	7	111	3.2%
Subtotal	$67.1	67.6%	195	2,642	77.3%
GRAND TOTAL	$99.3	100%	262	3,417	100%

Source: DOER/DTE Comparative Statistics of 1998 Ratepayer-funded Energy Efficiency Activities

Appendix E: *Overview of 1998 Energy Efficiency Programs by Customer Class* provides further discussion on program offerings and breakdown of expenditures and savings.

D. Summary: Progress on the Balanced Savings Objective

Table 10 summarizes the short- and long-term benefits of different program strategies funded by ratepayer energy efficiency funds.

Table 10: Summary of Program Strategies

Program Type	Short-Term Energy Savings	Long-Term Energy Savings
Retrofit Programs (or In-home Services)	Substantial immediate energy savings and cost reductions to participating customers, primarily through the provision of rebates.	Programs have long-term saving impacts over the life of the installed conservation measures . However, savings beyond the life of the measures may not be achieved if markets have not been transformed.
New Construction (or Lost Opportunity) Programs	Substantial immediate energy savings and cost reductions to participating customers through the provision of rebates.	Programs have long-term saving impacts over the life of the installed conservation measures . Savings beyond the life of the measures may be achieved as a result of changing standard building practice and upgrading building codes or standards.
Products and Services	Some immediate savings for participating customers through rebates, but the savings ramp-down as the energy efficient product market begins to transform.	Potential for long-term savings is large if technology markets are successfully transformed, thus benefiting not just participating customers, but all customers.
Educational Programs	Focuses on increasing customer awareness about energy efficiency products, and helping customers understand how they can reduce their electricity bills. Difficult to quantify energy savings in short-run.	Focuses on increasing customer awareness about energy efficiency products, and helping customers understand how they can reduce their electricity bills. Difficult to quantify energy savings in the long run.
Other Programs (e.g., Load Management Programs)	Helps customer achieve immediate savings by shifting electricity use to less costly periods of the day, or paying credits to customers for disrupting service during capacity shortage and emergency periods.	Historically, load management programs have helped to reduce demand for electricity, and thus costs to all customers over time by prolonging the need to build new generation capacity.

DOER concludes that 1998 ratepayer-funded energy efficiency programs provided participating customers with substantial and important immediate savings, primarily through Retrofit programs and New Construction/Lost Opportunity programs. These

program activities also contributed to progress made in changing energy efficiency markets on a long-term basis. However, DOER believes that greater emphasis should be placed on evolving these programs so that they bring about permanent changes to energy efficiency markets, and thus benefiting all customers. This essentially requires that the programs be designed to further leverage non-ratepayer funded activities. The extent to which ratepayer funds are able to leverage private funds is an important indicator of success of transformation of the energy markets. For example, Retrofit programs should be designed to compliment private-sector activities more aggressively, focus on trade ally education, and be coordinated with Products & Services programs to the greatest extent possible. Secondly, as experience with Products & Services programs increasingly demonstrates quantifiable changes in market share for specific energy efficiency technologies, funding for these types of programs should be expanded.

VI. The Development of a Competitive Energy Efficiency Market

A. Background

A fundamental intent of the 1997 Restructuring Act is to develop competitive markets for purchasing electricity, including a market for energy efficiency services. The Legislature recognized the need for continued public support to promote energy efficiency investments in the near term. However, they also envisioned that, over time, competitive energy markets would evolve as a result of industry restructuring and that energy efficiency services would expand sufficiently to displace the need for ratepayer supported energy efficiency.

The energy efficiency provisions of the legislation are based on the supposition that the level of energy efficiency after restructuring would be equal or greater than the period before restructuring, with all customer classes and important product markets eventually being addressed in the marketplace. The Legislature made an exception for ratepayer energy efficiency funding for low-income customers where they explicitly directed that the charge be kept after 2002.

In this discussion regarding whether a competitive market for energy efficiency will emerge for all customer sectors and for the most critical products, it is useful to generally describe what the market looked like in 1998. To begin, then, this section lays out a description of the energy efficiency market as it existed in 1998, and discusses the advent of new competitive players.

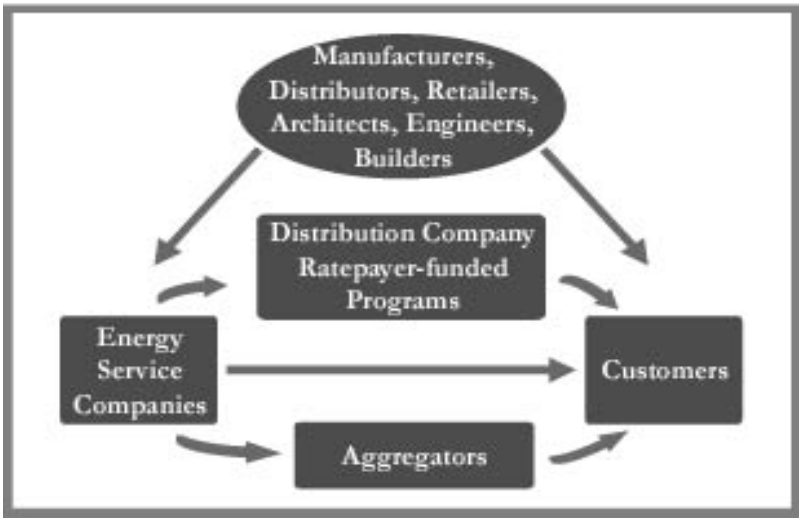
B. Key Players in the Energy Efficiency Market in 1998

Up until 1998, the competitive energy efficiency market in Massachusetts included a variety of market players. This included energy service companies (ESCos) that provided energy efficiency services to customers through ratepayer-funded programs as well as separate from those programs. The market also included a host of product manufacturers, distributors and dealers, other retailers, and an array of design and construction professionals such as architects, engineers, lighting designers and builders. All of these actors have played, and continue to play, critical roles in influencing the choice of energy equipment and/or in delivering energy efficiency products and services to customers, and reducing barriers to consumer energy efficiency investments.

In addition to these market players, the restructuring of the electric utility industry has introduced new players to the energy efficiency marketplace, in the form of competitive retail suppliers and aggregators.

Figure 5: *The Flow of Products and Services in the Energy Efficiency Market* illustrates the interrelationships between these various energy efficiency market players.

Figure 5: The Flow of Products and Services in the Energy Efficiency Market



1. Energy Services Companies

Over the past decade or more, energy service companies have traditionally provided energy efficiency products and services to customers either directly or through ratepayer-funded energy efficiency programs. Today, the term ESCo has broadened to include a new type of energy service company – competitive retail suppliers – which began offering a range of energy services, including energy efficiency, to customers as a bundled product with energy commodity sales and delivery. These services were provided either directly to customers or partnered through aggregators, and often referred customers to participate in ratepayer-funded energy efficiency programs administrated by the distribution companies. These distinct, yet overlapping types of ESCos are discussed in turn below.

a) ESCos Active in Ratepayer Funded Programs. In 1998, the vast majority of ratepayer-funded energy efficiency was delivered by energy services companies through competitively procured contracts with Massachusetts electricity distribution companies. ESCos provided an array of energy efficiency services under these programs, including program design and implementation, marketing and evaluation. As discussed further below, the competitive procurement of distribution company administered energy efficiency programs has been important to the growth and development of the Massachusetts energy services industry. In addition, ratepayer-funded programs have also allowed ESCos to leverage efforts in existing markets and promote performance contracting[29] in new markets.

[29] Performance contracting refers to contracts for energy efficiency services wherein payments to the ESCO are made on the basis of measured, and often guaranteed, energy savings.

b) ESCos Bundling Energy Efficiency with Commodity Electricity.
In 1998, competitive retail suppliers began offering a range of energy services to customers as a bundled (or packaged) product with electricity commodity services. For the most part, these energy services were offered to medium and large C&I customers, and focused heavily on load management (i.e., advising customers on how to shift their energy use to periods during the day when electricity is cheaper), and power quality services. Energy services also included energy audits of customers' facilities, with recommendations for improvements in building and process efficiency. Audited customers could then choose to participate in ratepayer-funded programs for financial and technical assistance, or could choose to receive services directly from an ESCo vendor referred by the competitive retail supplier. These new competitive retail suppliers included Exelon Energy Services, PG&E Energy Services, and Select Energy.

A number of these competitive retail suppliers also partnered with energy aggregators to provide bundled commodity/energy efficiency services to customers. These aggregators included the Massachusetts Health & Educational Facilities Authority, the Massachusetts High Technology Council, and National Energy Choice (for the Massachusetts Municipal Association). These aggregators administered the contracts (for commodity and energy efficiency services) between the competitive retail suppliers and customers, and in some cases provided financing options.

SelectEnergy and National Energy Choice (NEC) – Select Energy, the energy services subsidiary of Northeast Utilities, joined with NEC, a Boston-based energy aggregator, to offer municipalities and businesses a combined electricity /energy efficiency program in 1998. The *MunEnergy* program, provided through the Massachusetts Municipal Association, offers energy efficiency services in addition to electricity supply services. To participate, customers pay for an energy audit (priced according to facility square footage) then implement the audit's recommendations either directly, through SelectEnergy or through vendors of their choice. Implementation may also include participating in programs offered by the customer's distribution company. NEC also offers help financing energy efficiency investments. NEC may earn its fee by sharing a percentage of the savings it obtains, so customers see no up-front costs. By the end of 1998, approximately 70 customers had signed up for NEC's combined commodity and energy efficiency program.

PG&E Energy Services for the Massachusetts High Tech Council (MHTC) – In 1998, PG&E Energy Services offered MHTC members a host of energy services, including load management and energy efficiency services. Over 70% of participating MHTC members signed up for the energy efficiency services offered by PG&E, primarily energy audits. While these audits typically recommended that the member participate in the ratepayer-funded programs, the extent to which customers sought financial support from these distribution company programs varied. In addition, the recommendations from the energy audits typically went significantly beyond the services provided through ratepayer-funded programs, e. g., in the areas of power quality services and consultation on electricity billing and rates.

Exelon Energy Services and Massachusetts Health and Education Facilities Authority (HEFA) – HEFA's PowerOptions program includes a combined commodity/energy efficiency program provided by Exelon Energy Services (formerly PECO Energy). Exelon offers customers a full range of energy management programs, including energy audits and energy efficiency services linked to tax-exempt financing provided by HEFA. In 1998, 255 HEFA members signed PowerOptions contracts representing approximately $3 million in energy cost savings for commodity purchases for these members. Of these members, 22 signed combined energy and energy efficiency contracts. These energy audits are estimated to save an additional $2 million in annual electricity costs to HEFA members. Customers can implement the audit's recommendations either directly through Exelon or through vendors of their choice. Implementation may also include participating in ratepayer-funded programs offered by the customer's distribution company.

c) ESCos Offering Independent Efficiency Services. Many Massachusetts energy service companies provide services independent of either competitive retail suppliers or ratepayer-funded activities. The magnitude of this activity in 1998, however, is unknown. DOER plans to research the size and scope of this market in future years. Independent energy services that are not supported by ratepayer funds typically fall into the following categories:

- Third-party financing[30] and performance contracting services to large commercial and industrial customers. These types of services include retrofit services to replace lighting systems, air compressors, chillers and boilers, etc.
- Municipal and state building efficiency services. ESCos provide energy conservation and efficiency improvement services to the Massachusetts Division of Capital Asset Management (DCAM), which manages the design and construction process for all state building projects (e.g., courthouses, correctional facilities, and state and community college buildings). Energy efficiency services are provided either through performance contracting or bond-funded projects.
- Load management services offered to large commercial and industrial customers. These services include measures or actions taken to alter the time pattern of energy use, such as shifting electricity use to hours or periods during the day when electricity is cheaper through the use of metering and control systems.

Energy Efficiency in State Buildings. During 1998, the Massachusetts Division of Capital Asset Management (DCAM) was involved in a number of energy efficiency projects throughout the state. Five performance contracting projects were initiated during this period: Cape Cod Community College, Mass College of Art; Springfield Technical Community College; Westfield State College; and Wrentham Development Center. These five facilities comprise a total of 3.6 million square feet. The total energy efficiency investment in these projects was $11.9 million, with guaranteed annual savings to the state of $1.6 million. In addition to these projects, there are twelve on-going performance contracting being tracked, representing a total investment of $12 million and savings to the state in 1998 of over $2 million.

[30] Third-party financing is where a separate entity (a third party) provides a loan to a customer that wishes to invest in energy efficiency so that the customer can pay, in full, the vendor (energy service company) providing it services, and pay off the loan to the third-party over time.

2. Product Suppliers and Design Services

Energy services companies are only one segment of the multi-faceted market depicted in Figure 5. Other elements include manufacturers that make high efficiency products, wholesalers and retailers that stock them and architects, engineers and builders who know about the products and how best to use them:

- **Design, engineering and construction entities –** Architects, engineers, lighting designers, and a host of associated professions provide design specifications regarding the use of energy efficiency equipment in the customers' home or facility. Construction personnel may fulfill those specifications, and in many cases provide their own recommendations.
- **Manufacturers** – Manufactures of energy efficiency equipment must invest in product research and development to provide energy efficiency improvements to the market.
- **Product distribution chain** – Wholesales and retailers that carry and recommend energy efficiency products and services are a critical link between manufactures and consumers. They must be fully knowledgeable about, and comfortable with recommending high efficiency equipment to their customers.

To expand the Massachusetts energy efficiency market to the level envisioned by the Legislature and that will function without ratepayer funding, it is critical to change how these market players manufacture products, provide design guidance and equipment specification that utilize higher efficiency products. These actions are necessary to transform energy efficiency markets on a permanent basis.

C. Competitive Procurement of Ratepayer-funded Programs

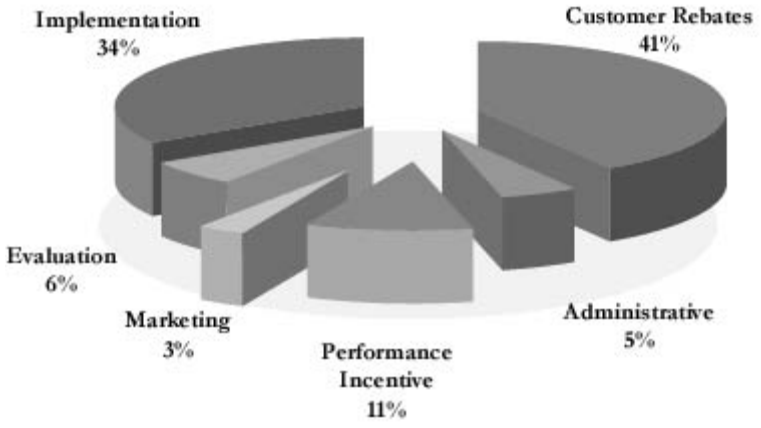
At the end of 1998, DOER had not completed the market analysis necessary to determine which measures provide the best indicators of progress toward increasing competition in the energy efficiency industry. In the absence of that framework, the extent to which competitive procurement was used in 1998 to contract ratepayer funded energy efficiency program activities and services is a useful indicator.

The Act requires that competitive procurement processes be used to the greatest extent practicable when delivering ratepayer funded energy efficiency programs to Massachusetts' customers. These procurement processes benefit customers in two important ways. First, they result in lower, competitively set program costs. Second, they may also introduce innovative elements to program designs and/or implementation.

Competitive procurement processes are typically utilized by distribution companies to obtain services in some aspects of program administration, marketing, implementation (including customer rebates) and program evaluation. Contracted administration services are primarily for assistance in development of program plans. Contracted marketing services includes those associated with marketing the specific energy efficiency

programs, while contracted implementation includes all program delivery services such as inspections, technical assistance, and customer rebates. Contracted evaluation includes services such as cost-effectiveness evaluation for program design, market research, and program impact and process evaluations. In 1998, these cost categories represented about 84% of total ratepayer-funded energy efficiency expenditures, as shown in **Figure 6:** *1998 Electric Distribution Company Expenditures by Cost Category.* Only the 11% of costs for performance incentives (those rewards earned by the distribution company for achieving specific program performance goals) and most internal administrative expenses are not subject to competitive procurement.

Figure 6: 1998 Electric Distribution Company Expenditures by Cost Category
Total = $99.3 Million



Source: 1998 Comparative Statistics, DOER/DTE

Of the $99.3 million total spent on ratepayer-funded energy efficiency programs in 1998, $76.6 million represented services contracted out to independent energy service companies. Further, as shown in **Table 11:** *1998 Competitive Procurement of Ratepayer-funded Energy Efficiency Activities*, almost all of these contracted out services, or $74.4 million, were secured by competitive procurement. This amount represents 75% of total 1998 expenditures. The

Table 11: Competitive Procurement of Ratepayer-funded Energy Efficiency Activities

Cost Category	Internally Expended Activities	Competitively Procured Activities	Total Expenditures
Administration	5%	0%	5%
Marketing	1%	2%	3%
Implementation (including rebates)	5%	70%	75%
Evaluation	3%	3%	6%
Performance Incentives	11%	n/a	11%
TOTAL	25%	75%	100%

majority of these services were related to implementation (including processing customer rebates), followed by evaluation and marketing of programs. The remaining 25% of total expenditures that was not competitively procured was comprised mainly of program administration costs and performance incentives. On balance, the provision of ratepayer-funded energy efficiency services relied substantially on competitive procurement processes.

At the same time, while most program implementation and evaluation activities were competitively procured in 1998, DOER observed that these services were largely dominated by a small number of energy service companies. This was particularly true in the case of program implementation in the residential market for new construction and in-home services, where only a small number of companies provide vendor services. DOER plans to examine this issue more closely as part of its research on the evolvement of the competitive energy efficiency market.

D. Summary: Progress on the Development of a Competitive Market Objective

Because of the early stage of market transition in 1998, there is insufficient data on which to base an evaluation of progress on this objective. In more qualitative terms, however, in 1998 DOER observed several indicators of both strength and weakness in Massachusetts' energy efficiency markets. Indications of competitiveness were: 1) the volume of competitive procurement activity that occurred with the ratepayer funded energy efficiency services, and 2) the 1998 offerings of competitive retail suppliers who bundled energy efficiency services with commodity offerings, at least for medium-large commercial and industrial customers. The market was not sufficiently developed in 1998 to observe any changes in the residential and small commercial markets for energy efficiency services.

At the same time, however, DOER observed that the offerings of competitive retail suppliers focused on providing *retrofit* energy efficiency services to customers. As discussed earlier (see Section V on Balanced Savings objective), these services provide immediate and long-term savings to *participating* customers but may not necessarily succeed in transforming markets for energy efficiency products and services on a long-term basis, thus benefiting *all customers*. It is also unclear the extent to which these energy efficiency services rely on financing available through ratepayer funded programs or through the private sector. In short, while this new market player is an important vehicle for increasing customer awareness about energy efficiency and building credibility for energy efficiency products, it is unclear whether the role of competitive retail suppliers will significantly change the overall structure of the energy efficiency marketplace. In the years ahead, DOER intends to monitor this and other competitive developments closely.

VII. Summary

The year 1998 was largely a transitional year for ratepayer-funded energy efficiency activities in the state. Electric distribution companies developed energy efficiency plans according to funding levels required by the Act, which involved introducing new programs, expanding existing ones, and developing a coordinated, statewide low-income program, as required by the Act. In addition, the 1998 energy efficiency plans began to better balance the portfolio of programs so that both participating as well as other customers receive short- and long-run electricity savings and cost reductions.

DOER anticipates that 1999 program activities will likely produce greater savings and benefits for customers than seen in 1998. DOER will continue to monitor the ratepayer-funded energy efficiency program activities to ensure they are consistent with the statewide goals and are helping to facilitate the development of competitive energy efficiency markets. In this regard, DOER will also continue to monitor products and services offered by competitive retail suppliers and/or aggregators, and analyze the extent to which customers are purchasing these energy efficiency services.

Appendices

Appendix A: DOER Oversight of Energy Efficiency Activities Relevant Sections of the Restructuring Act of 1997

Appendix B: Energy Efficiency Working Group Stakeholder List

Appendix C: E^3AS Model – Overview and Assumptions

Appendix D: 1998 Electricity Bill Impact Analysis

Appendix E: Overview of 1998 Energy Efficiency Programs By Customer Class

Appendix F: Air Quality Effects of Electricity Generation

Appendix G: Common Barriers to Investing in Energy Efficiency

Appendix H: Glossary of Terms

Appendix A: DOER Oversight of Energy Efficiency Activities

Relevant Sections of the Restructuring Act of 1997

Below are sections of the 1997 Restructuring Act relevant to DOER's role regarding energy efficiency activities. Language specific to DOER's responsibilities are highlighted.

Chapter 164 of the Acts of 1997

An Act Relative To Restructuring The Electric Utility Industry In The Commonwealth, Regulating The Provision Of Electricity And Other Services, And Promoting Enhanced Consumer Protections Therein.

SECTION 37.

Section 19. Beginning on March 1, 1998, and for a period of five years thereafter, the department is authorized and directed to require a mandatory charge per kilowatt-hour for all consumers of the commonwealth, except those served by a municipal lighting plant, to fund energy efficiency activities, including, but not limited to, demand-side management programs. Said charge shall be the following amounts: 3.3 mills ($0.0033) per kilowatt-hour for calendar year 1998; 3.1 mills ($0.0031) per kilowatt-hour for calendar year 1999; 2.85 mills ($0.00285) per kilowatt-hour for calendar year 2000; 2.7 mills ($0.0027) per kilowatt-hour for calendar year 2001; and 2.5 mills ($0.0025) per kilowatt-hour for calendar year 2002; provided, however, that in authorizing such programs the department shall ensure that they are delivered in a cost-effective manner utilizing competitive procurement processes to the fullest extent practicable. At least 20 per cent of the amount expended for residential demand-side management programs by each distribution company in any year, and in no event less than the amount funded by a charge of 0.25 mills per kilowatt-hour, which charge shall also be continued in the years subsequent to 2002, shall be spent on comprehensive low-income residential demand-side management and education programs. A distribution company shall not be allowed to assess any other charge relative to energy efficiency programs which would exceed the levels permitted herein. The low-income residential demand-side management and education programs shall be implemented through the low-income weatherization and fuel assistance program network and shall be coordinated with all gas and distribution companies in the commonwealth with the objective of standardizing implementation. On March 1, 2001, the division of energy resources shall, in order to determine if energy investments shall continue beyond that time, review then-current market barriers, experience with competitive markets, and related environmental and economic goals. If said division determines that the continued operation of the programs delivers cost-effective, energy efficiency services, said division shall file, with the clerk of the house of representatives of the general court, legislation to extend for a time certain the authorization contained herein for such a charge to fund energy efficiency activities.

SECTION 50.

Section 11E. The division of energy resources is hereby authorized and directed to monitor any independent systems operator or power exchanges organized pursuant to the provisions of chapter 164. The division shall determine the extent to which said operators and exchanges serve the needs of retail customers and contribute to the achievement of energy efficiency and fuel

diversity goals as said goals are identified by the division and the department of telecommunications and energy.
The analysis and publication of all data and information collected by the division, shall be conducted to inform consumers, energy suppliers, the department of telecommunications and energy, and the general court about the operation of retail markets and any deficiencies in the operation of those markets, and to recommend improvements to such. Said data and information shall be used by the division for the publication of periodic projections of the supply, demand, and price of energy on statewide and regional basis.

The division shall annually issue a report containing information on all issues of electricity system reliability, including, but not limited to, generation and transmission data detailing load and capacity, for the prior calendar year and forecasting potential future capacity excesses or deficits for the next five calendar years. The division shall utilize any and all information available to forecast potential capacity excesses or deficits, including, but not limited to, analyses by the independent system operator and other such data collected by the division pursuant to section 7. Said report shall contain (i) electricity spot price information for the previous calendar year, including, but not limited to, the average regional monthly spot price; (ii) a determination of the extent to which the energy markets are maintaining necessary levels of reliability; (iii) a determination of whether or not all customer classes are being adequately served by competitive energy markets; (iv) a determination of the competitiveness of energy markets; including a determination whether or not the electric industry is providing consumers with the lowest prices possible within a restructured, competitive retail marketplace; and (v) a determination of the extent to which the energy markets are achieving the energy efficiency and fuel diversity goals of the commonwealth. Said report may be undertaken in combination with the report required pursuant to section 7, at the discretion of the commissioner. Said report shall identify any substantial fluctuation or pricing differences in the cost of electricity available to consumers, especially with respect to geographic regions and low and moderate income consumers. Said reports shall make recommendations for improving any deficiencies so identified in electricity energy markets, including non-competitive pricing situations, which are within the authority of the general court, the department of telecommunications and energy, the federal energy regulatory commission, or any other governmental body with jurisdiction over the deficiency so identified. The division shall submit such report to the joint committees on government regulations and energy, respectively, and the house and senate committees on ways and means no later than April thirtieth of each year, including drafts of legislation to implement recommendations within such report.

Section 11G. The division of energy resources shall have the authority to oversee and coordinate ratepayer-funded energy efficiency programs. The division shall seek to achieve goals including, but not limited to, the following: (i) ensure that energy efficiency funds are allocated equitably among customer classes; (ii) ensure that there will be adequate support for "lost opportunity" efficiency programs in areas such as new construction, remodeling, and replacement of worn-out equipment; (iii) give due emphasis to statewide market transformation programs in order to systematically eliminate market barriers to energy efficiency goods and services; and (iv) provide weatherization and efficiency services to low-income customers. The division of energy resources shall annually file a report with the department of telecommunications and energy on the proposed funding levels for energy efficiency programs. The department shall review and approve energy efficiency expenditures after determining that implementation of such programs was cost-effective. Within one year of enactment of this legislation, the division shall conduct a public hearing process to investigate the role of the

division in the oversight and statewide coordination of energy efficiency programs. Not later than March 1, 1999, the division shall promulgate rules and regulations necessary to implement the findings of this section.

Appendix B. Energy Efficiency Working Group Stakeholder List

	Company/Agency	Contact Name
1	Division of Energy Resources	Bruce Ledgerwood, Julie Michals Steve Venezia
2	Raab Associates	Jonathan Raab, Joe Eto
3	Department of Telecommunications and Energy	Barry Perlmutter, Gene Fry Janet Gail Besser
4	Attorney General's Office	Rebeca Perez
5	Northeast Energy Efficiency Council Peregrine Energy Group	John Manning Paul Gromer
6	Conservation Services Group	Steve Cowell
7	Conservation Law Foundation	Richard Kennelly
8	Northeast Energy Efficiency Partnerships	Sue Coakley
9	The Energy Consortium	Bruce Paul, Roger Borghesani
10	Associated Industries of MA	Judy Silvia
11	Low-income (WAP) Network National Consumer Law Center	Elliott Jacobson Jerry Oppenheim
12	Cape Light Compact	Maggie Downey, Tim Woolf
13	Bay State Consulting	John Shortsleeve
14	MASSPirg	Rob Sargent
15	Eastern Edison	Carol White
16	COM/Electric	Lisa Carloni, Tina Torres
17	Mass Electric	Liz Hicks, Amy Rabinowitz
18	Boston Edison	Bob Cuomo, Scott Albert
19	Western Mass Electric	Steve Waite, Lisa Anderson
20	Fitchburg Gas & Electric	Deborah Jarvis, Sasha Krashenny
21	New Energy Ventures	Barbara Kates-Garnick Elisa Derby
22	ENRON	Sue Nord
23	MA Division of Capital Asset Mgmt.	Hope Davis
24	Dept. of Environmental Protection	Nancy Seidman, Paul Hibbard
25	IRATE	Curt Collyer
26	Union of Concerned Scientists	Michelle Robinson
27	Clean Water Action	Cindy Luppi
28	Honeywell DMC	Anne Gross
29	MacGregor Energy Consultancy	Theo MacGregor
30	Berkshire/Fall River Gas	Emmett Lyne
31	MASS Save	Mike Plasski
32	Senator Steven Panagiotakos	D.J. Corcoran
33	Senator Michael Morrisey	Sandy Callahan
34	Senator Henri Rauschenbach	Leslie Schuermann
35	Representative Dennis Murphy	Lisa (Yarid) Marsh
36	Representative Daniel E. Bosley	Kevin Grant

Appendix C: E^{3}AS Model – Overview and Assumptions

A. The E^{3}AS Software - Overview

The economic development and air emissions impacts provided in this annual report to the Legislature were estimated using the E^{3}AS (Energy, Economic, and Environmental Analysis System) software. E^{3}AS was developed by The Goodman Group, Ltd. (TGG) on behalf of the U.S. EPA and is available free of charge to assist government agencies in evaluating the economic and environmental impacts of energy supply and efficiency programs. DOER retained TGG to perform the E^{3}AS model analysis for this report.

The E^{3}AS software is designed to consider both the benefits and costs of energy alternatives. The economic development impacts provided in this report are the sum of the following three components: (1) the *increase* in economic activity as a result of expenditures on efficiency programs, (2) the *decrease* in economic activity as a result of decreased expenditures on electricity supply, and (3) the *increase* in economic activity as consumers *increase* their spending for other goods and services (to the extent that efficiency programs reduce consumers' overall costs, these savings are available for other spending).

The E^{3}AS software provides several measures of the economic development impacts generated by the energy options being evaluated. Employment is denominated in person-years (1 job for 1 person for 1 year = 1 person-year). Earnings are the compensation associated with this employment, as well as property income. Value-added represents the difference between the value of output (sales) and the cost of intermediate inputs (goods and services purchased from other businesses); stated another way, it represents the value that is added by the application of capital and labor in converting intermediate inputs to finished products. In this report, data for earnings and value-added are reported in terms of real (1998) dollars, i.e., the effect of inflation after 1998 has been removed.

To estimate economic development impacts, the E^{3}AS software uses an input-output model. Input-output models generate regional economic impact estimates by first tracing the industries involved in a study region throughout successive rounds of supply linkages. At each step, they trace the portion of the inputs required from each industry which are supplied locally (within the regional economy being modeled).

For example, the impacts of Massachusetts lighting equipment purchases are not only based on the effects upon in-state lighting product manufacturers, but also include the effects on other in-state industries (e.g., fabricated metals) supplying in-state lighting manufacturers. Total impacts also include the effects of expenditures by households and governments as they spend the personal income and taxes derived from in-state businesses (in the example above, the businesses supplying lighting equipment and inputs to the lighting equipment suppliers).

The E^3AS software incorporates input-output multipliers for a wide variety of energy supply and efficiency technologies, e.g., employment generated per dollar spent on commercial lighting fixtures. The results in this report were developed using the Massachusetts-specific version of E^3AS, which contains multipliers estimated using the Massachusetts version of the IMPLAN input-output model. The IMPLAN model was developed at the US Forest Service and University of Minnesota and is now maintained by Minnesota IMPLAN Group.

In order to develop the input-output multipliers in E^3AS, the total expenditures upon each type of energy efficiency and supply technology had to be dissaggregated into expenditures upon each of the 528 industries represented in the IMPLAN model. The data used to perform this translation for each activity is called a bill of goods (BOG). The BOG data utilized in E^3AS were developed by TGG in an extensive research effort commencing in 1992.

For efficiency technologies, BOG data were principally derived from Massachusetts utility accounting records which incorporated all aspects of costs (program administration, overhead, labor, and consulting services, as well as materials and equipment). For electricity supply technologies, BOG data were largely based on (1) engineering studies performed by Oak Ridge National Laboratories for inclusion in the U.S. Department of Energy (DOE), Energy Economic Database, (2) utility accounting records, and (3) Electric Power Research Institute (EPRI) Technology Assessment Guide (TAG) data.

The air emissions impacts provided in this report are those avoided by efficiency programs owing to the decreased need for electricity generation. In order to estimate the air emission impacts of these programs, assumptions were made about the future portfolio of electricity generating units/plants in the region over the average lifetime of the efficiency measures installed in 1998. The air emission impacts considered the following air pollutants: nitrogen oxides (NO_X), sulfur dioxide (SO_2), and carbon dioxide (CO_2).

B. Inputs to the E^3AS Software

In order to use the E^3AS software to produce results for this report, various input data were required for 1998 Massachusetts efficiency programs and the electricity supply that was avoided by these programs. Below is a listing of assumptions used to support the E^3AS analysis.

1. Energy efficiency expenditures. Includes all direct program costs and participant costs, but excludes interruptible program costs, load management costs, and performance incentives to administrators. Expenditures were assigned to E^3AS technology cost categories and by customer sector.

2. Respending Effect. The respending effect occurs when energy efficiency program activities lower customer energy costs, and customers thus have more money to spend on

other (non-energy related) activities, and these activities are more beneficial to the economy than spending on energy-related activities.

3. Avoided Energy Supply. E^3AS is neither a dispatch or system expansion model. As such, input data must be provided. TGG developed an avoided supply plan consistent with the Resource Insight Avoided Energy Supply Component (AESC) Study submitted to the DTE in Docket 98-100. The assumptions regarding the supply plan for New England include the following:

- Existing generating units in place for 1998-2001
- New combined-cycle (CC) unit with pollution control equipment (SCR) come on-line after 2001, but no combustion turbine units
- Set amount of CC capacity based upon average capacity needed 2001-2017
- For existing supply, assumed 50/50 mix of oil/gas steam boiler based on conferring with Resource Insight and the assumptions used in the AESC Study.
- For existing units, assumptions regarding heat rate, avoided cost (fuel cost & variable O&M) based on AESC Study
- For new supply, capital & operating cost (fuel, fixed & variable O&M) and heat rate based on assumptions used in AESC Study
- Adjusted energy efficiency program energy and capacity savings data to exclude interruptibles/load management and grossed-up capacity for reserve margin

4. Avoided T&D Investment. Provided to DOER by distribution companies from 1998 Annual Energy Efficiency Reports

5. Emissions Rates. Assumptions for common air pollutant emission rates associated with electricity generation include the following:

- Default emission rates for NO_X and SO_2 are based on data from Alliance to Save Energy et al. (1992), California Energy Commission (1993), Duke Power Company (1992), Electric Power Research Institute (1993), Energy Information Administration (1995), Manning et al. (1991), New York State Energy Planning Board (1994), and Tellus Institute (1990; 1991). CO_2 emission rates for all supply options are based on values from Energy Information Administration (1995).
- For existing generation units, E^3AS default emission rates were used.
- For new CC units, E^3AS default emission rates were used for CO_2, while other emissions were zeroed out.

C. Interpreting the Results of an Input-Output Analysis

Input-output models trace the short-term "ripple effects" which occur as a result of a given economic activity. The results derived from input-output analysis indicate the match between the industries supplying inputs required for each energy option and the industries comprising the local economy. In the previous example of lighting equipment

purchases, regions which produce fabricated metal products will likely benefit from expanded sales of locally manufactured ballasts, while regions without such production will not benefit in the same way. The employment estimates also reflect the labor intensities of the industries involved. Earnings impacts represent the wage earnings and property income generated along the way.

Input-output analysis estimates the near term impacts of changes in economic stimuli. Near term is defined in relation to the year in which an expenditure occurs. For example, estimates of impacts associated with an expenditure occurring in 2010 describe activity in the years immediately following 2010.

However, the reaction of an economy to changes in demand evolves over time: prices, wages and interest rates adjust. For example, power plant construction may encourage construction wage increases. These wage increases may in turn dampen residential construction activity, thereby reducing the net gains in construction employment over time. Input-output only provides information on changes in employment and earnings prior to this adjustment process. The accuracy of estimates derived using input-output analysis therefore decline over longer-time periods and in larger regions.

Over the long term, net gains in employment and real earnings (i.e. those not offset eventually by losses elsewhere in the economy) depend on increases in productivity. Such increases are supported by adherence to a cost-effectiveness criterion. That criterion selects the course of action which provides the greatest return for the economic resources utilized.

Appendix D: 1998 Electricity Bill Impact Analysis

Annual Energy Savings. In order to calculate bill impacts, DOER multiplied the 1998 kWh savings per month per customer (for the four customer groups) by 1998 avoided retail electricity cost figures. These avoided retail electricity cost figures are the actual cents/kWh avoided by the average customer that otherwise would have been charged to the customer on his/her monthly bill. The estimate of the avoided retail electricity cost figures included only those charges that are variable and thus could be avoided; fixed customer charges were assumed as unavoidable. DOER used the 1998 revenue per kWh figures for residential, commercial, and industrial customers from the distribution companies' FERC Form 1 filings as a base. DOER then examined the rate filings for the companies in order to determine the percentage of total revenues per kWh accounted for by the variable portion of the bill. This percentage was multiplied by the FERC Form 1 figures to establish avoided retail electricity charges for the customer classes for all distribution companies.

Lifetime Energy Savings. DOER's estimate of $265 million of lifetime energy cost savings to 1998 participating customers begins with the assumption that the average total cost for electricity over the productive life of the energy efficiency measures installed in 1998 is 9.6 cents per kWh (using DOER's Energy 2020 forecast). This reflects the weighted average (for residential, commercial, and industrial) price calculated by using rate class information from the distribution companies. DOER then reduced the total average price by 81% in order to separate out the variable from the fixed portion of the bills. The variable portion of the average cost, or 7.8 cents per kWh, times the total lifetime energy savings from 1998 programs (3.4 billion kWhs) provides total cost savings of roughly $265 million.

Annual Capacity Savings. Because of incomplete data, DOER's bill impact analysis did not analyze avoided capacity charges, which are typically given in $/kW of peak capacity used. For those customers that feature this charge -- medium to large commercial/industrial customers -- total savings would be higher than those simply shown by the avoided energy cost estimates. For an approximation of annual capacity savings, however, DOER used an estimated value of $9.65 per kW saved for these customer groups.

Appendix E: Overview of 1998 Energy Efficiency Programs By Customer Class

Listed below are program descriptions by customer class for the 1998 energy efficiency programs. Please refer to Table 9 in Section V for a summary of program expenditures and savings by customer class.

1. Low-Income Customers

In 1998, over 12,900 low-income customers were served by $8.3 million in energy efficiency activities[31]. These programs resulted in $62 in annual bill reductions per participating customer. The majority of these services were In-home Service activities which saved 11 million kWh of electricity annually and lifetime energy savings projected at 151 million kWh.

The In-home Services program supported a variety of services targeted to meet the needs of low-income customers in the Commonwealth. These services included customer home energy audits, an explanation of customers' electric bills, replacement of high-use refrigerators, and installation of energy conservation measures, such as lighting. All measures are provided at no cost to the low-income customers. Low-income programs also provided wall and ceiling insulation and programmable thermostats to electric space heat customers.

As directed by the Act, the low-income programs were largely administered and delivered by the low-income Weatherization Assistance Program (WAP) and fuel assistance program network ('the Network'), and coordinated closely with gas utilities. The percentage of total statewide funding for low-income programs that was directed to services provided through the low-income network was over 90%.[32] The remaining 10% of low-income program activities focused on multi-family projects administered by the distribution company.

2. Residential (Non L/I) Customers

2.1 In-home Services

In-home service programs provide comprehensive, whole-house retrofit services and education to residential customers with historically high levels of electricity consumption. Eligible customers receive an energy audit, education on energy savings opportunities, direct installation (free of charge) of low cost efficiency measures and discounts on the installation of major (higher cost) measures. The types of rebates offered on measures can include installation of lighting, heating, ventilation and air conditioning (HVAC) systems, as well as water heating. Typically, all non-low income residential customers

[31] While the funding level available for low-income programs in 1998 was consistent with the requirements of the Act, actual expenditures were less. Unexpended low-income funds for the year were carried forward to the 1999 program year.

[32] Source: Elliott Jacobson, Community Action, Weatherization Assistance Program

with electricity consumption of at least 12,000 kWh per year are eligible to participate in this program.
In 1998, $7.1 million was expended on in-home service activities, or 7.1% of total expenditures. These programs resulted in 23 million kWh of annual electricity savings, while lifetime energy savings associated with measures installed in 1998 are projected to be 282 million kWh (approximately 8.2% of total projected lifetime savings).

2.2 Residential New Construction

In 1998, all distribution companies offered a new construction program for residential customers. The majority of companies participated in the ENERGY STAR™ Homes Program, a national energy efficiency campaign sponsored by the Environmental Protection Agency (EPA) and the Department of Energy (DOE). This regional initiative was created to help home builders and buyers design and construct homes that use at least 30% less energy than homes built to Model Energy Code (MEC) standards. The ENERGY STAR™ Homes Program shows homebuyers and builders how to achieve greater energy efficiency for heating, cooling, lighting and appliance operations. These homes are designed, site-inspected, and performance-tested to achieve a 5-Star Home Energy Rating--the highest energy efficiency rating on the nationally recognized 0-100 point scale. The program is co-sponsored by all Massachusetts investor-owned distribution companies, and Boston Gas Company. It operates by providing home energy ratings as a means of certifying compliance with the Energy Star standard and helping consumers, builders, and other key market actors differentiate between efficient homes and standard homes. As of December 1998, there were 163 homes certified in all the participating utility service territories. In addition to home certification, the ENERGY STAR™ Homes program provided incentives (e.g., rebates) for appliances and energy efficiency lighting products.

Residential Building Energy Code. The Massachusetts Board of Building Regulations and Standards (BBRS) adopted CABO MEC 95 as the new residential building energy code. The new code was adopted in September 1997 and took effect in March 1998. The new code, supported by training and implementation tools, is expected to improve code implementation and compliance. In 1998, distribution companies provided financial, technical and in-kind support of training sessions for builders and code officials sponsored by DOER and BBRS. These training sessions explained the new building codes, and provided an introduction to ENERGY STAR™ Homes and other market-driven energy efficiency programs.

In 1998, a total of $2.7 million, or 2.7% of total expenditures, were spent on programs in this category. These expenditures resulted in estimated annual savings of 9 million kWh. Lifetime energy savings are projected to be 105 million kWh, or 3.1% of total lifetime savings.

2.3 Residential Products and Services

A number of residential product and services programs were implemented in 1998, including high efficiency residential lighting (*Starlights)* and the ENERGY STAR™

Appliance program, which included the statewide clothes washer (*TumbleWash*) program. Their overall goal was to transform the product market to one which sustains availability of and demand for quality, energy efficient lighting and appliance products. These Product & Services programs entailed:

- Increasing consumer awareness, acceptance and use of high-efficiency lighting technologies;
- Reducing the first-cost purchase price barriers of high efficient products;
- Facilitating the development, manufacture and adoption of quality products that meet the needs of residential applications;
- Enabling manufacturers to profit from the increased market share of the energy efficient product;
- Increasing the availability of the products in standard market channels; and
- Educating vendors and contractors about residential lighting products and marketing resources.

StarLights Program -- In collaboration with the Northeast Energy Efficiency Partnership (NEEP), a number of Massachusetts electric distribution companies developed a marketing campaign to establish compact fluorescents as the value leader in lighting products (compared to incandescent bulbs). The program worked through retailers, with builders and developers in new construction, and with larger property owners to encourage sales of "Starlights" lighting. The programs provided over 250,000 rebates to residential customers as an incentive to purchase higher efficient lighting.

TumbleWash/ENERGY STAR™ Appliances Program -- Numerous Massachusetts electric and gas distribution companies collaborated in a regional initiative for high efficiency clothes washers, facilitated by Northeast Energy Efficiency Partnerships (NEEP). In 1998 sixteen electric and gas distribution companies throughout the states of Massachusetts, Connecticut, and Vermont participated in this initiative, which included among other elements a high visibility television advertising campaign. The regional objectives include development of a competitive market for high efficiency appliances, reduced product costs and improved customer awareness of the economic and non-economic benefits e.g., cleaner clothes) associated with the high efficiency design. In 1998, this program provided information and labels for retailers to identify models of appliances that met the ENERGY STAR efficiency guidelines. In recognition of the market barrier posed by higher initial costs for the high efficiency washers, the program also provided a $100 rebate to participating customers.

Preliminary analysis of sales data in the Northeast suggests a doubling of market share from 1997 to 1998 for high efficiency clothes washers. Largely as a result of the TumbleWash program, most major appliance manufacturers now sell a high efficiency clothes washer (commonly referred to as a horizontal axis washer), and market these washers throughout Massachusetts and the Northeast.

In addition to clothes washers, the ENERGY STAR™ Appliance program includes dishwashers, refrigerators, and room air-conditioners. In 1998, the program provided information and labels for use by retailers to identify which models of these appliances met the ENERGY STAR™ efficiency guidelines. The program required that all of these appliances be at least 11% more energy efficient than required for the Federal Appliance Standards for each appliance. Given that these appliances comprise a significant portion of the residential electricity bill, these energy efficient appliances can reduce electricity-use significantly, and thus costs to customers.

In 1998, $9.4 million were spent on statewide/regional Product & Services initiatives, or 9.5% of total 1998 expenditures. These initiatives are estimated to have resulted in estimated annual savings of 22 million kWh. Lifetime savings are projected to be 225 million kWh, which was approximately 6.6% of total projected lifetime savings.

2.4 Residential Information and Education

Ratepayer energy efficiency funds were used to educate residential customers about the benefits of energy efficiency and the opportunities for saving money through a number of venues. These included the Energy Smart CD and numerous publications.

Energy Smart CD and Web Site Software -- This program uses each distribution company's web site to provide education to customers on residential energy use. Using the Nexus Company's *EnergySmart* computer software, customers can interactively analyze energy use in their own homes. Energy efficiency topics addressed include typical appliance energy use, energy savings opportunities, associated costs and benefits, and other information. *EnergySmart* is available in CD-ROM format or downloaded directly off the web for use on customers' home PCs. Additionally, some of the web and CD-ROM versions allow access to the "Account Link" feature of the Nexus Company's web site, which allows residential customers to download their monthly electric energy consumption and cost information.

Other Educational Activities/Publications -- Newspaper ads and distribution company web-sites were also used to inform customers, regulators, state agencies, and other regional energy partners of customer education initiatives. A number of the distribution companies also made high-efficiency products and information readily available to residential customers through home product catalogs, including the energy efficiency publication "Consumer Guide to Home Energy Savings."

Energy Conservation Services -- The Energy Conservation Services (ECS) is a state mandated efficiency and education program that provides various conservation services to residential customers. The program targets customers in 1-4 unit dwellings and multifamily dwellings with 5 or more units and mobile homes. For 1-4 unit dwellings, the program provides home energy audits, installation of selected energy saving materials, conservation education literature and a toll-free hot line for additional technical information. For multifamily dwellings, the program provides building energy audits and workshops on energy maintenance for building management personnel. The program uses various mass-

media and direct customer contact methods, including bill inserts, and provides fully subsidized audits combined with fully subsidized measure installations. This program is administered by DOER (pursuant to M.G.L. Chapter 164 App §§2-1 to 2-10), and requires DTE approval regarding the program cost-effectiveness.

In 1998, a total of $4.3 million was expended on educational programs for residential customers, or 4.3% of total expenditures. While some effort was made to estimate energy savings from these programs, it is very difficult to link all types of educational programs to energy savings. Table 9 in Section V provides estimated savings (a total of 15 million kWh lifetime savings) for the ECS program.

3. C&I Customers

3.1 C&I Retrofit Programs

The C&I retrofit programs were offered to both large and small C&I customers. Generally, the program encourages the replacement of outdated and inefficient electrical or mechanical equipment (retrofits). These programs also provided some financial assistance, as well as education, project design, and commissioning services. Customer rebates reduced the incremental cost of higher efficient equipment, including the installation of variable speed drives, building envelope measures, controls, energy management systems, and process redesign/improvement.

Funding for C&I retrofit projects in 1998 represented the largest proportion of funding for any program type. Over $40 million were spent on C&I retrofit programs (or 41.3% of total 1998 expenditures). Similarly, estimated energy savings from these programs were the most substantial, 140 million kWh in 1998, and 1,684 million kWh over the lifetime of the energy efficiency measures installed in that year. These lifetime savings represented 49.3% of the total savings expected over the lifetime of all efficiency programs.

3.2 C&I New Construction/Lost Opportunity Programs

The overall goal of the C&I lost opportunity programs is to transform, over time, several key equipment markets: the new construction market, the replacement market for failed equipment, and major renovation markets. The objective of these programs is to achieve significant market penetration for higher efficiency equipment and practices in the areas of new building design, equipment installation, and system operations.

During 1998, utilities offered lost opportunity programs to all C&I customers. These programs encouraged the installation of energy efficient equipment and systems in what are considered to be “time dependent” opportunities. These programs also gave C&I customers the opportunity to receive financial assistance to cover the incremental cost of higher efficiency equipment over the standard equipment that might otherwise be selected. Such support covered heating and cooling systems, motors, lighting design, and equipment. In addition to customer incentives, the programs also offered education and technical assistance to encourage the adoption of design features and selection of equipment that optimize the efficient use of electricity. Customer incentives were based

the incremental costs of the higher efficiency equipment and labor costs, compared to standard practice.

Commercial Building Code -- An important component of new construction programs is that they help to transform energy efficiency markets by promoting the upgrading of the commercial building code in Massachusetts (CMR 780). In 1998, the Energy Advisory Committee (EAC)[33] to the Board of Building Regulations and Standards (BBRS) began work on upgrading the commercial code in January 1998. The EAC reviewed several model codes that were in various stages of draft review around the country (ASHRAE 90.1-R, IECC, Multi-State working document). At the end of 1998, the EAC had not yet completed its work on revising the code, but had committed to send its proposed amendments to the Board for their review in May of 1999. Ratepayer-funded energy efficiency activities supported the process of upgrading the commercial building code during 1998 by providing technical information to BBRS and developing commercial building profiles of energy efficiency performance and baselines for design, construction and operation practices.

In 1998, $18.7 million were spent on C&I lost opportunity programs in 1998, or 18.8% of total ratepayer energy efficiency expenditures. Estimated energy savings for these programs totaled 47 million kWh in 1998 alone, and an estimated 837 million kWh over the lifetime of the energy efficiency measures installed in that year (approximately 24.5% of total lifetime savings). Delivery of lost opportunity programs also evolved throughout 1998, as several distribution companies adopted a more standardized yet more flexible approach to delivering efficiency services to C&I customers. These improvements proved valuable to C&I customers by reducing confusion and ensuring consistent program offerings regardless of utility service territory. Furthermore, consistent program design and implementation help to transform markets by influencing technology and distribution channels.

3.3 C&I Products and Services Programs

Massachusetts distribution companies participated in several statewide C&I Product & Services initiatives in 1998, coordinated through regional entities such as the Northeast Energy Efficiency Partnerships (NEEP) and the Consortium for Energy Efficiency (CEE). These included programs for premium efficiency motors, high efficiency commercial unitary HVAC, and lighting design guidelines. Relatively limited funding was expended on other C&I programs - only $1.4 million – and thus annual energy savings were small (1 million kWh) compared to savings from other C&I program categories. Where appropriate, program development was also coordinated with national and regional organizations such as the U.S. DOE Motor Challenge program and initiatives sponsored by Consortium for Energy Efficiency (CEE).

Premium Efficient Motors -- The principle objective of the Premium Efficiency Motors Initiative is to establish high efficiency, premium motors as competitive products, broadly

[33] The EAC is a voluntary group of practicing designers, architects, and engineers appointed by the Board as an expert panel with respect to energy related issues connected to the Building Code.

available in the regional marketplace for electric motors (1 to 200 horsepower). Qualifying premium motors reduce motor energy use by about 2 percent compared to standard motors that minimally meet federal standards. These electric motors consume 50 percent of the Northeast's C&I electric energy resources.

The Massachusetts distribution companies worked with regional partners to develop and implement a regional program which, through strategic intervention in the marketplace, attempts to make premium efficient motors the product of choice for new and replacement motors. This program offers all C&I customers a rebate on installation of premium-efficiency motors that meet CEE's national standard. The regionally consistent program uses common eligibility requirements, common customer incentives, and consistent marketing campaigns throughout the Northeast. In 1998, a total of 53 Massachusetts dealers participated.

High Efficiency HVAC -- In 1998, Massachusetts electric distribution companies joined with other utilities in a NEEP-facilitated regional initiative to establish energy efficient packaged HVAC equipment and installation practices as the product/service-of-choice for new and replacement installations. The initiative coordinates trade allies (such as equipment manufacturers, distributors and dealers), utilities, and commercial, industrial and institutional energy users in New England in a consistent program of strategic market interventions. Over time, this initiative will increase the availability of, and demand for, high efficiency HVAC products.

Through the High Efficiency HVAC initiative, a regional circuit-rider is currently informing packaged HVAC retailers about the program. The circuit rider also distributes and processes the appropriate rebate forms. Rebates are designed to cover the entire incremental cost associated with the difference in cost between the premium high efficiency HVAC unit and the standard unit being replaced. This initiative is also exploring various ways to encourage HVAC contractors to follow energy efficient installation and service practices.

Commercial Lighting Guidelines – All Massachusetts electric distribution companies participated in the NEEP regional market transformation initiative on commercial lighting in 1998. This initiative undertook, first, to better understand how lighting decisions are made when buildings go through a periodic remodel. In an effort to affect these decisions, the companies worked with NEEP through the *DesignLightsConsortium™,* to develop commercial lighting guidelines that can be used as templates, or patterns, for lighting design. These guidelines were developed with input from designers, contractors and building owners with the goal of making efficient lighting designs more commonplace as buildings go through remodeling or renovation.

3.4 C&I Educational Programs

Many of the C&I program activities discussed above include integrated educational components, including technical assistance and auditing services. Such services inform customers about higher efficiency equipment or process options, or about their energy use

and steps that can improve the efficiencies of their facilities or operations. A few distribution companies also provided educational programs in 1998 that targeted specific commercial categories, such as schools. For example, one program taught junior high and high school students to recognize energy inefficiencies in their school, to identify appropriate, cost-effective solutions, and calculate the energy that could be saved by implementing those solutions. This program also provided a summary of the students' findings to the school principal and custodian, with recommendations to improve the overall energy efficiency of school facilities. Implementation of all low cost and no cost energy conservation measures was strongly encouraged, and implementation of all other cost-effective measures was facilitated to the extent possible.

The value of educational programs such as these is two-fold. First and foremost, they provide direct energy savings to schools through installation of energy conservation measures recommended by students. At the same time, these programs help to increase the ethic of energy efficiency by educating youth – the next generation of consumers – about the benefits and availability of energy efficient products and services.

3.5 C&I Load Management Programs

In 1998, a number of distribution companies offered load management programs. These programs mostly funded C&I interruptible service programs, in which large C&I customers were paid credits if they agreed to reduce their electricity load when called upon by their distribution company during capacity shortage or emergency situations. In 1998, participating C&I customers received $3.8 million in interruptible service credits, thus providing them immediate "savings." Because these programs also helped to maintain system reliability, they benefited all customers as well.

Appendix F: Air Quality Effects of Electricity Generation

A description of and air quality effects of key pollutants emitted by electricity generation are summarized below:

Nitrogen Dioxide

Nitrogen dioxide (NO2) is a reddish brown, highly reactive gas that is formed in the ambient air through the oxidation of nitric oxide (NO). Nitrogen oxides (NOx), the term used to describe the sum of NO, NO2 and other oxides of nitrogen, play a major role in the formation of ozone. The major sources of man-made NOx emissions are high-temperature combustion processes, such as those occurring in power plants and automobiles. Home heaters and gas stoves also produce substantial amounts of NO2 in indoor settings.

Health and Environmental Effects: Short-term exposures (e.g., less than 3 hours) to current nitrogen dioxide (NO2) concentrations may lead to changes in airway responsiveness and lung function in individuals with pre-existing respiratory illnesses and increases in respiratory illnesses in children (5-12 years old). Long-term exposures to NO2 may lead to increased susceptibility to respiratory infection and may cause alterations in the lung. Atmospheric transformation of NOx can lead to the formation of ozone and nitrogen-bearing particles (most notably in some western urban areas) which are both associated with adverse health effects.

Nitrogen oxides also contribute to the formation of acid rain. Nitrogen oxides contribute to a wide range of environmental effects, including potential changes in the composition and competition of some species of vegetation in wetland and terrestrial systems, visibility impairment, acidification of freshwater bodies, eutrophication (i.e., explosive algae growth leading to a depletion of oxygen in the water) of estuarine and coastal waters (e.g., Chesapeake Bay), and increases in levels of toxins harmful to fish and other aquatic life.

Sulfur Dioxide

Sulfur dioxide belongs to the family of sulfur oxide gases. These gases are formed when fuel containing sulfur (mainly, coal and oil) is burned and during metal smelting and other industrial processes. Most SO2 monitoring stations are located in urban areas. The highest monitored concentrations of SO2 are recorded in the vicinity of large industrial facilities.

Health and Environmental Effects: High concentrations of SO2 can result in temporary breathing impairment for asthmatic children and adults who are active outdoors. Short-term exposures of asthmatic individuals to elevated SO2 levels while at moderate exertion may result in reduced lung function that may be accompanied by such symptoms as wheezing, chest tightness, or shortness of breath. Other effects that have been associated with longer-term exposures to high concentrations of SO2, in conjunction with high levels of PM, include respiratory illness, alterations in the lungs' defenses, and aggravation of existing cardiovascular disease. The subgroups of the population that may be affected under these conditions include individuals with cardiovascular disease or chronic lung disease, as well as children and the elderly.

Together, SO2 and NOx are the major precursors to acidic deposition (acid rain), which is associated with the acidification of soils, lakes, and streams, accelerated corrosion of buildings and monuments, and reduced visibility. Sulfur dioxide also is a major precursor to PM-2.5, which is a significant health concern as well as a main pollutant that impairs visibility.

Carbon Dioxide

The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases—primarily carbon dioxide, methane, and nitrous oxide. The heat-trapping property of these gases is undisputed. Although uncertainty exists about exactly how earth's climate responds to these gases, global temperatures are rising. Scientists generally believe that the combustion of fossil fuels and other human activities are the primary reason for the increased concentration of carbon dioxide. Plant respiration and the decomposition of organic matter release more than 10 times the CO_2 released by human activities; but these releases have always been in balance with the carbon dioxide absorbed by plant photosynthesis. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of society's carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture, deforestation, landfills, industrial production, and mining also contribute a significant share of emissions.

Health and Environmental Effects: Rising global temperatures are expected to raise sea level, and change precipitation and other local climate conditions. Changing regional climate could alter forests, crop yields, and water supplies. It could also threaten human health, and harm birds, fish, and many types of ecosystems. Deserts may expand into existing rangelands, and the character of some of the U.S. National Parks may be permanently altered.

Source: U.S. Environmental Protection Agency, Office of Air and Radiation, 1999 www.epa.gov/oar

Appendix G: Common Barriers to Investing in Energy Efficiency

Historically, much of the rationale for public intervention in energy efficiency markets has been based on the fact that there is a large, well-documented gap between the level of investment in energy efficiency that appears to be cost-effective and the level actually found in the market. Advocates of intervention generally argue that this gap is caused by problems in the structure and functioning of markets for energy efficiency, and that these problems can and should be addressed through public means. Opponents of intervention tend to argue either that the efficiency gap does not represent a major source of economic inefficiency, or that whatever economic inefficiency exists cannot easily be addressed through public intervention.

In understanding this debate, it is helpful to draw a distinction between *market barriers* and *market failures.* A market barrier can be defined as any factor which helps to account for the discrepancy between the level of investment in cost-effective energy efficiency and the level actually found in the market. A market failure occurs when one or more market barriers results in an inefficient allocation of resources. Most of the debate about the appropriateness of public intervention in energy efficiency markets has hinged not on whether there are market barriers preventing individuals and businesses from installing cost-effective energy efficiency measures, but on whether or not these barriers constitute market failure and who should be responsible for addressing them.

Broadly, it is possible to distinguish between three classes of market barriers to energy efficiency: A) barriers involving the price of energy and of energy efficiency measures; B) barriers involving market structure; and C) barriers involving limitations to the economic rationality of consumer behavior. Each of these classes is discussed in turn.

A. Price-Related Market Barriers

Price-related barriers to the adoption of energy efficiency measures include externalities, distortions in the price of energy, liquidity constraints, and high transaction costs.

A.1. Externalities. Perhaps the factor that is most widely accepted as a market barrier impeding the adoption of energy efficiency measures is the presence of significant external costs associated with the production and transmission of electricity. Because these externalities are generally not reflected in the rates paid by electric utility customers, from a societal perspective they tend to result in an under-investment in energy efficiency.

A.2. Price Distortions. It is also generally accepted among energy economists that the existing structure of prices for electricity can incorporate significant distortions, which have the potential to skew investment in both supply- and demand-side resources. For example, depending on the specific time and region, marginal electricity rates in the U.S. have often been either well below or well above the marginal costs of production. From a societal perspective, the former scenario has the potential to lead to under investment in energy efficiency, while the later has the potential to lead to over investment. Further, electric rates often do not reflect the cost differentials associated with time-of-use, the geographic location of the customer being served, or the costs of either new or added load.

A.3. Liquidity Constraints and High First Costs. There are plenty of energy efficiency measures available in the marketplace that will pay back their incremental costs compared to

standard measures within a period of a few years or less. However, surveys of utility customers in all sectors consistently reveal that many feel they cannot afford to meet the up-front "first-costs" of such measures, regardless of how good an investment they may represent.

A.4. High Transaction Costs. Even if consumers can afford the first costs of energy efficiency measures, locating efficient equipment or services can often present substantial transaction costs. An example of such costs is the time required to go to multiple retailers to find one that stocks the equipment with the desired efficiency level, as well as desired secondary features. Another example is the cost of collecting detailed information on the performance of high-efficiency technologies, to determine whether their marginal cost over standard technologies is justified.

B. Structural Market Barriers

For the purposes of this discussion, the term "structural market barriers" includes all those market barriers to energy efficiency hinging on the role of individual market participants or on the patterns of stable relationships among participants. The following are examples of structural market barriers: third-party purchases; barriers to market entry; lack of market availability; infrastructure limitations; inseparability of product features; and imperfections in capital markets.

B.1. Third-Party Purchases. In many cases, the person or organization making decisions about the purchase of energy-consuming equipment is not the same person in the organization responsible for paying the bill to operate this equipment. The equipment purchaser thus has little, if any, motive to pay the incremental cost of energy efficiency. The most common example of this situation is when the owner of a residential rental property buys the appliances for it, while the tenants pay the utility bill. However, third-party purchases can also present a market barrier in the context of firms and other formal organizations, where the employee with responsibility for equipment purchasing may have little incentive to fully consider energy efficiency in making his or her decisions.

B.2. Barriers to Market Entry. One key requirement for the efficient operation of a market is that the barriers to entry for individuals or firms wishing to compete in the market are not insurmountable. Unfortunately, such barriers to entry are not at all unusual in energy efficiency markets. For example, the appliance industry is highly competitive with relatively stable (as opposed to growing) demand. High R&D costs are generally associated with the development of new energy efficient products. These high R&D costs represent barriers to entering the energy efficient appliance market. Similarly, some observers have argued that energy services companies (ESCOs) currently face prohibitive barriers to market entry due to dominance of the energy efficiency market by utilities.

B.3. Lack of Market Availability. Sometimes, energy efficiency measures cannot be found in a local market at *any* cost. An example from recent years is high-efficiency motors, which until recently were often not routinely stocked by distributors. Buyers with burnt-out motors would thus be forced either to buy a standard-efficiency unit on the spot, or wait for several days or weeks until a high-efficiency motor could be obtained

B.4. Infrastructure Limitations. Just as energy efficiency measures may be hard to find at a regional level, qualified firms and individuals to sell or service these products may be lacking as well. For example, market research studies have often found the diffusion of new energy efficient

residential appliances to be hampered by the lack of repair workers experienced in servicing them.

B.5. Inseparability of Product Features. In the case of residential appliances, there is a documented tendency for energy efficiency features to be packaged along with luxury features (for example, through-the-door ice in a refrigerator). Its net effect is to lead to underinvestment in energy efficiency on the part of those consumers who cannot afford luxury features.

B.6. Imperfections in Capital Markets. Whatever the specific reasons, it has been well-documented that consumers purchasing energy-using equipment often employ discount rates many times higher than those used by utilities in making plant investment decisions. This can lead to substantial over-investment in electric generation resources, and under-investment in energy efficiency. In essence, those with the most incentive to pursue demand-side measures have prohibitively high discount rates.

C. Economic Rationality of Energy Consumers

Finally, regardless of whether the structure of energy efficiency markets and of the prices of energy and energy-consuming equipment are conducive to energy efficiency, there may still be barriers to the adoption of energy efficiency measures if consumers do not have perfect knowledge and full rationality. Two such barriers are discussed below: imperfect information and bounded rationality.

C.1. Imperfect Information. Economic theory holds that, for markets to allocate resources with perfect efficiency, there must be complete and identical information on the part of both buyers and sellers. However, energy efficiency markets depart from this ideal in a number of important ways. First, most utility customers receive bills which do not provide them with detailed end-use information on energy, making it difficult to assess the cost-effectiveness of individual energy efficiency measures. Second, information on the specific performance characteristics of standard and efficient measures not widely available. Third, and perhaps most important, there are often asymmetries between the level of information held by various market participants -- a condition known to have important implications for economic efficiency. Two common examples are the level of knowledge shown by building owners and tenants, and the level of expertise of appliance purchasers and appliance dealers.

C.2. Bounded Rationality. There is a growing body of behavioral research suggesting that, even when they have reasonably complete information, energy consumers do not consistently act to maximize the return on their investment in energy-using equipment. Instead, they tend to display what economists have come to call bounded rationality: behavior that shows some tendency to maximize utility, but deviates from the ideal of perfect rationality in the use of simplified information sets, heuristic rules for action, and the search for merely satisfactory rather than ideal outcomes. Bounded rationality has most often been cited in the context of individual consumers. However, due to limited resources and the presence of competing objectives within the organization

Appendix H: Glossary of Terms

Administrator - See "Energy Efficiency Program Administrator."

Annual Savings – Energy (kWh) and/or capacity (kW) savings from energy efficiency programs that accrue to customers in a single year. Typically, when evaluating programs, distribution companies report annualized savings, which reflect savings from the installation of energy conservation measures assuming the measures were all installed at the *beginning* of the year, as opposed to the middle or end of the year. While this may overstate annual savings in the first year, the savings average out over the lifetime of the energy conservation measures.

Capacity Savings - Represent the impact that the energy efficiency programs have on reducing demand (in the form of kilo-watts, or kW) on the electricity system during very high or "peak" periods, when the cost of electricity is more expensive.

Coordinated Programs - These are programs that are implemented by multiple administrators in a consistent manner, but are not jointly implemented.

Demand-Side Management (DSM) - Refers to energy efficiency or load management programs funded by electric ratepayers that can be implemented to increase the efficiency of energy use by end users or alter energy consumption usage patterns.

DOER - Massachusetts Division of Energy Resources.

DTE - Massachusetts Department of Telecommunications and Energy.

Energy Efficiency Program - Energy efficiency products, features, and services designed to reduce the amount of electricity used to serve energy end-uses (such as lighting, heating, and cooling) among residential, commercial and industrial customers. A combination of these activities bundled into a program with a single budget is evaluated for cost effectiveness.

Energy Efficiency Program Administrator ("Administrator") - Any electric utility distribution company or municipal aggregator authorized by the Department to utilize ratepayer funding to implement an energy efficiency program.

Energy Savings - Represent the electricity savings available immediately to customers in the form of bills lowered because fewer kilowatt-hours (kWh) were used.

Energy Service Company (ESCO) - The traditional definition of an energy services company, according to the National Association of Energy Services Companies, is " a company engaged in developing, installing and financing comprehensive, performance-based projects centered around improving the energy efficiency of facilities owned or operated by customers". Today, however, the activities of an ESCo are generally

considered broader than the traditional definition, and may or may not entail all or any of the elements of performance contracting, long-term agreements or financing.

Jointly Implemented Program - An energy efficiency program implemented by several administrators jointly. Examples include programs implemented by Northeast Energy Efficiency Partnerships (NEEP) programs and the Joint Management Committee (JMC).

Lifetime Savings - Refers to the cumulative electricity savings resulting from the installation of an energy conservation measure, such as a compact fluorescent, over the entire period (the "life") during which the energy conservation measures remain in place. The life of an energy conservation measure begins when the measure is installed, and can last as long as 20 years.

Lost Opportunity – A type of program that captures energy efficiency opportunities at the time of a naturally occurring market event, such as new construction, expansion, renovation, and replacement of failed or retired equipment.

Market Barrier – Customer barriers to investing in energy efficiency products and services as a result of: include initial high transaction costs for energy efficient equipment, performance uncertainties, lack of product availability, lack of information about energy efficiency products and services, lack of access to financing, and misplaced or split incentives. An example of split incentives arises in rental property where the landlord has no incentive to install energy saving measures in the building because he/she does not pay the electricity bill, and the tenant has no financial interest in doing so because he/she is not in a position to authorize the installation of such measures, such as installing energy efficient appliances, heating systems, lighting etc.

Market Transformation - Generally refers to the process by which collective actions, policies, and programs affect a positive, lasting change in the market for energy-efficient technologies and services. It is one of the goals of many energy efficiency programs, especially some of the regional initiatives.

Mill - A mill is one-tenth of a cent or one-thousandth of a dollar.

Municipal Aggregator - Any municipality or group of municipalities exercising the powers or authorities granted by G.L. 164, §134.

Municipal Energy Plan - A plan developed by a municipality (or group of municipalities) pursuant to G.L. c. 164, §134(b) that defines the manner in which the municipality proposes to implement demand side management and renewable energy programs.

Outsourced Activities - Energy efficiency activities delivered or services provided by entities other than the administrator or administrator's affiliate.

Payback Period - The amount of time it takes to recover the higher cost of energy efficiency equipment. The payback period varies depending on what technologies and/or applications are being considered.

Retrofit Program – A type of program that seeks to exchange functioning equipment with higher efficiency equipment, or to induce efficiency where it is not present.