The Achievable Conservation Potential in New York State from Utility Demand-Side Management Programs

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EXECUTIVE SUMMARY

A. INTRODUCTION

This report examines the level of energy and peak demand savings that could be achieved over a period of 10 to 20 years as a result of cost-effective utility conservation programs.

This study is the final part of a multiphase project on the potential for electricity conservation in New York State being conducted by the American Council for an Energy-Efficient Economy (ACEEE) for the New York State Energy Research and Development Authority (NYSERDA). In the first phase of the project, ACEEE examined the technical potential for cost-effective conservation and load management (C&LM) measures in New York State and concluded that if all conservation measures which are cost-effective to society were implemented, current electricity use in the State would be reduced by approximately 34%. That study did not consider the design or costs of programs and policies needed to promote the C&LM measures identified.

In the second phase of the project, ACEEE examined experience across the country with utility conservation and load management programs for commercial and industrial customers. A particular focus of the study was on programs with high participation rates and/or high electricity savings. The study found that while most programs were serving less than 5% of eligible customers on a cumulative basis, and were reducing electricity use among participating customers by less than 10%, a few programs were serving 50% or more of targeted customers and were reducing customer electricity use by 10-30% (depending on end-use and building type).

The first study identified the major conservation opportunities - their costs, savings, current penetration rates, and the proportion of facilities for which each measure is suitable. The second study identified ways to promote these measures through programs which achieve high participation and measure adoption rates. In this, the final study, we combine the data developed in the first two studies to estimate the costs and savings of an aggressive set of conservation programs which are designed to capture a large share of the technical savings potential while being cost-effective to the sponsoring utility and to society-at-large.

In addition to examining the achievable conservation potential from utility programs, this study had a second, more specific goal. The New York State Energy Plan, prepared jointly by the State Energy Office (NYSEO), Department of Environmental Conservation (NYDEC), and Department of Public Service (NYDPS), calls for electric utility demand-side management programs to achieve savings in electric energy use and peak demand of 8-10% by 2000 and 15% by 2008. One of the purposes of this study was to see if the goals in the State Energy Plan are realistic.

B. APPROACH

For this analysis, 21 conservation programs were analyzed for energy and demand savings, costs, and cost-effectiveness. Programs were analyzed for New York's three largest utilities -- Niagara Mohawk (serving large portions of northern and western New York), Consolidated Edison (serving New York City and northern suburbs), and Long Island Lighting Company (serving suburban Long Island). Programs were analyzed using the COMPASS computer model -- a demand-side management screening program developed by the Synergic Resources Corporation.

The programs included in the study target all sectors (residential, commercial, and industrial), all major end-uses (lighting, heating, cooling, refrigeration, water heating, industrial process, and miscellaneous), and the three major market types (retrofit of existing equipment, replacement of existing equipment when the old equipment wears out, and new construction). The programs analyzed are listed in Table S-1.

This study examined only utility conservation programs (i.e. programs which promote the more efficient use of electricity). Due to time and budget constraints, we did not examine the achievable savings from other types of utility programs such as load management programs, fuel switching programs, or cogeneration. Also, we concentrated on conservation programs because they reduce pollution and other environmental costs with every kWh saved. Other program types have both environmental benefits and costs, which makes the computation of net benefits more complicated (for example, cogeneration saves kWh, but the emissions from the cogeneration system also must be taken into account).

We examined only conservation measures which are commercially available today (with one exception). To the extent new, more efficient technologies are commercialized over the analysis period (which is likely, particularly after 2000), this analysis will underestimate the achievable conservation potential. A further conservatism employed in the study is that we assumed that building codes and equipment efficiency standards will be strengthened during the 1990's. All programs included in the analysis begin where the strengthened standards end.

Table S-1
Programs Analyzed in the Study

RESIDENTIAL:

Energy Fitness (low-cost lighting, water heating and weatherization measures)
Compact fluorescent coupon/catalog
Water heater retrofit (wrap, low-flow showerhead, etc.)
House doctor (infiltration reduction)
Home insulation
Very high efficiency refrigerator rebate
Heat pump water heater rebate
New construction
Submetering of master-metered apartments

COMMERCIAL AND INDUSTRIAL:

Lighting rebate
HVAC rebate
Refrigeration rebate
Motor rebate
Adjustable-speed-drive rebate
Custom measure rebate
Audit
Small C&I lighting direct installation (free installation of energy-saving lamps, ballasts, reflectors, fixtures and controls)
Medium/large C&I direct installation (identification, installation and financing of all cost-effective conservation measures)
Commercial renovation
Commercial new construction
Industrial new construction/modernization

Our analysis begins in 1991, with traditional audit and rebate programs of the type that are now being implemented by many utilities in New York and other states. However, unlike the traditional rebate program, our programs feature high rebate levels (typically 80% of measure cost), extensive personal marketing, and an emphasis on new technologies which receive only limited use at present. Beginning in 1992-1994, we introduce comprehensive direct installation programs into our analysis -- programs which package measure identification, installation, and financing into a single service. These programs are designed to make it as easy as possible for customers to participate -- in many cases, all the customer has to do is say "yes."

In developing programs, we generally based participation rates, program costs, and other important input variables on the results of successful programs highlighted in the Phase II study for this project. Information on measure costs and savings was generally from the Phase I report for this project. Baseline information on utility characteristics came from the NYSEO Reference II forecast of future electricity needs, and from data supplied by the individual utilities.

C. CAVEATS

This analysis of the achievable conservation potential in New York State is subject to a number of significant limitations which should be kept in mind in using this report.

Most importantly, the estimates of program participation rates and free rider fractions are based on limited data -- actual rates may vary. However, while the estimates of savings achieved will change if participation rates change, the results are not nearly as sensitive to errors in the free rider estimates. This is the case because the baseline forecast used by NYSEO and most utilities includes only limited conservation -- in line with the low free rider estimates generally assumed in our study. If free riders are higher than we assume, these savings will still be over and above the savings currently included in most forecasts (however an increase in free riders may affect program cost-effectiveness).

Second, the program designs presented here are not blueprints ready for immediate implementation. Many details need to be filled-in for each program before programs can begin. In some cases, as these details are worked out, substantial changes to the designs discussed here may be required.

Third, program impacts and cost-effectiveness in this report assume a static utility supply plan, i.e., that conservation savings will not change utility load shapes and long-run avoided costs. In reality, as savings exceed 10% of utility energy sales and peak demand, load shapes and long-run avoided costs will undergo considerable change, which will tend to decrease program benefits. On the other hand, our calculations only include benefits through 2020, even though many of the measures installed in later years of the programs will continue to provide benefits after 2020.

Fourth, the energy saving and cost projections in this study are based on the New York State Reference II forecast which was prepared in 1989. A new forecast will be issued in 1991. Due to recent slowdowns in the economy, the 1991 forecast will likely predict slower growth in electricity demand than the 1989 forecast. If the programs examined in this study were modified to fit the 1991 forecast, we would expect program costs, kW savings, and kWh savings to be proportionately smaller, but program benefit-cost ratios and percentage savings (savings as a percent of predicted future demand) to show little change.

Finally, this report estimates the achievable conservation savings from utility-sponsored conservation programs, not the achievable conservation savings from all program approaches. As was alluded to previously, and is discussed at more length below, substantial additional savings can be achieved with complementary program approaches such as strengthened building code and minimum efficiency standards.

D. RESULTS

Each of the 21 programs were analyzed separately for the three utilities. For each utility, all of the programs were found to be cost-effective (benefit-cost ratio greater than one) from the utility, participant, total resource, and societal perspectives (these perspectives are described in the body of the report).[1] In most cases the benefit-cost ratio was at least two, meaning that benefits were at least twice as large as costs. Very few of the programs were found to be cost-effective from the non-participant perspective (also called the rate-impact perspective, the unit cost test, and the "no-losers" test).

When programs fail to pass the non-participant test, rates go up somewhat because: (1) program costs are included in rates; and (2) fixed costs for providing services are spread among fewer kWh of sales. For Niagara Mohawk, the rate increase due to all the conservation programs examined amounts to the equivalent of an average increase of $0.0014/kWh (in 1991 $). This is equivalent to less than 2% of Niagara Mohawk's current average retail rate.

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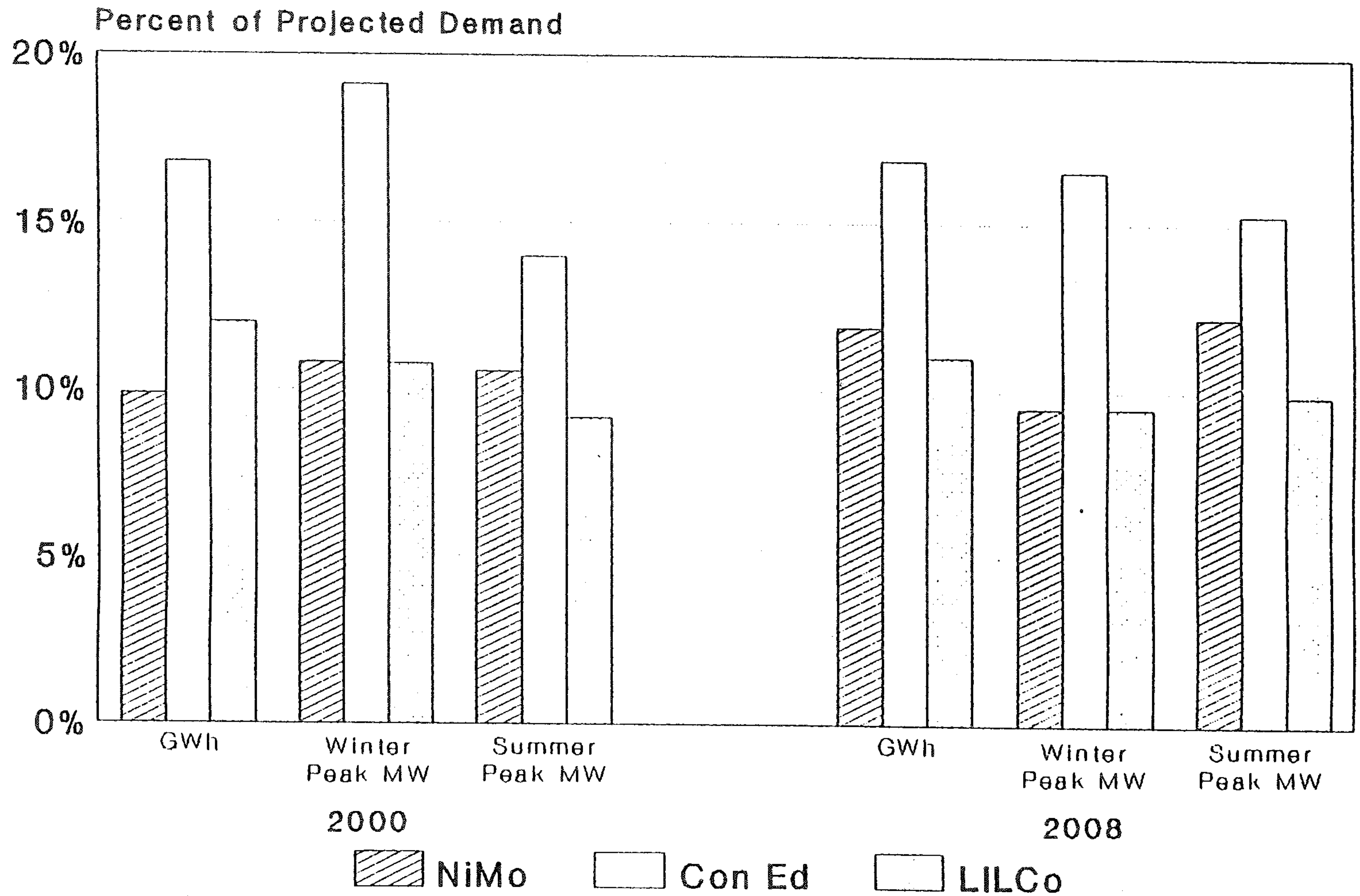
[1] The Rental Submetering program examined for Con Edison may be an exception to this rule. This program passes the utility, participant, and societal tests (the latter by a minimal margin), but fails the total resources test.

For Con Edison, due to very high fixed costs, the rate impact is more substantial, amounting to approximately 9% of current average retail rates. For Long Island Lighting, the rate impact totals approximately 5% of current rates (Note: these figures somewhat overestimate the rate increase needed because avoided distribution capacity costs are not factored into the calculations). While rates may go up slightly, since electricity use decreases as a result of the conservation programs, average bills will decrease relative to where they would have been if the programs were not offered. Also, rate increases will likely be phased in gradually. Still, to ensure that no particular class of ratepayer is disadvantaged by the conservation programs proposed here, we recommend that programs be specifically targeted and marketed to all customer classes and end-uses (as is done in this report), so that the only customers who do not conserve, and hence see their bills increase, are those who decide not to participate in any programs. Furthermore, even non-participants benefit from the reduced pollution and other avoided environmental costs resulting from conservation programs.

Energy and demand savings for each program were calculated for 2000 and 2008. Total savings were then compared to projected electricity sales and peak demand in 2000 and 2008, in the absence of extensive demand-side management programs. Results are summarized in Figure S-1. For Niagara Mohawk and Long Island Lighting, energy and demand savings in 2000 and 2008 range from 9-12% of projected electricity sales and peak demand. For Consolidated Edison, savings range from 14-19%. Savings are higher for Consolidated Edison because two-thirds of Con Edison's load is in the commercial sector, the sector with the highest conservation potential (according to the Phase I study).

For all three utilities, savings, as a percent of projected sales and demand, are approximately the same in 2000 as in 2008. This is the case for several reasons. First, as sales grow, more and

Figure S-1
Conservation Savings Due to Utility DSM Programs as a Percent of Projected Demand for Three New York Utilities



more conservation is needed just to keep the conservation percentage constant. Second, measures installed before 2000 begin wearing out in the 2000-2008 period. While some of these measures are replaced, others are not. Moreover, some measures become standard practice and no credit for savings can be taken. Third, this analysis is limited to existing technologies. After 10-20 of aggressive conservation programs, these technologies will be widely used and additional savings will primarily be available from new technologies that are not included in the analysis.

For all of the utilities, the largest energy and peak demand savings are generally achieved by the C&I Lighting Rebate, C&I Direct Installation, Commercial New Construction, Residential Lighting, C&I Custom Measure, C&I HVAC Rebate, C&I Refrigeration, and Commercial Renovation programs. In addition, for Niagara Mohawk, which has a high saturation of electric space and water heaters in the residential sector, the Residential New Construction, and Heat Pump Water Heater programs also achieve substantial energy savings.

In addition to calculating savings as a proportion of projected electricity sales and demand, we also compared savings to projected growth in electricity sales and demand. For Niagara Mohawk and Long Island Lighting, savings from conservation programs are equal to 54-69% of projected sales and load growth over the 1991-2000 period, and 27-43% of projected growth over the 1991-2008 period. For Niagara Mohawk and Long-Island Lighting, the conservation programs examined will reduce kWh sales by 1.2-1.5% annually over the 1991-2000 period (i.e. 1.9-2.2% sales growth in the absence of programs declines to 0.7% growth with the programs). Over the 1991-2008 period, due to the programs; sales will be cut by 0.7-0.8% annually. Thus, conservation programs can meet the majority of projected load growth over the next 10 years, but in the post-2000 period, new resources (either power plants, new conservation technologies, or non-conservation demand-side resources) increasingly may be needed. For Con Edison, savings from conservation programs are equal to 101-123% of projected sales and load growth over the 1991-2000 period, and 56-61% of growth over the 1991-2008 period. For Con Edison, the conservation programs will reduce kWh sales by an average of 2.0% annually over the 1991-2000 period and 1.2% over the 1991-2008 period.

With impacts of this magnitude, conservation programs can have a substantial impact on utility capacity requirements. For example, if we assume for the sake of illustration that the standard new power plant is a 600 MW coal unit, by 2008, the conservation programs analyzed will displace approximately two new plants in the Niagara Mohawk service territory, approximately three to four new plants in the Consolidated Edison territory, and approximately one such plant in the Long Island Lighting territory. Program costs are also substantial. Over the 1991-2010 period, utility program costs average approximately $96 million/year for Niagara Mohawk, $167 million/year for Con Edison, and $59 million/year for Long Island Lighting (1991 $).

In order to put these results into perspective, we performed two comparisons. First, we compared our estimates of achievable conservation savings from utility programs with analogous data from the long-range resource plans of 17 electric utilities (including six in New York State). This comparison found 11 utilities (including six New York utilities) projecting peak demand savings from conservation and load management programs of 8-16% in 2000, and/or 8-22% in 2008. Much of these projected savings are due to load management programs. In addition, we found five plans which project a 8-15% reduction in electricity sales in 2010. Three of these -- Con Edison, Long Island Lighting, and Rochester Gas & Electric -- serve New York State. Con Edison, alone among the utilities examined, meets the New York State Energy Plan targets for energy and demand savings in 2000 and 2008.

Thus, both our analysis and long-range resource plans prepared by other utilities tend to confirm that the peak demand reduction targets in the New York State Energy Plan (8-10% reduction by 2000, 15% by 2008) are probably reasonable. A 10% reduction in electricity sales is probably also reasonable. However, except for Con Edison, achieving a 15% reduction in electricity sales will require technologies (e.g., new technologies) and/or program types (e.g., cogeneration and fuel switching) that were not included in this analysis.

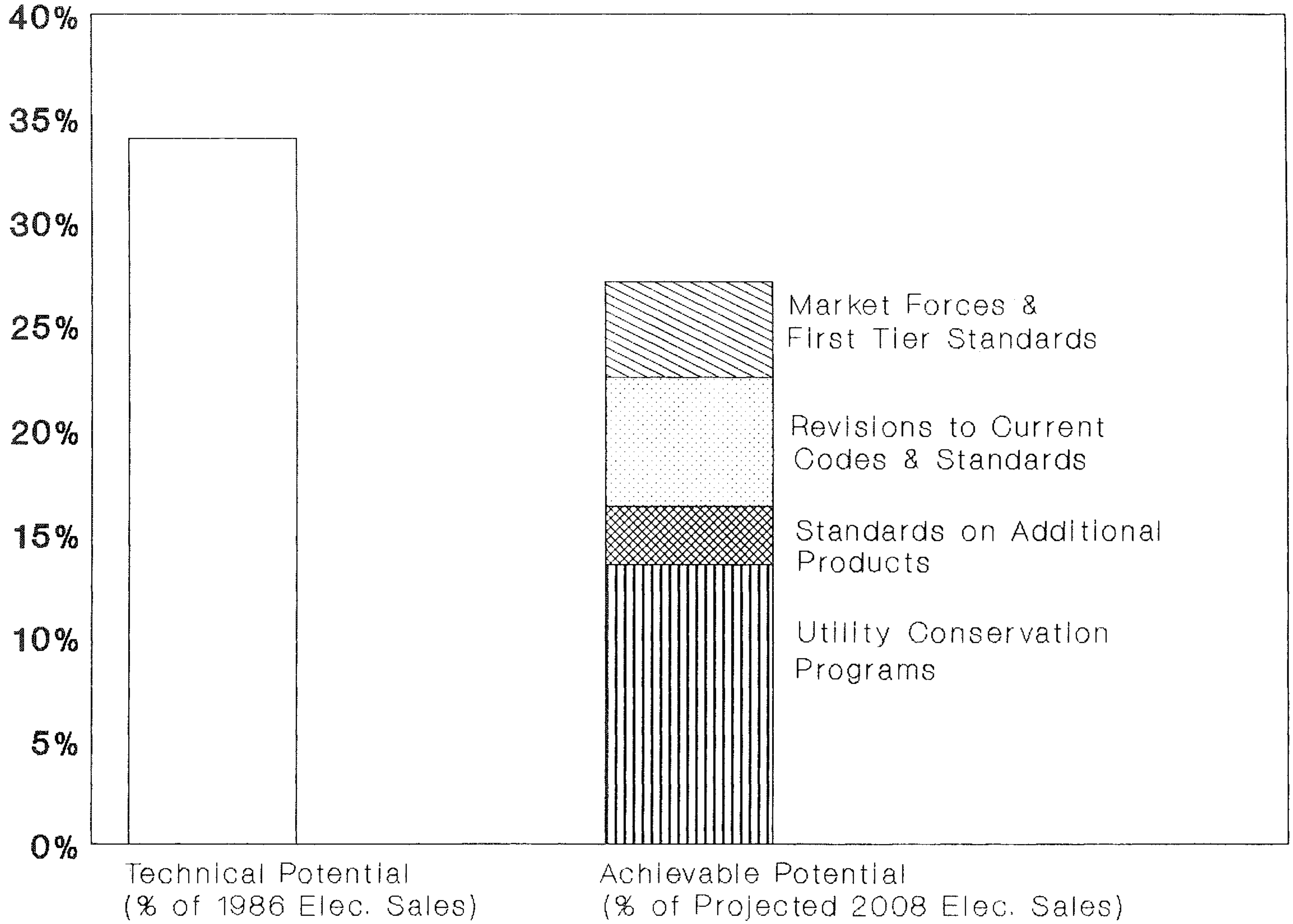
Second, we compared our estimates of achievable conservation savings from utility programs with estimates of the additional savings achievable in New York State in 2008 as a result of mechanisms other than utility programs, such as market forces, building codes, and equipment efficiency standards (details are provided in Appendix C to the main report). This comparison, which is illustrated in Figure S-2, found that achievable savings due to other mechanisms are approximately equal to achievable savings from utility programs. Combining savings from utility programs with savings from other mechanisms results in a total estimated savings potential of approximately 27% in 2008 (including an estimated 5% due to market forces and efficiency standards which are already reflected in official load forecasts). The 27% achievable savings potential represents nearly 80% of the technical savings potential estimated in the Phase I study.

E. CONCLUSIONS AND RECOMMENDATIONS

Based on these results, we reach the following conclusions:

* In 2000, successful pursuit of the utility DSM programs examined in this study will reduce energy use and peak demand below projected levels by 9-12% for Niagara Mohawk and Long Island Lighting, and by 14-19% for Con Edison. Savings in 2008 relative to projected energy use and peak demand in 2008 are similar. For all utilities, available savings represent over 50% of projected growth in electricity sales and peak demand over the 1991-2000 period.

Figure S-2
Technical and Achievable Conservation Potential in New York State



* In order to obtain savings of this magnitude, a comprehensive array of conservation programs must be pursued aggressively, including programs directed at all major sectors, end-uses, and market types (e.g., retrofit, replacement, and new construction). Furthermore, achievement of these savings will require a transition from traditional program approaches (e.g., audits and modest rebates) toward new program approaches (e.g, high rebates and direct installation services).

* All of the programs examined were cost-effective from the utility, participant, total resource, and societal perspectives (with one possible exception). Most of the programs had a benefit-cost ratio greater than two. Thus, the conservation potential estimated in this study is not limited by cost-effectiveness, but rather it is limited by the measures promoted and the predicted participation rates.

* For Con Edison (and secondarily for Long Island Lighting) the programs examined will have an impact on rates due to the fact that as electricity sales decrease, fixed costs must be spread over fewer kWh of sales. For program participants (which ultimately will be the vast majority of customers), the benefits of the conservation programs outweigh the rate impacts by a factor of three or more. In order to reduce potential impacts on non-participants, we recommend that special efforts be made to target conservation programs to all customer and end-use segments. In this way, all customers have an opportunity to participate, thereby saving energy and money, and the only customers who see bill increases are those who make a conscious decision not to participate in any programs.

* The New York State Energy Plan recommends that utilities seek to reduce predicted electricity use and demand by 8-10% in 2000 and 15% in 2008 through demand-side management programs. Our research indicates that the 8-10% target is achievable by all three utilities, but that the 15% target can only be reached by Con Edison (assuming no other programs beyond those analyzed in this study). An analysis of long-range resource plans prepared by other utilities indicates that when load management programs are added to the analysis, a 15% reduction in projected winter and summer peak demand should be achievable in 2008. In order to reduce electricity sales in 2008 by 15%, new technologies (beyond those commercially available today) and/or additional program approaches, such as fuel-switching and self generation, will be required.

* On a statewide basis, achievable conservation savings resulting from non-utility mechanisms (i.e., market forces, codes, and efficiency standards) are approximately equal to the achievable savings due to utility programs.

Based on these findings, we make the following recommendations:

* New York utilities should develop demand-side management programs to reach the savings targets specified in the State Energy Plan. The targets appear to be ambitious but achievable (with the possible exception of the 15% kWh saving targets for Niagara Mohawk and Long Island Lighting). The program designs featured in this study provide many insights into how these programs should be structured, although details need to be worked out by each utility based on its strengths and customer attributes.

* The State of New York should continue to pursue the development of energy-related codes and standards, including: (1) finalizing pending amendments to the state energy code; (2) periodically reviewing and strengthening the state energy code as warranted by available technologies, their costs and benefits; (3) urging the U.S. Department of Energy to pursue all cost-effective savings as specific appliance and ballast efficiency standards come up for revision; and (4) enacting state-level efficiency standards on new products such as commercial packaged HVAC equipment, lamps, motors, and luminaires.

* New York utilities and New York State agencies presently operating energy conservation programs (NYSEO and New York State) should work together to coordinate their respective programs in order to guard against duplication of effort and to ensure that all cost-effective opportunities for energy efficiency improvements are promoted.

* Additional research is needed to identify the potential savings from other demand-side management program approaches such as load management, cogeneration, and fuel switching (switching from one fuel to another for a particular end use where one fuel offers significant efficiency advantages). Additional research is also needed on likely conservation savings from new technologies now under development.

* While most of the programs analyzed in this study are based on the results of previous programs, program experience in several areas is limited and needs further development. All of the programs analyzed can benefit from some further development, but several program areas are especially worthy of attention due to the large

savings at stake and/or the limited experience to date. Programs which fall into this latter category include: (1) programs to promote technologies with very low current market share, such as lighting controls, heat pump water heaters, adjustable-speed drives, and compact fluorescent lamps (in the residential sector); (2) programs directed at HVAC savings other than purchase of new high-efficiency units, such as programs which promote control, distribution, and sizing improvements; (3) remodeling programs; (4) industrial programs; and (5) C&I refrigeration programs.

* Utility demand-side management efforts are now undergoing rapid development in New York, other states, and even other countries. As additional program results become available, and as information on new technologies becomes available, this analysis should be repeated, in order to improve the estimate of achievable conservation potential, particularly over the long-term (beyond the year 2000).

Chapter 1

INTRODUCTION AND APPROACH

A. BACKGROUND. GOALS AND SCOPE

This report examines the level of energy and peak demand savings that could be achieved over a period of 20 years as a result of cost-effective utility conservation programs.

This report is the final part of a multiphase study on the potential for electricity conservation in New York State being prepared by the American Council for an Energy-Efficient Economy (ACEEE) for the New York State Energy Research and Development Authority (NYSERDA).

In the first phase of the study, ACEEE examined the technical potential for cost-effective conservation and load management (C&LM) measures in New York State. This study (Miller et al., 1989) concluded that if all conservation measures which are cost-effective to society were implemented (i.e, measures whose cost is less than utility avoided costs, assuming a 3% real discount rate), current electricity use would be reduced by approximately 34% in the residential sector, 47% in the commercial sector and 16% in the industrial sector, with an average electricity use reduction of 34% across all sectors. The technical potential study analyzed the installed costs of conservation measures and did not examine the cost of programs needed to promote these measures. Furthermore, the technical potential study deliberately ignored the very important and difficult issue of how to convince or encourage end-users to undertake all cost-effective conservation opportunities. As study after study has shown, there are many reasons end-users do not install conservation measures, even when it is cost-effective for them to do so (see for example Hirst et al., 1986).

In the second phase of the study, ACEEE examined experience across the country with conservation and load management programs for commercial and industrial customers. A particular focus of that study (Nadel, 1990a) was on programs with high participation rates and/or high electricity savings. This study collected detailed data on program structure, marketing, participation rates, costs, savings, and free riders (the proportion of program participants who would have implemented conservation improvements even if the program were not offered). The study found that while most programs were serving less than 5% of eligible customers on a cumulative basis, and were reducing electricity use among participating customers by less than 10%, a few programs were serving 50% or more of targeted customers and were reducing customer electricity use by 10-30% (depending on end-use and building type). A number of program elements were found to contribute to above-average participation and savings including:

* Marketing which employs multiple approaches but emphasizes personal contacts (via phone and face-to-face).
* Targeting of program approaches and marketing efforts to specific audiences.
* Technical assistance to help the target audience identify and implement C&LM opportunities.
* Program procedures and materials which are easy for customers and trade allies to understand.
* Financial incentives to catch customer attention and reduce the first cost of implementing C&LM measures.
* Multiple measures for customers to choose from.
* A focus on new technologies which are not widely adopted in the marketplace.

In this, the final phase of the ACEEE study for NYSERDA, we draw from the studies of technical potential and utility program experience to examine the savings that are achievable if current knowledge on how to structure and run cost-effective programs is applied in a systematic and comprehensive manner. The first study identified the major conservation opportunities -- their costs, savings, current penetration rates, and the proportion of facilities for which each measure is suitable. The second study identified ways to promote these measures through programs which achieve high participation and measure adoption rates. In this study we combine the data developed in the first two studies to estimate the costs and savings of an aggressive set of conservation programs which are designed to capture a large share of the technical savings potential while being cost-effective to the sponsoring utility and to society-at-large.

This report examines the achievable savings from utility conservation programs (i.e., programs which promote the more efficient use of electricity). This report does not examine the achievable savings from other types of utility programs such as load management programs (shifting use from peak to off-peak periods), fuel switching programs (switching end-uses from [or to] electric energy to [or from] other fuels), or cogeneration (using small generators to produce electricity and heat at a customer's facility). All of these techniques are viable methods to reduce electric loads. Given the resources available for our work, we were not able to evaluate all utility demand-side management options. We elected to concentrate on conservation programs because these programs reduce both electricity consumption and peak demand (unlike load management programs, which reduce only peak demand), while avoiding complex inter-fuel interactions (which makes analysis of fuel switching and cogeneration programs difficult). Also, we concentrated on conservation programs, because, by reducing the number of kWh that must be generated, these programs reduce pollutant emissions from power plants.

This study focuses on the three largest utilities in New York State -- Consolidated Edison [Con Ed] (serving New York City and suburban Westchester County), Niagara Mohawk Power Corporation [NiMo] (serving large portions of northern and western New York State), and Long Island Lighting Company [LILCo] (serving Long Island, a primarily suburban area bordering New York City). Figure 1-1 shows the service territories of the three utilities examined. Table 1-1 summarizes basic information about the three companies.

In addition to examining the achievable conservation potential from utility programs, this study had a second, more specific goal. The

Figure 1-1
Service Areas of Niagara Mohawk, Consolidated Edison, and Long Island Lighting

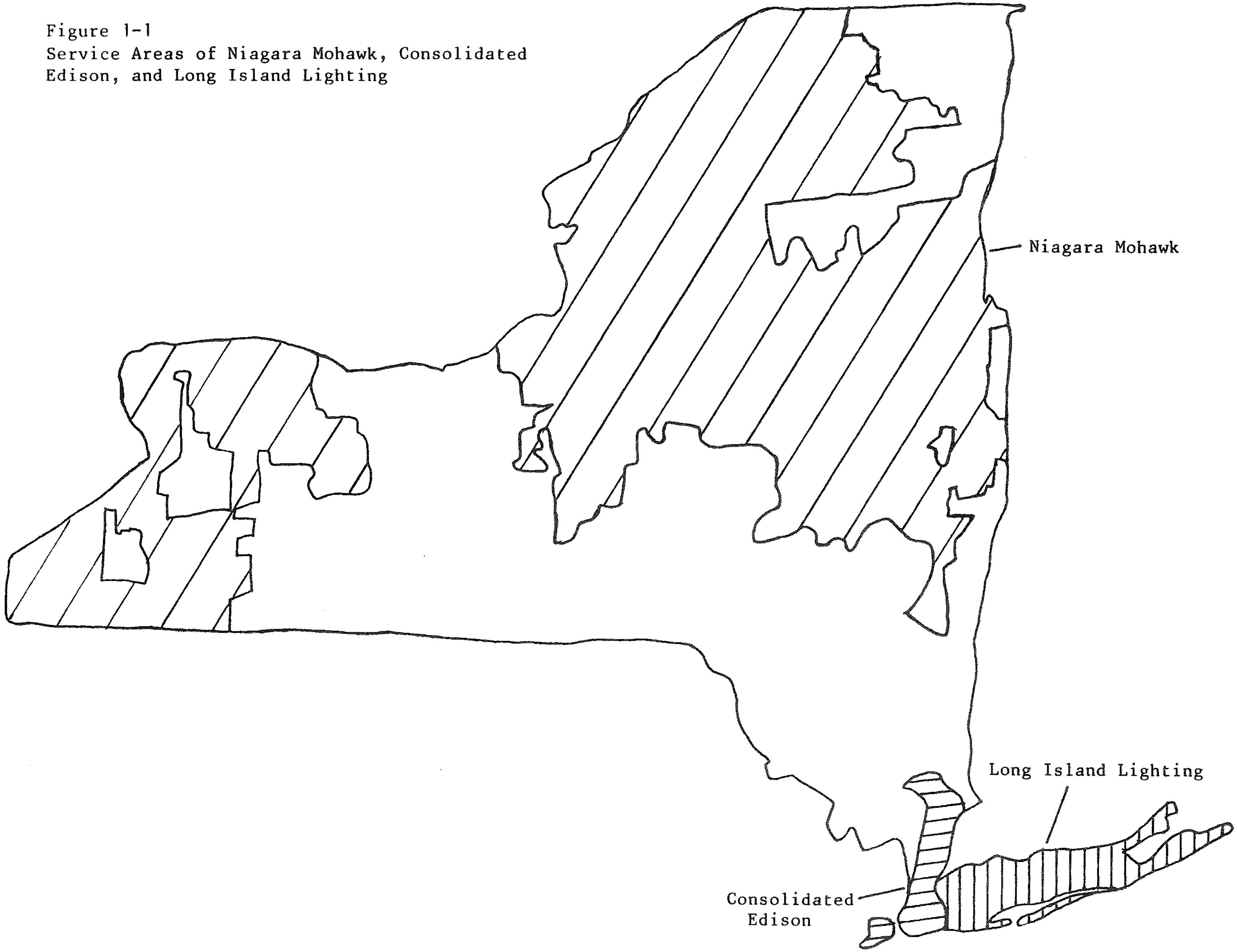


Table 1-1
Descriptive Information on Utilities Covered by the Study - 1989

	Consolidated Edison	Long Island Lighting	Niagara Mohawk
Number of customers (1000's)			
Residential	2,504 #	890	1,345
Commercial	404 +	100 +	143
Industrial	NA	NA	2.3
Total*	2,909	995	1,493
Annual GWh sales			
Residential	9,699	7,063	10,357
Commercial	24,709 +	8,636 +	11,432
Industrial	NA	NA	12,184
Total	37,352	16,169	35,396
Growth in sales (%):'88-89			
Residential	4.4%	1.2%	2.6%
Commercial	3.2	0.8	2.2
Industrial	NA	NA	3.7
Total	3.5	0.8	1.1
Peak demand (MW)			
Summer	8,585	3,688	5,801
Most likely time of peak	2 pm	4 pm	1 pm
Winter	5,974	3,017	6,326
Most likely time of peak	5 pm	6 pm	6 pm
Total generating capacity**	10,543	4,466	7,372
Reserve margin	23%	21%	17%
Gross annual revenues from electric operations (millions)	$4,285	$1,983	$2,419

Source:
All data, except for the time of coincident peak, are from the utilities' Annual Report to the NYPSC and their published annual reports to stockholders. Times of most likely peak were calculated by NYSEO from the utilities' Peak Hour Weekly Load and Capacity Reports to the NYPSC for 1986-90.

Notes:
* Includes miscellaneous small classes such as highway lighting.
** Includes firm purchases.
\# This refers to the number of accounts, many of which are master-metered apartment buildings. According to NYSEO's Reference II forecast database, there were 3.154 million households in 1989.
\+ Con Ed and LILCo do not separate commercial from industrial customers in their annual reports, so both C&I are listed on the commercial line. In 1987, Con Ed had 380,746 commercial customers using 21,099 GWh, and 1,066 industrial customers using 1,400 GWh. In 1987, LILCo had 95,283 commercial customers using 5,314 GWh, and 586 industrial customers using 2,690 GWh (EIA, 1989).

New York State Energy Plan, prepared jointly by the State Energy Office (NYSEO), Department of Environmental Conservation (NYDEC), and Department of Public Service (NYDPS) (Cotter, Jorling and Bradford, 1989), calls for electric utility demand-side management programs to achieve annual electric energy savings of 8-10% by 2000 and 15% by 2008. These goals were developed as part of a general, statewide analysis. One of the purposes of this, the ACEEE/NYSERDA study, was to conduct a more in-depth analysis, to examine whether the goals in the State Energy Plan are achievable and cost-effective at the individual utility level.

B. METHODOLOGY

The achievable conservation potential in New York State was estimated through a five-step process:

1. Gather detailed data on utility, customer, and equipment characteristics, and on previous experience with utility conservation programs.

2. Develop a list of demand-side management programs for detailed analysis.

3. Develop assumptions for the analysis, including general assumptions applicable to all programs (e.g., utility avoided cost rates and discount rates), and assumptions specific to each program (e.g., program participation rates, costs, and savings).

4. Analyze each program using a demand-side program screening model.

5. Compile the individual programs into a plan which seeks to maximize the amount of cost-effective conservation savings achieved over the 1991-2008 period.

Each of these steps is described briefly below.

Data Gathering

Data on utility, customer, and equipment characteristics were gathered from many sources. Major data sources included the following:

New York State Reference II energy forecast (NYSEO, 1989a and 1989b). This forecast formed the basis for the State Energy Plan, and was used in this study for forecasts of present and future electricity use at the end-use level, electric retail rates, and basic data on number of households, commercial floor area, and baseline energy use characteristics.

Utility filings with the NYPSC -- for long-run avoided costs, rates, and selected baseline information.

The Phase I report from the NYSERDA/ACEEE project on the technical potential for electricity conservation in New York State (Miller et al., 1989) -- for data on equipment costs and savings, and some baseline data on equipment saturations.

The Phase II report from the NYSERDA/ACEEE project on the lessons learned by conservation and load management programs for commercial and industrial customers (Nadel, 1990a) -- for data on utility conservation programs including costs, participation rates, free rider proportions, and savings.

Reports by and discussions with staff working on utility conservation programs -- for additional data on utility conservation programs.

List of Programs for Analysis

Based on the data described above, a list of programs for analysis was prepared by ACEEE, with input from NYSERDA, NYSEO, NYDPS, and Niagara Mohawk. Table 1-2 contains a list of the programs chosen for detailed analysis. Details on the program selection criteria and on each of these programs are provided in Chapter 2. Programs which were considered, but not chosen for detailed analysis are also briefly discussed in Chapter 2.

In developing this list of programs, we began with the list of programs now offered by New York utilities, and in particular, several of the core programs (C&I lighting; C&I audit; and heating and cooling equipment rebates) which are offered by all New York utilities as a result of orders from the New York Public Service Commission [PSC] (NYPSC, 1988b). Building on these initial program offerings, an effort was made to include programs addressed to all sectors and all major conservation opportunities, and to use program approaches which had been shown to achieve high participation rates while being cost-effective to the sponsoring utility. In many cases, for the early years of this analysis, programs proposed are expanded versions of programs that are

Table 1-2
List of Utility Conservation Programs and Sub-Programs Included in the Analysis

RESIDENTIAL PROGRAMS

Energy Fitness direct installation
  Low-cost lighting
  Water heating retrofits
  Weatherization
Compact fluorescent coupon/catalog
Water heater retrofit (wrap, low-flow showerhead, etc.)
House doctor (infiltration reduction)
Home insulation (major weatherization improvements including insulation and window upgrades)
Very high efficiency refrigerator rebate
Heat pump water heater rebate
New construction
Master-meter to submeter conversion*
  Condo/coop
  Apartment

COMMERICIAL AND INDUSTRIAL PROGRAMS

Lighting rebate
  Compact fluorescent lamps
  Compact fluorescent fixtures
  Reflectors
  Electronic ballasts and T8 lamps
  Post 1995 ballast program
  High intensity discharge lamp retrofits
  Occupancy sensors
  Daylighting controls
HVAC rebate
  Chillers
  Packaged systems
Refrigeration rebate
Motor rebate
Adjustable speed drive rebate
Custom measure rebate
Audit
Small C&I lighting direct installation
  Ballasts, reflectors, compact fluor. fixtures, HID upgrades
  Compact fluorescent bulbs
  Occupancy sensors
Medium/large C&I direct installation
Commercial renovation - lighting
Commercial new construction
Industrial new construction/modernization

* Consolidated Edison only.

already being offered. After a few years, new program concepts are introduced, and these new programs dominate the list of program offerings in the latter years of the analysis.

With one exception (the Very High Efficiency Refrigerator Rebate Program), programs were designed to promote technologies which are commercially available today. New technologies are not included in the analysis. To the extent that new, more efficient technologies are commercialized over the analysis period (which is likely, particularly after 2000), this analysis will underestimate the achievable conservation potential.

Programs were generally selected to promote advanced technologies not yet in wide use. If technologies are already widely used, we have assumed that remaining users will adopt the measures without the aid of a utility program, either due to normal market forces, or because their use is mandated as a result of government codes or efficiency standards. For example, programs to promote reduced wattage incandescent and fluorescent lamps (e.g. using a 34 Watt "energy-saver" fluorescent lamp instead of a 40 Watt standard lamp) are not included in the analysis. Instead, programs to promote advanced technologies such as compact fluorescent lamps (a substitute for incandescent lamps in many applications) and T8 lamps (narrow-diameter lamps which use even less energy than the "energy-saver" fluorescent lamps) are included.

In addition, in developing programs, we assumed that building codes and equipment efficiency standards would be strengthened during the 1990's; hence programs included in the analysis begin where the strengthened standards end. For example, we assumed that commercial building code amendments recently proposed by NYSEO (1990), would be adopted, effective in 1991, and would be strengthened again in 2000. We assumed that as of 1993, refrigerators and freezers would meet new minimum efficiency standards recently promulgated by the U.S. Department of Energy (DOE), and that these standards will be revised in 2003. We also assumed new efficiency standards on fluorescent lamp ballasts and residential water heaters, effective 1995, even though DOE has yet to propose specific 1995 standards for these products. The issue of energy savings due to codes and standards is discussed further in Chapter 3.

Assumptions for the Analysis

Based on the data gathered in the first two steps of the analysis, detailed program parameters were estimated and general assumptions made to guide the entire analysis. Assumptions for the individual programs are discussed in Chapter 2 and Appendix A. General assumptions are summarized in Table 1-3. Additional detailed assumptions, which apply to the individual utilities examined, are summarized in Appendix B.

In developing assumptions for individual programs, we based our assumptions to the extent possible, on the results of actual programs which have been run by utilities. The COMPASS computer model which we used in our analysis (discussed below) includes procedures to estimate participation rates and free riders based on the simple payback period of each measure. We did not use this part of the model because many factors enter into purchase decisions besides measure payback (see Berry, 1990). A model based on just one factor is likely to produce misleading results in many situations. In particular, many of the programs we examined include high incentive payments, and hence rapid payback to the customer. As the payback period declines, other customer acceptance factors become increasingly important, and a model which includes payback acceptance alone is likely to overestimate participation rates. This is particularly a problem with programs where the utility pays all costs (of which several are included in our analysis). In these cases, a payback acceptance model predicts 100% participation, but such a prediction is clearly unrealistic (Berry, 1990).

Table 1-3
General Assumptions Made for the Analysis

Variable	Assumption	Notes
Inflation rate	4.4%	From NYSEO, Impact Assessment Unit, based on WEFA 9/89 estimate.
Discount rates		
Utility	10.5% nominal	From NYSEO, Impact Assessment Unit based on WEFA, Moody's & utility data.
Customer	11% nominal	For residential sector based on prevailing 1990 home equity loan rates. For C&I sectors, based on prime rate plus 1%.
Society	10.5% nominal	Used same rate as for utility, so that COMPASS "societal" test is equivalent to NYPSC total resources test which includes environmental externalities.
Current electric rates	Current tariffs or blends of current tariffs	From the individual utilities or NYSEO calculations -- see Appendix B.
Growth in electric rates	-0.5% real	From SEO Reference II forecast.
1991 average revenue/kWh	$.124 for Con Ed $.133 for LILCo $.076 for NiMo	From the individual utilities or NYSEO data and calculations.
Utility long-run avoided costs	See Appendix B	July, 1989 values issued by NYPSC, diaggregated by the utilities or NYSEO using NYDPS PROMOD outputs.
Load shapes	See Tables A-1, A-2, and A-3	For the residential and industrial sectors, from NYSEO HELMS model. For commercial sector, end-use load shapes from RG&E and Con Ed. Total sector load shape from NYSEO HELMS model.
Transmission & distribution loss factors	11.8% for Con Ed 11% for LILCo 12% for NiMo	From the individual utilities and NYPSC, 1990a.
Dollar value of environmental externalities	$.014/kWh	NYDPS estimate from NYDPS, 1990.
Incentives given to utilities by NYDPS	No incentives	Incentive regulations are now being developed by the NYDPS but details on the incentive structure were not

Analysis of Programs

Programs were analyzed using the COMPASS computer program developed by Synergic Resources Corporation (1990). This model estimates the costs, savings, and cost-effectiveness of specific demand-side management programs based on detailed inputs provided by the user. The COMPASS model is one of several demand-side screening models in use today. We elected to use COMPASS because it is presently used by six out of seven of New York's investor-owned utilities as well as by NYDPS.

The COMPASS model is illustrated schematically in Figure 1-2. Basic information on utility retail rates, and utility characteristics (e.g., avoided costs, peak periods, and transmission loss factors) are entered into COMPASS's databases. In addition for each program, databases on the costs and savings of specific technologies (e.g., electronic ballasts), size of the market, market acceptance (e.g., participation rates), and end-use loadshapes are prepared. Then, for each program, a program design file is prepared which indicates the technologies being promoted, and program costs (e.g., staff and marketing costs) including incentive structure (e.g., rebates, loans, etc.).

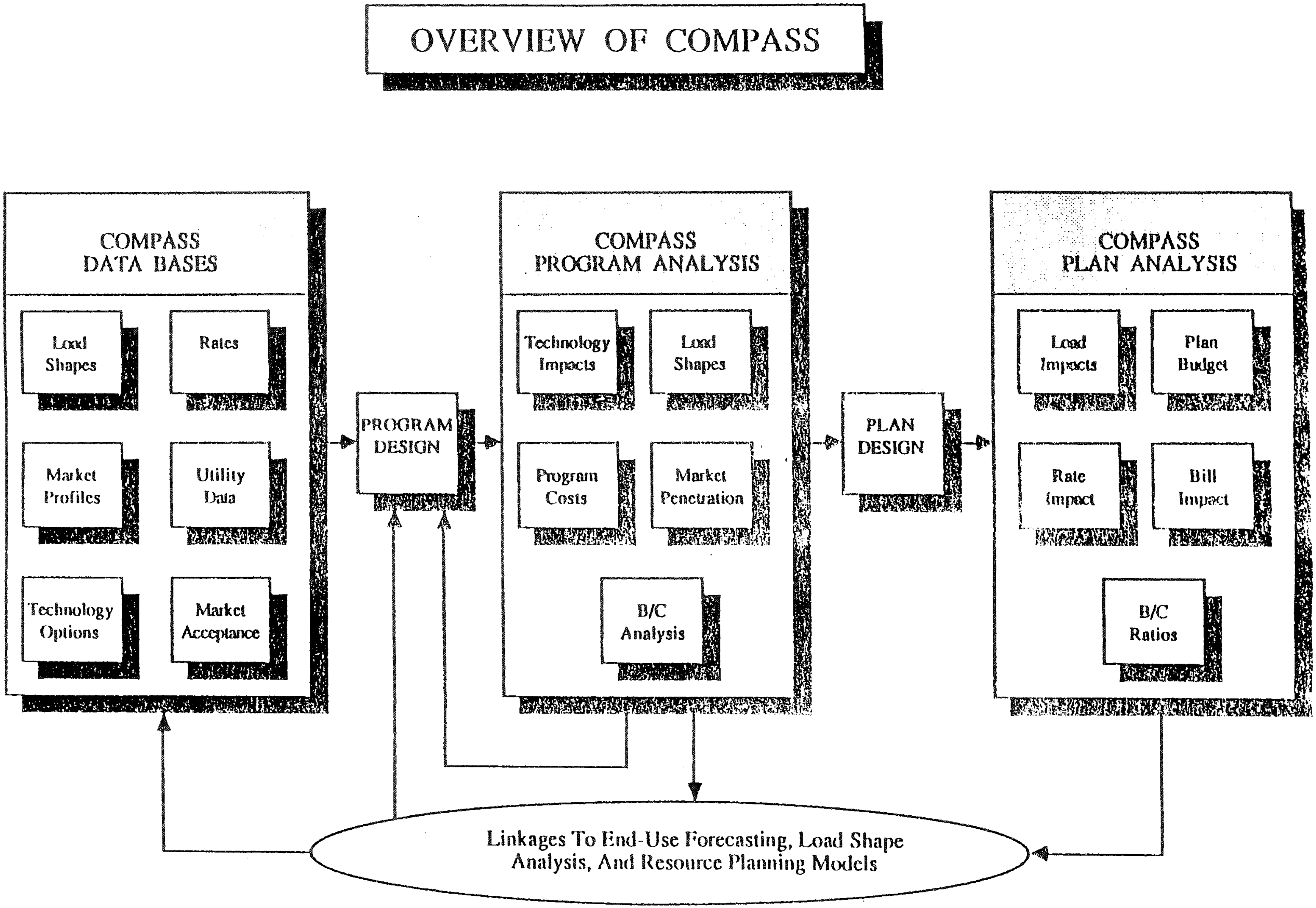
With this data in hand for each program, COMPASS calculates program costs and savings (kWh and summer and winter peak kW) for a 30-year period, and calculates several benefit-cost ratios for each program. Program costs and kWh savings are simple multiples of model inputs. Peak kW savings are estimated by allocating kWh savings according to end-use load shapes for New York State which were input into the model. Benefit-cost ratios (the ratio of program benefits to costs) are calculated for five different perspectives as follows:

1. Program participants.

2. Program non-participants (also known as the "rate impact," "unit cost," and "no-losers" test).

3. Utility.

Figure 1-2


OVERVIEW OF COMPASS
COMPASS DATA BASES
Load Shapes
Rates
Market Profiles
Utility Data
Technology Options
Market Acceptance
PROGRAM DESIGN
COMPASS PROGRAM ANALYSIS
Technology Impacts
Load Shapes
Program Costs
Market Penetration
B/C Analysis
PLAN DESIGN
COMPASS PLAN ANALYSIS
Load Impacts
Plan Budget
Rate Impact
Bill Impact
B/C Ratios
Linkages To End-Use Forecasting, Load Shape Analysis, And Resource Planning Models

4. Total resource (the sum of all direct program costs and benefits, regardless of who receives the benefits or pays the costs).

5. Society (includes indirect costs and benefits such as the value of environmental externalities).

Costs and benefits for each perspective are illustrated in Table 1-4. In these calculations, COMPASS is consistent with the California Standard Practices Manual (California Public Service Commission, 1987.), which has been adopted for use by many public utility commissions, including New York's.

In New York State, the NYPSC has ruled that all the cost-effectiveness tests must be examined in determining whether to proceed with a program, and that no single benefit-cost test be used in isolation (NYPSC, 1988a). In calculating the benefit-cost ratio from the societal perspective, NYPSC staff has advised that a modified version of the total resource test be used, which incorporates an environmental benefit of $.014/kWh for all net reductions in kWh consumption resulting from demand-side management programs. This standardized environmental benefit was recommended as a way to quantify environmental benefits in the absence of better information (NYPSC, 1990).

In addition to benefit-cost ratios, COMPASS calculates a number of other economic parameters including the levelized cost of each program (the cost of each kWh saved assuming all program costs are financed with a mortgage-type loan, with term equal to the measure life, and interest rate equal to the discount rate), and the impact of the program on electric rates (i.e., how much the average cost of a kWh of electricity will go up or down as a result of the program).

Synergic Resources Corp. (1990) has published a detailed description of the COMPASS model.

Table 1-4
Summary of Economic Benefit-Cost Perspectives

Economic Perspective	Benefit Components: Utility Avoided Costs	Benefit Components: Customer Bill Savings/ Utility Revenue Loss	Benefit Components: Utility Incentive Payment	Benefit Components: Avoided Environmental External.	Cost Components: Utility Program Admin.	Cost Components: Utility Incentives	Cost Components: Customer Direct Costs Before Rebates	Cost Components: Customer O&M Costs	Cost Components: Customer Bill Savings/ Utility Revenue Loss
Participant		X	X				X	X	
Non-participant	X				X	X			X
Utility	X				X	X			
Total resource	X				X		X	X	
Society	X			X	X		X	X	

Based on table in Krause and Eto, 1988.

Compilation of a Conservation Plan

A conservation plan for each of the utilities analyzed was prepared by aggregating the results of each individual conservation program. Overlap between programs was taken into account in the development of program input assumptions (as described further in Chapter 2), so that program costs and savings were aggregated through simple addition. Using these aggregated costs and benefits, COMPASS was used to calculate benefit-cost ratios and other economic parameters for the entire plan.

C. CAVEATS

This analysis of the achievable conservation potential in New York State is subject to a number of significant limitations which should be kept in mind in using this report.

Most importantly, the estimates of program participation rates and free rider fractions are based on limited data -- actual rates may vary. In general, the participation rates and free rider fractions are based on actual utility experience with pilot programs and programs offered to limited groups of customers. We assume here that over a period of 10 years or more, similar participation rates can be achieved with programs addressed at all of a utility's customers. If programs cannot be successfully scaled up, then the ultimate amount of savings achieved will be lower. On the other hand, due to the level of incentives used in many of the program designs, the simple payback period to individual consumers, after incentives, are typically only a few months, making the programs very attractive. This could result in long-term participation rates even higher than we assume here. In either case, participation rates and free rider estimates are subject to a considerable degree of uncertainty -- uncertainty which will not be reduced until large-scale programs of the type proposed here are offered and evaluated.[1]

Second, the program designs presented here are not blueprints ready for immediate implementation. Many details need to be filled-in for each program before they can begin. As such, these program designs offer illustrative examples of the expected costs and energy savings that could be achieved. In some cases, as these details are worked out, substantial changes to the designs discussed here may be required. In particular, the program designs outlined here are "generic" programs which have not been customized to the particular needs of each utility. For example, upstate utilities may want to package components of the residential and small commercial programs together into a special program directed at farm customers. Likewise, Con Edison and other urban utilities may want to package components of the residential and small commercial programs into a special multifamily housing program, which is packaged and marketed in such a way as to be most appealing to landlords and tenants.

Third, program impacts and cost-effectiveness in this report assume a static utility supply plan, i.e., that conservation savings will not change utility load shapes and long-run avoided costs. In reality, as savings exceed 10% of utility energy sales and peak demand, load shapes and long-run avoided costs will undergo considerable change, which will reduce the value of program benefits. On the other hand, the COMPASS model fails to value program benefits after the year 2020, when it is likely that many of the devices installed in the later years of the analysis period will still be in use.

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[1] It should be noted that the baseline forecast used by NYSEO and most utilities includes only limited conservation - in line with the low free rider estimates generally assumed in our study. If free riders are higher than we assume, these savings will still be over and above the savings currently included in most forecasts.

Fourth, the energy saving and cost projections in this study are based on the New York State Reference II forecast which was prepared in 1989. A new forecast will be issued in 1991. Due to recent slowdowns in the economy, the 1991 forecast will likely predict slower growth in electricity demand than the 1989 forecast. If the programs examined in this study were modified to fit the 1991 forecast, we would expect program costs, kW savings, and kWh savings to be proportionately smaller, but program benefit-cost ratios and percentage savings (savings as a percent of predicted future demand) to show little change.

Finally, this report estimates the achievable conservation savings from utility-sponsored conservation programs, not the achievable conservation savings from all program approaches. As was alluded to previously, and is discussed at more length in Chapter 3, substantial additional savings can be achieved with complementary program approaches such as load management programs, strengthened building codes and minimum efficiency standards.

D. ORGANIZATION OF THIS REPORT

The remainder of this report is divided into two chapters. Chapter 2 discusses the specific conservation programs that are included in the analysis, including a general description of each program, how each program fits in with other programs, and assumptions used to model the individual programs. Chapter 3 discusses the results of the COMPASS analysis -- including savings, cost, and benefit-cost ratio results -- for each program, and for the sum of all programs for each utility. In addition, the relationship between achievable savings from utility programs, and savings due to market forces, codes, and standards, are discussed in more detail. Finally, Chapter 3 summarizes the conclusions from the study, and makes recommendations for next steps, including recommendations on how the estimates of achievable conservation savings can be improved, and recommendations on next steps for New York State utilities.

Chapter 2

PROGRAMS

A. INTRODUCTION

A total of 21 conservation programs were analyzed for this study of the achievable conservation potential in New York State. The basic principles guiding the selection of these programs were discussed in Chapter 1. Most of the programs analyzed are of two types -- rebate programs and direct installation programs.

Rebate programs pay incentives to encourage the purchase of high-efficiency equipment. Rebate programs are probably the most common type of utility conservation program. All New York utilities presently offer rebate programs to encourage purchase of high efficiency commercial lighting and cooling equipment, and some utilities offer rebates for other types of equipment. The Phase II NYSERDA/ACEEE study found that the typical utility rebate program, including most rebate programs in New York State, pays incentives equal to 25-50% of the cost of high efficiency equipment. Experience in other states, and limited data from New York, indicates that the typical rebate program has a cumulative participation rate (over several years) of less than 10% of eligible customers. This low participation appears to be due to confusing program designs, limited marketing, and limits on the number of customers that can be motivated by 25-50% rebates.

The rebate programs analyzed in this study often build upon existing New York rebate programs, but feature above-average rebate levels (typically 80% of measure cost), supplemental rebates paid to dealers and/or contractors, and extensive personal marketing (i.e., one-on-one visits) with eligible customers and trade allies (e.g., equipment distributors and design professionals).

However, even with these enhancements to the typical rebate design, data from the most successful rebate programs now in operation indicate that even after many years, the majority of customers will not participate in a rebate program and that other program approaches need to be used if additional customers are to be reached (Nadel, 1990a). In order to address this need, beginning in the second year of the analysis, a series of direct installation programs are introduced.

Direct installation programs provide comprehensive services to customers to identify energy-saving measures and to have these measures installed. Typical services provided include energy audits, arranging for measure installation (in some cases utility crews or contractors actually install measures), and financing. Services are often provided as a complete package, and in many cases, services are provided to the customer at little or no cost. In a direct installation program, much or most of the administrative work is handled by the utility, which when combined with the large utility subsidy involved, makes these programs very attractive to eligible customers. For this reason, participation rates of 50% or more have been achieved by several direct installation programs (Nadel, 1990a).

In New York State, work with direct installation programs is just beginning. The New York Power Authority (NYPA) recently initiated a direct installation lighting program for their public customers in southeastern New York. In the program, which is called the High Efficiency Lighting Program (HELP), NYPA provides on-site energy use analysis, arranges for measure installation, and assists with financing, including rebates or low-interest loans (NYPA, 1990).

Similarly, Orange and Rockland Utilities, Inc., as part of a rate agreement with NYDPS and various intervenors, has proposed to implement three direct installation programs over the 1991-93 period -- a small commercial lighting program, a residential low-cost measure program, and a residential lighting program. The Small Commercial Lighting program will provide lighting analyses and installation of cost-effective lighting measures. The Residential Low-Cost Measure program will install low-cost measures (water heater wrap, faucet aerators, low-flow shower heads, and compact fluorescent lamps) in homes with electric water heaters. The Residential Lighting program will install compact fluorescent lighting measures in residences without electric water heaters (Orange and Rockland, et al., 1990).

In developing conservation program designs, be they rebate programs, direct installation programs, or other program approaches, a critical factor is the market to be served. The market for conservation opportunities can be segmented in many ways. In this study, we use three primary variables: (a) sector (residential, commercial, or industrial), (b) end-use (lighting, space heating, etc.), and (c) market type (retrofit, replacement, remodeling, and new construction). The first two variables are used by most utilities and do not need any further explanation. The third variable is discussed below.

Conservation opportunities, costs, savings, and decision-makers vary depending on whether a building is existing, remodeled, or new. For example, with an existing building not undergoing renovation or equipment replacement, conservation opportunities include operations and maintenance changes, and low-and moderate-cost conservation retrofits. Change-outs of entire systems (e.g., ventilation systems or lighting fixtures) are often very expensive and are difficult to justify when existing equipment is functioning satisfactorily. With existing buildings, decisions are generally made by building owners or building managers, with the aid of equipment suppliers and contractors.

In a new building, entire systems are being designed from scratch, so more efficient building systems can be specified that result in substantial energy savings. Furthermore, since systems must be purchased anyway, the cost of a conservation improvement is only the incremental difference between standard equipment and high efficiency equipment. If efficient systems are not installed at the time of new construction, it is usually expensive, and sometimes impossible, to change to more efficient systems later.

In new construction, decisions are generally made by building owners, architects, engineers and contractors.

Buildings undergoing remodeling or equipment replacement fall in-between these two extremes. At the time of equipment replacement (e.g., replacement of worn-out air-conditioners or motors) or building remodeling, many conservation measures can be purchased for the incremental cost difference between standard- and high-efficiency equipment. However, only some systems are affected. For example, Katz et al. (1989), in a study on remodeling practices in the Pacific Northwest, found that over a 20-year period, approximately 40% of buildings had their lighting systems remodeled, but only about 10% had their heating, ventilating, and air-conditioning (HVAC) systems remodeled. Thus, at the time of equipment replacement or building remodeling, more conservation opportunities are available than in a typical existing building, but less opportunities are available than in a typical new building. During equipment replacement and building renovation, decisions can be made by many different people, including building owners and managers, equipment suppliers and contractors, architects, engineers, and even tenants and interior designers (in the case of lighting layouts).

Due to the differences between these different markets, it often pays to target specific programs at each market. The programs examined in this study generally target only one of these markets. A breakdown of programs, by market, is illustrated in Figure 2-1 and Figure 2-2.

While the distinctions between target markets are useful, these distinctions are not rigid. Many times, the different markets overlap, and this overlap must be taken into account when designing programs, so as to avoid customer confusion or double-counting available savings. For example, a customer purchasing an electronic ballast for a new building needs to know whether to apply for an incentive through the ballast rebate program or the commercial new construction program. Likewise, in estimating

Figure 2-1

Schematic of Residential Conservation Programs

Residences

Retrofit

Energy Fitness (DI)
Lighting Coupon/Catalog
Water Heater Retrofit (DI)
House Doctor (DI)
Home Insulation (DI)
Submetering (DI)

Replacement

Refrigerator Rebate
Lighting Coupon/Catalog
Heat Pump Water Heater Rebate

New Construction

Residential New Construction

Note: Repeated programs serve two markets
DI = Direct Installation

Figure 2.2
Schematic of Commercial & Industrial Conservation Programs

C & I Facilities

Existing Facilities

Retrofit	Replacement	Remodel
C & I Audits	HVAC Rebates	Comm'l Renovation
Lighting Rebates (except ballasts)	Refrigeration Rebate	Indus. Modernization
Custom Rebates	Ballast Rebates	
ASD Rebates	Motor Rebates	
Small C&I (DI)		
Med/Lg C&I (DI)		

New Facilities

Commercial New Construction
Industrial New Construction

Note: Repeated programs serve two markets.
DI = Direct Installation

savings available from electronic ballasts, to avoid counting potential savings twice, either ballasts sold for new buildings need to be excluded from the ballast program, or savings achieved in the new construction program must exclude electronic ballasts.

In this study, to avoid double-counting, four general rules are applied as follows:

1. All new and remodeled buildings are assumed to go through the new construction and remodeling programs. For the equipment replacement programs, annual equipment sales are reduced by 25% (based on an ACEEE analysis of equipment sales and forecasted new construction and remodeling rates), in order to exclude sales for new and remodeled buildings.

2. In determining the population eligible for retrofit programs in future years, customer growth (the number of new customers hooked-up each year) is adjusted to exclude customers who participate in new construction programs.

3. In calculating the average life of measures installed through programs, remodeling rates are taken into account. For most types of equipment, this results in an average estimated measure life which is shorter than the rated engineering life.

4. Where two programs seek to tap the same pool of available savings, customers are assumed to participate in one program first, and the eligible population, participation rate, and savings for the second program are adjusted to eliminate overlap.

The remainder of this chapter discusses the general design of each of the conservation programs analyzed in this study. Key assumptions are also discussed. Detailed assumptions for each program are summarized in a set of tables in Appendix A. Program results, including costs, savings, and benefit-cost ratios, are discussed in Chapter 3.

B. RESIDENTIAL PROGRAMS

Energy Fitness

The Energy Fitness program is the "flagship" residential program. The Energy Fitness program promotes low-cost lighting, water heating, and space heating improvements (the latter only for households with electric space and/or water heating), and refers customers to other residential programs for additional conservation services.

The Energy Fitness program is based on previous programs of the same name run by the City of Santa Monica, California (Egel, 1986), the Michigan Public Service Commission (Kushler et al., 1989), and New England Electric (New England Electric, 1990). The program provides conservation improvements, complete with installation, at no cost to the homeowner. Measures promoted through the program include the following:

> Lighting. Up to four free compact fluorescent light bulbs are installed per household. Residents may purchase additional bulbs from the installer at a cost of only $3 apiece (in our analysis, these additional bulbs are counted as part of the lighting coupon/catalog program).
>
> Water heating. In homes with electric water heaters, a water heater wrap, and low-flow showerheads and aerators (one for each shower or sink) are installed. In addition, the water heater thermostat is checked and reset to 120 degrees Fahrenheit (with resident permission).
>
> Space heating. Homes with electric space heat are provided with a box of rope caulk and two plastic storm windows. Installation is demonstrated for each of these products and homeowners are given an opportunity to purchase additional materials from the installer. In addition, foam gaskets are installed in all electric outlets (to reduce air infiltration), and weatherstripping is installed on two exterior doors.

In order to achieve high participation rates, while keeping marketing and labor costs to manageable levels, the program is marketed on a neighborhood-by-neighborhood basis. A specific day is scheduled to target each individual neighborhood. Advance publicity is used to inform residents about the program, including the day services will be provided in their neighborhood. On the day before a neighborhood is served, door-hangers are left at each home which discuss the services that will be available the next day. On the day services are provided (or the evening in neighborhoods with many working families), a canvasser knocks on each door and asks residents if they would like to participate. If the answer is yes (and New England Electric achieved a 70% acceptance rate among residents who were home that day), an installation crew is contacted by radio and an appointment is made for that day. For residents not home that day, information is left on how to schedule an appointment at a future time. Staff for the program can be either utility employees, or the utility can hire one or more outside contractors to manage the program.

Experience by Michigan and New England Electric indicates that 30-60% of households can be served through an Energy Fitness type program (varying by neighborhood). For this analysis, we assume that 45% of the households in each neighborhood participate in the program, and that it will take 13 years to serve all neighborhoods. This ramp-up rate is based on New England Electric experience and projections. In order to obtain high participation rates, it is important to involve local community organizations that know a particular community and are trusted in that community. Involvement of community organizations is particularly important in low-income neighborhoods, because in these neighborhoods, distrust of the utility can be high, and more-trusted organizations are better able to get their "foot in the door."

For the COMPASS analysis of the Energy Fitness program, the lighting, water heating, and space heating components of the program are each analyzed separately.

Lighting Coupon and Catalog

Compact fluorescent lamps can reduce lighting energy use by 75% compared to conventional incandescent lamps, but compact fluorescent lamps are presently used by few households because: (1) few consumers know about compact fluorescent bulbs; (2) compact fluorescent bulbs are not readily available to most residential customers -- few retail outlets stock compact fluorescent bulbs and commercial lamp outlets are not generally accessible to residential consumers; and (3) compact fluorescents typically cost 20 times more than conventional incandescent lamps ($15 versus $0.75), and even though the bulbs last ten times longer and save a large amount of energy, most consumers are reluctant to pay so much for a single lightbulb.

The Lighting Coupon and Catalog program is designed to overcome each of these obstacles. Program publicity and educational materials will inform consumers about the many advantages of compact fluorescent lamps and where these lamps are most useful (applications with moderate to high operating hours -- e.g., greater than 1-3 hours per day, depending on local electric rates). The catalog portion of the program will make compact fluorescents available, via the mail, to all households. The coupon portion of the program will provide an inducement for retailers to stock compact fluorescents. Both portions of the program will subsidize the cost of bulb purchases, so that bulbs only cost consumers an average of $3.

The Lighting Coupon and Catalog program included in this study is based loosely on a catalog program operated by Wisconsin Electric (Schick et al., 1990) and a series of coupon programs offered by several utilities in Europe (Mills et al., 1990). In addition, aspects of a compact fluorescent lightbulb sale conducted by Central Maine Power in conjunction with local Lions Club's (Schick et al., 1990) are incorporated in the program. In a period of one year, each of these programs served from 7-20% of their residential customers (Nadel, 1990b).

The Lighting Coupon and Catalog program is designed to promote compact fluorescent lamps to three audiences -- (1) households that are missed by the Energy Fitness program, (2) households served by the Energy Fitness program who wish to purchase additional bulbs; and (3) households who participate in either the Energy Fitness or Lighting Coupon/Catalog program and desire to purchase replacement bulbs.

Two distribution mechanisms are incorporated in the program in order to reach as many households as possible. A catalog explaining compact fluorescent products is sent to all residential customers. The catalog will contain punch-out, actual size models of each featured product so that people can test to see which products will fit in specific fixtures. Customers are given the option of ordering bulbs via mail, or tearing out coupons from the catalog, and redeeming them at a local retail store. Coupons are also given to retail stores for distribution to customers served by the sponsoring utility (customers fill in their address on the coupon in order to verify their home utility). With the catalog mechanism, the utility purchases compact fluorescent bulbs in bulk and sells them at reduced cost to customers. Order fulfillment is handled by a mail order house. This mechanism should be phased out in a few years, once compact fluorescents are widely available through retail outlets. The coupon gives a substantial discount (approximately $10 per bulb) off the retail price, thereby encouraging stores to stock bulbs and customers to purchase them. Retail outlets will be encouraged to stock a range of products, so that customers can find products to fit specific fixtures. Coupons will be phased out when the compact fluorescent market has developed to the point that consumers are likely to replace bulbs on their own, without utility subsidy (we estimate this phase-out will occur around the turn-of-the-century). Roughly speaking, both the catalog and coupon programs result in the same cost to the utility. With the coupon the average utility subsidy is $10 per bulb. With the catalog, the subsidy per bulb is less (due to bulk purchase discounts) but additional printing and mail order distribution costs are incurred.

Both the catalog and coupon programs emphasize the sale of two-piece compact fluorescent products (i.e., separate bulbs and ballasts). With two-piece products, when the bulb burns out, only a replacement bulb is needed (typical undiscounted cost $3-6), which lowers replacement costs to the consumer and increases the likelihood that burned-out bulbs will be replaced. In addition to discounts on bulbs, the program will also provide discounts on fixtures designed specifically for compact fluorescent lamps.

Other important elements of the program include the following:

* The utility should work closely with retailers and distributors to encourage them to stock bulbs and to sell them to customers at a reasonable price. In particular, distributors throughout a service territory should be encouraged to stock bulbs, so that all customers can readily purchase bulbs. Ways to develop close cooperation with distributors and retailers include funding of cooperative advertising campaigns, and providing advance notice about the program to manufacturers, distributors, and retailers so that sufficient stocks can be on hand when the program begins.

* The utility should test units for quality (e.g., light output, failure rate, buzzing and flicker, etc.) so that only high-quality products are promoted. If consumers do not like compact fluorescents due to problems with low-quality products, efforts to promote compact fluorescents will be set back substantially.

* Program marketing should cover the energy and financial savings customers will realize, as well as the benefit of these savings to the environment.

For the COMPASS analysis of the program, the program is split into two pieces -- an initial period of six years during which sales to first-time purchasers are emphasized, and a second period of seven years during which replacement of burned-out lamps is emphasized. In actuality, these two phases will overlap, but distinguishing between these two phases makes it easier to model the program in COMPASS.

Water Heater Retrofit

This program is designed to provide water heater retrofits to households with electric water heaters that are not served by the Energy Fitness program. After the Energy Fitness program is completed in a community, households who did not participate in the Energy Fitness program, but who have electric water heaters, will be solicited for the Water Heater Retrofit program. The program promotes the same hot water conservation measures as the Energy

Fitness program. Eligible households are solicited over the telephone and are offered free services, complete with installation, at a time convenient to the resident, including weekends and evenings. The program is based on similar programs offered by Seattle City Light (Tim Newcomb, Seattle City Light, personal communication), New England Electric (New England Electric, 1990), Central Maine Power, and other New England utilities (Spellman, 1989). These programs generally use outside contractors to conduct tele-marketing and installation work. Experiences by these utilities indicate that approximately 60% of eligible customers will participate in the program. Due to the close link with the Energy Fitness program, the program is offered over a 13-year period.

A possible enhancement to the program, that was not included in our analysis, is to give away several compact fluorescent bulbs to households participating in the program.

House Doctor

"House doctor" is a term developed by researchers at Princeton University to connote energy conservation specialists who (1) use sophisticated diagnostic tools, such as a blower door and infrared camera, to identify hidden heat leaks, (2) seal these leaks on the spot, and (3) use their diagnostic equipment to verify that "the fix" was successful. During the 1970's, these researchers discovered that hidden heat leaks were reducing the effectiveness of conventional weatherization measures such as caulking, weatherstripping, and insulation. The house doctor approach to weatherization was developed to address this problem (Harrje et al., 1980).

The House Doctor program included in this study is designed as a follow-up program to the Energy Fitness program. This program is based loosely on programs run by the Sun Power Consumer Association (Proctor and deKieffer, 1988) and New England Electric (Jacobson et al., 1990).

As part of the Energy Fitness program, homes with electric space heat are provided with low-cost weatherization services. These homes are then referred to the House Doctor program for additional services. In addition, the House Doctor program is offered to electrically heated homes which were missed by the Energy Fitness program.

Under the House Doctor program, households are provided with a half-day of house doctor services by a two-to-three person crew. Crews can be either utility staff or outside contractors. Work is limited to a half-day visit because research indicates that as more time is spent in a house, savings per crew-hour decrease and the cost per unit of saved energy increases (Schlegel and Wigington, 1988). Typical costs for a half-day visit are $300 per household (Proctor and deKieffer, 1988). This cost is primarily for single-family homes -- for apartments, costs can be somewhat less. Reported savings from the service have been estimated by Jacobson et al. at 5.2-5.5% of average heating and cooling energy consumption (for an average of $200 of work per household) and by Proctor and deKieffer at 10.6% (for $300 of work per household by an experienced crew with good quality control). For our analysis, we assume average savings of 7.5%, taking into account two considerations: (1) some savings have been achieved in the same homes through the Energy Fitness program, and (2) training and quality control in a large-scale program will probably not be as good as in the Proctor and deKieffer program. Still, in order to obtain savings at this level, the utility will need to devote considerable attention to training and quality control. Proctor and deKieffer make many useful suggestions in this area.

In addition to house doctoring services, for homes needing insulation and window upgrades, as part of the House Doctor program, insulation and window work orders will be prepared, and the job referred to the Home Insulation program (discussed below).

The House Doctor program will be promoted only in communities served by the Energy Fitness program. This will reduce program costs by helping to keep marketing and travel costs in check. Over the 13-year life of the Energy Fitness program, all communities in a particular service territory will be served.

Services will be provided to households for a modest charge ($19.95). The fee is assessed so that the homeowner places value on the services performed, and hence is more likely to leave measures in place, and to replace them when they are damaged. Low-income households will be provided services for free. Work on homes with low-income households should be coordinated with the Weatherization Assistance Program (WAP) operated by New York State.

Home Insulation

The Home Insulation program is a follow-up program to the House Doctor program. Under the House Doctor program, work orders will be prepared for homes needing insulation upgrades, ventilation upgrades, and other weatherization improvements which pass a cost-effectiveness test (i.e., measures are cost-effective from the societal perspective, as discussed in Chapter 1). Under the Home Insulation program, the utility will arrange for measure installation using private contractors who have demonstrated a high quality of workmanship and have negotiated a fixed-price schedule with the utility (e.g., a fixed charge per square foot of wall insulation). The utility will pay 70% of measure cost and the homeowner 30% (this allocation has proven very effective in a weatherization program operated by the Bonneville Power Administration -- Schick et al., 1990). For low-income households, the program should be coordinated with the Weatherization Assistance Program so that services can be provided to residents at no charge. Costs and savings for the Home Insulation program included in our analysis are based on results from a similar program offered by New England Electric in conjunction with local community organizations (Jacobson et al., 1990).

Services provided under the Home Insulation program overlap somewhat with services presently provided by New York utilities under the Home Insulation and Energy Conservation Act (HIECA) program and by NYSEO under the Energy Conservation Bank program. Coordination among the three programs will need to be worked out so that services to residents are maximized and duplication of effort is minimized.

Heat Pump Water Heater Rebates

Heat pump water heaters use a heat pump cycle to heat water approximately twice as efficiently as an electric resistance water heater. However, despite the fact that heat pump water heaters cut the cost of electric water heating by approximately 50%, few households purchase heat pump water heaters because (1) few homeowners know about heat pump water heaters, (2) few dealers stock heat pump water heaters, and (3) most potential purchasers are reluctant to invest in heat pump water heaters because these devices cost approximately three times more than a conventional electric water heater. The Heat Pump Water Heater Rebate program is designed to overcome these barriers through a combination of public and dealer education, and rebates paid to customers, plumbers, and wholesalers (when added together, these rebates will be equal to the cost difference between conventional and heat pump water heaters)

The Heat Pump Water Heater program will be targeted at existing homes with electric water heaters, and new homes with electric space heat (these homes are highly likely to also have electric water heaters). Other homes will not be eligible, so as not to encourage the conversion of gas or oil water heaters to electric water heaters. The Heat Pump Water Heater program is based on programs operated by the Bonneville Power Administration (Majors and Cody, 1987) and Wisconsin Electric (Schick et al., 1990).

Marketing of the heat pump water heater program will combine efforts directed at homeowners and plumbers. Available research indicates that most water heater purchase decisions are made by plumbers or builders -- the homeowner is usually not involved (Michael McAteer, New England Electric, personal communication). For this reason, the program will include an extensive marketing effort directed at plumbers and wholesalers, including an incentive of $100 per unit installed. However, plumbers are unlikely to promote new high efficiency products unless significant consumer interest has already been established (Bernie Mittelstaedt, DEC International, personal communication), hence the need for a major homeowner/homebuyer marketing program.

Due to the immaturity of the heat pump water heater market, participation rates in the program are assumed to be low in the initial years of the program (based on the Bonneville Power Administration and Wisconsin Electric experience), even with the very large incentives involved, but to slowly ramp up over a ten year period (i.e., participation rates range from 1% of water heater sales in the first year up to 40% in the eleventh year).

<u>Very High Efficiency Refrigerator Rebates</u>

Refrigerator rebate programs have been offered for many years by utilities, including several New York utilities and NYSEO. However, as a result of minimum efficiency standards which went into effect nationwide in January 1990, average refrigerator efficiencies have climbed substantially, and only modest energy savings (typically 10% or so) are available by purchasing the most efficient units on the market (Nadel, 1990b). While the efficiency of the most efficient refrigerators on the market only marginally exceeds the average efficiency on the market, a recent analysis by the U.S. Department of Energy indicates that units approximately 50% more efficient than those sold today are possible using designs now in the prototype stage (U.S. DOE, 1989a). However, manufacturers are reluctant to produce these models because they are unsure if a market will be available (Sasnett, 1990).

In order to untie this knot, a number of observers (e.g., Goldstein, 1990) have suggested that utilities offer rebates for very high efficiency models (more efficient than those presently produced), and promise to honor the rebate offer for a several-year period. With the availability of rebates, manufacturers would have additional incentive to bring these models to market.

The Very High Efficiency Refrigerator Rebate program is just such a program. Under this program, utilities would offer rebates of $200 per refrigerator for units whose energy use meets or exceeds "Level 5 standards" recently studied by DOE (U.S. DOE, 1989a). These models feature vacuum panel insulation and other improvements designed to dramatically improve refrigerator efficiency while reducing the amount of CFC's contained in the refrigerator. Based on the DOE analysis, these rebate levels are likely to cover the full incremental cost of these very high efficiency refrigerators while allowing manufacturers to recoup research and retooling expenditures. After rebates on 5% of the refrigerator stock have been paid, rebate levels would drop to $100 per unit (equivalent to DOE's estimate of the long-term incremental cost of such units in mass production). A program of this type has been formally proposed by Pacific Gas and Electric (PG&E) in a recent filing with the California Public Utilities Commission (PG&E, 1990).

In analyzing the costs and savings of this program, we make one further assumption -- that if such a program is offered by several major utilities, development of very high efficiency units will be accelerated, which will allow DOE to mandate these efficiency levels, effective 1998, under the provisions of the National Appliance Energy Conservation Act of 1987 (NAECA). At this point, rebates would be phased out. If utilities do not offer this program, the effective date of these minimum efficiency standards is assumed to be delayed until 2002 (NAECA provides for the review and revision of refrigerator efficiency standards every five years).

Residential New Construction

The Residential New Construction program provides financial incentives, training, and promotional assistance to builders who construct homes that meet energy efficiency requirements set by the utility. Financial incentives will pay approximately 75% of the cost of efficiency improvements. Training will teach builders how to build homes with low air infiltration and adequate ventilation, so that both energy use and indoor air quality problems are reduced. In order to generate consumer demand for certified homes, a public information campaign will be conducted, to inform potential homebuyers of the advantages of a home certified through the program. Quality control inspections will be conducted to help assure that energy savings are achieved, and to complement other builder training efforts.

The design of the program is based on similar programs run by utilities and home builder's associations, particularly Canada's R-2000 program and the Bonneville Power Administration's Super Good Cents program (Vine and Harris, 1988). Specific cost and savings estimates generally come from a program now being developed cooperatively by seven Massachusetts utilities (New England Electric, 1990). Ideally, New York utilities would follow the Massachusetts model and adopt the same program throughout New York State. This would reduce utility costs and would be less confusing to builders who work in more than one utility service territory.

As with the Massachusetts program, the detailed design of the program should involve all interested parties, including NYSEO, the New York Home Builders Association, and the Departments of Public Service and State. Such a program would be a nice enhancement to the home energy rating system proposed in the New York State Energy Plan, and now being discussed by several New York utilities and the above-listed parties.

As analyzed here, the Residential New Construction program is directed only at homes with electric heat, including heat pumps and baseboard resistance heaters. We strongly recommend that similar programs be offered by gas utilities and by NYSEO (using oil overcharge funds to help finance upgrades to oil heated homes), so that builders have no incentive to switch to electric heat in order to participate in the program. An incentive program of this sort is included in the State Energy Plan. If these complementary programs are offered, electric utilities should contribute to any appliance and lighting energy savings that can be obtained. If complementary programs are not offered, then the electric utilities should provide some services to homes with gas and oil heat, in order to discourage conversion of these homes to electric heat.

Energy efficiency requirements for participating homes will be more stringent than current requirements for homes with electric resistance heat, and substantially more stringent than code requirements for homes with heat pumps. For example, under the program, the utility will require R-26 walls, R-3.5 windows, R-8 doors, and R-38 ceilings in participating homes. Builders will be allowed to decrease the efficiency of one component, provided the efficiency of another component is increased by a compensating amount (such a procedure is already included in the New York building code). Under the current building code (most recently amended in 1987), homes must have R-18 to R-23 walls (the low end of this range applies to homes with heat pumps, the high end to homes with resistance heat), R-1.7 to R-2.6 windows, R-2.5 doors, and R-19 to R-33 ceilings (NYSEO, 1990a).

In addition to R-value requirements, all homes participating in the Residential New Construction program must have an infiltration rate of no more than 0.35 air-changes per hour, as measured with a blower door test. To certify compliance with the infiltration requirements, utilities will test 100% of homes in the first two years of the program, 50% in the third year, 25% in the fourth, and 10% thereafter. Homes must also have automatic ventilation systems, and air-conditioners, heat pumps, and water heaters must surpass efficiency requirements. Supplementary incentives will be offered for high efficiency lighting systems using compact fluorescent or high-intensity discharge lamps.

The program targets single-family, townhouse, and multifamily buildings. For multifamily buildings, energy efficiency requirements should differ (because code requirements differ) and additional design assistance services offered. In some cases, it may be desirable to serve large multifamily buildings through the Commercial New Construction program instead of the Residential New Construction program.

Program marketing will emphasize personal contacts with homebuilders, and a multimedia campaign for potential home buyers.

A useful complement to this program would be a program directed at the manufactured home industry. The Bonneville Power Administration has conducted such a program for several years (Riewer, 1990). A manufactured home program is not included in our analysis.

Apartment Submetering

The Apartment Submetering program promotes installation of individual apartment sub-meters in individual apartments. With master-metering, landlords' or owners' associations pay the electrical bill, which is then rolled into each individual tenant's rent. Individual tenants therefore have little incentive to conserve as electricity costs are shared equally by high users and low users. With submetering, each tenant pays their own electrical bill, thus providing a direct price signal to reduce their energy use. A study conducted by Con Edison of condominium and coop owners who switched from master-metering to submetering found that on average, following the conversion, energy consumption fell 30% in the summer, 10-18% annually, and coincident peak demand was reduced by an average of 24% (NYPSC, 1989b). With submetering, the landlord or owners' association still pays the electric bill, but the landlord or owners' association in turn bills individual tenants based on their submetered electricity consumption.

Con Edison, under orders from the NYPSC (1989b), has proposed a pilot submetering program for condominiums and coops, and possibly rental units. The program analyzed in this study is based on the proposed Con Edison program, with several significant changes. First, under the Con Edison program, the building owner pays all conversion costs (typically on the order of $500 per apartment -- Joseph Kleinmann, Quadlogic Controls, personal communication), and Con Edison pays an incentive of $100 per apartment converted. In our program, the utility pays all conversion costs (but no incentive beyond that). Second, the Con Edison program is a strictly voluntary program -- the choice of conversion is left up to each owners' association. In our program, we recommend that ways to mandate conversion (e.g., NYPSC order, or passage of appropriate legislation) be pursued. Third, the Con Edison program may not apply to rental buildings. Our program does include rental buildings, although this aspect of the program does not begin for several years, in order to allow sufficient time to work out program details, such as the relationship between submetering and existing rent control regulations.

In our analysis, the Apartment Submetering program is applied only to Con Edison, because master-metered apartments are widespread in Con Edison's territory. Since Con Edison's pilot program is only now being initiated, good data on likely long-term participation rates are not available. Actual participation rates could range from less than 10% (under a strictly voluntary program that is confronted with considerable market resistance) to 100% (for a mandatory program). Faced with this lack of data, we assume a mid-point participation rate of 50%. If submetering is mandated, savings from the program could be substantially higher. In addition to uncertainties about participation rates, due to the shortage of actual program experience, there is also considerable uncertainty about program costs and savings, particularly for the rental market (as opposed to the condo/coop market). As new data becomes available, program assumptions should be refined.

For the COMPASS analysis, the program is divided into two components -- one for condominiums and coops, and one for rental buildings. The two markets are assumed to differ in two respects: (1) conversions begin later in the rental market, in order to allow time to work out rent control and other issues, and (2) savings in the rental market are assumed to be less than in the condo/coop market because households are typically less affluent, and hence less likely to have air conditioning and other energy-consuming appliances.

Residential Programs Not Analyzed

In addition to the programs discussed above, a number of programs were considered, but not analyzed in detail. These programs include an energy audit program, water heater and air conditioner rebate programs, a used appliance turn-in program, and an air conditioner maintenance program.

New York utilities have offered residential energy audits for many years. Experience around the country with residential energy audits indicates that cumulative participation rates of up to 25% of residential customers can be achieved. Savings due to programs tend to average 3-5% for the prime heating fuel (Nadel, 1990b). While these participation rates and savings are significant, other program approaches (e.g., the combination of programs analyzed in this study) appear to produce higher participation rates and savings. For this reason we elected to analyze these other program approaches, and not to analyze an energy audit program. Due to the attractiveness of the program approaches that are examined in this study, once these programs begin, we expect that demand for energy audits in homes with electric heat will decline significantly.

Water heater rebate programs have been offered by several utilities. These programs promote improved-efficiency electric resistance water heaters. In this study, we assume that as a result of updated minimum efficiency standards, the only electric water heaters which can be sold after January 1995, are high-efficiency models. Experience with water heater rebate programs offered by other utilities indicates that participation rates tend to be low in the initial years of the program (Nadel, 1990b). Given the likelihood that participation rates will be low for several years, and that the program will no longer be needed as of 1995, we elected not to analyze a water heater rebate program.

Air conditioner and heat pump rebate programs have been offered by many utilities, including several New York utilities. These programs pay rebates for units which exceed specified efficiency ratings. National efficiency standards for central air conditioners and heat pumps go into effect in 1992 which will mandate efficiency levels that exceed minimum efficiency requirements for most existing rebate programs. While rebates could be offered for units with still higher efficiencies, the Phase I NYSERDA/ACEEE study found that at current equipment prices, these high efficiency levels are generally not cost-effective in New York's temperate climate. The same considerations also apply to high-efficiency room air conditioners in New York State. Furthermore, an evaluation of Wisconsin Electric's air conditioner rebate program found that actual measured savings by program participants were considerably less than engineering estimates. A likely cause of the discrepancy is that homeowners purchasing high-efficiency units, thinking that their units are energy-efficient, operate their air-conditioners for more hours each year, thereby "taking back" some of the available savings (Rogers, 1989). Thus, until the cost of high efficiency air conditioners comes down, and until "take back" concerns are resolved, after 1992, air conditioner rebates are unlikely to be cost-effective in New York State.

Used appliance turn-in programs have been operated by a number of utilities, including Pacific Gas and Electric, and Wisconsin Electric (Nadel, 1990b). Often, when a new refrigerator is purchased, it is difficult to dispose of the old unit, so if the unit still works, it is moved to the basement and used for parties, or to keep extra beverages cold. However, these appliances, which are typically old and inefficient, use a large amount of energy. If the utility offers to dispose of the used appliance, and in addition pays an incentive (Wisconsin Electric provides a $100 savings bond), many customers will agree to get rid of their old refrigerator, resulting in significant energy savings. Offering incentives to dispose of old room air conditioners can offer similar benefits.

Researchers at the North Carolina Alternative Energy Corporation (NCAEC, 1988) and the Salt River Project (Kuenzi and Wood, 1987) have found that standard air conditioner (and heat pump) installation and maintenance practices often result in suboptimal efficiency. The NCAEC has run a pilot training program for air conditioning installers and maintenance personnel on improved installation and maintenance practices, although savings resulting from this program have not been measured. Further work is needed on the likely cost and savings of this and other program approaches to improve air conditioning installation and maintenance practices.

C. COMMERCIAL AND INDUSTRIAL PROGRAMS

Lighting Rebates

The Lighting Rebate program provides rebates for reflectors, compact fluorescent lamps and fixtures, high-intensity discharge (HID) retrofits, occupancy sensors, and daylighting controls. In addition, rebates for electronic ballasts and T8 lamps (the most efficient type of fluorescent lamp presently on the market) are available until 1995. Electronic ballast rebates are phased out in 1995 under the assumption that revised efficiency standards, which take effect in 1995, will require use of electronic ballasts. After 1995, rebates will be available for 3- and 4-lamp electronic ballasts (which are more efficient than standard 2-lamp ballasts) and for T8 lamps. All rebates end in the year 2000, under the assumption that most customers who will participate in a rebate program, will have participated by that time. After 2000, direct installation programs are emphasized in order to obtain additional lighting energy savings.

Rebates will not be available for "energy-saving" fluorescent lamps (e.g., 34 Watt lamps which replace standard 40 Watt lamps) because these products are widely used at present, and hence many rebate recipients are likely to be free riders. Furthermore, lamp efficiency standards, which will require use of energy-saving lamps (or higher efficiency products), are being adopted by neighboring Massachusetts, and are being considered by NYSEO.

New York utilities presently offer rebates for most of the products covered by this program. This program differs from current programs in several respects. First, rebate levels are significantly higher. Existing rebates generally range from 25-50% of measure cost. In this program, rebates are set at 80% of measure cost. Second, existing programs are generally marketed with a combination of direct mail advertising combined with limited personal contacts with lighting distributors and large customers. This program will include much more extensive personal contacts, so that an ongoing relationship is developed between utility representatives, trade allies, and customers. Third, existing programs pay the entire rebate to customers and none of the rebate to dealers. We recommend that a small portion of the rebate be paid to dealers as a year-end bonus. This bonus would substantially increase dealer year-end profits, and could induce lighting distributors to undertake special marketing efforts.

Program costs, and participation and free rider rates are based on results from other utility programs. In particular, short-term participation data from New England Electric's lighting rebate program is used because of its similarity to the program proposed here (White, 1989, and John Eastman, New England Electric, personal communication). Long-term participation figures are generally based on programs operated by Pacific Gas and Electric and the City of Palo Alto, California (Nadel, 1990a).

In order to analyze the Lighting Rebate program in COMPASS, the program is divided into eight sub-programs as follows: reflectors, HID retrofits, compact fluorescent lamps, compact fluorescent fixtures, occupancy sensors, daylighting controls, ballasts/T8 lamps (1991-1994), and ballasts/T8 lamps (1995-1999).

HVAC Rebates

The Heating, Ventilating, and Air Conditioning (HVAC) Rebate program is designed to encourage end-users to purchase high-efficiency chillers (large, central cooling systems) and packaged HVAC systems (small- and medium-sized air conditioners and heat pumps) at the time existing equipment needs replacement. The program is also designed to encourage proper sizing of replacement HVAC systems.

The program features two rebate eligibility levels -- a moderate efficiency level and a high efficiency level. The moderate efficiency level is approximately 10% more efficient than building code standards scheduled to take effect in New York in 1992. The high efficiency level is approximately 5-10% more efficient than the moderate efficiency level (and thus 15-20% higher than code requirements). Specific thresholds used in the analysis are approximate -- further research is needed, involving HVAC manufacturers and dealers, to determine optimal efficiency levels. An alternative to having two specific eligibility levels, is to have one baseline level, and pay an incentive for each efficiency point the rebated unit exceeds the baseline level.

Rebates are set to cover approximately 80% of the typical incremental cost of the more efficient HVAC system. Actual incremental costs vary widely, depending on the specific features incorporated into each model. We recommend that the rebate be split approximately 80% to the customer and 20% to the dealer. Experience by Southern California Edison and Eastern Utilities indicates that HVAC dealers are responsive to dealer rebates (Nadel, 1990a).

In order to receive a rebate, calculations must be submitted to show that the HVAC system is properly sized for the application. Free educational programs and one-on-one technical assistance will be provided on proper procedures for doing sizing calculations. Free sizing software will be distributed, as needed. Every effort should be made to review sizing calculations quickly, so that equipment replacement is not delayed.

Program participation rates are based on a program operated by Northern States Power (NSP), that after several years provides rebates for 70% of the chillers sold in the NSP service territory (NSP, 1988). Program savings assume that 10% of annual sales are at the high efficiency level and 40-60% at the moderate efficiency level. Program savings also assume that as a result of the program, the typical unit size will be reduced by 10%. This reduction is approximately 40% of the potential resizing savings that are available (Miller et al., 1989).

The program is primarily marketed through personal contacts with HVAC distributors, engineers, installers, and large C&I customers. These contacts will seek to identify HVAC systems that are about to be replaced, so that decision-makers can be targeted for special marketing efforts. Small C&I customers will generally be made aware of the program through trade allies.

In addition to the features included in this analysis, an additional program feature which should be considered is to provide supplemental rebates for energy-saving controls that are often packaged with HVAC equipment as optional features. Examples of these controls include economizers on small HVAC systems (economizers are generally standard on large systems), and enthalpy controls on all systems (most systems rely on temperature controls to switch on the economizer cycle, even though enthalpy controls, which sense both temperature and humidity, are more efficient).

For purposes of the COMPASS analysis, this program is divided into two programs -- one for chillers and one for packaged systems.

Commercial Refrigeration

The Commercial Refrigeration program is designed to encourage refrigeration system efficiency improvements at the time existing systems are replaced on remodeled. The program will encourage high-efficiency refrigeration improvements which are not widely used at present such as:

- Oversized evaporative condenser
- Anti-condensate heater controls
- Refrigerator (medium temperature) case covers
- External liquid-suction heat exchangers
- High-efficiency compressors
- High-efficiency multiplex compressors
- Variable-speed compressors

Descriptions of these measures can be found in the Phase I NYSERDA/ACEEE study and a recent study conducted for the Electric Power Research Institute (Walker et al., 1990). These measures will be encouraged through rebates and technical assistance.

A number of refrigeration measures included in the Phase I NYSERDA/ACEEE study, and in other utility rebate programs (e.g., floating heat pressure control, mechanical subcooling, hot gas defrost, and case covers for freezers), are not included in this program because recent data indicate that these measures are widely incorporated into new refrigeration systems (Scott Gardner, New England Electric, personal communication).

Marketing of this program will emphasize personal contacts with refrigeration equipment vendors, engineers, and purchasers. These contacts will be made by utility technical staff who have received special training in refrigeration efficiency improvements. Utility staff will be assisted by outside technical experts on retainer to the utility. In the refrigeration industry, marketing efforts can be highly targeted because only a limited number of specialty engineering and equipment distribution firms serve a region. Also, many refrigeration systems are purchased by a limited number of supermarket and convenience store chains. Baylon et al. (1987) have written extensively on strategies for marketing to these customers.

Motor Rebates

The Motor Rebate program provides rebates for high-efficiency motors. Most major motor manufacturers produce two major lines of motor -- a standard efficiency line and a high efficiency line. High-efficiency motors typically cost 10-30% more than standard motors, but reduce energy use by 2-10% (varying with motor size -- Stout and Gilmore, 1989). In many cases, the cost to operate a motor for one year is greater than the original purchase price. Thus, even small efficiency improvements can quickly pay for themselves. Suggested rebate eligibility levels, which vary by motor type and size, are listed in Table 2-1.

Three major markets for high-efficiency motors exist that can be targeted by a utility program:

1. The new motor market -- situations when a new motor must be purchased, and the cost of a high-efficiency motor is the cost difference between a standard and high-efficiency motor.

2. The rewind market -- situations when an old motor needs to be rebuilt (which happens approximately every 15 years), and the cost of a high-efficiency motor is the cost difference between the rebuilding work and the purchase price of a new high-efficiency motor.

3. The retrofit market -- situations where the existing motor does not need repair or replacement, and the cost of a high-efficiency motor is the full cost of a high-efficiency motor.

The Motor Rebate program analyzed in this study targets both the new motor and rewind markets. With this approach, over a period of approximately 15 years, most existing motor applications will be targeted by the program (i.e., over the 15-year average life of a motor, most existing motors will be rebuilt or replaced). The retrofit market is not targeted because very high rebate levels are

Table 2-1
Recommended Minimum Efficiency Standards for Motor Rebate Program

	Minimum Nominal Efficiency					
	Open Motors			Closed Motor		
# poles --->	6	4	2	6	4	2
Approx. RPM --->	1200	1800	3600	1200	1800	3600
Motor Horsepower						
1	80.0	82.5	----	81.5	84.0	----
1.5	84.0	84.0	82.5	85.5	85.5	84.0
2	86.5	84.0	84.0	86.5	84.0	85.5
3	86.5	86.5	84.0	88.5	88.5	86.5
5	88.5	87.5	85.5	88.5	88.5	87.5
7.5	89.5	88.5	87.5	89.5	91.0	88.5
10	89.5	89.5	88.5	89.5	91.0	89.5
15	91.0	90.2	89.5	90.2	91.0	89.5
20	90.2	90.4	89.5	91.0	91.7	90.2
25	91.7	92.4	90.2	91.7	92.4	90.2
30	92.4	93.0	91.0	92.4	93.6	91.0
40	93.0	93.0	92.4	93.0	93.0	91.0
50	92.4	94.1	92.4	93.6	93.6	92.4
60	93.0	93.6	92.4	93.6	94.1	94.1
75	93.6	94.1	93.0	94.1	94.5	94.1
100	93.6	94.1	93.6	94.1	95.0	94.1
125	94.1	94.1	93.6	94.1	95.0	94.1
150	94.5	94.5	93.6	95.0	95.0	94.1
200	94.5	95.0	94.5	95.0	95.8	95.0
250	95.0	95.0	95.4	95.0	95.0	94.5

Note: These levels are based on a review of current catalogs for seven major motor manufacturers. The recommended minimum efficiency level generally corresponds to the least efficient "high-efficiency motor" produced by the seven manufacturers. In cases where the high-efficiency motor with the second lowest efficiency is at least 1% more efficient than the lowest-efficiency motor, the recommended minimum corresponds to the second least-efficient high-efficiency motor. In all cases except for 250 hp, 1200 rpm open motors, at least three major manufacturers produce motors which exceed these recommended minimums (two manufacturers exceed the minimum in the 250 hp, 1200 rpm open motor case). No major manufacturer produces efficient 1 hp, 3600 rpm motors.

likely needed to influence this market. For utilities with short-term capacity needs, it might be useful to target the retrofit market, because this market is the only source of quick savings. For utilities with long-term capacity needs, targeting the rewind market should result in the same long-term load savings, but at a lower cost to the utility.

In order to target the rewind market for motors of 5 horsepower (hp) or less, rebates will be based on the cost difference between new and standard-efficiency motors (it is usually not cost-effective to rewind motors in this size range). For motors of more than 5 hp, rebate levels will be based on the cost difference between a typical new high-efficiency motor and a typical rewind job. In both cases, rebates will be set so that purchase of a new high-efficiency motor will have a one-year simple payback to the average user. A program of this type has recently been proposed by Boston Edison (1990). In order to avoid paying too high a rebate for purchases in the new motor market, customers could be required to turn in their old motor in order to receive the full rebate. When an old motor is not turned in, the rebate amount would be based on the cost difference between a standard- and high-efficiency motor.

A strong involvement by motor dealers/repair shops is essential to the success of the program. Utility staff must seek to develop a regular, personal relationship with dealers. Dealers will be provided with sales materials to use with prospective customers. Materials will include brochures, counter-top displays, educational seminars and publications, lists of motors eligible for the program, and economic analysis software for calculating the economics of high-efficiency motor investments. A motor rebate program operated by British Columbia Hydro has very successfully used these techniques to actively involve motor dealers in its program (Nadel, 1990a). In addition to these marketing and technical services, motor dealers will receive rebates, equal to 10% of the customer rebate, in order to provide dealers with additional incentive to stock and promote high-efficiency motors. Educational efforts will also be directed to utility customers. Educational materials and seminars will emphasize the advantages of high-efficiency motors and will discuss procedures to avoid oversizing of motors. Technical assistance on proper motor sizing will be provided as well. For example, utility staff will work with motor users to identify oversized motors, so that when oversized motors are replaced, a proper-sized motor can be installed (such a service is now provided by Carolina Power and Light -- Walt Johnston, North Carolina Industrial Extension Service, personal communication).

Adjustable-Speed-Drive Rebates

The Adjustable-Speed-Drive Rebate program promotes the use of electronic adjustable-speed drives. For many motor applications, the load served by the motor varies with time (e.g., an air conditioning motor needs to work harder on hot days than cool days), but with single-speed motors, motor speed and electric power requirements are often constant. An adjustable-speed drive (ASD) allows the motor speed to be reduced when maximum motor power is not needed. As speed is reduced, so is energy use. ASD's are particularly appropriate for applications with high operating hours and low load factors (i.e., situations where motors often operate at less than full load).

The ASD Rebate program will provide rebates to install ASD's in situations where ASD's are clearly cost-effective from the utility and societal perspectives. For these situations, rebates will be paid per hp connected to the ASD. A sample rebate schedule and a set of application guidelines are contained in Table 2-2. This schedule and set of guidelines come from the ASD rebate program operated by New England Electric. In the ASD Rebate program analyzed in this study, rebates will cover approximately 80% of ASD costs for the first five years of the program. Thereafter, the rebate will be reduced to 60% of ASD costs, under the assumption that as customers become accustomed to ASDs, they will be willing to pay a larger share of the costs. For many applications, detailed engineering calculations are needed before the cost-effectiveness of ASD's can be assessed. For these applications, the ASD Rebate program will provide technical assistance in conducting the necessary calculations, and will provide rebates for those applications which pass cost-effectiveness tests.

In addition to one-on-one technical assistance, the ASD Rebate program will include an extensive education program on assessing motor applications for ASD suitability. The educational program will include informational materials, preparation of detailed case studies, and calculation guides and software. This education program will be similar to the ASD education program operated by B.C. Hydro (Kristin Schwartz, BC Hydro, personal communication).

The ASD Rebate program will be marketed in conjunction with the Motor Rebate program, and will emphasize personal contacts with motor dealers, other ASD dealers, and large customers.

ASD Rebate program costs and savings are based on the pool of available ASD savings, as estimated in the NYSERDA/ACEEE Phase I study, and an assumed annual penetration rate. In the first year of the program, the penetration rate is based on New England

Table 2-2
Sample ASD Rebate Schedule and Eligibility Guidelines

Motor Size	Incentive
20 hp or less	$300/hp
25-100 hp	$200/hp
125 hp or more	$125/hp

Eligible Applications

1. Variable air volume fans for commercial buildings or for commercial parts of industrial facilities (such as offices).

2. Chiller water pumps for HVAC systems that meet one of the following criteria:

   a. The pump runs in all seasons

      (1) Buildings with a water-side economizer

      (2) Pumps that supply dedicated cooling units for computer rooms

      (3) Other buildings where cooling is required all year

   b. Buildings with 24-hour occupancy (e.g., hospitals, computer centers, prisons)

3. Hot water pumps for HVAC systems that meet the following criteria:

   a. The pump runs in all seasons (e.g., reheat is required to meet ventilation or humidity control standards, such as in hospitals or some process areas).

4. Process pumps and fans that meet one of the following criteria:

   a. Average operation of at least 100 hours/week operated at less than 80% of rated flow

   b. Average operation of at least 70 hours/week operated at less than 70% of rated flow

Source: New England Electric

Electric projections for its ASD rebate program (New England Electric, 1990). Thereafter, penetration rates are ACEEE estimates, because no long-term data on penetration rates in utility ASD programs are available. Given this lack of data, as well as significant uncertainty in the estimate of available ASD savings, cumulative savings for the ASD program may be considerably higher or lower than is estimated in this study. ASD costs are known with more certainty, and thus the cost-effectiveness of the ASD program is not likely to change appreciably, even if cumulative savings do change.

Custom Rebates

The Custom Rebate program pays rebates for measures proposed by customers that are not specifically encouraged under another program. Customers submit applications for individual measures. Applications are reviewed for reasonableness and cost-effectiveness by the utility. Energy-saving ideas are developed by customers, or can be suggested by utility technical assistance providers, utility audits (under the C&I Audit program), or NYSEO audits (under the Technical Feasibility Study program which provides a matching grant for an in-depth engineering analysis of a commercial or industrial facility). For measures that are accepted by the utility, the rebate will cover 50% of the cost of the measure. Rebates will not be provided for measures with a simple payback period of less than one year, under the assumption that customers can be expected to pursue rapid payback measures without a utility rebate. Alternatively, rebates could vary with the simple payback of the measure, with higher rebates paid for measures with long payback periods, and lower rebates paid for measures with short payback periods. Such an approach is recommended by Weedall and Gordon (1990).

Program costs, savings, and participation rates are based on a custom rebate program operated by Wisconsin Electric (Clippert, 1989). These figures have been adjusted to include only data for measures not specifically encouraged through another program examined in this study.

Program marketing emphasizes personal contacts with equipment vendors, consulting engineers, and large customers. Marketing of the program should be closely coordinated with the audit programs mentioned above.

C&I Audit

The C&I Audit program provides energy audits to C&I customers. The program will recommend no- and low-cost operations and maintenance improvements customers can pursue on their own, as well as higher cost improvements customers can pursue through a utility rebate program. C&I rebate programs are presently operated by all New York utilities. In addition, NYSEO offers free audits for small- and medium-sized C&I customers through its Small Business Energy Efficiency and Energy Advisory Service to Industry programs. The program analyzed here includes several features that are not found in many of the existing audit programs including:

1. Services will be provided for free. Some of the other audit programs charge customers a fee for audit services. A study recently completed by New York State Electric & Gas (NYSEG) demonstrated that customers are much more likely to request an audit when services are provided for free (Xenergy, 1990).

2. Audits will be marketed through personal contacts and telemarketing. Many of the existing audit programs rely on direct mail marketing approaches. The NYSEG audit study discussed above found that personal marketing approaches were much more effective at obtaining audit requests than direct mail marketing. As a result of expanded marketing efforts, the number of audits conducted each year will be considerably greater than with existing audit programs.

3. Audit complexity will be varied depending on the customer size. Small customers will receive a walk-through audit which emphasizes operations, maintenance, and lighting improvements. Medium customers will receive a computerized, non-engineering audit which emphasizes measures with a payback period of five years or less. Large customers will receive an engineering audit at a limited level of detail. For small customers, operations,

maintenance, and lighting measures are more likely to be implemented than other measures. Full, computerized audits are more expensive than a walk-through audit, and may not result in any additional energy savings. For medium customers, a computerized audit can cover a wide range of measures. Customers are highly unlikely to implement recommendations with more than a five-year payback period. For small- and medium-sized customers wanting to explore measures in more depth, the NYSEO's Technical Feasibility Study program can be tapped. Large customers typically find non-engineering audits too simplistic to be useful. A basic engineering audit at a limited level of detail can provide useful information while keeping costs to a reasonable level (Cambridge Systematics, 1988; Kowalczyk, 1983; Nadel, 1990a).

4. Annual post-audit follow-up visits will be conducted for three years after the audit is conducted, in order to track measure installation, and to encourage and assist customers to implement additional audit recommendations. Experience by Pacific Gas and Electric (PG&E) and the Sacramento Municipal Utility District (SMUD) have found that post-audit follow-up visits can significantly increase implementation of audit recommendations (Nadel, 1990a).

The audit program analyzed in this study builds and improves upon existing utility- and state-sponsored audit programs. There is a potential for this proposed audit program to become an integral element of a coordinated utility- and state-sponsored comprehensive energy audit and technical feasibility study program. Currently, discussions are under way between the NYSEO and the State's investor-owned utilities on how to effectively coordinate the delivery of audits to all classes of C&I customers.

Experience by several utilities including NYSEG, Con Edison, the Sacramento Municipal Utility District (SMUD), Southern California Edison, and New England Electric, indicates that with extensive personal marketing efforts, cumulative audit program participation rates of 70% are possible. For this study, we assume a cumulative participation rate of only 41%, under the assumption that by 1997, the C&I direct installation programs will have gained enough momentum, that an audit-only program is no longer needed.

As is shown in Chapter 3, compared to audit programs, direct installation programs offer higher savings per customer and higher benefit-cost ratios to the utility. They also offer a more attractive financial package to the customer. Thus, direct installation programs are a preferable program approach. However, due to the large range of services provided under a typical direct installation program (discussed below), only a limited number of customers can be served each year. Until direct installation programs can ramp up to serve a large portion of customers, audit programs allow all interested customers to receive limited services, while waiting for the more comprehensive services of direct installation programs to become available.

For this analysis, we assume that the transition from audit to direct installation programs takes place in 1997. Depending on utility and customer interest, this transition date can be moved forward or back. For example, if basic audit services are incorporated into the Small C&I Direct Installation program, audits to small C&I customers can be phased-out before 1997. If this happens, some of the costs and savings attributed to the C&I Audit program in this analysis, should instead be incorporated into the Small C&I program analysis. On the other hand, if rebate and audit programs are more successful at saving energy than we assume here, the start-date of direct installation programs could be delayed. If this happens, some of the costs and savings attributed to the direct installation programs should be incorporated into the audit and rebate program analyses.

Small C&I Lighting Direct Installation

The Small C&I program is a direct installation program designed to increase the use of high-efficiency lighting equipment in small C&I facilities. The program is open to C&I customers using between 5,000 and 250,000 kWh per year. Very small customers are not served because they are difficult to reach and expensive to serve (however, these very small commercial customers could be targeted by the residential Energy Fitness program). Eligible customers will be solicited via an introductory letter and personal contacts (site visits and phone calls). Customers will be recruited on a community-by-community basis. Once a customer agrees to participate, an initial lighting survey will be conducted and work orders prepared for all cost-effective lighting improvements. Facilities will be assessed for the following measures: electronic ballasts, T8 lamps, HID upgrades, compact fluorescent lamps and fixtures, reflectors, and occupancy sensors. The work orders will be presented for customer approval, along with estimates of costs and savings. If a customer agrees to proceed, all measures will be installed at no cost to the customer, and at a time convenient to the customer. The utility will arrange for measure assessment, installation and financing -- all the customer has to do is say "yes."

The program modeled in this study is based on a similar program now being offered by New England Electric (New England Electric, 1990). Programs of this type have also been run by SMUD and the City of Austin (Nadel, 1990a). Program costs and savings are based on the program now being offered by New England Electric. Long-term participation rates are based on the SMUD program, and a pilot program conducted by New England Electric. Overlap between this program and the Lighting Rebate program is expected to be minimal, because even the most successful rebate programs have found that after five years or more of rebate program operation, only 5% or so of small C&I customers apply for rebates (Nadel, 1990a).

Due to the large number of customers served and the large amount of work at each facility, very large equipment orders can be put out to bid, resulting in low equipment prices. Lamp installations can be done by semi-skilled labor, but electricians will be needed to install ballasts, HID fixtures, and some lighting controls. Electricians can either be hired by the utility, or the utility can contract with outside service providers. This will be a complex program to administer -- data tracking procedures need to be carefully set up, so that information flows smoothly from audits, to work orders, to billing, to evaluation. Also, auditors need extensive training on how to identify and specify the optimal retrofit for a particular facility. Training for installers may also be needed for measures that are not standard practice, such as tandem-wiring of ballasts (wiring two fixtures to the same ballast) and installation of occupancy sensors. Due to the large training, staff, and administrative needs of the program, the program is not scheduled to begin until 1992, and the number of customers served annually will ramp up slowly.

As currently constituted, the Small C&I program addresses only lighting improvements. It may be desirable to promote other energy efficiency measures at the same time, such as operations and maintenance measures, and HVAC controls (e.g. 7-day clock thermostats). Further research is needed on the costs and benefits of enhancing the program along these lines. Some of these issues may be addressed in a study the Minneapolis Energy Office has planned (Martha Hewett, Minneapolis Energy Office, personal communication).

Another potential program enhancement is to develop specialized small C&I direct installation programs targeted at important end-users. For example, rural utilities may want to develop a special program directed at farmers, which complements lighting improvements with efficiency measures unique to farms. Similarly, urban utilities may want to develop special programs directed at multifamily buildings or restaurants.

For the COMPASS analysis, the Small C&I program is divided into three programs -- a compact fluorescent lamp program (with an average measure life of 3 years), an occupancy sensor program (with an average measure life of 10 years), and an "other measure" program (with an average measure life of 15 years). Average measure lives are from Gordon et al. (1988). While a separate sub-program is devoted to compact fluorescent lamps, the emphasis of the overall program will be on compact fluorescent fixtures and retrofit kits, which allow the lamps to be replaced without replacing the ballast.

Medium/Large C&I Direct Installation

The Medium/Large Direct Installation program will serve customers using more than 250,000 kWh annually. The program will provide comprehensive services to help eligible customers implement nearly all energy-efficiency measures which are cost-effective from the societal perspective in a retrofit situation (other programs will encourage additional efficiency improvements in remodeling and equipment replacement situations). Services will include comprehensive energy audits, financing (the utility pays 70% of measure costs, the customer only 30%), and training and assistance with measure commissioning and maintenance.

The program is based on similar programs run by Puget Power and Light, Northeast Utilities, Boston Edison, and the Bonneville Power Administration (Nadel, 1990a). Program participation rates and costs are based on these other programs. Program savings are also based on these other programs, but are adjusted downward by approximately 50% to eliminate overlap with other rebate and audit programs directed at the same customers.

Due to the large amount of assistance provided each customer, only a limited number of customers can be served each year. For purposes of our analysis, we assume the program begins in 1993, and that no more than 4% of eligible customers can be served each year. A 1993 start date is selected under the assumption that only a limited number of new programs can be started each year, and that because medium and large C&I customers are likely to participate in rebate programs, the Medium/Large C&I program is a lower priority than the other C&I direct installation programs (Small C&I, C&I New Construction, Commercial Renovation, and Industrial New Construction/Modernization). For some utilities it may be possible to begin the Medium/Large C&I program earlier, or to serve more customers each year.

Before the Medium/Large C&I Direct Installation program could begin, one issue that must be resolved is the relationship between this program and pilot bidding programs recently begun by New York utilities. Bidding programs tend to target the same large C&I customers targeted by this program. Also, bidders sometimes offer comprehensive direct installation services. Possible ways to coordinate the programs include letting the two programs directly compete for customers (although this might result in considerable customer confusion), assigning customers to one or the other program based on established criteria, or selecting outside service providers to run the Medium/Large C&I Direct Installation program through a bidding mechanism. Even without these adjustments, given the large number of eligible customers and the limited number of customers each program can serve each year, overlap should not be a significant problem until both programs have run for several years. An evaluation of the pilot bidding programs is planned for 1990-91, which should be a useful input into discussions on how best to integrate bidding and direct installation programs.

Commercial Renovation

The Commercial Renovation program is designed to promote efficient lighting systems at the time existing commercial buildings are remodeled. Existing commercial buildings are periodically remodeled as tenants change, or as building systems are updated to enable existing buildings to compete in the rental market with new buildings. When commercial buildings are remodeled, lighting systems are most commonly affected, followed by HVAC systems.

Because lighting systems are most frequently renovated, and because they provide major opportunities for energy savings, the Commercial Renovation program will emphasize lighting upgrades. The program will provide technical assistance and incentives in order to encourage building owners to install lighting systems significantly more efficient than prevailing construction practice. Technical assistance and incentives will encourage use of lighting controls, high-efficiency fixtures, determination of proper light levels for the task, and task-ambient lighting designs (where ambient light levels are sufficient for circulation and quick tasks, and high light levels are available only at desks and other work areas).

The program will be marketed through personal contacts with building owners, architects, engineers, equipment distributors, interior designers, and lighting designers. Clear definitions will be needed to distinguish customers eligible for this program from customers eligible for retrofit and new construction programs. A particular effort will be made to identify buildings that are about to be remodeled, so that the utility can become involved early in the design process. A program of this sort has recently been proposed by Boston Edison (1990).

Commercial New Construction

The Commercial New Construction program provides free technical assistance to architects, engineers, and developers on how to improve energy-efficiency beyond the requirements of the New York building code (for purposes of the analysis, we assume that code amendments proposed by NYSEO (1990a) are adopted effective 1991. Financial incentives are included to pay the full incremental cost of measures which exceed prevailing construction practice (prevailing construction practices will be determined through periodic surveys of new commercial buildings).

The program examined in this analysis is based on the Bonneville Power Administration's Energy Edge program, Northeast Utilities' Energy Conscious Construction program, and New England Electric's Design 2000 program (Nadel, 1990a).

The program will primarily be marketed through personal contacts with the target audience. In particular, efforts will be made to identify new buildings still in the preliminary design stage. When buildings are identified early in the design process, few design decisions have been made, and project design teams are more open to energy-saving suggestions. Additional marketing support will come from an awards program that recognizes especially efficient buildings. Recognition and awards can be attractive inducements to architects, engineers, and developers who are constantly competing for work and tenants (Nancy Benner, Portland Energy Conservation Inc., personal communication).

Technical assistance activities will seek to make the utility an active participant throughout the design process. Utility staff and technical consultants will participate in brainstorming meetings with project architects and engineers to develop lists of conservation measures for consideration. Utility consultants, or the project's regular design team, will then investigate each of these options, including computer modeling of each option as applied to the preliminary baseline design of the building. This modeling is the most accurate way to estimate savings. Where research is done by the project's regular design team, design incentive payments will be provided by the utility. Technical assistance will also be available for building commissioning, and for training on proper operations and maintenance procedures. These services can help ensure that measures are properly installed, and continue to operate properly for many years.

A key to program success is providing high-quality technical assistance. Technical assistance will generally be provided by outside consultants, on retainer to the utility, who are tops in their field. High-quality technical assistance is needed for two reasons: (1) so that the best package of conservation improvements is put together, and (2) so that program participants are satisfied with the services they receive, and are likely to recommend the program to others. If services are poor quality, design professionals will keep away from the program for many years to come.

In situations where a building is well into the design process and there is insufficient time for in-depth design assistance, technical assistance and incentives will emphasize substituting efficient equipment for the less-efficient equipment previously specified. This same approach will be used on small commercial buildings (generally less than 10,000 sq. ft.) where in-depth services are unlikely to be cost-effective.

In addition to one-on-one technical assistance, the program will include an extensive training component which emphasizes the interactive relationship between individual conservation measures, and how designers can examine the entire building as an interactive system in order to minimize costs and maximize energy savings.

Industrial New Construction/Modernization

The Industrial New Construction/Modernization program targets efficiency improvements in new and modernized (remodeled) industrial facilities and production lines. A particular emphasis of the program will be industrial process improvements. As in the residential and commercial sectors, in the industrial sector, more conservation opportunities are available and cost-effective at the time new equipment is installed than in a retrofit situation.

Services provided under the program will include technical assistance (provided by experts in particular process industries who are on retainer to the utility) and incentives averaging 80% of the cost of efficiency improvements. The program will build upon the NYSEO's Technical Feasibility Studies (TFS) program, but unlike TFS, will include industries employing more than 400 persons. Measures will be eligible for incentives if they are not already common practice in new facilities in the industry in question. Common practice will be determined by consulting with industry experts. As an alternative to paying 80% incentives for all measures, it may be preferable to vary the incentive with the simple payback period of the measure. For example, no incentive may be needed for measures with a payback of less than one year, while a higher incentive may be desirable for long payback measures.

As in the Commercial New Construction program, the Industrial New Construction/Modernization program will seek to identify projects early in the design stage. The program will primarily be marketed through personal contacts with large industrial customers, industrial design consultants, and equipment vendors.

Utility experience promoting conservation services in industrial new construction and modernization situations is very limited, so the data on program costs, participation rates, and savings are only rough estimates. As additional data become available, these estimates should be revised.

C&I Programs Not Analyzed

A number of C&I programs were not analyzed in this study which may be useful to study at a later date. First, we did not develop a particular program to promote improvement of HVAC distribution systems, such as installing variable air volume (VAV) systems instead of constant air volume systems. While VAV conversions are eligible for custom rebates, a special program to promote VAV conversions at the time existing buildings are renovated, may be worthwhile. The Phase I ACEEE/NYSERDA study found large available savings from this measure. Thus far, to our knowledge, no utility program has specifically targeted this measure.

Second, special programs directed at computers, copy machines, and other office equipment are not included in our analysis. The NYSEO Reference II forecast projects that over the next 20 years, this equipment, combined with other miscellaneous loads, will climb from 10% to 20% of commercial sector electricity use (NYSEO, 1989a). Research by Norford et al. (1990) shows a potential to reduce electricity use of electronic office equipment in 2000 by more than 50%, using equipment and technologies that are on the market today. Research is needed on programs and policies to tap into this lucrative pool of savings.

Third, programs specifically targeted at converting inefficient incandescent and mercury vapor streetlights to more efficient equipment is not included in our analysis. Many streetlights are owned by utilities and leased to municipalities. Other streetlights are owned by the municipalities themselves. These ownership arrangements present a number of unique issues which probably justify development of a special streetlighting program. For example, Northeast Utilities operates a special program designed to convert all incandescent and mercury vapor streetlights to high-pressure sodium streetlights by 2001 (Northeast Utilities, 1990). Many New York utilities also offer programs in this area.

Fourth, we did not investigate programs to promote efficiency improvements to utility-owned transmission and distribution systems. While not strictly a C&I program, such a program is worthy of investigation because of the significant energy savings which may be available. For example, New England Electric plans to achieve over one MW of summer peak reduction in 1991 as a result of reconductoring three transmission lines (New England Electric, 1990). Another option is to replace existing distribution transformers with new low-loss transformers using advanced materials, such as amorphous alloy cores. Schreiber (1988) and Curran (1989) have described the significant savings that are available from this measure.

Chapter 3

RESULTS

A. INTRODUCTION

This chapter discusses the results of the COMPASS analyses of the programs discussed in Chapter 2. Results are discussed for each of the three utilities analyzed (Niagara Mohawk, Con Edison, and LILCo), including program costs, savings, and benefit-cost ratios. From these results, the achievable, cost-effective, conservation potential is estimated for each utility. Next, trends that are common to the three utilities are discussed, and these results compared to the long-range resource plans recently released by a number of utilities throughout the U.S., including several New York utilities. Third, the estimates of achievable utility conservation savings are analyzed in the context of achievable conservation savings from all sources, including market-driven conservation, and conservation resulting from government codes and standards. Finally, overall conclusions are summarized and recommendations made.

B. NIAGARA MOHAWK

A total of 36 conservation programs and sub-programs were analyzed for Niagara Mohawk. The benefit-cost ratio for each of these programs is summarized in Table 3-1. As can be seen in this table, all of the programs analyzed are cost-effective (benefit-cost ratio greater than one) from the utility, participant, total resource, and societal perspectives. In fact, in nearly all cases, the benefit-cost ratio is greater than two, meaning that program benefits are more than double program costs. The majority of programs are not cost-effective from the non-participant perspective, meaning that for customers who do not participate in any programs, electric bills will go up slightly. Electric bills will increase for these customers because: (1) the utility recoups program costs through rates and, (2) as kWh sales decline, fixed costs are spread among fewer kWh of annual sales. However, while non-participants will help pay for programs through their rates,

Table 3-1

Program Costs and Benefit-Cost Ratios - Niagara Mohawk

Program Name	BENEFIT COST RATIOS Utility	Parti-cipant	Non-Partic	Total Res.	Soci-etal	Program Costs Over 20 yrs in 1991$ (1000's)	LEVELIZED ¢/KWH (In 1991 $) Utility	Total Res.
R ENERGY FITNESS - LIGHT	2.43	3.50	0.91	2.65	3.04	$35,741	3.33	3.05
R ENERGY FITNESS - WTR HTG	5.76	11.31	0.91	6.13	7.35	14,185	1.11	1.04
R ENERGY FITNESS-WEATHRZTN	8.03	7.40	1.17	6.92	8.01	3,898	1.09	1.26
R LIGHT COUPON 91-96	3.99	4.96	1.06	4.81	5.47	31,837	1.79	1.03
R LIGHT COUPON 97-2003	5.32	10.33	1.17	9.04	10.32	24,051	1.97	0.90
R WATER HEAT RETROFIT	8.66	20.78	0.96	9.19	11.02	9,055	0.74	0.69
R HOUSE DOCTOR	2.32	3.03	0.86	2.41	2.79	33,752	3.64	3.50
R HOME INSULATION	2.37	2.34	0.87	1.94	2.24	18,035	3.85	4.72
R HIGH EFFICIENCY REFRIG	5.01	1.59	0.90	1.46	1.75	27,384	1.60	5.49
R HEAT PUMP WATER HEATER	2.75	2.88	0.80	2.13	2.55	149,998	3.24	4.18
R NEW CONSTRUCTION	3.38	2.52	1.06	2.60	2.97	69,644	3.50	4.56
C LIGHT REB.-COMPACT BULB*	4.69	11.19	0.93	6.81	8.14	2,897	1.18	0.81
C LIGHT REB.- COMPACT FIXT	8.90	17.04	1.05	13.87	16.34	9,935	0.71	0.03 #
C LIGHT REB.- REFLECTORS	4.77	5.41	0.95	4.98	5.92	42,585	1.33	1.20
C LIGHT REB.-BALLAST 91-94	3.41	3.73	0.88	3.20	3.81	17,258	1.81	1.93
C LIGHT REB.-BALLAST 95-99	13.45	6.45	1.14	7.22	8.57	6,756	0.64	1.20
C LIGHT REB.- HID RETROFIT	4.15	3.82	0.96	3.51	4.18	25,483	1.49	1.76
C LT. REBATE OCC.SENS	5.69	3.71	1.07	3.73	4.33	7,784	1.37	2.09
C LIGHT REB.-DAYLIGHT CNTL	2.15	1.99	0.69	1.36	1.62	19,799	3.20	5.06
C HVAC CHILLER REBATE	3.87	4.34	0.95	3.24	3.79	21,473	2.46	2.94
C HVAC PKGD SYSTEM REBATE	10.25	13.57	1.22	9.00	10.56	12,586	0.91	1.04
C REFRIGERATION REBATES	1.58	1.82	0.73	1.39	1.67	240,352	4.46	5.09
C MOTOR REBATE	5.42	4.11	1.02	3.91	4.66	54,024	1.46	2.02
C ADJUSTABLE SPEED DRIVE	2.84	2.05	0.87	1.83	2.18	146,518	2.78	4.31
C CUSTOM MEASURE	4.36	2.52	0.97	2.39	2.84	73,937	1.56	2.84
C AUDIT PROGRAM	3.21	3.80	0.88	1.90	2.27	52,304	1.85	3.13
C SM.DIRECT INSTALL-GEN'L	2.34	4.05	0.72	2.92	3.46	250,144	3.15	2.38
C SM.DIRECT INSTL-COMPACT*	1.99	5.67	0.68	2.93	3.48	8,170	3.29	2.23
C SM.DIRECT INSTL-OCC SENS	4.13	4.02	0.91	3.55	4.12	11,164	2.13	2.48
C MED/LG DIRECT INSTALL*	3.38	2.49	0.99	2.26	2.69	117,526	2.59	3.86
C RENOVATION - LIGHT 91-94	4.30	5.54	0.94	4.17	4.96	7,405	1.60	1.65
C RENOVATION-LIGHT 95-2010	3.80	4.65	0.95	3.92	4.65	75,911	2.45	2.37
C NEW CONSTRCTN 1991-2000	2.61	3.10	0.86	2.39	2.84	106,434	3.12	3.41
C NEW CONSTRCTN 2001-2010	1.75	2.28	0.75	1.60	1.90	120,257	6.00	6.57
INDUS NEW CONST/MODERNZTN	3.19	3.18	0.95	2.83	3.37	80,207	2.51	2.83
TOTAL	3.1	3.1	0.89	2.57	3.04	1,928,489		

R = Residential

C = Commercial and industrial

* Values shown for utility costs include some customer repurchase costs, thereby exaggerating the cost to the utility and modestly underestimating the cost-effectiveness as determined with the Utility and Non-participant tests.

Negative or negligible levelized costs indicate significant O&M savings.

they will also benefit from reduced air pollution and other environmental benefits resulting from the programs. For example, if an environmental externality benefit of \$.014/kWh saved were factored into the non-participant test (as is presently done only for the societal test) many more programs would be cost-effective from the non-participant perspective. The overall average rate increase resulting from all 36 programs is \$0.0014/kWh -- an increase of less than 2% of current rates.

The overall benefit-cost ratio for all 36 programs is summarized in Figure 3-1. From the utility, participant, and societal perspectives, the benefit-cost ratio for the package of programs is approximately three. From the total resources perspective, the benefit-cost ratio is approximately 2.6, while from the non-participant perspective, the ratio is 0.9. As previously noted, the NYPSC has ruled that utilities should look at all the benefit-cost tests, and should proceed with programs that fail the non-participant test, if they are found worthwhile on a broader basis. By this standard, we believe all of the programs are cost-effective, because all programs clearly pass the utility, participant, total resources, and societal tests.

Energy savings from each program are summarized in Table 3-2. Savings listed in this table are net savings (i.e., they exclude free riders) and include avoided transmission and distribution losses. Peak savings do not include a reserve margin adjustment (an allowance for the fact that power plant capacity must exceed peak demand in order to allow for plant downtime). Savings are reported for 2000, 2008, and for the peak year for each program (i.e., the year of maximum energy savings for each program).

Programs with the largest savings are listed in Table 3-3. The allocation of savings among the different program types is also illustrated in Figure 3-2. In 2000, rebate programs (e.g. lighting, HVAC, Custom, and ASD rebates) generally have the highest savings. In addition, the Small C&I lighting program has large energy savings. Thus, lighting conservation measures are a major

Figure 3.1
Benefit-Cost Ratio for Package of Conservation Programs - Niagara Mohawk

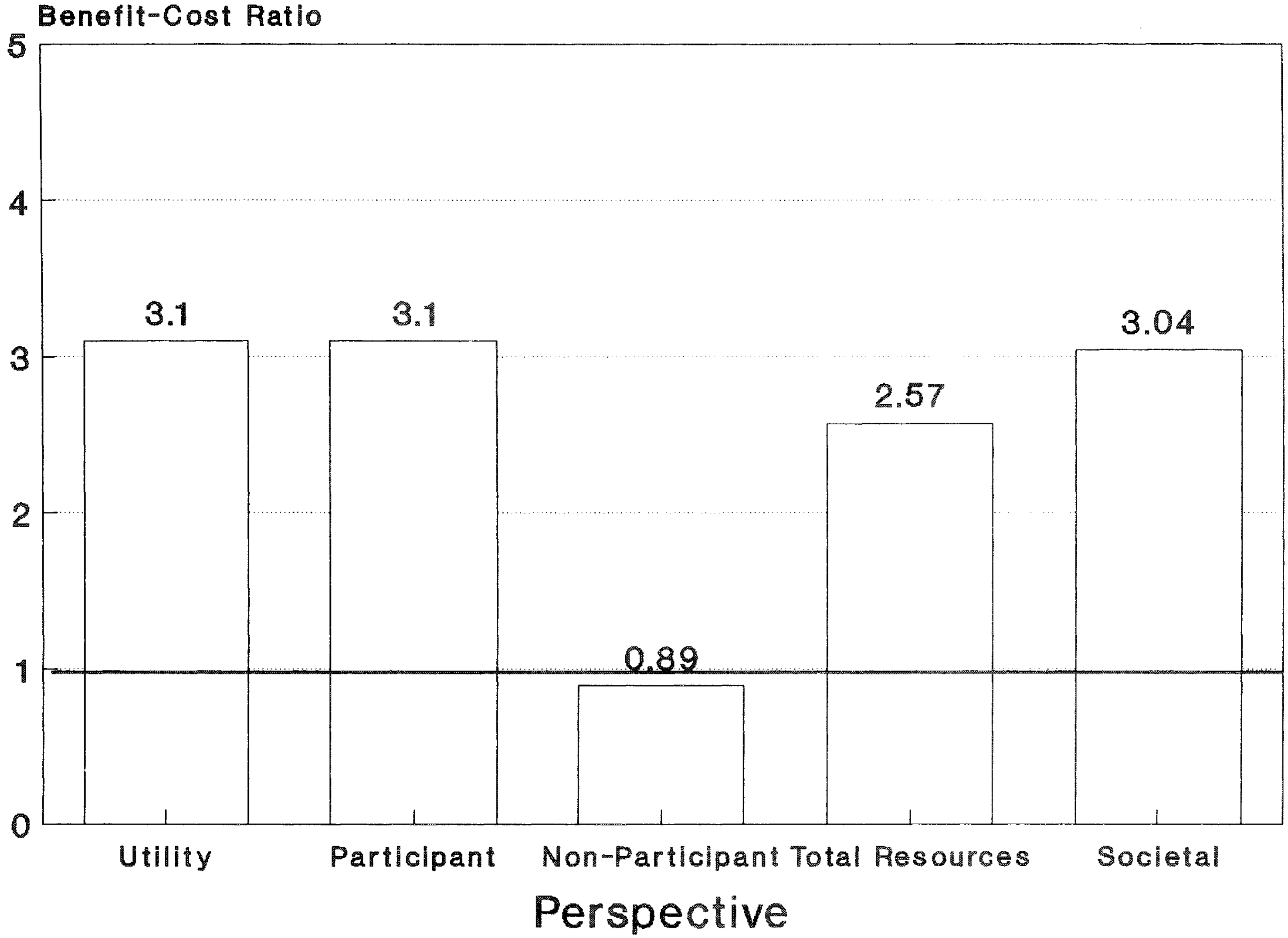


Table 3-2

Cumulative Program GWh and Peak MW Savings - Niagara Mohawk

Program Name	2000 GWh	2000 Winter MW	2000 Summer MW	2008 GWh	2008 Winter MW	2008 Summer MW	Peak Year	Peak Year GWh	Peak Year Winter MW	Peak Year Summer MW
R ENERGY FITNESS - LIGHT	84	39	5	15	7	1	2003	86	40	5
R ENERGY FITNESS - WTR HTG	105	14	7	60	8	4	2003	119	16	8
R ENERGY FITNESS-WEATHRZTN	25	10	0	23	9	0	2003	30	12	0
R LIGHT COUPON 91-96	92	43	6	0	0	0	1996	205	95	13
R LIGHT COUPON 97-2003	99	46	6	103	48	7	2003	185	86	12
R WATER HEAT RETROFIT	101	13	6	58	7	4	2003	114	15	7
R HOUSE DOCTOR	66	26	1	61	24	1	2003	89	35	1
R HOME INSULATION	28	11	0	37	15	0	2003	37	15	0
R HIGH EFFICIENCY REFRIG	116	13	15	176	20	22	2008	176	20	22
R HEAT PUMP WATER HEATER	170	23	11	628	84	40	2010	718	96	46
R NEW CONSTRUCTION	94	45	9	214	104	21	2010	245	119	24
C LIGHT REB.-COMPACT BULB	13	2	2	2	0	0	1996	18	2	3
C LIGHT REB.- COMPACT FIXT	93	11	18	49	6	10	2000	93	11	18
C LIGHT REB.- REFLECTORS	214	25	42	113	13	22	2000	214	25	42
C LIGHT REB.-BALLAST 91-94	59	7	11	32	4	6	1994	59	7	11
C LIGHT REB.-BALLAST 95-99	58	7	11	134	16	26	2009	138	16	27
C LIGHT REB.- HID RETROFIT	108	19	13	42	7	5	2000	108	19	13
C LT. REBATE OCC.SENS	40	10	10	22	6	6	2000	40	10	10
C LIGHT REB.-DAYLIGHT CNTL	48	0	17	28	0	10	2000	48	0	17
C HVAC CHILLER REBATE	41	1	32	91	2	71	2010	105	2	82
C HVAC PKGD SYSTEM REBATE	66	7	30	145	15	67	2010	168	17	78
C REFRIGERATION REBATES	358	40	51	439	49	62	2010	447	50	63
C MOTOR REBATE	216	28	37	345	44	60	2005	357	45	62
C ADJUSTABLE SPEED DRIVE	302	39	52	486	62	84	2005	507	65	88
C CUSTOM MEASURE	353	50	65	210	30	38	2000	353	50	65
C AUDIT PROGRAM	153	22	28	51	7	9	1996	246	35	45
C SM.DIRECT INSTALL-GEN'L	574	68	111	661	79	128	2002	729	87	141
C SM.DIRECT INSTL-COMPACT	22	3	4	6	1	1	2002	24	3	5
C SM.DIRECT INSTL-OCC SENS	39	10	10	35	9	9	2002	49	12	12
C MED/LG DIRECT INSTALL	239	34	44	486	69	89	2011	563	80	103
C RENOVATION - LIGHT 91-94	25	3	5	25	3	5	1994	25	3	5
C RENOVATION-LIGHT 95-2010	139	17	27	369	44	71	2010	431	51	83
C NEW CONSTRCTN 1991-2000	261	37	48	261	37	48	2000	261	37	48
C NEW CONSTRCTN 2001-2010	0	0	0	317	45	58	2010	403	57	74
INDUS NEW CONST/MODERNZTN	166	21	29	304	39	53	2010	345	44	60
TOTAL	4,566	741	763	6,029	911	1,037				

R = Residential

C = Commercial and industrial

Table 3-3
Programs with the Largest Savings - Niagara Mohawk

In 2000:

GWh	Winter Peak MW	Summer Peak MW
Small C&I DI	Res. Lighting Coupon	C&I Lighting Rebate
C&I Lighting Rebate	C&I Lighting Rebate	Small C&I DI
C&I Refrigeration	Small C&I DI	C&I Custom Measure
C&I Custom Measure	Res. Energy Fitness	C&I HVAC Rebate
Adjust.-Speed Drive	C&I Custom Measure	Adjust.-Speed Drive
Comm'l New Const.	Res. New Const.	C&I Refrigeration

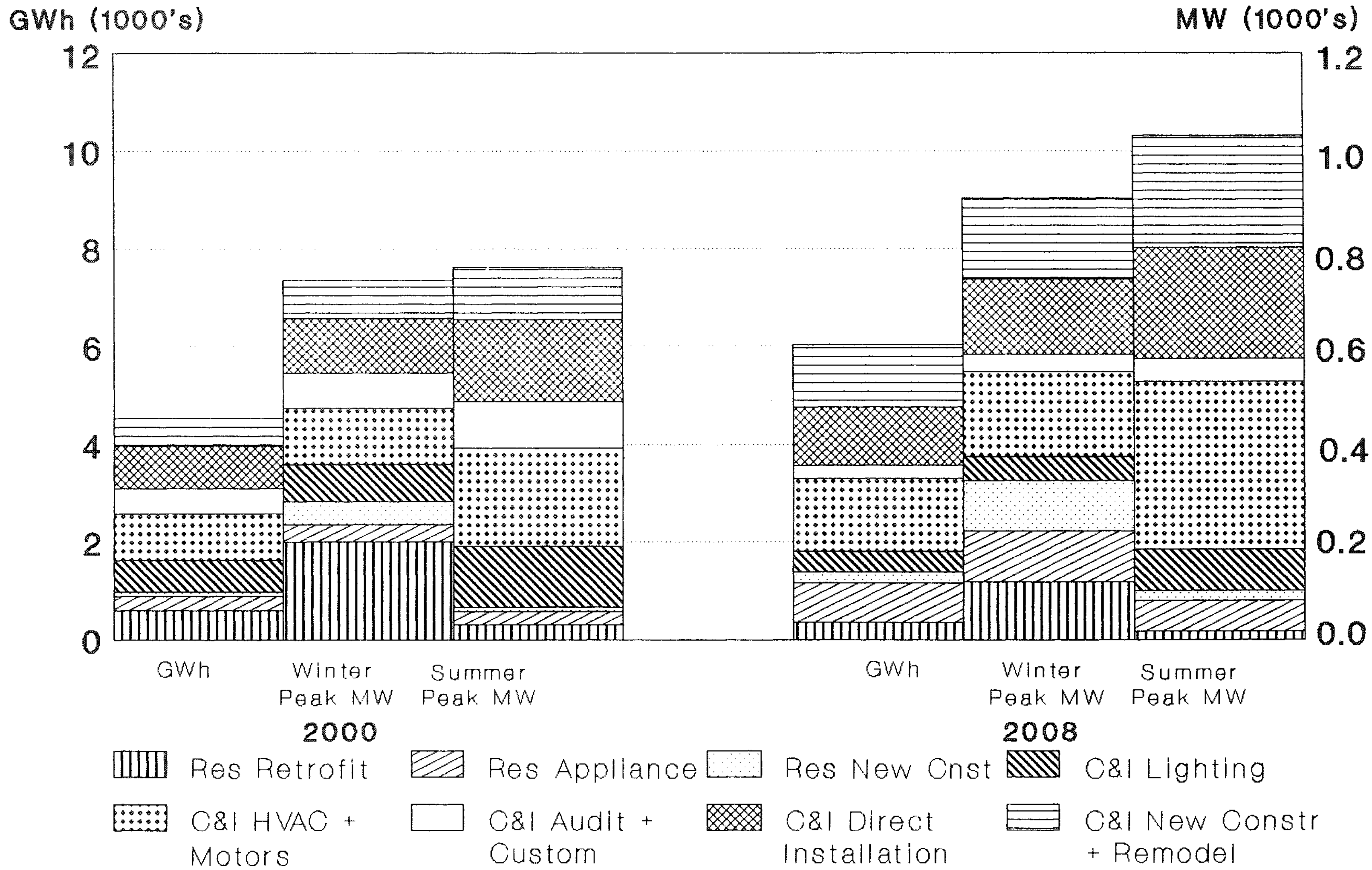
In 2008:

GWh	Winter Peak MW	Summer Peak MW
Small C&I DI	Res. New Const.	C&I HVAC Rebate
Res. Heat Pump WH	Small C&I DI	Small C&I DI
Comm'l. New Const.	Res. Heat Pump WH	Comm'l New Const.
Adjust.-Speed Drive	Comm'l New Const.	Medium/Lg C&I DI
Medium/Lg C&I DI	Medium/Lg C&I DI	C&I Lighting Rebate
C&I Refrigeration	Adjust.-Speed Drive	Adjust.-Speed Drive

DI = Direct installation
WH = Water heater

Note: Programs are listed in order of savings, with programs with the highest savings listed first.

Figure 3-2
Conservation Savings by Year & Program Type - Niagara Mohawk

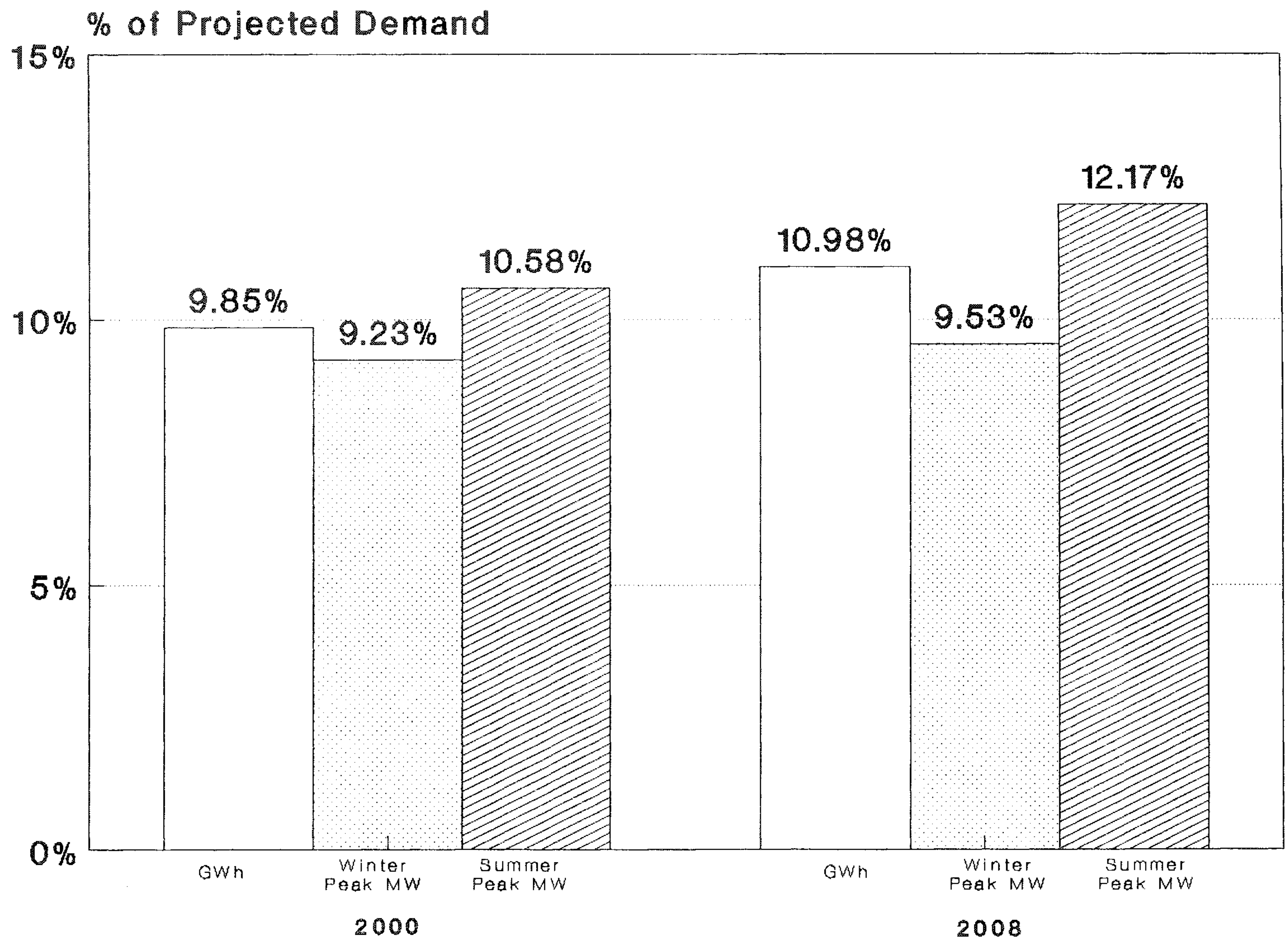


source of conservation savings in 2000. Residential programs tend to make their largest contribution during the winter peak. These high winter peak savings are primarily due to compact fluorescent bulbs promoted through the Energy Fitness and Lighting Coupon programs. In 2008, the programs with the highest energy savings are generally long-term programs whose savings slowly ramp up from year to year. Examples include the new construction programs, the Residential Heat Pump program, and the C&I direct installation programs. The C&I HVAC program figures prominently in summer peak savings. By 2008, many of conservation measures installed in early year rebate programs are no longer in place, and hence programs with the highest savings in 2000 are often not among the programs with the highest savings in 2008.

Since all of the programs examined are cost-effective, and since program inputs were adjusted to eliminate overlap between programs, the achievable conservation potential is the sum of savings from the individual conservation programs. In 2000, the achievable conservation potential is 4,566 GWh, 742 winter peak MW, and 763 summer peak MW. These savings represent 9.2-10.6% of projected Niagara Mohawk electricity sales and peak demand in 2000 (see Figure 3-3). These savings also represent 58-69% of projected growth in electricity sales and peak demand over the 1991-2000 period (based on NYSEO Reference II forecast). In 2008, the achievable conservation potential is 6,028 GWh, 911 winter peak MW, and 1,036 summer peak MW. These savings represent 9.5-12.2% of projected Niagara Mohawk electricity sales and peak demand in 2008. These savings also represent 33-43% of projected growth in electricity sales and peak demand over the 1991-2008 period. As a result of these programs, Niagara Mohawk's projected 1.9% compound sales growth over the 1991-2000 period and 2.0% over the 1991-2008 period, are reduced to 0.7% and 1.3% respectively. Thus, for Niagara Mohawk, it appears that the State Energy Plan goal of 8-10% savings by 2000 can be achieved in a cost-effective manner, but the goal of 15% savings by 2008 cannot be achieved by the conservation programs analyzed in this study. During the 1991-2000 period, conservation programs can meet the majority of

Figure 3-3

Conservation Savings as a Percent of Projected Demand - Niagara Mohawk



projected load growth for Niagara Mohawk, but over the 2000-2008 period, load growth will substantially exceed conservation savings. These issues are discussed more extensively later in this chapter.

By 2008, summer and winter peak savings, including a 20% reserve margin, are in excess of the output of a large nuclear power plant and approximately equivalent to the output of two large (600 MW) coal plants. Program costs are also of power plant magnitude; over the 1991-2011 period, costs to the utility total approximately $1.9 billion (in 1991 dollars). Utility costs average $96 million annually. However, while costs are substantial, recall that benefits are significantly greater.

C. CONSOLIDATED EDISON

A total of 38 conservation programs and sub-programs were analyzed for Consolidated Edison -- the same 36 programs analyzed for Niagara Mohawk, plus two residential submetering programs. Table 3-4 summarize the benefit-cost ratio for each of these programs. With one partial exception, all of the programs analyzed are cost-effective (benefit-cost ratio greater than one) from the utility, participant, total resource, and societal perspectives.[1] In fact, in nearly all cases, the benefit-cost ratio is greater than two, meaning that program benefits are more than double program costs. None of the programs analyzed are cost-effective from the non-participant perspective, meaning that for customers who do not participate in any programs, electric bills will go up. Electric bills will increase for these customers primarily because as kWh sales decline, fixed costs are spread among fewer kWh of annual

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[1] The rental submetering program is cost-effective from the utility and participant perspectives, but is not cost-effective from the total resources perspective (benefit-cost ratio of 0.87). The program is barely cost-effective from the societal perspective (benefit-cost ratio of 1.01). However, as is discussed in Chapter 2, due to a lack of experience with this type of program, many of the assumptions underlying the analysis are extremely tentative. We recommend that research take place in the next few years to better estimate critical program inputs, so a more accurate benefit-cost analysis can be conducted.

Table 3-4

Program Costs and Benefit-Cost Ratios - Consolidated Edison

Program Name	------ BENEFIT COST RATIOS -------					Program Costs Over 20 Years in 1991 $ (1000's)	LEVELIZED ¢/KWH (1991 $)	
	Utility	Participant	Non-Partic	Total Res.	Societal		Utility	Total Res.
R ENERGY FITNESS - LIGHT	1.47	5.35	0.39	1.60	1.91	125,368	4.06	3.74
R ENERGY FITNESS- WTR HTG	4.15	15.69	0.47	4.42	5.29	9,673	1.55	1.45
R ENERGY FITNESS-WEATHRZTN	2.62	6.63	0.40	2.24	2.74	4,881	2.34	2.73
R LIGHT COUPON 91-96	2.91	8.39	0.44	3.62	4.28	73,044	1.78	1.02
R LIGHT COUPON 97-2003	3.97	19.23	0.47	6.75	8.02	58,553	1.96	0.89
R WATER HEAT RETROFIT	7.35	41.66	0.50	7.73	9.25	3,542	0.88	0.83
R HOUSE DOCTOR	1.63	4.83	0.38	1.70	2.06	17,969	3.85	3.68
R HOME INSULATION	1.20	3.53	0.34	1.01	1.24	11,526	5.32	6.34
R HIGH EFFICIENCY REFRIG	5.27	3.08	0.50	1.55	1.84	50,817	1.63	5.52
R HEAT PUMP WATER HEATER	2.70	5.32	0.45	2.11	2.52	62,579	3.34	4.28
R NEW CONSTRUCTION	1.90	3.80	0.41	1.45	1.74	25,336	4.35	5.72
R CONDO/COOP SUBMETER	2.51	2.36	0.53	1.19	1.38	73,052	3.79	7.99
R RENTAL SUBMETER	1.78	1.86	0.48	0.87	1.01	61,519	5.94	12.11
C LIGHT REB.-COMPACT BULB*	5.21	18.84	0.67	7.39	8.62	4,704	1.25	0.88
C LIGHT REB.- COMPACT FIXT	9.98	28.55	0.72	14.96	17.24	16,099	0.75	0.06 #
C LIGHT REB.- REFLECTORS	5.64	9.12	0.68	5.89	6.83	90,703	1.32	1.20
C LIGHT REB.-BALLAST 91-94	5.08	6.06	0.65	3.83	4.45	42,665	1.79	1.91
C LIGHT REB.-BALLAST 95-99	16.09	12.29	0.74	8.62	9.99	16,168	0.63	1.18
C LIGHT REB.- HID RETROFIT	4.87	6.62	0.66	4.12	4.80	50,726	1.49	1.76
C LT. REBATE OCC.SENS	5.39	6.44	0.59	3.52	4.14	16,189	1.35	2.07
C LIGHT REB.-DAYLIGHT CNTL	3.05	3.44	0.57	1.92	2.18	41,663	3.19	5.05
C HVAC CHILLER REBATE	7.12	9.59	0.82	5.93	6.61	51,574	1.98	2.38
C HVAC PKGD SYSTEM REBATE	15.89	30.17	0.81	13.78	15.68	28,504	0.74	0.85
C REFRIGERATION REBATES	1.72	2.68	0.57	1.51	1.79	611,319	4.47	5.10
C MOTOR REBATE	5.66	6.20	0.72	4.09	4.84	38,368	1.47	2.04
C ADJUSTABLE SPEED DRIVE	2.95	2.90	0.65	1.91	2.26	107,805	2.81	4.34
C CUSTOM MEASURE	4.90	4.21	0.69	2.71	3.16	77,436	1.59	2.88
C AUDIT PROGRAM	3.90	6.60	0.67	2.26	2.63	123,101	1.76	3.04
C SM.DIRECT INSTALL-GEN'L	2.75	5.76	0.60	3.42	3.95	602,304	3.16	2.39
C SM.DIRECT INSTL-COMPACT*	2.33	8.07	0.58	3.44	3.99	19,745	3.31	2.24
C SM.DIRECT INSTL-OCC SENS	3.84	6.11	0.57	3.30	3.87	26,913	2.14	2.49
C MED/LG DIRECT INSTALL*	3.86	4.33	0.67	2.59	3.01	291,699	2.58	3.85
C RENOVATION - LIGHT 91-94	5.21	9.63	0.67	5.04	5.86	11,515	1.56	1.62
C RENOVATION-LIGHT 95-2010	4.42	8.00	0.65	4.57	5.29	115,396	2.47	2.39
C NEW CONSTRCTN 1991-2000	2.93	4.96	0.63	2.70	3.14	171,535	3.18	3.46
C NEW CONSTRCTN 2001-2010	1.97	3.53	0.57	1.81	2.10	186,880	6.09	6.64
INDUS NEW CONST/MODERNZTN	3.05	5.00	0.65	2.73	3.23	15,800	2.75	3.06
TOTAL	3.24	4.95	0.61	2.70	3.15	3,336,673		

R = Residential; C = Commercial and industrial

* Values shown for utility costs include some customer repurchase costs, thereby exaggerating the cost to the utility and modestly underestimating the cost-effectiveness as determined with the Utility and Non-participant tests.

Negative or negligible levelized costs indicate significant O&M savings.

sales. This effect is particularly large for Con Edison because retail rates average approximately $0.12/kWh (in 1990 -- NYSEO, 1990b), while avoided costs are only $0.034 (in 1990 -- NYDPS, 1989a). Thus revenue losses per kWh conserved are over $0.08/kWh. This is likely due to high fixed costs for Con Edison's underground transmission and distribution system. Overall, according to the COMPASS model, the revenue loss due to the 38 conservation programs leads to an average increase in retail rates of $0.0109/kWh. This amount is approximately 9% of average current retail rates (NYSEO, 1990b).

However, actual impacts on retail rates may be somewhat less, because the NYPSC long-run avoided costs used in our analysis include only avoided energy, generation capacity, and transmission capacity costs, and do not include avoided distribution capacity costs. When avoided distribution capacity costs are factored into the analysis, the projected rate increase is reduced by approximately 30%.[2] Furthermore, while non-participants will see modest rate increases, they will also benefit from reduced air pollution and other environmental benefits resulting from the programs. Inclusion of environmental benefits in the non-participant benefit-cost test would significantly improve the cost-effectiveness of DSM programs.

The overall benefit-cost ratio for all 38 programs is summarized in Figure 3-4. From the utility, total resource, and societal perspectives, the benefit-cost ratio for the package of programs is approximately three. From the participant perspective, the benefit-cost ratio is approximately five. Due to Con Edison's high retail rates, kWh savings are extremely valuable to program

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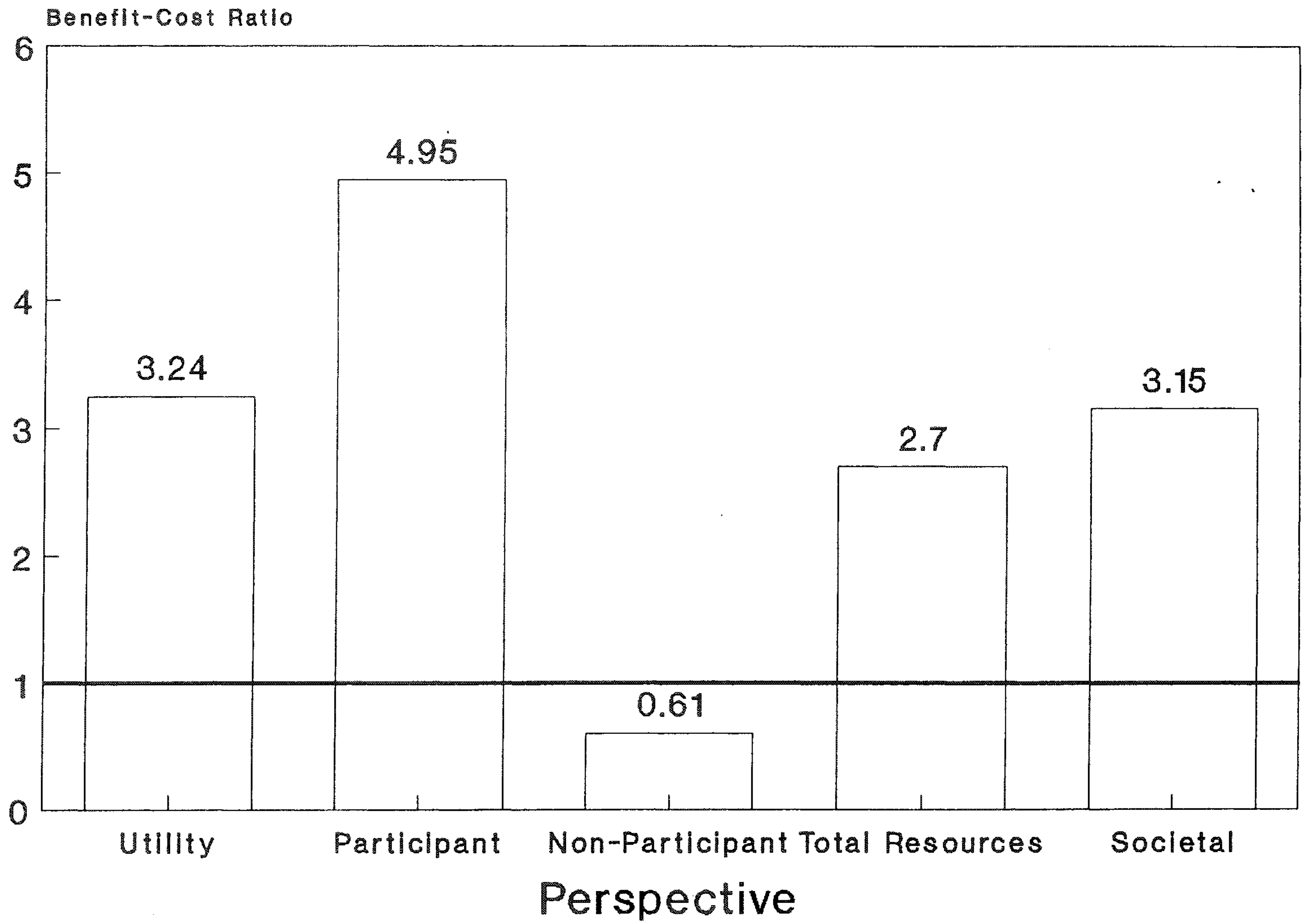
[2] According to the COMPASS model, the present-value rate impact resulting from all 38 programs is $4.34 billion over a 30 year period. Assuming a $57/kW distribution capacity benefit at the time of the summer peak (based on Con Edison estimates for 1991 and the simplification that all program participants are at the secondary distribution level), the present value of avoided distribution capacity costs from all conservation programs over the 1991-2020 period is about $1.32 billion.

Figure 3-4
Benefit-Cost Ratio for Package of Conservation Programs - Consolidated Edison



participants. From the non-participant perspective, the benefit-cost ratio averages 0.6. As electricity is conserved, program participants' share of fixed costs is reduced, while non-participants' share of fixed costs is increased.

As previously noted, the NYPSC has ruled that utilities should look at all the benefit-cost tests, and should proceed with programs that fail the non-participant test, if they are found worthwhile on a broader basis. By this standard, we believe all of the programs (with the possible exception of the Rental Submetering program) are cost-effective, because all programs clearly pass the utility, participant, total resources, and societal tests. However, due to the high fixed-cost component in Con Edison's rates, the impacts of the programs on non-participants are significant. In order to address these impacts, we recommend that special efforts be made to target conservation programs to all customer and end-use segments. By offering a large array of broad-based programs targeted at all customer classes, all customers have an opportunity to participate and reap the energy and monetary rewards of participation. While programs could be restructured so that program participants bear a larger share of program costs, this would have only a limited effect on the benefit-cost ratio for non-participants, because the non-participant benefit-cost ratio is driven primarily by revenue losses.[3]

Energy savings from each program are summarized in Table 3-5. Savings listed in this table are net savings and include avoided transmission and distribution losses. Peak savings do not include a reserve margin adjustment. Savings are reported for 2000, 2008, and for the peak year for each program. Programs with the largest savings are listed in Table 3-6. The allocation of savings among the different program types are also illustrated in Figure 3-5.

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[3] Costs over 30 years from the non-participant perspective total approximately $11.1 billion (present value). Of these costs, 19% are due to program costs, and 81% to revenue losses from reduced sales. Thus, even if program costs were cut in half, the impact on rates would be minimal.

Table 3-5

Cumulative Program GWh and Peak MW Savings - Consolidated Edison

	------ 2000 ------			------ 2008 ------			--------PEAK YEAR --------			
		Summer	Winter		Summer	Winter	Peak		Summer	Winter
Program Name	GWh	MW	MW	GWh	MW	MW	Year	GWh	MW	MW
R ENERGY FITNESS - LIGHT	241	17	92	41	3	16	2003	244	17	93
R ENERGY FITNESS- WTR HTG	51	4	5	29	2	3	2003	57	5	6
R ENERGY FITNESS-WEATHRZTN	14	0	5	13	0	4	2003	17	0	6
R LIGHT COUPON 91-96	211	14	98	0	0	0	1996	472	30	219
R LIGHT COUPON 97-2003	247	16	115	246	16	114	2003	448	29	208
R WATER HEAT RETROFIT	33	3	3	19	2	2	2003	37	3	4
R HOUSE DOCTOR	33	1	10	30	1	9	2003	45	2	13
R HOME INSULATION	13	0	4	17	0	6	2003	17	0	5
R HIGH EFFICIENCY REFRIG	213	28	26	321	42	39	2002	321	42	39
R HEAT PUMP WATER HEATER	69	6	7	254	22	26	2010	289	25	30
R NEW CONSTRUCTION	28	1	9	63	3	20	2010	72	4	23
R CONDO/COOP SUBMETER	121	36	16	135	40	18	2001	134	40	18
R RENTAL SUBMETER	61	18	8	101	30	14	2004	101	30	14
C LIGHT REB.-COMPACT BULB	19	4	4	3	1	1	1994	29	6	6
C LIGHT REB.- COMPACT FIXT	143	30	30	74	16	15	2000	143	30	30
C LIGHT REB.- REFLECTORS	454	96	94	235	50	49	2000	454	96	94
C LIGHT REB.-BALLAST 91-94	148	31	31	79	17	16	1994	148	31	31
C LIGHT REB.-BALLAST 95-99	144	31	30	325	69	68	2009	335	71	70
C LIGHT REB.- HID RETROFIT	215	46	45	84	18	17	2000	215	46	45
C LT. REBATE OCC.SENS	84	13	21	46	7	12	2000	84	13	21
C LIGHT REB.-DAYLIGHT CNTL	100	36	0	59	21	0	2000	100	36	0
C HVAC CHILLER REBATE	124	74	7	272	162	14	2010	314	188	17
C HVAC PKGD SYSTEM REBATE	183	70	14	405	155	32	2010	468	179	37
C REFRIGERATION REBATES	900	127	100	1,137	161	126	2010	1,165	164	129
C MOTOR REBATE	153	23	17	241	36	27	2005	250	38	28
C ADJUSTABLE SPEED DRIVE	221	33	25	350	53	40	2005	365	55	41
C CUSTOM MEASURE	360	81	47	213	48	28	2000	360	81	47
C AUDIT PROGRAM	379	85	49	126	28	16	1996	609	137	80
C SM.DIRECT INSTALL-GEN'L	1,381	293	286	1,577	334	326	2002	1,744	370	361
C SM.DIRECT INSTL-COMPACT	52	11	11	14	3	3	2002	56	12	12
C SM.DIRECT INSTL-OCC SENS	93	14	24	83	13	21	2002	116	18	29
C MED/LG DIRECT INSTALL	605	136	79	1,196	268	156	2011	1,369	307	179
C RENOVATION - LIGHT 91-94	40	8	8	40	8	8	1994	40	8	8
C RENOVATION-LIGHT 95-2010	213	45	44	554	117	115	2010	645	137	133
C NEW CONSTRCTN 1991-2000	413	92	54	413	92	54	2000	413	92	54
C NEW CONSTRCTN 2001-2010	0	0	0	485	109	63	2010	614	138	80
INDUS NEW CONST/MODERNZTN	30	5	3	53	8	6	2010	60	9	7
TOTAL	7,787	1,528	1,420	9,331	1,954	1,484				

R = Residential

C = Commercial and industrial

Table 3-6
Programs with the Largest Savings - Consolidated Edison

In 2000:

GWh	Winter Peak MW	Summer Peak MW
Small C&I DI	Small C&I DI	Small C&I DI
C&I Lighting Rebate	C&I Lighting Rebate	C&I Lighting Rebate
C&I Refrigeration	Res. Lighting Coupon	C&I HVAC Rebate
Medium/Lg C&I DI	Res. Energy Fitness	Medium/Lg. C&I DI
Res. Lighting Coupon	C&I Refrigeration	C&I Refrigeration
Comm'l New Const.	Medium/Lg C&I DI	Comm'l New Const.

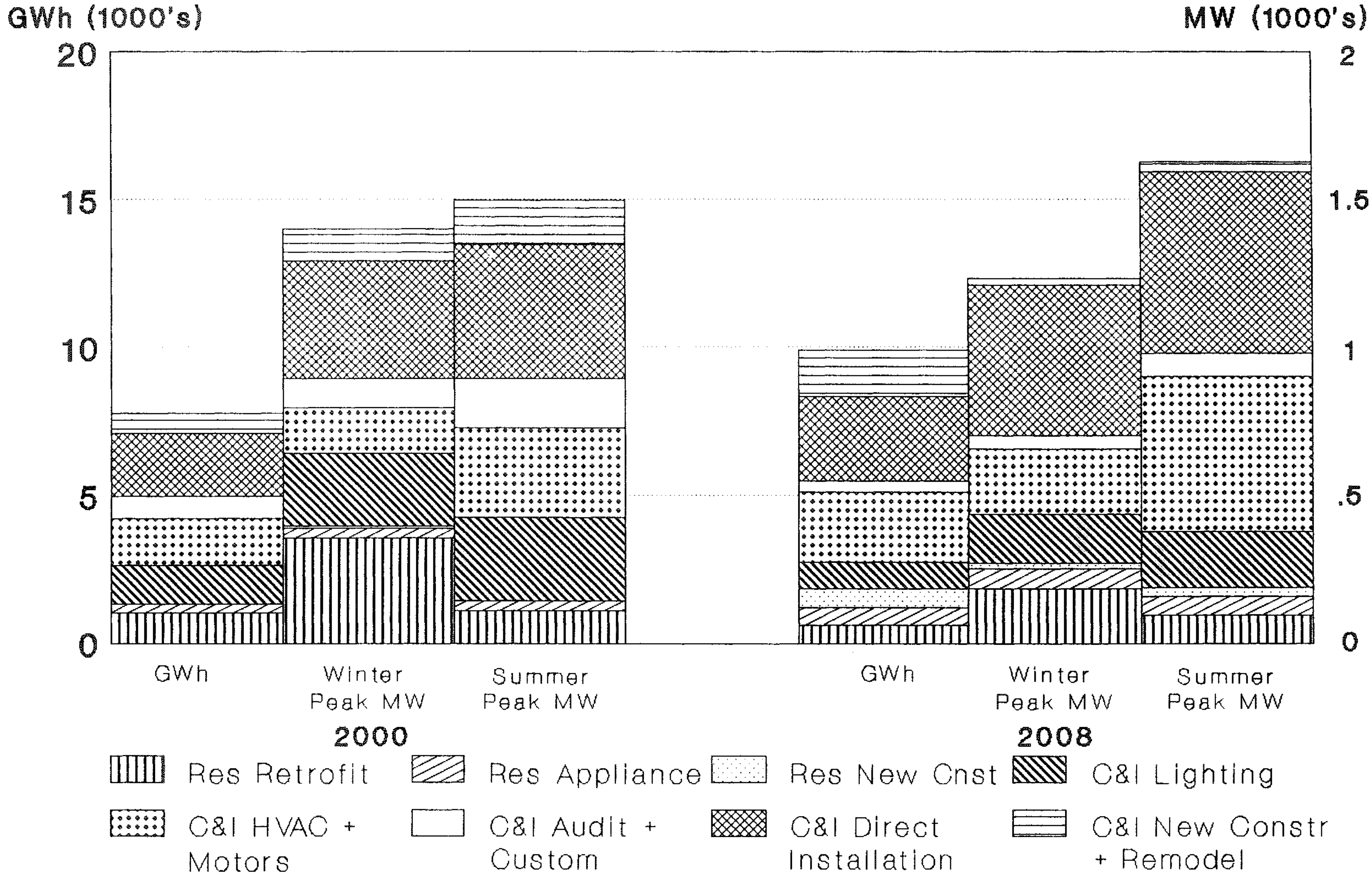
In 2008:

GWh	Winter Peak MW	Summer Peak MW
Small C&I DI	Small C&I DI	Small C&I DI
Medium/Lg DI	C&I Lighting Rebate	C&I HVAC Rebate
C&I Refrigeration	Medium/Lg DI	Medium/Lg DI
Comm'l New Const.	C&I Refrigeration	Comm'l New Const.
C&I Lighting Rebate	Comm'l Renovation	C&I Lighting Rebate
C&I HVAC Rebate	Comm'l New Const.	C&I Refrigeration

DI = Direct installation
WH = Water heater

Note: Programs are listed in order of savings, with programs with the highest savings listed first.

Figure 3-5
Conservation Savings by Year & Program Type - Consolidated Edison

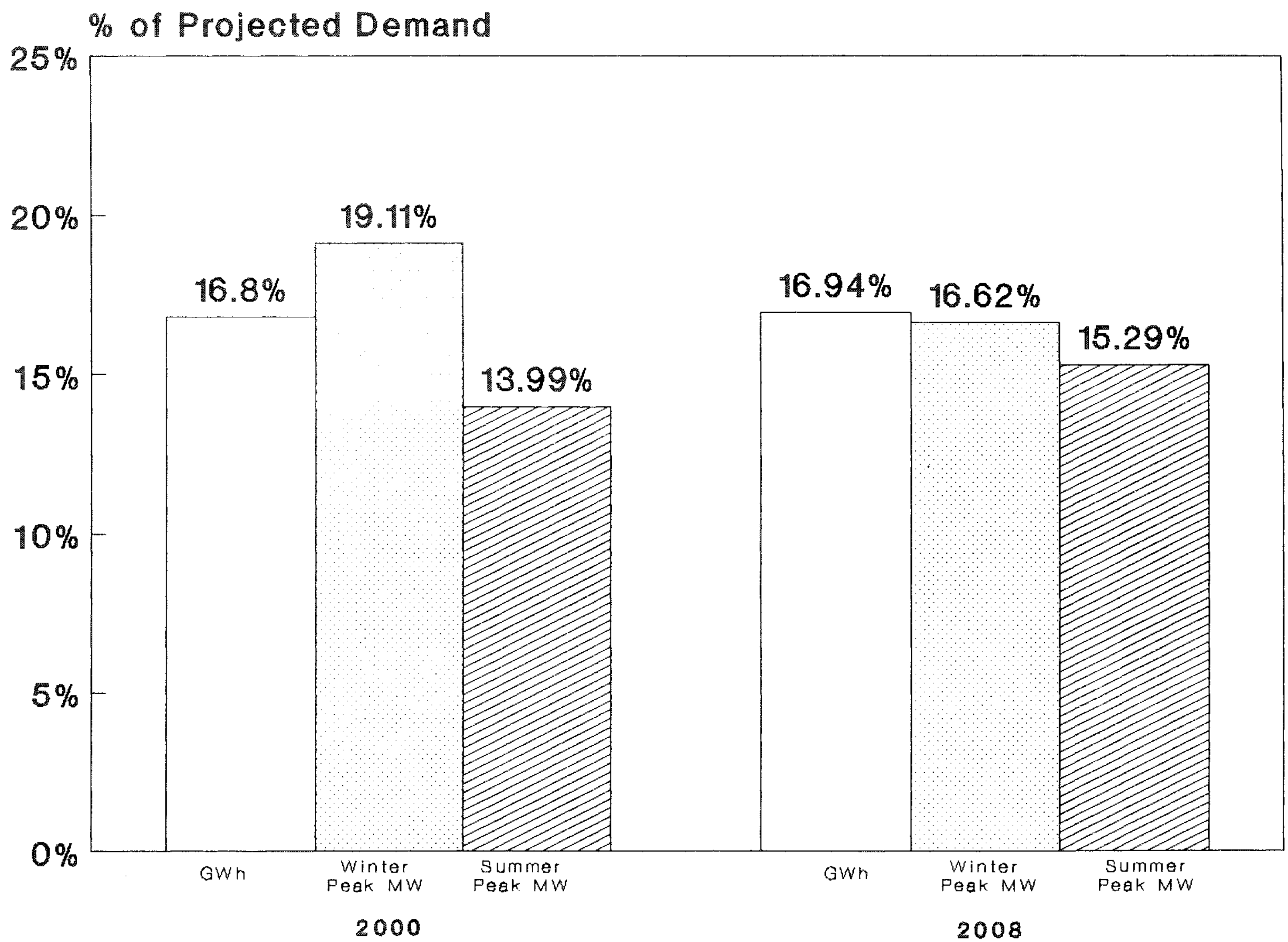


In 2000, the largest savings are due to commercial lighting programs, including the Small C&I Direct Installation program and the C&I Lighting Rebate program. Other commercial rebate programs and the residential lighting programs also figure prominently. The large commercial savings are due to the fact that 67% of Con Edison's GWh sales are to the commercial sector (Miller et al., 1989). The high residential lighting savings are due to the large number of residential customers Con Edison serves. Under the Energy Fitness and Residential Lighting Coupon programs, most of these customers receive compact fluorescent bulbs. In 2008, high savings are achieved by the C&I direct installation programs, the Commercial New Construction program, and C&I rebate programs.

Since all of the programs examined are cost-effective (with the possible exception of the rental submetering program), and since program inputs were adjusted to eliminate overlap between programs, the achievable conservation potential is the sum of savings from the individual conservation programs. In 2000, the achievable conservation potential is 7,787 GWh, 1,420 winter peak MW, and 1,528 summer peak MW. These savings represent 14.0-19.1% of projected Con Edison electricity sales and peak demand in 2000 (see Figure 3-6). These savings also represent 101-123% of projected growth in electricity sales and peak demand over the 1991-2000 period. Thus, based on the NYSEO Reference II forecast, if all projected savings are achieved, electricity sales and peak demand would actually decline over the 1991-2000 period. In 2008, the achievable conservation potential is 9,331 GWh, 1,484 winter peak MW, and 1,955 summer peak MW. These savings represent 15.3-16.9% of projected Con Edison electricity sales and peak demand in 2008. These savings also represent 56-61% of projected growth in electricity sales and peak demand over the 1991-2008 period. As a result of these programs, Con Edison's projected 1.9% compound sales growth over the 1991-2000 period and 2.1% over the 1991-2008 period are reduced to -0.1% and 0.9% respectively. Thus, for Con Edison, it appears that the State Energy Plan goals of 8-10% savings by 2000 and 15% savings by 2008 can be achieved cost-effectively. During the 1991-2000 period, conservation programs

Figure 3-6

Conservation Savings as a Percent of Projected Demand - Consolidated Edison



can keep electricity sales and demand at present levels. During the 2000-2008 period, growth in energy sales and demand will exceed conservation savings, but only by a modest margin.

By 2008, summer and winter peak savings, including an allowance for a 20% reserve margin, are approximately equivalent to the output of two large nuclear power plants, or to three to four large (600 MW) coal plants. Program costs total approximately $3.3 billion (in 1991 dollars). Utility costs average approximately $167 million annually (1991 $).

D. LONG ISLAND LIGHTING

A total of 36 conservation programs and sub-programs were analyzed for the Long Island Lighting Company (LILCo). The benefit-cost ratio for each of these programs is summarized in Table 3-7. As can be seen in this table, all of the programs analyzed are cost-effective from the utility, participant, total resource, and societal perspectives. In fact, for most programs, the benefit-cost ratio is greater than two. With one exception (the C&I Chiller Rebate program), none of the programs are cost-effective from the non-participant perspective, meaning that for customers who do not participate in any programs, electric bills will go up slightly. Electric bills will increase for these customers because: (1) the utility recoups program costs through rates and, (2) as kWh sales decline, fixed costs are spread among fewer kWh of annual sales. The overall average rate increase resulting from all 36 programs is $0.0064/kWh -- an increase of approximately 5% of current rates (NYSEO, 1990b). However, as with Con Edison, when avoided distribution capacity costs are factored into the calculation, the rate impact will decline somewhat. Since, these programs are directed at all customer classes, over time, the majority of LILCo customers will participate in these programs, and will thus benefit from the programs. Therefore, we believe that this small rate increase is acceptable. However, in order to minimize the chance that any class of rate payer will be disadvantaged by the programs, we believe special efforts should

Table 3-7

Program Costs and Benefit-Cost Ratios - Long Island Lighting

Program Name	BENEFIT COST RATIOS Utility	Parti-cipant	Non-Partic	Total Res.	Soci-etal	Program Costs Over 20 Years in 1991 $ (1000's)	LEVELIZED ¢/KWH (in 1991 $) Utility	Total Res.
R ENERGY FITNESS - LIGHT	1.15	5.03	0.44	1.65	1.96	$40,171	4.24	3.92
R ENERGY FITNESS- WTR HTG	4.41	14.78	0.58	4.67	5.48	4,065	1.67	1.58
R ENERGY FITNESS-WEATHRZTN	3.31	8.36	0.47	2.91	3.55	2,221	1.92	2.18
R LIGHT COUPON 91-96	3.06	7.89	0.50	3.76	4.40	22,356	1.84	1.06
R LIGHT COUPON 97-2003	4.14	16.88	0.56	6.92	8.14	17,947	2.02	0.94
R WATER HEAT RETROFIT	7.40	37.47	0.61	7.74	9.08	1,575	1.00	0.95
R HOUSE DOCTOR	1.72	4.70	0.46	1.76	2.10	10,378	4.12	4.01
R HOME INSULATION	1.28	3.44	0.39	1.08	1.32	6,145	5.22	6.16
R HIGH EFFICIENCY REFRIG	5.65	2.70	0.61	1.66	1.95	17,794	1.65	5.58
R HEAT PUMP WATER HEATER	2.99	4.63	0.57	2.35	2.75	29,870	3.43	4.38
R NEW CONSTRUCTION	2.74	3.96	0.53	2.07	2.46	22,701	3.35	4.43
C LIGHT REB.-COMPACT BULB*	5.47	18.48	0.70	7.79	9.03	1,538	1.25	0.88
C LIGHT REB.- COMPACT FIXT	10.41	27.93	0.77	15.72	18.03	5,203	0.75	0.06 #
C LIGHT REB.- REFLECTORS	5.91	8.81	0.73	6.15	7.10	35,006	1.32	1.20
C LIGHT REB.-BALLAST 91-94	4.22	5.90	0.69	3.96	4.58	13,538	1.80	1.92
C LIGHT REB.-BALLAST 95-99	16.46	11.06	0.83	8.83	10.18	5,309	0.65	1.20
C LIGHT REB.- HID RETROFIT	4.31	6.06	0.65	3.66	4.32	13,040	1.54	1.81
C LT. REBATE OCC.SENS	6.30	6.08	0.71	4.08	4.70	6,195	1.32	2.05
C LIGHT REB.-DAYLIGHT CNTL	3.15	2.94	0.68	1.98	2.24	16,268	3.18	5.06
C HVAC CHILLER REBATE	8.79	10.17	1.01	7.39	8.04	19,240	2.13	2.53
C HVAC PKGD SYSTEM REBATE	15.16	27.82	0.97	13.41	15.06	11,792	0.87	0.99
C REFRIGERATION REBATES	1.83	2.88	0.56	1.60	1.88	223,340	4.54	5.18
C MOTOR REBATE	5.51	6.67	0.70	4.05	4.77	15,661	1.58	2.15
C ADJUSTABLE SPEED DRIVE	3.03	3.10	0.63	1.97	2.31	38,882	2.88	4.42
C CUSTOM MEASURE	4.84	4.21	0.69	2.69	3.14	29,860	1.63	2.92
C AUDIT PROGRAM	3.37	6.81	0.63	2.07	2.41	46,127	2.06	3.34
C SM.DIRECT INSTALL-GEN'L	2.83	5.07	0.71	3.52	4.05	221,928	3.21	2.43
C SM.DIRECT INSTL-COMPACT*	2.40	7.17	0.66	3.52	4.06	7,279	3.35	2.29
C SM.DIRECT INSTL-OCC SENS	4.33	5.21	0.75	3.72	4.29	9,935	2.17	2.53
C MED/LG DIRECT INSTALL*	3.88	4.16	0.69	2.59	3.02	90,198	2.60	3.90
C RENOVATION - LIGHT 91-94	4.60	9.06	0.71	4.48	5.17	3,675	1.85	1.90
C RENOVATION-LIGHT 95-2010	4.32	7.28	0.73	4.46	5.14	34,467	2.64	2.56
C NEW CONSTRCTN 1991-2000	2.75	4.83	0.64	2.54	2.96	65,324	3.43	3.71
C NEW CONSTRCTN 2001-2010	1.92	3.39	0.59	1.76	2.05	71,002	6.33	6.88
INDUS NEW CONST/MODERNZTN	3.38	5.23	0.65	2.99	3.51	25,180	2.66	3.02
TOTAL	3.33	4.85	0.66	2.87	3.33	1,185,210		

R = Residential

C = Commercial and industrial

* Values shown for utility costs include some customer repurchase costs, thereby exaggerating the cost to the utility and modestly underestimating the cost-effectiveness as determined with the Utility and Non-participant tests.

Negative or negligible levelized costs indicate significant O&M savings.

be made to target and market programs to all customer classes and end-uses. In this way, all customers will have an opportunity to participate in programs, and the only customers whose electric bills go up are those customers who make a conscious decision not to participate. Furthermore, even non-participants will benefit from reduced air pollution and other environmental benefits resulting from the programs. Inclusion of these benefits in the non-participant benefit-cost test would significantly improve the economic attractiveness of DSM programs.

The overall benefit-cost ratio for all 36 programs is summarized in Figure 3-7. From the utility, total resources, and societal perspectives, the benefit-cost ratio for the package of programs is approximately three. From the participant perspective, the benefit-cost ratio is nearly five, while from the non-participant perspective, the ratio is 0.7. As previously noted, the NYPSC has ruled that utilities should look at all the benefit-cost tests, and should proceed with programs that fail the non-participant test, if they are found worthwhile on a broader basis. By this standard, we believe all of the programs are cost-effective, because all programs clearly pass the utility, participant, total resources, and societal tests.

Energy savings from each program are summarized in Table 3-8. Savings listed in this table are net savings (i.e., they exclude free riders) and include avoided transmission and distribution losses. Peak savings do not include a reserve margin adjustment. Savings are reported for 2000, 2008, and for the peak year for each program. Programs with the largest savings are listed in Table 3-9. The allocation of savings among the different program types is also illustrated in Figure 3-8.

In 2000, lighting programs are the leading energy savings -- the Small C&I Lighting Direct Installation, C&I Lighting Rebate, and Residential Lighting Coupon programs are all big energy savers.

Figure 3-7
Benefit-Cost Ratio for Package of Conservation Programs - Long Island Lighting

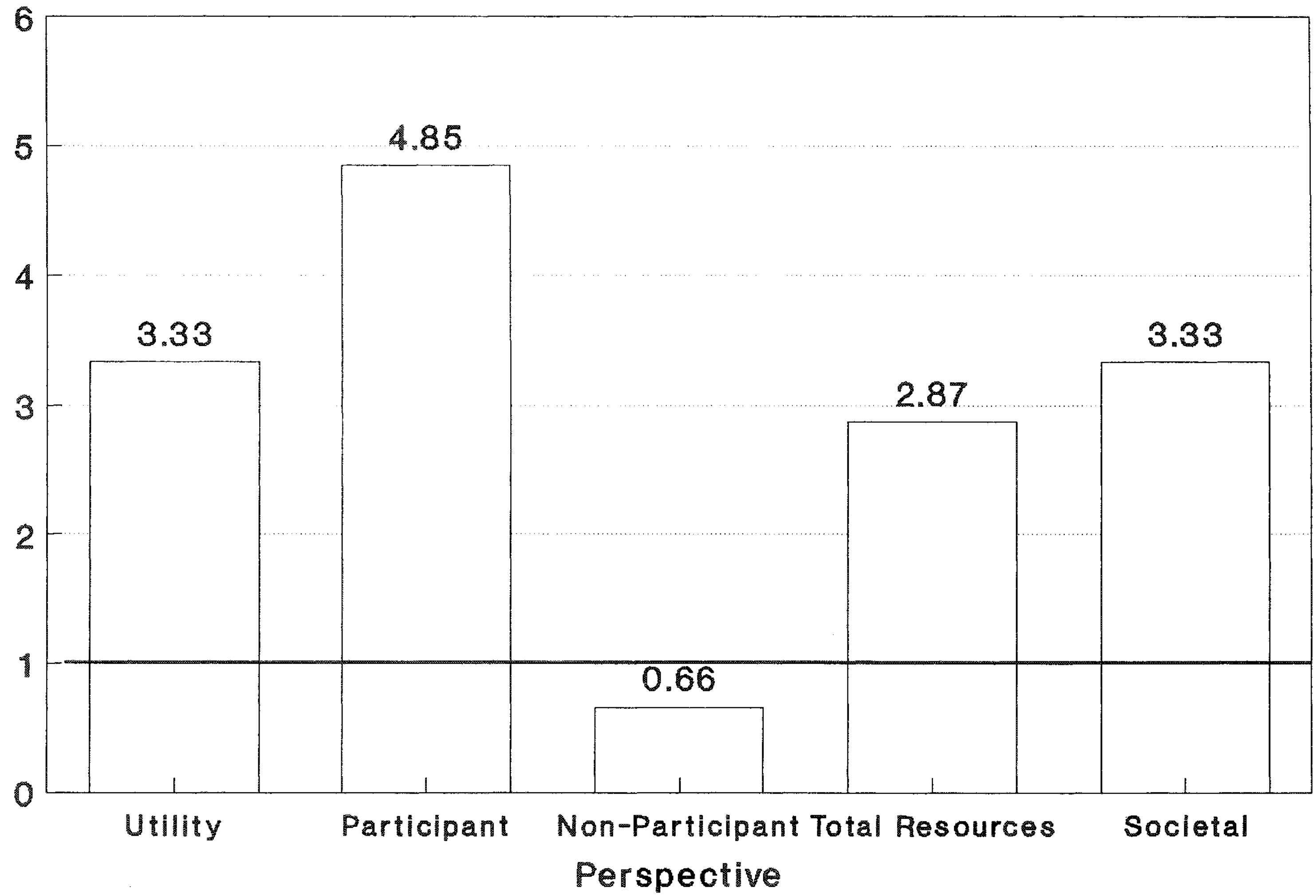


Table 3-8

Cumulative Program GWh and Peak MW Savings - Long Island Lighting

	2000			2008			PEAK YEAR			
Program Name	GWh	Summer MW	Winter MW	GWh	Summer MW	Winter MW	Peak Year	GWh	Summer MW	Winter MW
R ENERGY FITNESS - LIGHT	75	4	35	14	1	6	2003	78	4	36
R ENERGY FITNESS- WTR HTG	20	2	2	12	1	1	2003	23	3	3
R ENERGY FITNESS-WEATHRZTN	8	0	2	8	0	2	2003	10	0	3
R LIGHT COUPON 91-96	64	3	31	0	0	0	1996	141	7	69
R LIGHT COUPON 97-2003	73	4	34	74	4	34	2003	134	7	62
R WATER HEAT RETROFIT	13	1	2	8	1	1	2003	15	2	2
R HOUSE DOCTOR	18	1	4	17	1	4	2003	24	2	6
R HOME INSULATION	7	0	2	9	0	3	2003	9	0	3
R HIGH EFFICIENCY REFRIG	73	10	10	111	15	15	2002	111	15	15
R HEAT PUMP WATER HEATER	31	3	4	119	13	14	2010	136	15	16
R NEW CONSTRUCTION	32	3	8	73	6	20	2010	84	7	23
C LIGHT REB.-COMPACT BULB	6	1	1	1	0	0	1996	9	2	1
C LIGHT REB.- COMPACT FIXT	46	9	5	24	5	3	2000	46	9	5
C LIGHT REB.- REFLECTORS	176	33	21	93	17	11	2000	176	33	21
C LIGHT REB.-BALLAST 91-94	47	9	6	25	5	3	1994	47	9	6
C LIGHT REB.-BALLAST 95-99	46	9	5	105	19	12	2009	108	20	13
C LIGHT REB.- HID RETROFIT	54	6	9	21	2	4	2000	54	6	9
C LT. REBATE OCC.SENS	33	6	8	18	3	5	2000	33	6	8
C LIGHT REB.-DAYLIGHT CNTL	39	11	0	23	6	0	2000	39	11	0
C HVAC CHILLER REBATE	43	33	10	95	72	22	2010	110	83	26
C HVAC PKGD SYSTEM REBATE	64	24	6	142	54	12	2010	164	63	14
C REFRIGERATION REBATES	321	45	36	415	59	46	2010	427	60	47
C MOTOR REBATE	58	8	7	92	12	11	2005	95	12	11
C ADJUSTABLE SPEED DRIVE	77	10	9	125	16	15	2005	130	17	16
C CUSTOM MEASURE	137	22	18	81	13	11	2000	137	22	18
C AUDIT PROGRAM	122	20	16	40	7	5	1996	196	32	26
C SM.DIRECT INSTALL-GEN'L	502	93	60	578	107	69	2002	637	118	76
C SM.DIRECT INSTL-COMPACT	19	3	2	5	1	1	2002	21	4	2
C SM.DIRECT INSTL-OCC SENS	34	6	9	31	5	8	2002	42	8	11
C MED/LG DIRECT INSTALL	182	30	24	370	61	50	2011	428	70	57
C RENOVATION - LIGHT 91-94	11	2	1	11	2	1	1994	11	2	1
C RENOVATION-LIGHT 95-2010	59	11	7	155	29	19	2010	181	34	22
C NEW CONSTRCTN 1991-2000	146	24	20	146	24	20	2000	146	24	20
C NEW CONSTRCTN 2001-2010	0	0	0	177	29	24	2010	225	37	30
INDUS NEW CONST/MODERNZTN	47	6	6	95	12	11	2010	110	14	13
TOTAL	2,682	451	420	3,311	602	462				

R = Residential

C = Commercial and industrial

Table 3-9
Programs with the Largest Savings - Long Island Lighting

In 2000:

GWh	Winter Peak MW	Summer Peak MW
Small C&I DI	Small C&I DI	Small C&I DI
C&I Lighting Rebate	Res. Lighting Coupon	C&I Lighting Rebate
C&I Refrigeration	C&I Lighting Rebate	C&I HVAC Rebate
Medium/Lg DI	Res. Energy Fitness	C&I Refrigeration
Comm'l New Const.	C&I Refrigeration	Medium/Lg DI
Res. Lighting Coupon	Medium/Lg DI	Comm'l New Const.
C&I Custom Measure	C&I Custom Measure	C&I Custom Measure

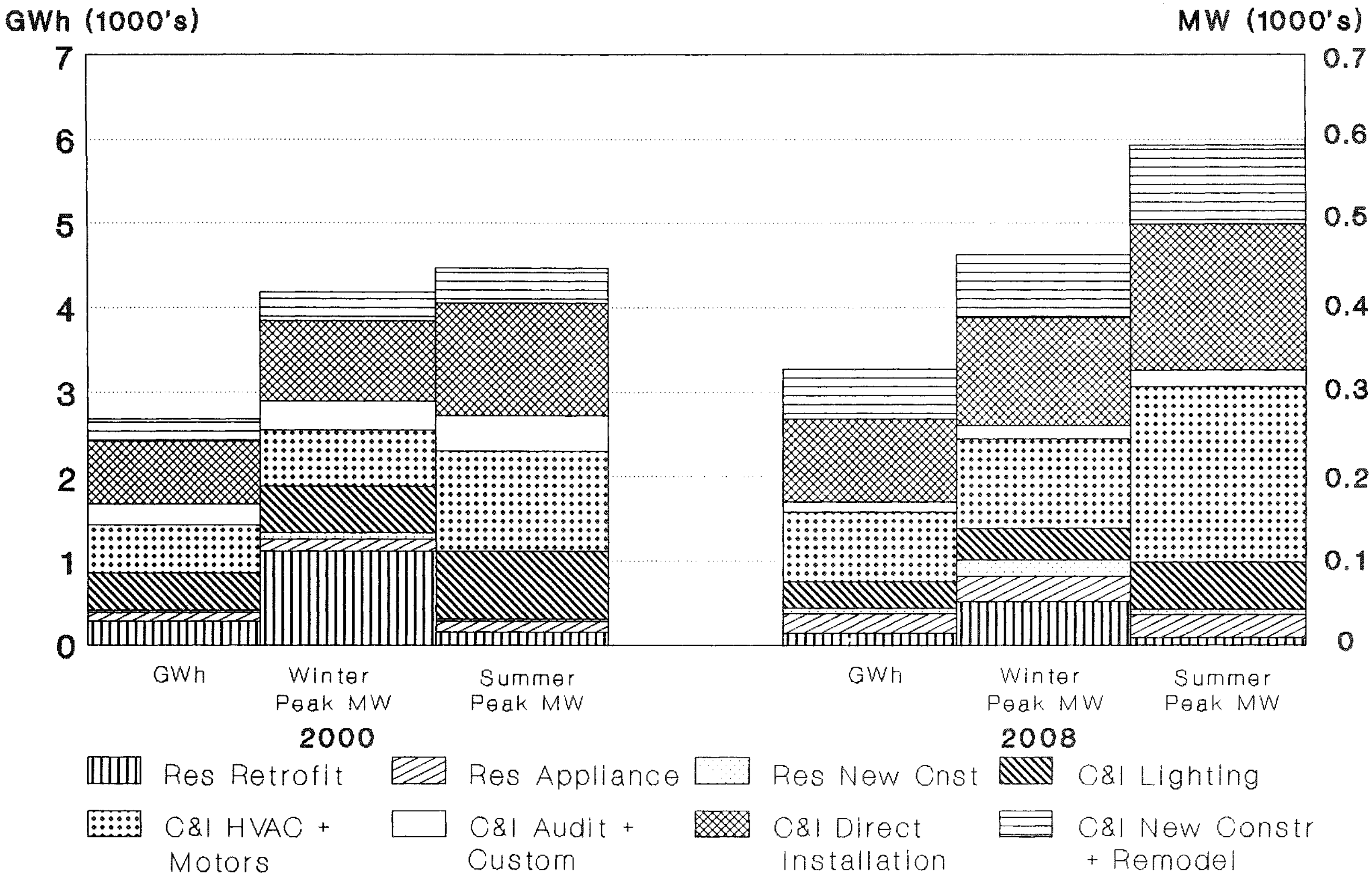
In 2008:

GWh	Winter Peak MW	Summer Peak MW
Small C&I DI	Small C&I DI	C&I HVAC Rebate
C&I Refrigeration	Medium/Lg DI	Small C&I DI
Medium/Lg DI	C&I Refrigeration	Medium/Lg DI
Comm'l New Const.	Comm'l New Const.	C&I Refrigeration
C&I Lighting Rebate	C&I Lighting Rebate	C&I Lighting Rebate
C&I HVAC Rebate	Res. Lighting Coupon	Comm'l New Constr.
Comm'l Renovation	C&I HVAC Rebate	Comm'l Renovation

DI = Direct installation
WH = Water heater

Note: Programs are listed in order of savings, with programs with the highest savings listed first.

Figure 3-8
Conservation Savings by Year & Program Type - Long Island Lighting

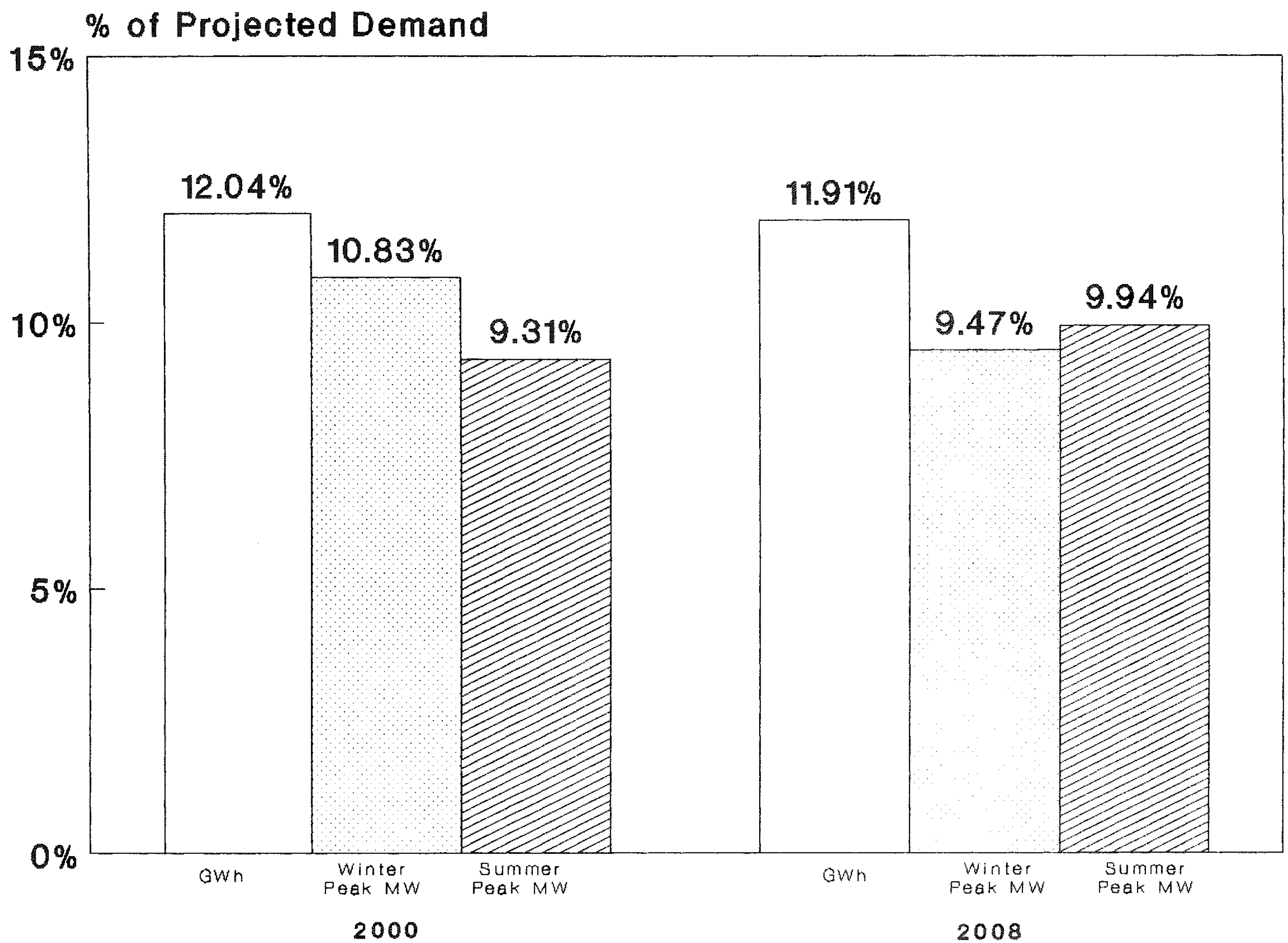


Other commercial programs also figure prominently. In 2008, the biggest energy savers are generally the direct installation programs including Small C&I, Medium/Large C&I, Commercial New Construction, and Commercial Renovation. In addition, the C&I HVAC Rebate program is the biggest single contributor to summer peak savings.

Since all of the programs examined are cost-effective, and since program inputs were adjusted to eliminate overlap between programs, the achievable conservation potential is the sum of savings from the individual conservation programs. In 2000, the achievable conservation potential is 2,682 GWh, 421 winter peak MW, and 451 summer peak MW. These savings represent 9.3-12.0% of projected LILCo electricity sales and peak demand in 2000 (see Figure 3-9). These savings also represent 54-68% of projected growth in electricity sales and peak demand over the 1991-2000 period (based on NYSEO Reference II forecast). In 2008, the achievable conservation potential is 3,311 GWh, 462 winter peak MW, and 603 summer peak MW. These savings represent 9.5-11.9% of projected LILCo electricity sales and peak demand in 2008. These savings also represent 27-35% of projected growth in electricity sales and peak demand over the 1991-2008 period. As a result of these programs, LILCo's projected 2.2% compound sales growth over the 1991-2000 period and 2.5% over the 1991-2008 period are reduced to0.7% and 1.7% respectively. Thus, for LILCo, it appears that the State Energy Plan goal of 8-10% savings by 2000 can be achieved cost-effectively, but the goal of 15% savings by 2008 cannot be achieved by the conservation programs analyzed in this study. During the 1991-2000 period, conservation programs can meet the majority of projected load growth for LILCo, but over the 2000-2008 period, load growth will substantially exceed conservation savings. These issues are discussed more extensively later in this chapter.

By 2008, summer and winter peak savings, including a 20% reserve margin, are approximately equivalent to the output of a large (600 MW) coal plant. Over the 1991-2011 period, costs to the utility

Figure 3-9
Conservation Savings as a Percent of Projected Demand - Long Island Lighting



total approximately $1.19 billion (in 1991 dollars). Utility costs average $59 million annually (1991 $).

E. SIMILARITIES AND DIFFERENCES AMONG THE THREE UTILITIES

The analysis of conservation programs for Niagara Mohawk, Con Edison, and Long Island Lighting shows a number of similarities and differences among the utilities.

For all three utilities, all of the programs examined are cost-effective from the utility, participant, total resource, and societal perspectives.[4] However, nearly all of the programs were not cost-effective from the non-participant perspective.

For all three utilities, the C&I Lighting Rebate, Small C&I Direct Installation, Medium/Large C&I Direct Installation, Commercial New Construction, C&I HVAC Rebate, Refrigeration, Energy Fitness, and Residential Lighting Coupon/Catalog programs are big energy savers. Total savings from all programs exceed 9% of projected electricity sales and 9% of projected summer and winter peak demand for all three utilities in the year 2000. Thus, the State Energy Plan targets of 8-10% savings by 2000 seem reasonable. Savings as a percent of projected sales and demand are approximately the same in 2008 as in 2000. This is illustrated in Figures 3-10, 3-11 and 3-12. There are several reasons for this leveling of savings in the 2000-2008 period. First, as sales grow, more and more conservation is needed just to keep the conservation percentage constant. Second, measures installed before 2000 begin wearing out in the 2000-2008 period. While some of these measures are replaced, other measures are not replaced, and some measures have become standard practice, so no credit for savings can be taken. Third, this analysis is limited to existing technologies. After 10-20 years, much of the savings from these technologies are realized, and additional savings are primarily available from new technologies that are not included in the analysis.

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[4] With the possible exception of the Con Edison Rental Submetering program.

Figure 3-10
Conservation Costs, Energy Savings & Peak Demand Savings by Year - Niagara Mohawk

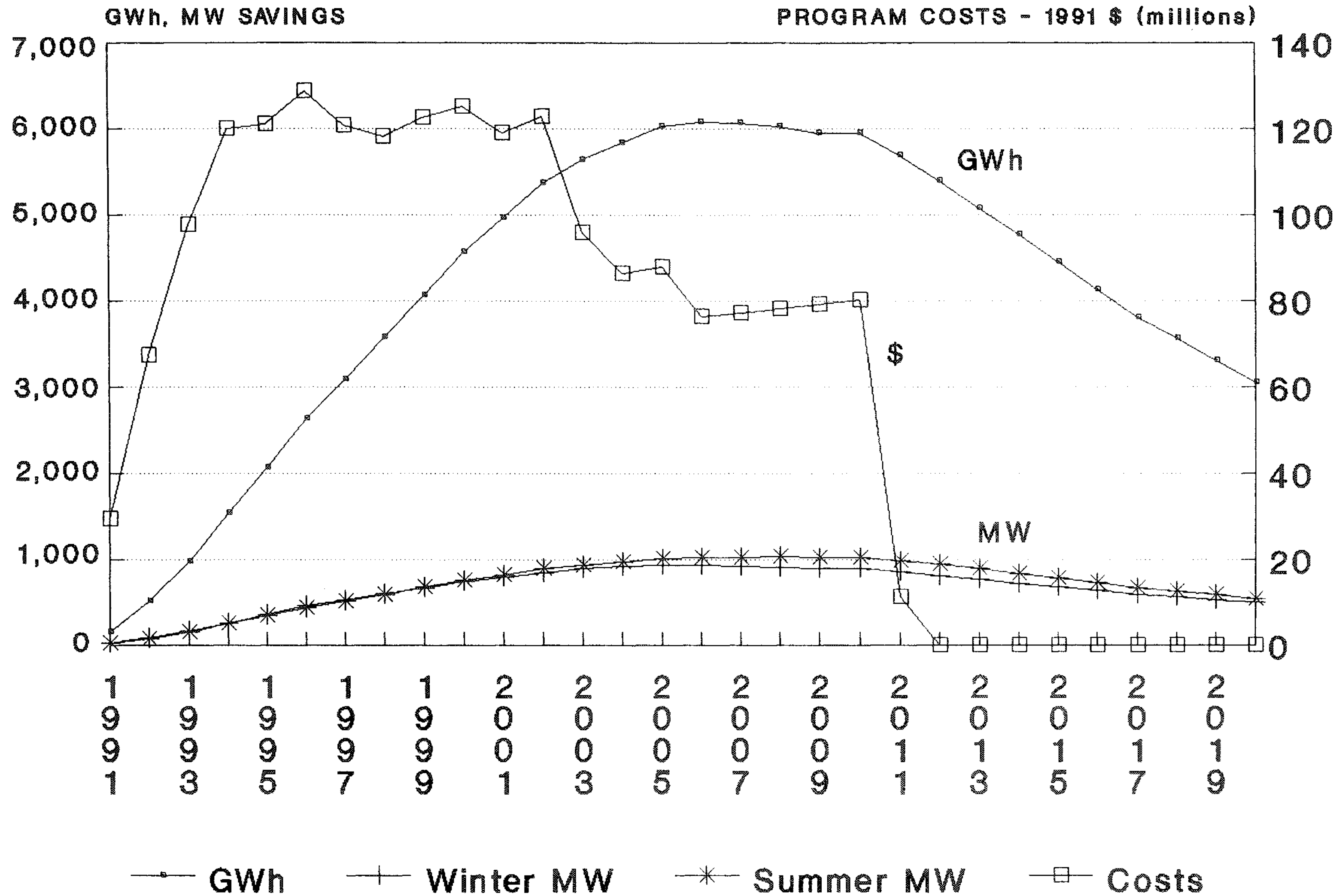


Figure 3-11

Conservation Costs, Energy Savings & Peak Demand Savings by Year - Consolidated Edison

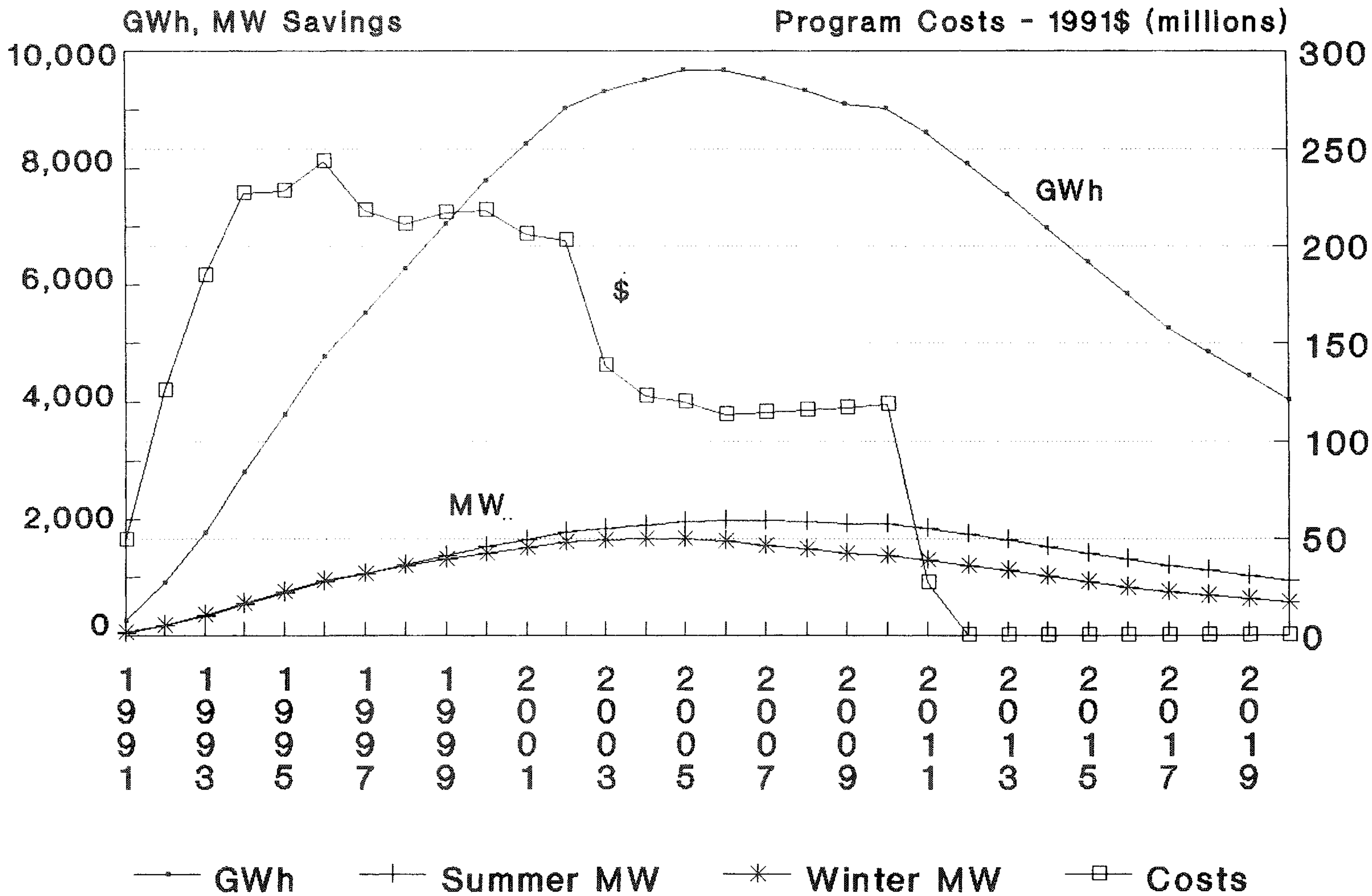
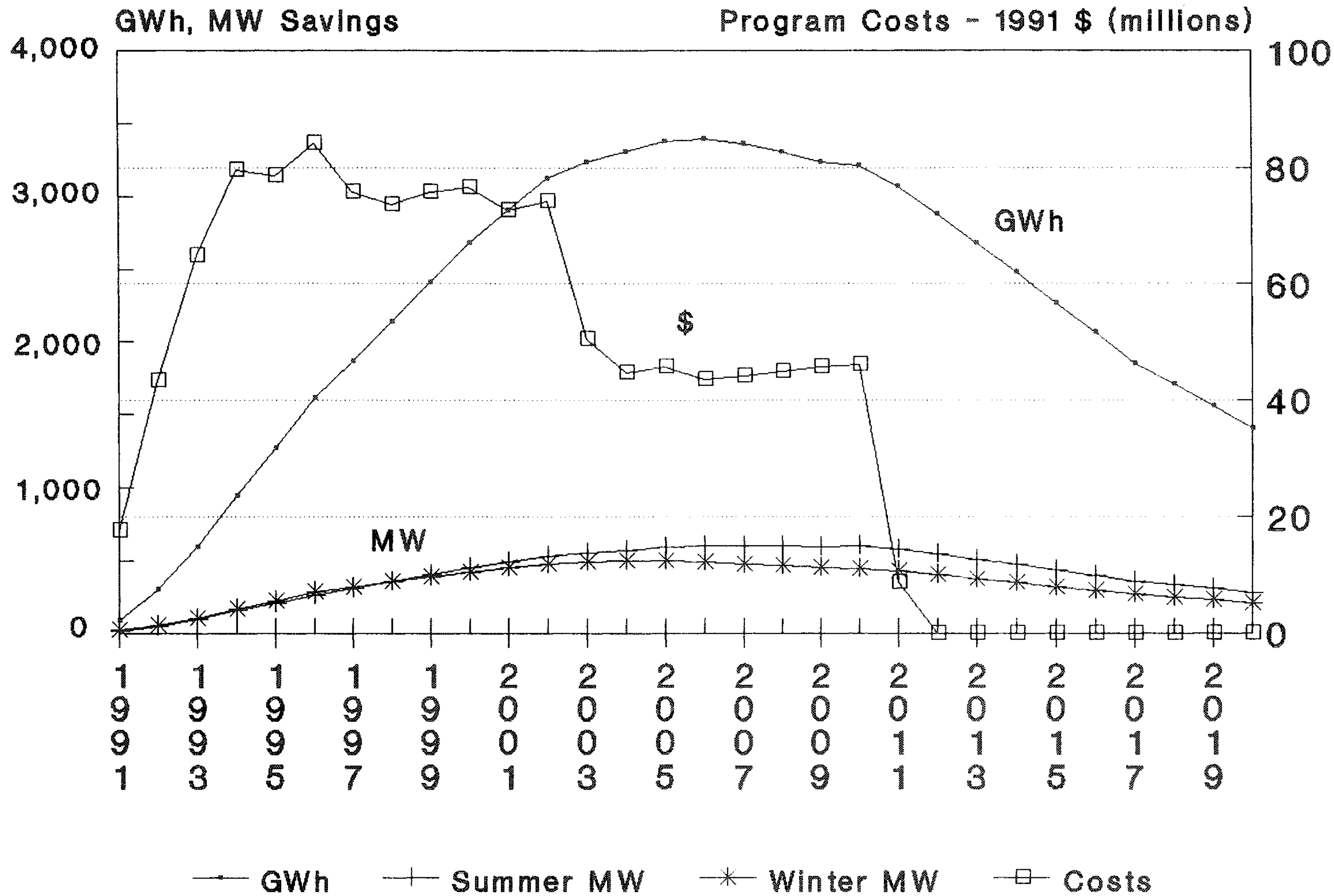


Figure 3-12

Conservation Costs, Energy Savings & Peak Demand Savings byYear - Long Island Lighting



The practicality of meeting the State Energy Plan 15% savings target in 2008 merits some discussion. On the one hand, based on the programs examined in this study, only Con Edison can reach the 15% target. On the other hand a number of viable program options that could be used to meet the 15% target were not examined in this study. For example, this study did not examine load management programs (which could be used to meet the peak demand targets, but not the kWh savings targets) or fuel switching programs. Also, this study assumed that new codes and standards will achieve substantial energy savings. If codes and standards are not strengthened as we project, some of these savings could be achieved by utility programs. Of perhaps even greater importance, this study ignored new technologies now under development, which can dramatically reduce electricity use in the first decade of the 21st century. Some of the many new technologies that are likely to be commercialized in the 1990's are discussed by Geller (1988a and 1988b). Examples include fluorescent lamps using as little as half the electricity of today's most efficient models and variable speed drives in residential appliances which can reduce electricity use by 20-50% (depending on the appliance and the application). Thus, while this study does not show that the 15% target for 2008 is achievable (except for Con Edison), given the programs and technologies that were not examined in this study, we think it likely that the 15% target (and perhaps even higher targets) can ultimately be met.

When conservation savings are compared to projected growth in electricity sales and peak demand, for all three utilities, conservation program savings will reduce growth rates by over 50% during the 1991-2000 period, and by approximately one-third or more over the 1991-2008 period.

While there are a number of common trends that emerge from the individual utility analyses, there are also a number of important differences. Differences which are specific to individual utilities are discussed below.

Niagara Mohawk generally has the lowest conservation savings of the utilities examined. Niagara Mohawk has an above-average industrial load (35% of total sales, compared to 21% for the State as a whole -- Miller et al., 1989) and a below average commercial load (34% of total sales, compared to 42% for the State as a whole). According to the Phase I NYSERDA/ACEEE study on the technical potential for electricity consumption in New York State, the conservation potential is highest in the commercial sector and lowest in the industrial sector. Thus, it is to be expected that achievable savings are lower for Niagara Mohawk than for the other utilities. Due to the high industrial load in Niagara Mohawk's service area, industrially oriented programs (e.g., motors and adjustable-speed drives) figure more prominently in the savings mix for Niagara Mohawk than for the other utilities. Also, due to the relatively high saturation rate of electric water heaters and new electrically heated homes in the Niagara Mohawk territory, the Residential Heat Pump Water Heater and Residential New Construction programs are large energy savers for Niagara Mohawk.

Consolidated Edison has the highest conservation savings of the utilities examined. Conservation savings over the 1991-2000 period are equal to approximately 15% of projected sales and demand in 2000. Conservation savings are so large that they exceed projected growth in sales and peak demand over the 1991-2000 period. The high conservation savings for Con Edison are due to two related factors: (1) Con Edison has a very high commercial load (67% of total electricity sales), and (2) conservation potential is largest in the commercial sector (Miller et al., 1989). Also contributing is the fact that Con Edison electricity sales are projected to increase at a slightly slower rate over the 1991-2008 period than the State as a whole (1.9% for Con Edison versus 2.0% for the State as a whole according to the NYSEO Reference II forecast -- NYSEO, 1989b).

Due to Con Edison's high commercial load, commercial sector conservation programs (e.g., lighting, HVAC, direct installation, and new construction) figure very prominently in the Con Edison savings mix. The only residential programs with large savings are the lighting programs. Savings from many of the other residential conservation programs are generally small, due to the fact that electric water and space heating saturation rates are low.

Con Edison also has the highest retail rates and the highest revenue losses per kWh saved of the utilities examined. This results in very high benefit-cost ratios from the participant perspective, and very low benefit-cost ratios from the non-participant perspective. For Con Edison, revenue losses due to conservation programs are significant, and mechanisms need to be established to ensure that no class of customer bears a highly disproportionate share of these revenue losses.

For Niagara Mohawk, revenue losses are small and thus should have little impact on the mix of programs offered. Long Island Lighting falls in-between Niagara Mohawk and Con Edison on the revenue loss spectrum.

Long Island Lighting has slightly higher GWh savings than Niagara Mohawk (on a percentage basis), similar winter peak savings, and slightly lower summer peak savings. LILCo's relatively low summer peak savings are due to the fact that the summer peak is reached between 4-5 pm -- after schools and some other commercial buildings begin shutting down. The late peak is likely due to the influence of residential air conditioning. The saturation of room and central air conditioners is higher in LILCo's service territory than in any other service territory in the State. Accordingly, air conditioning accounts for approximately two-thirds of the coincident peak demand in the residential sector (Miller et al., 1989). This indicates that a program directed at residential air conditioning may be a useful complement to the programs examined in this study. New program options in this area should be explored -- for example, the air conditioning maintenance program discussed briefly in Chapter 2. As with Con Edison, the saturation of electric water and space heating is low in the LILCo service territory, so with the exception of residential lighting programs, most of the energy savings are achieved by C&I programs.

F. PUTTING THE SAVINGS INTO PERSPECTIVE

In order to put the savings from the conservation programs examined in this study into perspective, we compared our savings results with analogous data from the long-range resource plans of several electric utilities; including many in New York State. We also compared our estimates of conservation savings from utility conservation programs in New York State with estimates of achievable conservation in New York State as a result of mechanisms other than utility programs.

The role of conservation <u>and load management</u> in the long-range resource plans of 17 major utilities (including six from New York) is summarized in Table 3-10. Many of the utilities featured in this table are known for extensive conservation and load management programs (Geller and Nadel, 1989). Other utilities in this table have recently made a significant commitment to conservation and load management (Schweitzer et al., 1990; Martin Schweitzer, Oak Ridge National Laboratory, personal communication).

As can be seen in the table, a number of utilities are projecting that conservation and load management savings will exceed 8-10% of peak demand in 2000, and/or approximately 15% of peak demand in 2008. Included in this group are Boston Edison, Central Maine Power, Consolidated Edison, Long Island Lighting, New England Electric, Niagara Mohawk, Northeast Utilities, Northern States Power, Orange & Rockland, and Rochester Gas & Electric. Five of the plans examined project GWh savings of 8-15% of projected sales in 2010. Included in this group are three New York utilities - Con Edison, Long Island Lighting, and Rochester Gas & Electric. Con Edison deserves particular mention; alone among the utilities examined, its plan meets the New York State Energy Plan targets for energy and demand reductions, in 2000 and 2008. A closer examination of each plan shows that most utilities are more

Table 3-10

Role of C&LM in the Long-Range Resource Plans of Selected Utilities

			Projected Demand*			Projected C&LM Savings			C&LM Svgs as % of Demand		
Utility	State	Year	GWh	Winter MW	Summer MW	GWh	Winter MW	Summer MW	GWh	Winter MW	Summer MW
Boston Edison	MA	2000	16,214	3,156	3,370	993	358	477	6.1%	11.3%	14.2%
Boston Edison	MA	2008	19,288	3,769	4,056	1,285	430	584	6.7%	11.4%	14.4%
Central Hudson	NY	2000	6547	1095	1130	259	74	86	4.0%	6.8%	7.6%
Central Hudson	NY	2008	7767	1295	1335	370	86	117	4.8%	6.6%	8.8%
Central Maine Power #	ME	2000		2,367			218			9.2%	
Central Maine Power #	ME	2008		2,995			280			9.3%	
Consolidated Edison	NY	2000	44854	7085	10530	3567	577	1326	8.0%	8.1%	12.6%
Consolidated Edison	NY	2008	48255	7485	11130	7122	1123	2509	14.8%	15.0%	22.5%
Long Island Lighting	NY	2000	19452	3709	4596	1712	396	489	8.8%	10.7%	10.6%
Long Island Lighting	NY	2008	21450	4139	5161	2143	521	589	10.0%	12.6%	11.4%
Montana Power	MT	2000	9,216			534			5.8%		
Montana Power	MT	2008	10,153			622			6.1%		
New England Electric	MA+	2000	30,225	5,300	5,594	1,275	582	766	4.2%	11.0%	13.7%
New England Electric	MA+	2008			9,180			1,412			15.4%
Niagara Mohawk	NY	2000	42059	7239	6527	2123	585	628	5.0%	8.1%	9.6%
Niagara Mohawk	NY	2008	45634	7917	7068	2681	722	849	5.9%	9.1%	12.0%
Northeast Utilities	CT+	1999	31,345	6,371	6,588	2,104	591	607	6.7%	9.3%	9.2%
Northeast Utilities	CT+	2008		7,376	7,614		588	715		8.0%	9.4%
Northern States Power	MN+	2000	43,006	7,110	8,982	1,576	732	1,397	3.7%	10.3%	15.6%
Northern States Power	MN+	2008	51,415	8,393	10,665	2,293	1,023	1,847	4.5%	12.2%	17.3%
NW Power Planning Council #	WA/OR+	2010	186,973			16,206			8.7%		
Orange & Rockland	NY	2000	5929	945	1335	204	38	131	3.4%	4.0%	9.8%
Orange & Rockland	NY	2008	7130	1135	1605	258	47	168	3.6%	4.1%	10.5%
Puget Sound Power & Light	WA	2010	16,761			1,752			10.5%		
Rochester Gas & Elec.	NY	2000	8320	1450	1540	610	114	126	7.3%	7.9%	8.2%
Rochester Gas & Elec.	NY	2008	9328	1640	1730	876	180	186	9.4%	11.0%	10.8%
Seattle City Light	WA	2000	10,083			333			3.3%		
Seattle City Light	WA	2010	11,379			561			4.9%		
Union Electric	MI	2000	36,732		7,763			282	0.0%		3.6%
Wisconsin Electric	WI	2000	29,400	4,149	5,149	1,260	215	289	4.3%	5.2%	5.6%

* The term "demand" is used loosely to connote projected GWh use and MW of peak demand in a utility's base case or mid-point forecast. Some utilities include transmission and distribution losses and/or reserve margin allowances in their figures, and others do not. For each individual utility, the same definitions apply to both projected demand and savings. When a range of C&LM savings is given, the midpoint of the range is reported here. To the extent C&LM has occured prior to the base year of the forecast, these C&LM savings are incorporated into the forecast and not into the savings estimates.

\# Long-range plan now being revised.

Source: Long-range resource plans prepared by each utility.

concerned with peak savings than GWh savings. With the possible exception of Con Edison, none of the plans examined included as comprehensive an array of conservation programs as was analyzed in this study. This explains why many of the plans fall far short of the State Energy Plan targets for GWh sales. Thus, this examination of long-range resource plans provides evidence that the State Energy Plan targets for peak savings are reasonable, while the achievement of the GWh savings targets requires a strategy directed at energy savings rather than on-peak reductions.

While the GWh savings estimated in this study for utility conservation programs are substantial (weighted average savings in 2008 of 13.5% of projected electricity sales), the utility programs examined by no means capture all achievable conservation savings. In order to put the utility conservation savings in perspective, we also estimated, on a state-wide basis, the achievable savings in 2008 as a result of market forces, codes and standards.

Estimates were made for three classes of savings. First, savings due to market forces and to initial appliance and ballast efficiency standards were estimated. These savings are generally incorporated into the NYSEO Reference II forecast, and are often incorporated into the forecasts prepared by individual electric utilities. Second, savings due to revised codes and standards were estimated, including updated commercial building codes, and "second tier" (revised) minimum efficiency standards for residential appliances and fluorescent lamp ballasts. Commercial code revisions were recently proposed by the NYSEO (1990a). Updated efficiency standards are now being considered by the U.S. Department of Energy under the provisions of the National Appliance Energy Conservation Act. Third savings from efficiency standards on lamps, luminaires (lighting fixtures), and motors were estimated. These products are not presently covered by efficiency standards, but work on developing standards for these products is presently proceeding in New York, Massachusetts, and at the national level (Nadel, 1990c). Details on each of these analyses are contained in Appendix C.

Savings due to each of these mechanisms are summarized in Table 3-11. As can be seen, savings from market forces and first-tier (initial) efficiency standards are approximately 5% of projected state-wide GWh sales in 2008. Savings from revised codes and standards total approximately 6%, and savings from new standards, are approximately 3% (after excluding overlap with codes and utility conservation programs). When savings from these three mechanisms are added to utility program savings, total savings in 2008 total to 27% of projected 2008 electricity sales. The allocation of these savings among the different conservation mechanisms is illustrated in Figure 3-13. Since savings due to market forces and first-tier efficiency standards are already included in the base forecast, net savings beyond the base forecast amount to approximately 22%.

Looked at another way, the 27% savings achievable through all mechanisms examined in this study amount to nearly 80% of the 34% technical savings potential (from the societal perspective) estimated for New York State in the NYSERDA/ACEEE Phase I study.

G. CONCLUSIONS AND RECOMMENDATIONS

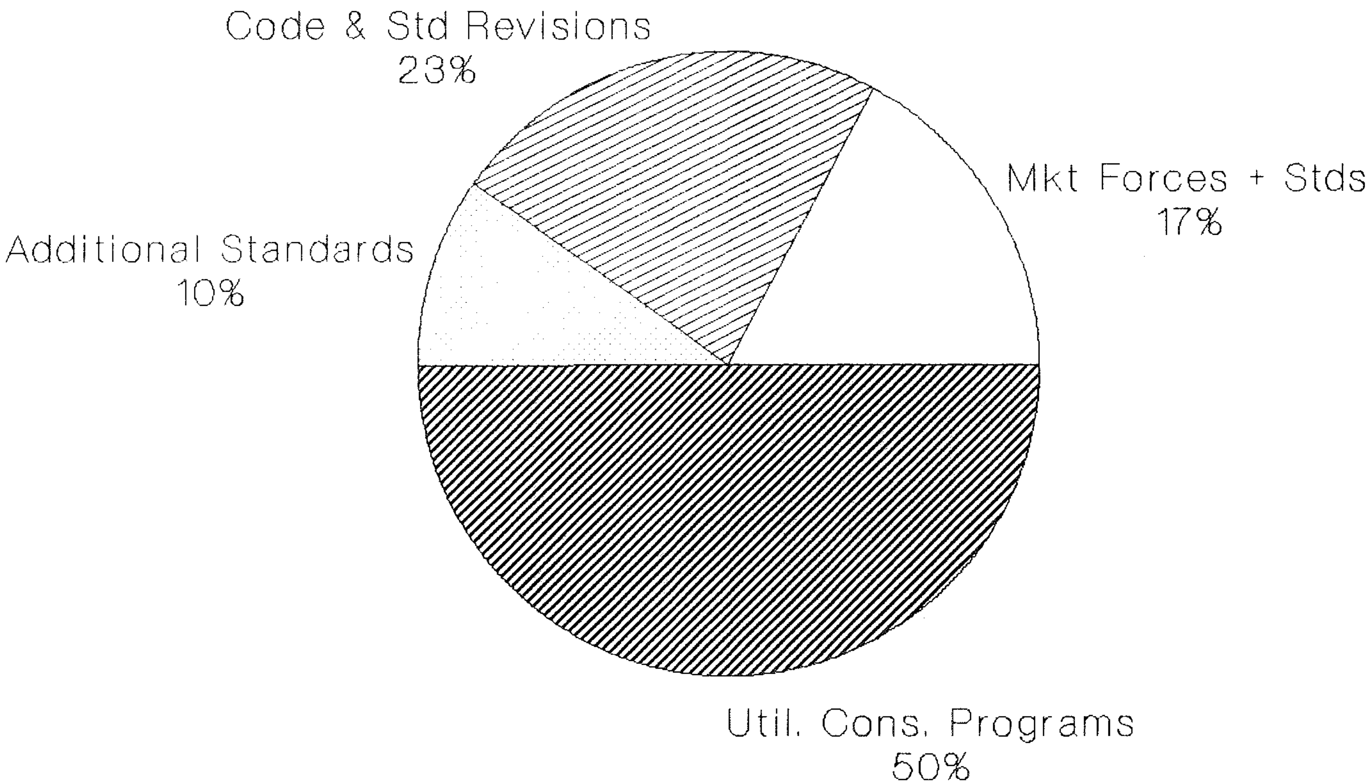
This study examined the achievable conservation potential in New York State from utility conservation programs. Nearly 40 programs (including sub-programs) were analyzed for New York's three largest utilities. This study did not examine other types of utility demand-side management programs such as load management, fuel switching, and self-generation programs. The programs that were examined address most major end-uses and sectors. Program assumptions were generally based on the results of actual conservation programs operated by utilities in the North America. Still, some of the key assumptions underlying the analysis, such as projected participation rates and free rider proportions, are subject to considerable uncertainty. The analysis covered only technologies which are commercially available today, and program approaches which have already been tried. As new technologies and

Table 3-11
Estimated Conservation Savings in New York State Resulting from Market-Forces, Codes, and Standards

	GWh Savings in 2008	% of Projected Sales in 2008
Market forces and first-tier standards: (included in forecast)		
Residential	4,391	2.3%
Commercial	3,929	2.0%
Industrial	621	0.3%
	-----	---
Total - market forces & 1st-tier stds.	8,941	4.6%
Revised codes & standards (for equipment that is currently regulated)		
Refrigerators and freezers	2,655	1.4%
Air conditioners and heat pumps	879	0.5%
Residential water heaters	556	0.3%
Other residential appliances	1,153	0.6%
Lamp ballasts	1,046	0.5%
Commercial building code ammendments - 1991	2,803	1.5%
Commercial building code ammendments - 2001	2,835	1.5%
	------	---
Total - revised codes & standards	11,927	6.2%
New efficiency standards (for regulations now under consideration)		
Lamps	4,420	2.3%
Luminaires (lighting fixtures)	910	0.5%
Motors	1,020	0.5%
Commercial packaged HVAC equipment	140	0.1%
	------	---
Subtotal	6,490	3.4%
Overlap between new stds. & utility programs		
HID standards	-497	-0.3%
Motor standards	-510	-0.3%
Commercial packaged HVAC equip. standards	-88	-0.0%
	------	---
Total - new standards	5,395	2.8%
GRAND TOTAL	26,263	13.6%

Notes:
* Derivation of savings estimates is explained in Appendix C.
* Figures do not include transmission and distribution losses.
* % savings based on projected sales in 2008 of 192,439 GWh (from NYSEO Reference II forecast, adjusted to exclude 10% T&D losses).

Figure 3-13
Distribution of Achievable Conservation Potential in 2008 By Implementation Mechanism



Sources:
Utility savings is weighted average of Con Edison, Long Island Lighting & Niagara Mohawk
Other estimates from Table 3-11

program approaches become available, additional savings can be achieved. Key findings are as follows:

* In 2000, successful pursuit of the conservation programs examined in this study will reduce energy use and peak demand by 9-19% below projected levels. Savings in 2008 relative to projected energy use and peak demand in 2008 are similar. Savings for Niagara Mohawk range from 9-12%, for Con Edison from 14-19%, and for Long Island Lighting from 9-12%. For all utilities, available savings represent over 50% of projected growth in electricity sales and peak demand over the 1991-2000 period. Savings are highest for Con Edison because conservation potential is greatest in the commercial sector, and Con Edison has a very large commercial load.

* In order to obtain savings of this magnitude, a comprehensive array of conservation programs must be pursued aggressively, including programs directed at all major sectors, end-uses, and market types (e.g., retrofit, replacement, and new construction). Furthermore, in order to obtain these savings will require a transition from traditional program approaches (e.g., audits and modest rebates) towards new program approaches (e.g, high rebates and direct installation services).

* All of the programs examined were cost-effective from the utility, participant, total resource, and societal perspectives.[5] Most of the programs had a benefit-cost ratio greater than two. Thus, the conservation potential estimated in this study is not limited by cost-effectiveness, but rather it is limited by the measures promoted and the predicted participation rates.

* For Con Edison (and secondarily for Long Island Lighting) the programs examined will have an impact on rates due to the fact that as electricity sales decrease, fixed costs must be spread over fewer kWh of sales. For program participants (which ultimately will be the vast majority of customers), the benefits of the conservation programs outweigh the rate impacts by a factor of three or more. For program non-participants, Con Edison and Long Island Lighting rates will rise by 9% and 5% respectively (relative to present rates, although rate increases will be less if avoided distribution capacity costs are factored into the calculation). Furthermore, costs to non-participants will be somewhat ameliorated because non-participants will share in the environmental benefits resulting from the programs. However, in order to further address these impacts, we recommend that special efforts

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[5] With the possible exception of the Con Edison Rental Submetering program.

be made to target conservation programs to all customer and end-use segments. In this way, all customers have an opportunity to participate in programs, and the only customers whose electric bills go up are those customers who make a conscious decision not to participate in any programs.

* The New York State Energy Plan recommends that utilities seek to reduce predicted electricity use and demand by 8-10% in 2000 and 15% in 2008 through demand-side management programs. Our research indicates that the 8-10% target is achievable by all three utilities, but that the 15% target can only be reached by Con Edison (assuming no other programs beyond those analyzed in this study). An analysis of long-range resource plans prepared by several utilities indicates that when load management programs are added to the analysis, a 15% reduction in projected winter and summer peak demand should be achievable in 2008. In order to reduce electricity sales in 2008 by 15% will require new technologies (beyond those commercially available today) and/or additional program approaches, such as fuel-switching and self generation.

* While utility conservation programs were the primary subject of this study, in order to put the savings from utility conservation programs in perspective, we also examined likely conservation savings resulting from non-utility mechanisms, including market forces, efficiency standards, and building codes. On a state-wide basis, achievable conservation savings resulting from these other mechanisms are approximately equal to the achievable savings due to utility programs. Of the additional conservation savings available (relative to present energy-use patterns), one-third are due to market forces and existing codes and standards (these savings are generally already included in baseline load forecasts), nearly one-half are due to revisions to existing codes and standards, and one-fifth are due to efficiency standards on products not presently subject to efficiency requirements.

Based on these findings, we make the following recommendations:

* New York utilities should develop demand-side management programs to reach the savings targets specified in the State Energy Plan. The targets appear to be ambitious but achievable. The program designs featured in this study provide many insights into how these programs should be structured, although details need to be worked out by each utility based on its strengths and customer attributes.

* The State of New York should continue to pursue the development of energy-related codes and standards, including:

(1) Finalizing pending amendments to the State energy code;

(2) Periodically reviewing and strengthening the State energy code as warranted by available technologies, their costs and benefits;

(3) Urging the U.S. Department of Energy to pursue all cost-effective savings as specific appliance and ballast efficiency standards come up for revision;

(4) Enacting State-level efficiency standards on new products such as commercial packaged HVAC equipment, lamps, motors, and luminaires.

* New York utilities and New York State agencies presently operating energy conservation programs (NYSEO and New York State) should work together to coordinate their respective programs in order to guard against duplication of effort and to ensure that all cost-effective opportunities for energy efficiency improvements are promoted.

* Additional research is needed to identify the potential savings from other demand-side management program approaches such as load management, cogeneration, and fuel switching (switching from one fuel to another for a particular end use where one fuel offers significant efficiency advantages). Additional research is also needed on likely conservation savings from new technologies now under development.

* While most of the programs analyzed in this study are based on the results of previous programs, program experience in several areas is limited and needs further development. All of the programs analyzed can benefit from some further development, but several program areas are especially worthy of attention due to the large savings at stake and/or the limited experience to date. Programs which fall into this latter category include:

  (1) Programs to promote technologies with very low current market share, such as lighting controls, heat pump water heaters, adjustable-speed drives, and compact fluorescent lamps (in the residential sector).

  (2) Programs directed at HVAC savings other than purchase of new, high-efficiency units, such as programs which promote control, distribution, and sizing improvements.

  (3) Remodeling programs.

  (4) Industrial programs.

(5) C&I refrigeration programs.

* Utility demand-side management efforts are now undergoing rapid development in New York, other states, and even other countries. As additional program results become available, and as information on new technologies becomes available, this analysis should be repeated, in order to improve the estimate of achievable conservation potential, particularly over the long-term (beyond the year 2000).

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Appendix A

Assumptions for Individual Programs

APPENDIX A

ASSUMPTIONS FOR INDIVIDUAL PROGRAMS

This appendix contains a detailed listed on the major assumptions used to model each program, for each of the three utilities. Assumptions for Niagara Mohawk are listed first, followed by Consolidated Edison, and Long Island Lighting. Assumptions for each program are listed on a separate page. Most of the terms used in these charts are self-explanatory. A few require further explanation, as follows:

Program type: Whether the program is primarily aimed at the *retrofit* of working equipment in existing buildings, the *replacement* of worn-out, existing equipment, or incorporating efficiency measures in *new construction*.

Replacement rate: The proportion of customers who replace conservation measures when the original equipment wears out.

Load shape: The load shape used to estimate coincident peak impacts, and to divide kWh savings into different seasons (summer, winter, spring/fall) and times of day (peak, shoulder, off-peak). Maximum demand and peak coincidence factors were derived from these load shapes. These are summarized in Tables A-1, A-2, and A-3.

Number eligible: The total number of customers eligible for a program, including customers who are unlikely to participate, and customers who may have participated in the program in previous years.

Annual growth rate: Growth in number of eligible customers. Specific growth rates for each program, and their derivation are summarized in Table A-4.

Annual participation rate: The proportion of eligible customers who participate on an annual basis. The number of program participants is calculated by multiplying the number of eligible customers for a given year by the participation rate for that year.

Free rider proportion: The proportion of program participants who are free riders (program participants who would have undertaken conservation actions, even if no program were offered).

Staff costs: The number of staff (from detailed charts on each program) times $60,000/year. This salary estimate is based on an informal survey by ACEEE of several utilities, and includes benefits and administrative support costs. Staff costs are assumed to increase with inflation. For simplicity's sake, we used the same staff costs for all three utilities. In actuality, staff costs are likely to be slightly higher downstate and slightly lower upstate. If differences in staff costs were included in the analysis, the impact on our results would be negligible.

Additional Notes:

* All costs are in 1990 dollars.

* The format "10,20,30%-->end" means 10% in the first year of the program, 20% in the second year of the program, and 30% in the third and subsequent years of the program, up to the program end year.

Table A-1

Maximum and Coincident Peak Demand Factors - Niagara Mohawk

Program	Summer			Winter		
	Coin-cidence Factor	Maximum Demand Reduction	Coincident Savings/ Customer	Coin-cidence Factor	Maximum Demand Reduction	Coincident Savings/ Customer
R ENERGY FITNESS LIGHT	0.25	0.08	0.02	1.00	0.14	0.14
R ENERGY FITNESS WTR HTG	0.36	0.15	0.05	0.58	0.19	0.11
R ENERGY FITNESS WEATHZTN	0.00	0.00	0.00	0.94	0.25	0.23
R LIGHT COUPON 91-96	0.25	0.09	0.02	1.00	0.17	0.17
R LIGHT COUPON 97-2003	0.25	0.09	0.02	1.00	0.17	0.17
R WATER HEAT RETROFIT	0.36	0.15	0.05	0.58	0.19	0.11
R HOUSE DOCTOR	1.00	0.01	0.01	0.94	0.42	0.39
R HOME INSULATION	0.00	0.00	0.00	0.56	0.94	0.53
R HIGH EFFICIENCY REFRIG	0.84	0.03	0.03	0.89	0.03	0.02
R WATER HEAT PUMP	0.36	0.52	0.19	0.58	0.68	0.39
R NEW CONSTRUCTION	0.75	0.38	0.29	0.94	1.53	1.44
C LT.REBATE FLUOR. BULBS	0.99	0.24	0.24	0.61	0.24	0.15
C LT.REBATE FLUOR. FIXT.	0.99	0.73	0.73	0.61	0.73	0.44
C LT. REBATE REFLECTORS	0.99	3.74	3.72	0.61	3.74	2.27
C LT. BALLAST REBATE91-95	0.99	0.01	0.01	0.61	0.01	0.01
C LT BALLAST REBATE 95-99	0.99	0.01	0.01	0.61	0.02	0.01
C LT REBATE HID RETROFITS	1.00	0.12	0.12	0.84	0.21	0.18
C LT. REBATE OCC.SENS	1.00	0.81	0.81	1.00	0.81	0.81
C LT. REB.-DAYLIGHT CNTL	1.00	1.38	1.38	0.00	1.61	0.00
C HVAC CHILLER REBATE	0.99	22.18	22.01	1.00	0.51	0.51
C HVAC PKGD SYSTEM REBATE	0.99	1.54	1.53	0.67	0.50	0.34
C REFRIGERATION REBATES	1.00	6.01	6.01	0.98	4.83	4.72
C MOTOR REBATE	0.98	0.28	0.27	0.79	0.26	0.21
C ADJUST.SPEED DR.REBATE	0.98	9.61	9.44	0.79	8.80	6.98
C CUSTOM MEASURE	1.00	15.09	15.09	0.81	14.46	11.66
C AUDIT PROGRAM	1.00	1.08	1.08	0.81	1.03	0.83
C SM.DIRECT INSTALL-GEN'L	0.99	2.25	2.24	0.61	2.25	1.37
C SM.DIRECT INSTL-COMPACT	0.99	0.13	0.13	0.61	0.13	0.08
C SM.DIRECT INSTL-OCC SEN	1.00	0.20	0.20	1.00	0.20	0.20
C MED/LG DIRECT INSTALL.	1.00	20.90	20.90	0.81	20.03	16.15
C RENOVATION -LIGHT 91-94	0.99	0.59	0.59	0.61	0.59	0.36
C RENOVATN-LIGHT 94-2010	0.99	0.51	0.51	0.61	0.51	0.31
C NEW CONSTRCTN 1991-2000	1.00	0.37	0.37	0.80	0.35	0.28
C NEW CONSTRCTN 2001-2010	1.00	0.31	0.31	0.80	0.30	0.24
INDUS NEW CONST/MODERNZTN	0.98	63.00	61.85	0.79	57.72	45.81

DEFINITIONS:

* Maximum Demand Reduction (in kW): The largest reduction for an "average" participant at any time during the peak period of the whole work day (includes allowance for diversity).
* Coincidence Factor: The proportion of the maximum demand reduction which coincides with the system peak.
* Coincident Savings/Customer (kW): The actual savings off system peak per participant, before multiplication by the T&D loss factor. Coincident Savings/ Customer is the product of Maximum Demand Reduction and Coincidence Factor.

Table A-2

Maximum and Coincident Peak Demand Factors - Consolidated Edison

Program	Summer Coin-cidence Factor	Summer Maximum Demand Reduction	Summer Coincident Savings/ Customer	Winter Coin-cidence Factor	Winter Maximum Demand Reduction	Winter Coincident Savings/ Customer
R ENERGY FITNESS LIGHT	0.28	0.08	0.02	0.82	0.14	0.11
R ENERGY FITNESS WTR HTG	0.36	0.20	0.07	0.45	0.19	0.09
R ENERGY FITNESS WEATHZTN	0.00	0.00	0.00	0.86	0.10	0.09
R LIGHT COUPON 91-96	0.25	0.09	0.02	1.00	0.17	0.17
R LIGHT COUPON 97-2003	0.25	0.09	0.02	1.00	0.17	0.17
R WATER HEAT RETROFIT	0.36	0.20	0.07	0.45	0.19	0.09
R HOUSE DOCTOR	0.60	0.03	0.02	0.86	0.18	0.15
R HOME INSULATION	0.00	0.00	0.00	0.86	0.21	0.18
R HIGH EFFICIENCY REFRIG	0.84	0.03	0.03	0.89	0.03	0.03
R WATER HEAT PUMP	0.36	0.71	0.26	0.45	0.67	0.30
R NEW CONSTRUCTION	0.51	0.19	0.10	0.77	0.79	0.61
R COOP/CONDO SUBMETER	1.00	0.36	0.36	1.00	0.16	0.16
R RENTAL SUBMETER	1.00	0.27	0.27	1.00	0.12	0.12
C LT.REBATE FLUOR. BULBS	0.99	0.18	0.18	0.97	0.18	0.17
C LT.REBATE FLUOR. FIXT.	0.99	0.54	0.53	0.97	0.54	0.52
C LT. REBATE REFLECTORS	0.99	3.68	3.64	0.97	3.68	3.57
C LT. BALLAST REBATE91-95	0.98	0.02	0.02	0.97	0.02	0.02
C LT BALLAST REBATE 95-99	0.99	0.01	0.01	0.97	0.01	0.01
C LT REBATE HID RETROFITS	0.99	0.21	0.21	0.97	0.21	0.20
C LT. REBATE OCC.SENS	0.61	0.73	0.45	1.00	0.73	0.73
C LT. REB.-DAYLIGHT CNTL	1.00	1.24	1.24	0.00	1.24	0.00
C HVAC CHILLER REBATE	1.00	20.29	20.29	0.80	2.25	1.81
C HVAC PKGD SYSTEM REBATE	1.00	1.41	1.41	0.61	0.48	0.29
C REFRIGERATION REBATES	1.00	6.01	6.01	0.98	4.83	4.72
C MOTOR REBATE	1.00	0.24	0.24	0.91	0.20	0.18
C ADJUST.SPEED DR.REBATE	1.00	8.20	8.20	0.91	6.79	6.17
C CUSTOM MEASURE	1.00	7.01	7.01	0.80	5.11	4.08
C AUDIT PROGRAM	1.00	1.38	1.38	0.80	1.00	0.80
C SM.DIRECT INSTALL-GEN'L	0.99	2.46	2.43	0.97	2.46	2.38
C SM.DIRECT INSTL-COMPACT	0.99	0.15	0.15	0.97	0.15	0.14
C SM.DIRECT INSTL-OCC SEN	0.61	0.20	0.12	0.99	0.20	0.20
C MED/LG DIRECT INSTALL.	1.00	43.03	43.03	0.799	31.35	25.05
C RENOVATION -LIGHT 91-94	0.99	0.47	0.46	0.97	0.47	0.45
C RENOVATN-LIGHT 94-2010	0.99	0.40	0.40	0.97	0.40	0.39
C NEW CONSTRCTN 1991-2000	1.00	0.37	0.37	0.80	0.27	0.22
C NEW CONSTRCTN 2001-2010	1.00	0.31	0.31	0.80	0.23	0.18
INDUS NEW CONST/MODERNZTN	1.00	19.66	19.66	0.91	16.29	14.82

DEFINITIONS:

* Maximum Demand Reduction (in kW): The largest reduction for an "average" participant at any time during the peak period of the whole work day (includes allowance for diversity).
* Coincidence Factor: The proportion of the maximum demand reduction which coincides with the system peak.
* Coincident Savings/Customer (kW): The actual savings off system peak per participant, before multiplication by the T&D loss factor. Coincident Savings/ Customer is the product of Maximum Demand Reduction and Coincidence Factor.

Table A-3

Maximum and Coincident Peak Demand Factors - Long Island Lighting

Program	Summer			Winter		
	Coin-cidence Factor	Maximum Demand Reduction	Coincident Savings/ Customer	Coin-cidence Factor	Maximum Demand Reduction	Coincident Savings/ Customer
R ENERGY FITNESS LIGHT	0.28	0.06	0.02	1.00	0.14	0.14
R ENERGY FITNESS WTR HTG	0.46	0.20	0.09	0.58	0.17	0.10
R ENERGY FITNESS WEATHZTN	0.00	0.00	0.00	0.94	0.13	0.12
R LIGHT COUPON 91-96	0.25	0.09	0.02	1.00	0.17	0.17
R LIGHT COUPON 97-2003	0.25	0.09	0.02	1.00	0.17	0.17
R WATER HEAT RETROFIT	0.46	0.20	0.09	0.58	0.17	0.10
R HOUSE DOCTOR	0.99	0.07	0.07	0.94	0.22	0.21
R HOME INSULATION	0.00	0.00	0.00	0.94	0.30	0.28
R HIGH EFFICIENCY REFRIG	0.86	0.03	0.03	1.00	0.03	0.03
R WATER HEAT PUMP	0.46	0.71	0.33	0.58	0.61	0.35
R NEW CONSTRUCTION	0.84	0.31	0.26	0.94	0.87	0.82
C LT.REBATE FLUOR. BULBS	0.95	0.14	0.13	0.61	0.14	0.09
C LT.REBATE FLUOR. FIXT.	0.95	0.41	0.39	0.61	0.41	0.25
C LT. REBATE REFLECTORS	0.95	3.45	3.27	0.61	3.45	2.10
C LT. BALLAST REBATE91-95	0.95	0.01	0.01	0.61	0.01	0.01
C LT BALLAST REBATE 95-99	0.95	0.01	0.01	0.61	0.01	0.01
C LT REBATE HID RETROFITS	1.00	0.12	0.12	0.84	0.21	0.18
C LT. REBATE OCC.SENS	0.70	0.75	0.53	1.00	0.75	0.75
C LT. REB.-DAYLIGHT CNTL	0.75	1.28	0.96	0.00	1.28	0.00
C HVAC CHILLER REBATE	0.97	26.62	25.79	1.00	7.99	7.99
C HVAC PKGD SYSTEM REBATE	1.00	1.41	1.41	0.67	0.48	0.32
C REFRIGERATION REBATES	1.00	6.01	6.01	0.98	4.83	4.72
C MOTOR REBATE	0.94	0.22	0.21	0.94	0.20	0.19
C ADJUST.SPEED DR.REBATE	0.94	7.57	7.09	0.94	7.03	6.59
C CUSTOM MEASURE	0.95	8.37	7.95	0.79	8.23	6.50
C AUDIT PROGRAM	0.95	0.93	0.88	0.79	0.91	0.72
C SM.DIRECT INSTALL-GEN'L	0.95	2.25	2.13	0.61	2.25	1.37
C SM.DIRECT INSTL-COMPACT	0.95	0.13	0.12	0.61	0.13	0.08
C SM.DIRECT INSTL-OCC SEN	0.70	0.20	0.14	1.00	0.20	0.20
C MED/LG DIRECT INSTALL.	0.95	18.95	18.00	0.79	18.65	14.73
C RENOVATION -LIGHT 91-94	0.95	0.31	0.29	0.61	0.31	0.19
C RENOVATN-LIGHT 94-2010	0.95	0.26	0.25	0.61	0.26	0.16
C NEW CONSTRCTN 1991-2000	0.95	0.24	0.23	0.79	0.24	0.19
C NEW CONSTRCTN 2001-2010	0.95	0.21	0.20	0.79	0.20	0.16
INDUS NEW CONST/MODERNZTN	0.94	43.25	40.48	0.94	40.17	37.64

DEFINITIONS:

* Maximum Demand Reduction (in kW): The largest reduction for an "average" participant at any time during the peak period of the whole work day (includes allowance for diversity).
* Coincidence Factor: The proportion of the maximum demand reduction which coincides with the system peak.
* Coincident Savings/Customer (kW): The actual savings off system peak per participant, before multiplication by the T&D loss factor. Coincident Savings/ Customer is the product of Maximum Demand Reduction and Coincidence Factor.

Table A-4
Growth Rates by Utility and Program

Program	Annual Growth Rate (%) Niagara Mohawk	Con Edison	LILCo	NOTES (with illustrative calculations for NiMo)
Residential:				
Heat pump & refrigerator	0.66	0.48	1.05	Growth in # res. customers from SEO REF II forecast.
Lighting (Energy Fitness-Ltg & Lighting Coupon)	0.40	0.20	0.80	New construction minus 50% of the participants in New Construction program: (.66% res. growth + .62% res. demolition) * (1 - (40% avg. partic. in new const. program * 50% of partic. who adopt ltg measures)) - .62% demo. rate.
Home insulation	-0.62	-1.04	-0.42	Decline in # existing res. blgs from SEO REF II forecast.
Submetering	--	0.00	--	SEO estimate -- master-metering uncommon in new construction.
All others	0.15	-0.10	0.50	New construction minus 100% of participants in New Construction program: (.66 res. growth + .62 res. demolition) * (1 - 40% avg. partic. in new const. program) - .62 demo. rate.
Commercial & industrial:				
Motor, refrigeration, post-95 ballast, renovation & new construction	1.60	1.20	1.50	Growth in # comm'l customers from SEO REF II forecast.
Chiller & packaged HVAC	2.70	2.70	2.70	Growth in comm'l cooling elec. use from SEO REF II forecast.
Industrial new/modernization	2.30	1.90	3.30	Growth in ind'l use from SEO REF II forecast.
All others	0.80	0.50	0.80	New construction minus 50% of the participants in New Construction program: (1.6% comm'l growth + 2.2% comm'l demolition) * (1 - (40% avg. partic. in new const. program * 50% of partic. who adopt measures)) - 2.2% demo. rate.

Residential Energy Fitness - Lighting (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Based on # of customers that can be effectively served in a year.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent lightbulbs	Compact fluorescents replace standard incandescent lightbulbs and reduce electricity use per lamp by approximately 75%.
Equipment cost	$36.96/household	4 bulbs replaced/household (other utility programs range from 3.4-5.5) * $11/bulb (typical bulk purchase price for 2-piece compact fluorescents) * 84% measure acceptance rate (based on Michigan Energy Fitness experience -- Kushler et al., 1989).
Installation cost	$10.18/household	2 people/HH for 1 hour and 1 lead person for every six teams (Kushler et al., 1989, and Egel, 1986) * $10/hr * 47% of labor costs assigned to lighting portion of program based on the lighting portion of total program electricity savings.
Incremental annual O&M	$0	Compact fluorescent lamps last longer and need to be changed less often, but we assume resident labor is free.
Annual kWh savings/unit	306	4 lamps * 57 watts * 1600 hours * 84% penetration. Based on replacing 75 watt bulbs with 18 watt bulbs which will be used 1600 hours/year (White, 1989). Penetration rate for compact fluorescents based on Michigan experience (Kushler et al., 1989).
Measure life (in years)	6	Based on 10,000 hour life and 1600 hours/year use (White, 1989).
Replacement rate	0%	Bulb replacement will occur thru the Lighting Coupon program.
Load shape	Residential lighting	
PARTICIPATION:		
# eligible in 1991	1,079,075 households	1,348,844 res'l customers * 80% (adjust. for ~20% of homes which are in areas that are too rural to be served cost-effectively).
Annual growth rate	0.4%	Based on NYSEO REF II forecast, but excluding 50% of customers served by Residential New Construction program (under assumption that due to efforts to promote compact fluorescent fixtures thru New Construction program, opportunities for compact fluorescent retrofits will be reduced by 50%). See Table A-4.
Annual participation rate	2, 2.5, 3, 4%=> end	First year rate based on 1st year of similar NEES program. Program to double in size over a three year timespan. On a cumulative basis, program will serve 47.5% of eligible homes (based on participation rates achieved by Michigan and NEES programs in targeted communities -- Nadel, 1990b).
Free rider proportion	10%	Based on Michigan program (Kushler et al., 1989).
UTILITY COSTS:		
Cost/Unit	$47.14/household	Utility pays all equipment and installation costs (see above).
Staff -- number	3.8	Based on 4 full time utility and 4 full time contractor staff * 47% (lighting portion of program costs -- see above). Based on NEES Energy Fitness Program (Obeiter, 1989) times two since this program will be twice as large.

VARIABLE	ASSUMPTION	NOTES
Marketing costs	$3.90/participant	$8.30/participant * 47% (lighting portion of program). Based on NEES experience ($8.30/participant -- New England Electric, 1990b) and Santa Monica Energy Fitness ($6.04/participant -- Egel, 1986).

Residential Energy Fitness - Water Heating (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Based on # of customers that can be effectively served in a year.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Hot water conservation measures	Water heater wraps, pipe wrap, low-flow showerheads, faucet aerators, and reseting the water heater thermostat to 120 degrees F (with customer permission).
Equipment cost	$12.72/household with electric water heat	From attached worksheet.
Installation cost	$30.09/household with electric water heat	2 people/HH for 1 hour and 1 lead person for every six teams (Kushler et al., 1989 & Egel, 1986) * $10/hr * 45% of labor costs assigned to water heating portion of program based on hot water portion of total Energy Fitness electricity savings / 32.4% electric water heat saturation rate (from Miller et al., 1989).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	827	From attached worksheet.
Measure life (in years)	10	ACEEE estimate. Some measures (low-flow showerheads and pipe wrap) will probably last more than 10 yrs on average, while other measures (water heater wraps and thermostat setback) will last less than 10 yrs on average.
Replacement rate	0%	Majority of savings are due to water heater wrap and thermostat setback. When new water heaters are purchased, due to impact of efficiency standards, high insulation levels will be a standard feature. Plumbers unlikely to reset thermostat.
Load shape	Residential water heating	
PARTICIPATION:		
# eligible in 1991	349,620 households	1,348,844 residential customers * 80% (adjustment for estimated 20% of households which live in areas that are too rural to be served cost-effectively) * 32.4% electric water heater saturation rate.
Annual growth rate	0.15%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because hot water retrofit measures will be incorporated into New Construction program).
Annual participation rate	2, 2.5, 3, 4%=> end	First year rate based on 1st year of similar NEES program. Program to double in size over a three year timespan. On a cumulative basis, program will serve 47.5% of eligible homes (based on participation rates achieved by Michigan and NEES programs in targeted communities -- Nadel, 1990b).
Free rider proportion	10%	Based on Michigan program (Kushler et al., 1989).
UTILITY COSTS:		
Cost/Unit	$42.81	Utility pays all equipment and installation costs (see above).

VARIABLE	ASSUMPTION	NOTES
Staff -- number	3.6	Based on 4 full time utility and 4 full time contractor staff * 45% (hot water portion of program costs -- see above). Based on NEES Energy Fitness Program (Obeiter, 1989) times two since this program will be twice as large.
Marketing costs	$11.53/participant	$8.30/participant * 45% (hot water portion of program) / 32.4% (electric water heater saturation rate). Based on NEES experience ($8.30/participant -- New England Electric, 1990b) and Santa Monica Energy Fitness ($6.04/participant -- Egel, 1986).

Energy Fitness Water Heating and Weatherization Measure Costs and Savings - Niagara Mohawk

Water heating:

	#/HH	Cost ea. w/o Install (a)	Cost/HH	Annual kWh Savings (b)	% HH to Receive Measure (c)	Weighted avg kWh Svgs/HH	Weighted Average Cost/HH	Note Number
Water Heater Wrap	1	$10.00	$10.00	460	85%	391	$8.50	1
Pipe Insulation	1	$1.80	$1.80	60	75%	45	$1.35	2
Low Flow Showerhead	1	$2.20	$2.20	250	62%	155	$1.36	3
2nd Low Flow Showerhead	1	$2.20	$2.20	250	15%	38	$0.33	4
Faucet Aerators	3	$0.50	$1.50	96	78%	75	$1.17	5
Thermostat Setbacks	1	$0.00	$0.00	250	50%	125	$0.00	6
			$17.70	1,366		828	$12.71	

a. The Energy Federation Inc. 1989.
b1. Usibelli, 1984.
b2. Work done by Bonneville Power Administration discussed in Solar Age article, November 1985.
b3. Hood River (Brown et al., 1987) and Snohomish County PUD Estimate (Aldrich, personal communication).
b5. Lovins, 1986.
b6. Resetting the water heater thermostat can decrease energy usage by 10% or more. (Meier, 1985). Initial water heating Energy usage (3200 kWh (Miller et al., 1989)) minus (the cummulative average savings due to other water heating measures included in the program (700 kWh) = 2500 kWh. 2500 kWh * 10% = 250 kWh savings due to thermostat setbacks.
c. New England Electric, 1988.
c6. ACEEE Estimate.

Space heating:

	#/HH	Cost ea. w/o Install (a)	Cost/HH	Annual kWh Savings (b)	% HH Who Receive Measure (c)	Weighted Average Cost/HH
Rope Caulk	1	$2.60	$2.60		80.0%	$2.08
Plastic Storm Windows	2	$4.40	$8.80		80.0%	$7.04
Weatherstripping	2	$8.50	$17.00		80.0%	$13.60
Electric Outlet Gaskets	20	$0.05	$1.00		80.0%	$0.80
			$29.40	599		$23.52

a. The Energy Federation Inc., 1989
b. 4.5% of 13,322. Where 4.5% is based on estimates which match those found in (Dunsworth, 1984) and (Massachusetts Audubon Society, 1986). 13,322 kWh/yr is the total electric space heating energy use for Niagara Mohawk (Miller, Eto, and Geller, 1989).
c. ACEEE estimate.

Residential Energy Fitness - Weatherization (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Based on # of customers that can be effectively served in a year.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Infiltration reduction measures	Rope caulk, weatherstripping, plastic storm windows, and outlet gaskets.
Equipment cost	$23.52/household with electric heat	From attached worksheet.
Installation cost	$16.05/household with electric heat	2 people/HH for 1 hour and 1 lead person for every six teams (Kushler et al., 1989 & Egel, 1986) * $10/hr * 8% of labor costs assigned to weatherization portion of program based on space htg portion of total Energy Fitness electricity savings / 10.8% electric space heating saturation rate (Miller et al., 1989).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	599	From attached worksheet.
Measure life (in years)	9	Based on a weighted average of the estimated life of each weatherization measure and the expected savings (Outlet gaskets 1% savings * 20 yrs + Weatherstripping 1.75% savings * 10 years + Caulking and Plastic Storm windows 1.75% savings * 1 year) / 4.5% total savings.
Replacement rate	50%	ACEEE estimate. Note: At time of replacement, equipment costs are increased by 50% to account for the fact that the initial purchase by the utility was at wholesale prices, but the repurchase is by consumers at retail prices.
Load shape	Residential space heating	
PARTICIPATION:		
# eligible in 1991	116,540 households	1,348,844 residential customers * 80% (adjustment for estimated 20% of households which live in areas that are too rural to be served cost-effectively) * 10.8% electric space heating saturation rate.
Annual growth rate	0.15%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because infiltration reduction measures will be incorporated into New Construction program).
Annual participation rate	2, 2.5, 3, 4%=> end	First year rate based on 1st year of similar NEES program. Program to double in size over a three year timespan. On a cumulative basis, program will serve 47.5% of eligible homes (based on participation rates achieved by Michigan and NEES programs in targeted communities -- Nadel, 1990b).
Free rider proportion	10%	Based on Michigan program (Kushler et al., 1989).
UTILITY COSTS:		
Cost/Unit	$39.57	Utility pays all equipment and installation costs (see above).

VARIABLE	ASSUMPTION	NOTES
Staff -- number	0.64	Based on 4 full time utility and 4 full time contractor staff * 8% (weatherization portion of program costs -- see above). Based on NEES Energy Fitness Program (Obeiter, 1989) times two since this program will be twice as large.
Marketing costs	$6.15/participant	$8.30/participant * 8% (weatherization portion of program) / 10.8% (electric space heat saturation rate). Based on NEES experience ($8.30/participant -- New England Electric, 1990b) and Santa Monica Energy Fitness ($6.04/participant -- Egel, 1986).

Residential Lighting Coupon/Catalog (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Program runs as long as Energy Fitness program.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent lightbulbs	Compact fluorescents replace standard incandescent lightbulbs and reduce electricity use per lamp by approximately 75%.
Equipment cost	$52.00/household thru 1996, $42.00/household thereafter.	4 bulbs purchased/household (other utility programs range from 3.4-5.5) * $13/bulb (average of utility bulk-purchase price of $11 (see Energy Fitness - Lighting program) and typical retail cost of $15 (based on Energy Federation, 1989). Beginning in year 7, replacement bulbs dominate the program, and we assume that half the customers will purchase replacement lamps (to go with existing ballasts) at $6 each, and half will purchase lamp/ballast combinations at a retail cost of $15. Thus, costs/household = 4 lamps/household * (6+15)/2 = $42.
Mailing cost	$0.82/household	$1.64 estimated warehousing, processing and mailing costs (estimate from Rockville mailing) * 50% of bulbs that are mailed (as opposed to sold thru stores).
Incremental annual O&M	-$6	Due to longer lifetime of compact fluorescent bulbs, each year two incandescent lamps are saved per socket. Savings/household = 4 compacts * 2 incandescents saved/socket * $.75 avg. incandescent cost.
Annual kWh savings/unit	365	4 bulbs * 57 watts * 1600 hours. Based on replacing 75 watt bulbs with 18 watt bulbs which will be used 1600 hours/year (White, 1989).
Measure life (in years)	6	Based on 10,000 hour life and 1600 hours/year use (White, 1989).
Replacement rate	80% during program, 50% after program ends	ACEEE estimate.
Load shape	Residential lighting	
PARTICIPATION:		
# eligible in 1991	1,348,844 households	From NYSEO REF II forecast.
Annual growth rate	0.4%	Based on NYSEO REF II forecast, but excluding 50% of customers served by Residential New Construction program (under assumption that due to efforts to promote compact fluorescent fixtures thru New Construction program, opportunities for compact fluorescent retrofits will be reduced by 50%).
Annual participation rate	2,4,6,8%-->yr 6. Thereafter 80% of Energy Fitness and Residential Lighting program participants from 6 yrs ago.	Program will reach 36% participation after 6 years. Wisconsin Electric served 7% in 1 year with a similar mail order program. A coupon program in Sweden served ~20% of customers after 2 years (Nadel, 1990b).
Free rider proportion	0% first 6 yrs, 25% thereafter	Due to present lack of product availability, free riders assumed to zero until bulbs need replacement. Beginning in year 7, program emphasizes replacement of burned-out bulbs, and free riders estimated to be 25% (ACEEE estimate).

Residential Lighting Coupon/Catalog (Niagara Mohawk) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Cost/Unit	$40.82/household thru 1996, $39.82 thereafter.	Customers pay $3/bulb and the utility pays remaining costs.
Staff -- number	2	ACEEE estimate.
Marketing costs	$3/participant	Based on Central Maine Power program (Schick et al., 1990).

Residential Water Heating Retrofit (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	Start and end dates coincide with Energy Fitness program since marketing of these programs is closely linked.
End year	2003	
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Hot water conservation measures	Water heater wraps, pipe wrap, low-flow showerheads, faucet aerators, and reseting the water heater thermostat to 120 degrees F (with customer permission).
Equipment cost	$12.72/household with electric water heat	From Residential Energy Fitness worksheet.
Installation cost	$10/household	1 person * 1 hour * $10/hour (ACEEE estimate based on total program costs reported by several utilities).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	827	From Residential Energy Fitness worksheet.
Measure life (in years)	10	ACEEE estimate. Some measures (low-flow showerheads and pipe wrap) will probably last more than 10 yrs on average, while other measures (water heater wraps and thermostat setback) will last less than 10 yrs on average.
Replacement rate	0%	Majority of savings are due to water heater wrap and thermostat setback. When new water heaters are purchased, due to impact of efficiency standards, high insulation levels will be a standard feature. Plumbers unlikely to reset thermostat.
Load shape	Residential water heating	
PARTICIPATION:		
# eligible	Electric water heat households served by Energy Fitness * 1.632	Two types of households are eligible each year: (1) households that were not reached by Energy Fitness when Energy Fitness served their community, and (2) households in nearby rural areas not targeted by Energy Fitness. Since 47.5% of households are served by Energy Fitness, category #1 = Energy Fitness participants * 52.5%/47.5%. Category #2 = Energy Fitness participants * 100%/47.5% * 20% not targeted / 80% targeted.
Annual growth rate in number eligible	0.15%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because hot water retrofit measures will be incorporated into New Construction program).
Annual participation rate	60% of households eligible each year	Based on experience by Seattle City Light and NEES (Nadel, 1990b).
Free rider proportion	12%	ACEEE estimate based on NEES evaluation of their water heater wrap program (New England Electric, 1988) which estimated that 12% of the customers had wrapped their water heaters on their own.
UTILITY COSTS:		
Direct costs/unit	$22.72/household	Utility pays all equipment and installation costs (see above).
Staff -- number	1	Based on NEES Water Heater Wrap program.

VARIABLE	ASSUMPTION	NOTES
Installation contractor administrative costs	$150,000/year	ACEEE estimate for a program of this size based on total program costs of $55/participant reported by Central Maine Power (Central Maine Power, 1989) and BC Hydro (Schick et al., 1990).
Marketing costs	$6.88/participant	From Schick et al., 1990.

House Doctor (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	Start and end dates coincide with Energy Fitness program since marketing of these programs is closely linked.
End year	2003	
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Infiltration reduction measures	Trained crew identifies and seals heat leaks with the aid of a blower door.
Cost/home	$300	Based on experience reported by Proctor & deKieffer (1988). Jacobson et al. (1990) report an average cost of less than $200/house, although their project involved less work per home.
Annual O&M	$0	Little maintenance required.
Annual kWh svgs/unit	1,009/home	7.5% of heating and cooling use. Proctor and deKieffer (1988) report 10.6% average heating savings with an experienced crew and good quality control. Jacobson et al. (1990) estimate 5 - 5.5% savings for a smaller amount of work ($200/home instead of $300/home as estimated here). We choose 7.5% to take into account that (1) some savings have been achieved in some homes through the Energy Fitness program, and (2) training and quality control in a large-scale program will probably not be as good as in the Proctor and deKieffer program. Average heating use of 13,322 kWh/yr and cooling use of 127 kWh/year assumed for NiMo (from Miller et al., 1989).
Measure life (years)	13	From Nadel & Heineman, 1986.
Replacement rate	0%	Measures which fail will be in hard to reach places, and thus, few homeowners are likely to replace failed measures.
Load shape	Residential space heating and cooling	Analyzed savings by end-use (see above) with the appropriate load shape.
PARTICIPATION:		
# eligible in 1991	145,681 households	1,348,900 residential customers (from NYSEO REF II forecast) * 10.8% electric space heating saturation rate.
Annual growth rate	0.15%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because infiltration reduction measures will be incorporated into New Construction program).
Annual participation rate	2,3,4,5%-->end	ACEEE estimate. Program cumulative participation rate totals 59%. Based on Hood River - 85% penetration (Brown et al., 1987), TVA - 62% penetration over 13 years and Central Maine Power - 50% penetration (Schick et al, 1990).
Free rider proportion	10%	Very few customers would use the blower door on their own. 10% free rider estimate captures overlap between House Doctor work and conventional caulking and weatherstripping work that may be done by some homeowners.

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Utility rebate/unit	$283	The utility pays $283, and the customer $17 (see Customer costs/unit).
Staff -- number	1,2,2,3-->end	ACEEE estimate.
Marketing costs (1000's)	$92,$113,$134,$155-->end	$15/house + $50,000. NEES program mktg costs averaged $30/home (Jacobson et at., 1990), but we assume that marketing is needed for only half of the participants because the other half are assumed to be Energy Fitness program referrals.
CUSTOMER COSTS:		
Customer costs/Unit	$17	Each participant (except low income) is charged a $20 fee. This fee is designed to ensure that the customer places value on the work being performed. Because low income participants (assumed to be 15% of the participants) pay nothing, the average customer cost is $20 * (1-15%) = $17.

Home Insulation (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	Start and end dates coincide with Energy Fitness program since marketing of these programs is closely linked.
End year	2003	
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Insulation and other energy-saving capital improvements	Includes attic, wall, and basement insulation, window repairs (and replacements where needed), and attic ventilation improvements.
Total Cost	$620/household	Includes materials, labor & arranging services: ~$520/home for materials and labor (Jacobson et al., 1990), and $100 for arrangi services (Jacobson et al. found these costs averaged $65/insulati contract).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	1,325/household	Based on engineering estimates of energy savings from insulation improvements in NEES weatherization program (Jacobson et al., 1990).
Measure life (in years)	20	From Miller et al., 1989.
Replacement rate	0%	Measures will most likely be replaced during remodeling, which will be subject to building codes, & therefore replacement will occur via another avenue. In addition degradation of insulation is difficult for the homeowner to see, therefore, few customers would know that something had to be corrected, let alone actually do the work.
Load shape	Residential space heating	
PARTICIPATION:		
# eligible in 1991	145,681 households	1,348,900 residential customers (from NYSEO REF II forecast) * 10.8% electric space heating saturation rate.
Annual growth rate	-0.62%	Demolition rate from NYSEO REF II forecast. We assume that new electrically heated homes will not need insulation upgrades.
Annual participation rate	0.7%, 1.05%, 1.40%, 1.75% --> end	Based on House Doctor participation * 35%. 35% assumes that 50% of electrically heated homes need upgrades (based on NEES pilot program experience -- Jacobson et al., 1990) and 70% of those will participate (ACEEE estimate).
Free rider proportion	10%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$434/household	The customer pays 30% ($186) and the utility 70% ($434) of $620. This cost-share has proven very effective in BPA's weatherization program (Schick et al., 1990).
Staff -- number	1,2,2,3--> end	ACEEE estimate.
Marketing costs ($1000's)	$65,$72,$79,$87-->end	$15/house + $50,000. NEES program mktg costs averaged $30/home (Jacobson et at., 1990), but we assume that marketing is needed for only half of the participants because the other half are assumed to be Energy Fitness program referrals.

Residential Refrigerator Rebate Program (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2002	Units of qualifying efficiency mandated in 2003 thru appliance efficiency standards.
Program type	Replacement & new	
TECHNOLOGY:		
Technology description	Very high efficiency refrigerators	Refrigerators meeting level 5 standards recently studied by DOE (1989). Includes vacuum panel insulation which dramatically reduces CFC's.
Incremental purchase cost	$200 until 5% of households reached, $100 thereafter.	DOE (1989) estimates $100 cost to manufacturer. This is doubled for first 5% of the refrigerator stock assuming manufacturers need to recover R&D expenses. Thereafter it is assumed manufacturers cover expenses (thus profit/unit is the same as at present.
Incremental annual O&M	$0	Same as present models.
Annual kWh savings/unit	197	From U.S. DOE, 1989a relative to 1993 efficiency standards.
Measure life	19	From U.S. DOE, 1989a.
Replacement rate	0%	Since qualifying units are assumed to be mandated as of 2003, the program cannot take credit for any replacements.
Load shape	Residential refrigeration	
PARTICIPATION:		
# eligible in 1991	125,325 refrigerators	(1,340,000 residential customers * 1.42 refrig./customer / 19 year avg refrig life) + (1,340,000 customers * 1.28% new construction rate * 1.42 refrig./customer). Life from DOE, 1989. Number refrig/hh from Miller et al., 1989. Remaining figures from NYSEO REFII forecast.
Annual growth rate	0.66%	Growth in # residential customers -- from NYSEO REFII forecast.
Annual participation rate	0,0,1,5,15,30,50,100%-->end	ACEEE estimates. 100% participation from 1998-2002 assumes that this type of program is offered by several utilities, and as a result, qualifying efficiency levels mandated in 1998 -- 5 years sooner than if program were not offered.
Free rider proportion	0%	Without utility-led effort, qualifying units would not be manufactured.
UTILITY COSTS:		
Rebate/unit	100% of incremental cost	Utility pays full incremental cost in order to stimulate manufacturers to produce & consumers to buy qualifying models.
Staff -- number	.25,.25,2.25,3.25,4.25, 4.25,4.25,0-->end	ACEEE estimate -- .25 each year for planning & evaluation; 2-4 staff to promote program (after qualifying models available) and process rebates.
Marketing costs ($1000's)	25,50,200,200,150,100,100, 0-->end.	ACEEE estimate. Assumes heavy marketing as soon as qualifying units available, with reduced marketing after market established.

Residential Heat Pump Water Heater Rebate Program (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Will take a year of effort (1991) to convince local dlrs to stock units.
End year	2010	
Program type	Replacement & new	
TECHNOLOGY:		
Technology description	Heat pump water heaters	Water heaters which use a heat pump to supply heat and not an electric resistance coil.
Incremental purchase cost	$750/unit	From Geller, 1988.
Incremental annual O&M	$0	Units require annual oiling and occaisional vacuuming (Bernie Mittelstaedt, DEC Int'l, personal communication). These are no cost measures which can be done by the homeowner.
Annual kWh savings/unit	2,972	13.99 kWh/day/.945 energy factor of high efficiency standard water heater * 365 days/yr * 55% savings. 13.99*365/EF formula developed by DOE for water heater labeling program. This applies to a family of four and not to the "average" family of approx. 2 people. National efficiency standards require a .88 EF in 1990 (Geller, 1988). We assume here that this rises to approx. .94 when the standards are revised effective 1995. 55% savings from Moore, 1981 based on his review of independent research results.
Measure life	13	13 yr life is standard for conventional water heaters (U.S. DOE, 1982). Heat pump water heaters should have the same life because the weak part of heat pump water heaters is the tank and most heat pump water heater manufacturers purchase tanks from producers of standard water heaters (Bernie Mittelstaedt, DEC Int'l, personal communication).
Replacement rate	50% after program ends.	ACEEE estimate. During program, replacement units are included as program participants.
Load shape	Residential water heating	
PARTICIPATION:		
# eligible in 1991	41,922 water heaters	(1,340,000 residential customers * 32.4% with electric water heaters / 13 year avg life) + (1,340,000 customers * 1.28% new home construction rate * 48.1% with electric water heaters). 32.4% from Miller et al., 1989. Remaining figures from NYSEO REFII forecast.
Annual growth rate	0.66%	Growth in # residential customers -- from NYSEO REFII forecast.
Annual participation rate	1,3,5,7,10,15,20,25,30,35, 40%-->end	ACEEE estimate. Participation in first two years is similar to participation in first two years of a pilot BPA program which combined high rebates and high promotion (Major and Cody, 1987). Participation rates beyond first two years have yet to be demonstrated in actual practice. These rates assume that few 1-person households will purchase heat pump water heaters.
Free rider proportion	0%	Due to high cost of technology without incentives, free riders in the residential sector are assumed to be zero.

Residential Heat Pump Water Heater Rebate Program (Niagara Mohawk) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Rebate/unit	$650/unit	Same rebate as presently paid by Wisconsin Electric.
Staff -- number	3	ACEEE estimate. In early years staff emphasize personal marketing to distributors, plumbers, and builders. In latter years, more effort is devoted to handling rebate requests.
Marketing costs ($1000's)	$50 in planning year, $250,$250,$150,$100-->end	ACEEE estimate. Assumes a major marketing campaign in first few years of program.

Residential New Construction (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Will take a year (1991) to plan program before it can begin.
End year	2010	
Program type	New construction	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed local building code and prevailing construction practices.	
Incremental construction cost	$1,234	From attached worksheet.
Incremental annual O&M	$0	Approximately the same as a conventional house.
Annual kWh savings/unit	2,955/home	From attached worksheet.
Measure life	30+	ACEEE estimate.
Replacement rate	Not applicable	Measure life is greater than the 30 year analysis period.
Load shape	Residential space heating, cooling, water heating, & lighting	Analyzed savings by end-use (from attached worksheet) with the appropriate load shape.
PARTICIPATION:		
# eligible in 1991	8,331 electrically heated homes	From NYSEO REF II forecast. Based on a 0.66% annual growth rate plus a 0.62% replacement rate for existing homes. Also includes a 48.1% saturation rate for electric heat in new homes in the NiMo service territory.
Annual growth rate	0.66%	Growth in # residential customers -- from NYSEO REFII forecast.
Annual participation rate	5,15,25,35,45,50%-->end	ACEEE estimate. Several utilities have achieved participation rates of over 40% with BPA's Super Good Cents program including one utility with a participation rate over 70% (Schick et al., 1990).
Free rider proportion	0%	It is assumed that only a few homes currently meet the program's standards, and these homes are more than compensated for by efficient homes built in the latter years of the program for which builders do not bother to apply for incentives.
UTILITY COSTS:		
Incentive/unit	$921/home	From attached worksheet.
Builder training	$100 in planning year, $100,$50,$25-->end	ACEEE estimate. These figures are similar to those for a similar program planned by New England Electric.
Inspections	$150/home	From Lou Gougoun, Retrotec, personal communication. We assume that 100% of the homes are inspected in the first 2 yrs, 50% in the 3rd yr, 25% in the 4th yr, and 10% thereafter.
Staff -- number	1 in planning year,2,3-->end	ACEEE estimate.
Marketing costs ($1000's)	$100-->end	ACEEE estimate.

Residential New Construction
Worksheet to Calculate Average Costs, Savings and Incentive - Niagara Mohawk

	Single Family	2-4 Family	5 + Family	Weighted Average	Notes
% of new homes	46%	20%	22%	88%	For new homes in NiMo territory from SEO REF II forecast.
Elec. saturation in new homes	38.7%	58.4%	58.4%	48.1%	For new homes in NiMo territory from SEO REF II forecast.
Space heat					
kWh savings due to program	3805	1650	1,246	2,434	For NEES residential new construction program from NEES, 1990. Savings are relative to Mass. building code which is very similar to NY building code. 5+ unit savings prorated from single family home savings based on data for NiMo in Miller et al., 1989.
Water heat					
kWh savings due to program	65	65	65	65	For NEES residential new construction program from NEES, 1990.
Central air conditioning					
kWh savings due to program	258	176	84	183	For NEES residential new construction program from NEES, 1990. Assumes half the floor area is cooled with either central or room A/C. 5+ unit savings prorated from single family home savings based on data for NiMo in Miller et al., 1989.
Lighting					
kWh savings due to program	273	273	273	273	For NEES residential new construction program from NEES, 1990.
Measure costs	$1,600	$1,100	$850	$1,234	Based on program being planned by seven Mass. utilities (Mark Kelley, personal communication). Cost for 5+ unit buildings prorated based on space heat savings relative to 2-4 unit building.
Incentive payments	$1,200	$850	$600	$921	Based on Mass. program (Mark Kelley, personal communication). Mass. program plans to pay incentives for electrically heated single-family homes of $1300 for the first 10 homes a builder builds, and $1000/home thereafter. Incentives for multi-family homes are $900 for first ten homes, and $650 thereafter. In addition, an average incentive of $100/unit for efficient lighting is planned.

NOTE: Weighted averages based on data for NiMo territory as summarized in first two lines of this worksheet.

Lighting Rebate Program - Commercial Compact Fluorescent Bulbs (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Need other program approaches to reach add'l customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent bulbs	Screw-in fluorescent bulbs which can be substituted for incandescent bulbs.
Equipment cost	$9/lamp	Typical price for a medium-sized commercial customer.
Installation cost	$1.33/lamp	From Nadel et al., 1989.
Incremental annual O&M	-$2/lamp	$1.33 installation cost (see above) * 1.5 incandescent lamps not replaced each year (assumes long-life incandescent lamps w/ a 2000 hr life are replaced). Replacement lamp costs are not included because (a) these are highly variable, and (b) compacts are equally likely to save money per socket-yr as to cost money (Nadel et al., 1989).
Annual kWh savings/unit	218/lamp	83 Watts for an avg incandescent lamp (from Xenergy, 1988) * 75% savings * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	3	10,000 hr rated life / 3500 op hrs/yr.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	90,225 customers	83,341 customers in 1986 using >5000 kWh/yr * 1.016^5 (growth during 1986-91 -- from NYSEO REF II forecast).
# lamps/participant	5.7	3216 GWh used for comm'l ltg in NiMo territory in 1986 (from Miller et al., 1989) * 21.5% incandescent share (from Nadel et al., 1989) / 83 avg Watts/lamp (see above) / 3500 avg. annual op hrs/lamp * 80% of fixtures for which replacement is appropriate (from Xenergy, 1989) * 25% of sockets which get compact bulbs, & not fixtures (ACEEE estimate) / 83,341 customers in 1986.
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from compact fluorescent bulbs).
Annual participation rate	2,6,4,4,2,2,1%-->end	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to decline beginning in year 3 due to impact of direct installation programs.
Free rider proportion	5%	Based on New England Electric estimate (Nadel, 1990a).
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	0.65	13 for Lighting Rebate program * 5% compact bulb share of program (ACEEE estimate).
Marketing costs ($1000's)	$5	5% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Commercial Compact Fluorescent Fixtures (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent fixtures	Two-piece compact fluorescent lamps or fixture inserts in which bulb can be replaced w/o replacing ballast.
Equipment cost	$17/lamp	Typical price for a medium-sized commercial customer -- fixture inserts cost more than this amount but two-piece screw-in units cost less.
Installation cost	$1.33/lamp	From Nadel et al., 1989.
Incremental annual O&M	-$2/lamp	$1.33 installation cost (see above) * 1.5 incandescent lamps not replaced each year (assumes long-life incandescent lamps w/ a 2000 hr life are replaced). Replacement lamp costs are not included because (a) these are highly variable, and (b) compacts are equally likely to save money per socket-yr as to cost money (Nadel et al., 1989).
Annual kWh savings/unit	218/lamp	83 Watts for an avg incandescent lamp (from Xenergy, 1988) * 75% savings * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	15	50,000 hr ballast life / 3500 op hrs/yr.
Replacement rate	0%	Units will often be removed at time of building remodeling. Savings accounted for in Commercial Renovation program.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	90,225 customers	83,341 customers in 1986 using >5000 kWh/yr * 1.016^5 (growth during 1986-91 -- from NYSEO REF II forecast).
# fixtures/customer	17.1	3216 GWh used for comm'l ltg in NiMo territory in 1986 (from Miller et al., 1989) * 21.5% incandescent share (from Nadel et al., 1989) / 83 avg Watts/lamp (see above) / 3500 avg. annual op hrs/lamp * 80% of fixtures for which replacement is appropriate (from Xenergy, 1989) * 75% of sockets which get compact fixtures, & not bulbs (ACEEE estimate) / 83,341 customers in 1986.
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from compact fluorescent fixtures).
Annual participation rate	2,6,4,4,2,2,1%-->end	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to decline beginning in year 3 due to impact of direct installation programs.
Free rider proportion	5%	Based on New England Electric estimate (Nadel, 1990a).

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	1.95	13 for Lighting Rebate program * 15% compact fixture share of program (ACEEE estimate).
Marketing costs ($1000's)	$15	15% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Commercial Reflectors (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Reflectors	Reflectors reduce the amount of light trapped in a fixture and thereby allow less lamps to be used per fixture.
Equip. & install. cost	$45/fixture	From Miller et al., 1989.
Incremental annual O&M	-$.67/fixture	Save 2 lamps/fixture * $2/lamp / 6 yr avg lamp life.
Annual kWh savings/unit	280/fixture	160 Watts/fixture * 50% savings * 3500 op hrs/yr. 160 Watts/fixture assumes customers use a 4-lamp fixture with either energy-saving lamps or ballasts. 3500 op hrs from Nadel et al., 1989.
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Measure life ends when fixture is replaced. Savings from fixture replacements accounted for in Commercial Renovation program.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	90,225 customers	83,341 customers in 1986 using >5000 kWh/yr * 1.016^5 (growth during 1986-91 -- from NYSEO REF II forecast).
# fixtures/customer	68.4	702 million sq.ft. of comm'l space in 1988 (from NYSEO REF II forecast) / 80 sq.ft./typical fixture (ACEEE estimate) / 86,029 customers in 1988 (see above) * 67% of fixtures which are appropriate for reflectors (from Miller et al., 1989).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from reflectors).
Annual participation rate	1,3,2,2,1,1,0.5%-->end	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to decline beginning in year 3 due to impact of direct installation programs.
Free rider proportion	15%	Based on New England Electric estimate (Nadel, 1990a).
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	2.6	13 for Lighting Rebate program * 20% reflector share of program (ACEEE estimate).
Marketing costs ($1000's)	$20	20% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Electronic Ballasts & T8 Lamps (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	1994	Assume that revised ballast efficiency standards, which take effect in 1995, will require electronic ballasts or equivalent.
Program type	Replacement	
TECHNOLOGY:		
Technology description	Electronic ballasts & T8 lamps	High frequency ballasts and narrow diameter lamps use less energy than conventional low frequency ballasts and standard diameter lamps.
Equipment cost	$18/ballast	$16/ballast + $1/lamp * 2 lamps/ballast (Miller et al., 1989).
Incremental install. cost	$0	Installation cost same as conventional ballast.
Incremental annual O&M	$0	Avg. O&M cost approximately same as with conventional equipment.
Annual kWh savings/unit	80.5/ballast	23 Watts/ballast (from Sylvania fixture test data & Triad/Utrad catalog data) * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Assume that revised ballast efficiency standards, which take effect in 1995, will require electronic ballasts or equivalent.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	913,179 ballasts	57,863,000 ballasts sold in U.S. in 1988 (from U.S. Census Bureau, 1989a) * 8053/102310 NY share of U.S. C&I employment (from U.S. Census Bureau, 1989d) * 702/3672 NiMo share of NY comm'l floorspace (from Miller et al., 1989) * 1.016^3 (from NYSEO REF II forecast -- used to adjust 1988 sales to 1991).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from electronic ballasts/T8 lamps).
Annual participation rate	5,10,20,40%	ACEEE estimate.
Free rider proportion	5%	Electronic ballasts presently account for less than 2% of U.S. ballast sales (U.S. Census Bureau, 1989a).
UTILITY COSTS:		
Rebate/unit	$16/T8 ballast	ACEEE suggestion based on measure cost.
Staff -- number	2.6	13 for Lighting Rebate program * 20% ballast share of program (ACEEE estimate).
Marketing costs ($1000's)	$20	20% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Post-1995 Ballast Program (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1995	Program begins where first ballast program leaves off.
End year	1999/2012	Program offers rebates through 1999 to accelerate shift in market towards 3- and 4-lamp ballasts. Without program, it will take until 2012 for 3- and 4- lamp ballasts to reach full market share.
Program type	Replacement	
TECHNOLOGY:		
Technology description	3- & 4- lamp electronic ballasts and T8 lamps	3- and 4-lamp ballasts are more efficient than 1- and 2-lamp ballasts which are widely used at present. T8 narrow diameter lamps are more efficient than the standard diameter lamps.
Equipment cost	-$16/ballast	Based on 4 T8 lamps @ incremental cost of $1 each plus $40 cost of 4-lamp ballast minus $60 cost of two 2-lamp ballasts. Costs from manufacturers.
Incremental install. cost	$6.67	No add'l labor costs for 4-lamp fixtures. When two 2-lamp fixtures are wired to the same ballast, add'l labor & mat'l costs approx. $20 (Alden Hathway, Sylvania, personal communication). Assuming these latter cases account for 1/3 of applications, avg. cost is $20/3.
Incremental annual O&M	$1.47/ballast	ACEEE analysis based on data from manufacturers.
Annual kWh savings/unit	59.5/ballast	17 Watts/ballast (avg. for 3- and 4-lamp ballasts based on Sylvania & Lithonia fixture test data) * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Assume these measures are standard practice when initial units need replacement.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1995	424,239 ballasts	913,179 ballasts in 1991 (from pre-1995 ballast program) * 1.008^4 (sales growth from 1991-95) * 60% (because use of 3- and 4-lamp ballasts reduce number of ballasts sold) * 75% (because 25% of ballasts go to new construction, which is served by another program).
Annual growth rate	1.6%	From NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	25,35,45,55,65,60,70,80%->end	ACEEE estimate.
Free rider proportion	15%, growing by 5%/yr until	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$5/T8 ballast	ACEEE suggestion - enough to catch purchaser's attention.
Staff -- number	2 thru 1999	ACEEE estimate.
Marketing costs ($1000's)	$100,$50,$50,$50,$50	ACEEE estimate. Includes start-up marketing campaign.

Lighting Rebate Program - HID Retrofits (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Metal halide & sodium vapor fixtures	Replace incandescent and mercury vapor fixtures with higher efficiency HID fixtures.
Equip. & install. cost	$200/fixture	Based on data from Clarke PUD industrial lighting program (Wolfe and McAllister, 1989).
Incremental annual O&M	$0	O&M costs vary widely depending on lamp life & cost. Typically, mercury vapor lamps have the lowest O&M cost, followed by sodium vapor, metal halide, & incandescent. On average, we assume O&M costs will be unchanged by the retrofit.
Annual kWh savings/unit	1000/fixture	(400 Watt mercury vapor - 150 Watt high pressure sodium) * 4000 op hrs/yr (from White, 1989).
Measure life	15	From Nadel et al., 1989.
Replacement rate	0%	Measure life ends when fixture is replaced. In new construction, use of HID fixtures a common practice.
Load shape	Synethesized load shape	Load shape estimated by blending commercial lighting load shape with limited data on load shape of outdoor lighting.
PARTICIPATION:		
Participation - number fixtures/yr	18672,28012,18672,9336,9336, 4668==>end	Based on results of New England Electric program in first two years (White, 1989; John Eastman, personal communication) adjusted by ratio of NiMo/NEES 1987 C&I sales. Results for years 3-10 are ACEEE estimates and assume that after several years participation drops off from peak levels, and then continues to drop due to the impact of concurrent direct installation program.
Annual growth rate	0%	Assumed to be a stable market because use of high efficiency HID lamps is common in new construction.
Free rider proportion	10%	Based on New England Electric estimate (Nadel, 1990a).
UTILITY COSTS:		
Rebate	$600/kW saved	Approximate rebate paid by New England Electric in 1988 and 1989.
Staff -- number	2.6	13 for Lighting Rebate program * 20% HID share of program (ACEEE estimate).
Marketing costs ($1000's)	$20	20% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Commercial Occupancy Sensors (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Occupancy sensors	Infrared or ultrasonic sensors which turn lights on when someone enters a room and off after they leave the room.
Equip. & install. cost	$0.42/sq.ft.	Avg. of a $65 control for a 125 sq.ft. room and a $115 control for a 350 sq.ft. room (from Miller et al., 1989).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	2.625/sq.ft.	120 Watts/fixture * 50% savings * 3500 op hrs/yr. 120 Watts/fixture assumes half of fixtures were previously fitted with reflectors. Previous use of efficient magnetic ballasts also assumed. 50% savings from Miller et al., 1989.
Measure life	10	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	Load shape modified to increase savings during lunch, early morning, and evening hours and decrease savings at other hours.
PARTICIPATION:		
# eligible in 1991	90,225 customers	83,341 customers in 1986 using >5000 kWh/yr * 1.016^5 (growth during 1986-91 -- from NYSEO REF II forecast).
Suitable sq.ft./customer	1224.4	702 million sq.ft. of comm'l space in 1988 (from NYSEO REF II forecast) / 86,029 customers in 1988 (see above) * 15% of sq.ft. which is suitable for occupancy sensors (from Miller et al., 1989).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from occupancy sensors).
Annual participation rate	1,2,2,2,1,1,1,1,0.5,0.5%	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to level off beginning in year 3 and decline in year 5 due to impact of direct installation programs.
Free rider proportion	5%	ACEEE estimate based on data cited in Nadel, 1990a.
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	1.3	13 for Lighting Rebate program * 10% for occupancy sensor share of program (ACEEE estimate).
Marketing costs ($1000's)	$10	10% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Daylighting Controls (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Daylighting controls	Light sensing controls which dim artificial lights in proportion to the amount of daylight that is available.
Equip. & install. cost	$60/fixture	From Miller et al., 1989.
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	150/fixture	120 Watts/fixture * 50% savings * 2496 op hrs/yr. 120 Watts/fixture assumes half of fixtures were previously fitted with reflectors. Previous use of efficient magnetic ballasts also assumed. 50% savings from Miller et al., 1989. Avg. op hrs/yr assumes that typical fixture operates 6 days/week and that dimming savings are achieved for an avg of 8 daylit hours/day.
Measure life	10	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	Load shape modified to include only savings during daylit hours.
PARTICIPATION:		
# eligible in 1991	90,225 customers	83,341 customers in 1986 using >5000 kWh/yr * 1.016^5 (growth during 1986-91 -- from NYSEO REF II forecast).
Suitable fixtures/customer	25.5	702 million sq.ft. of comm'l space in 1988 (from NYSEO REF II forecast) / 86,029 customers in 1988 (see above) / 80 sq.ft./fixture * 25% of sq.ft. which is suitable for occupancy sensors (from Miller et al., 1989).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from daylighting controls).
Annual participation rate	0.5,1,1.5,2,2,1%-->end	ACEEE estimate based on some of the most successful programs around the U.S. Participation rate stabilizes in year 5 and drops in year 6 due to impact of direct installation programs.
Free rider proportion	5%	ACEEE estimate based on data cited in Nadel, 1990a.
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	1.3	13 for Lighting Rebate program * 10% for occupancy sensor share of program (ACEEE estimate).
Marketing costs ($1000's)	$10	10% of Lighting Rebate program marketing budget (ACEEE estimate).

HVAC Rebate Program - Chillers (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	Replacement	
TECHNOLOGY:		
Technology description	High efficiency chilers	
Incremental equip. cost	$5628/chiller	From attached worksheet.
Incremental install. cost	$0	Installation cost same as conventional chiller.
Incremental annual O&M	$0	Approximately the same as for conventional chillers.
Annual kWh savings/unit	28,290	28.29 peak reduction (from attached worksheet) * 1000 full load op hrs/yr (based on a review of a number of estimates from utilities in similar climate zones).
Measure life	20	From Miller et al., 1989.
Replacement rate	0%	When equipment needs replacement, it is eligible for a rebate again, and hence replacement savings are captured as participants in out years of program.
Load shape	Commercial cooling	
PARTICIPATION:		
# eligible in 1991	230	Based on sales of chillers of 50 hp or more: 12,067 chillers sold in U.S. in 1988 (U.S. Census Bureau, 1989b) * 8.44% NY share (based on commercial employment from U.S. Census Bureau, 1989d) * 19.12% NiMo share (based on comm'l floor area from Miller et al., 1989) * 75% for existing buildings (new building savings accounted for in another program) * 1.45 (to add in rotary chillers to sales estimates -- based on estimates by Jim Block, Enerlogic, personal communication) * 1.027^3 (growth from 1988-91 -- see below).
Annual growth rate	2.7%	Growth rate in cooling energy use from NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	10,30,50,70%-->end	Ramp up over 3 years to 70% participation as achieved by Northern States Power (1988).
Free rider proportion	15%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$4,553/chiller	From attached worksheet. Specific rebate schedule also on attached worksheet. This rebate is split 80% to the customer and 20% to the dealer.
Staff -- number	3	1 central staffperson, 1 technical staff (to work on sizing issues), and 1 field person (ACEEE estimate).
Marketing costs ($1000's)	$61,$62,$64,$50 growing at 2.7%-->end	$200/eligible customer plus material development of $45,000 spread over first 3 yrs (ACEEE estimate).

CHILLER EFFICIENCIES, REBATES, AND SALES BREAKDOWN

Reciprocating/air-cooled: 29% of base sales (average capacity of 100 tons)

	Efficiency target (kW/ton)	Incremental cost ($/ton)	Rebate level ($/ton)	Estimated particpation (% of sales)	Demand reduction efficiency (kW/ton)	Demand reduction sizing (tons)	Unit reduction (kW)	Total reduction (kW)	Unit inc. cost ($)	Total inc. cost ($)	Unit rebate ($)	Total rebate ($)
Sales average	1.27	---	---	9%	---	---	---	---	---	---	---	---
Low rebate	1.20	$29	$23	17%	0.08	10	20	724	2,646	97,606	2,070	76,358
High rebate	1.10	$71	$55	3%	0.19	10	29	177	6,426	39,507	4,950	30,433
SUBTOTAL				29%				901		137,113		106,791

Reciprocating/water-cooled: 11% of base sales (average capacity of 100 tons)

	Efficiency target (kW/ton)	Incremental cost ($/ton)	Rebate level ($/ton)	Estimated particpation (% of sales)	Demand reduction efficiency (kW/ton)	Demand reduction sizing (tons)	Unit reduction (kW)	Total reduction (kW)	Unit inc. cost ($)	Total inc. cost ($)	Unit rebate ($)	Total rebate ($)
Sales average	0.90	---	---	3%	---		---	---	---	---	---	---
Low rebate	0.83	$29	$23	7%	0.08	10	16	223	2,646	37,023	2,070	28,963
High rebate	0.75	$63	$50	1%	0.17	10	23	54	5,670	13,222	4,500	10,494
SUBTOTAL				11%				277		50,245		39,457

Rotary/air-cooled: 14% of base sales (average capacity of 150 tons)

	Efficiency target (kW/ton)	Incremental cost ($/ton)	Rebate level ($/ton)	Estimated particpation (% of sales)	Demand reduction efficiency (kW/ton)	Demand reduction sizing (tons)	Unit reduction (kW)	Total reduction (kW)	Unit inc. cost ($)	Total inc. cost ($)	Unit rebate ($)	Total rebate ($)
Sales average	1.13	---	---	4%	---		---	---	---	---	---	---
Low rebate	1.02	$46	$38	8%	0.12	15	33	593	6,237	111,068	5,130	91,355
High rebate	0.95	$76	$70	1%	0.20	15	42	125	10,206	30,291	9,450	28,048
SUBTOTAL				14%				717		141,360		119,403

Rotary/water-cooled: 17% of base sales (average capacity of 150 tons)

	Efficiency target (kW/ton)	Incremental cost ($/ton)	Rebate level ($/ton)	Estimated particpation (% of sales)	Demand reduction efficiency (kW/ton)	sizing (tons)	Unit reduction (kW)	Total reduction (kW)	Unit inc. cost ($)	Total inc. cost ($)	Unit rebate ($)	Total rebate ($)
Sales average	0.81	---	---	5%	---		---	---	---	---	---	---
Low rebate	0.74	$29	$25	10%	0.08	15	23	488	3,969	85,826	3,375	72,981
High rebate	0.68	$55	$45	2%	0.14	15	30	110	7,371	26,565	6,075	21,894
SUBTOTAL				17%				597		112,391		94,875

Centrifugal/air-cooled: 6% of base sales (average capacity of 200 tons)

	Efficiency target (kW/ton)	Incremental cost ($/ton)	Rebate level ($/ton)	Estimated particpation (% of sales)	Demand reduction efficiency (kW/ton)	sizing (tons)	Unit reduction (kW)	Total reduction (kW)	Unit inc. cost ($)	Total inc. cost ($)	Unit rebate ($)	Total rebate ($)
Sales average	0.98	---	---	2%	---		---	---	---	---	---	---
Low rebate	0.90	$34	$27	4%	0.09	20	35	270	6,048	46,158	4,860	37,092
High rebate	0.85	$55	$45	1%	0.14	20	44	56	9,828	12,501	8,100	10,303
SUBTOTAL				6%				326		58,660		47,395

Centrifugal/water-cooled: 23% of base sales (average capcity of 200 tons)

	Efficiency target (kW/ton)	Incremental cost ($/ton)	Rebate level ($/ton)	Estimated particpation (% of sales)	Demand reduction efficiency (kW/ton)	sizing (tons)	Unit reduction (kW)	Total reduction (kW)	Unit inc. cost ($)	Total inc. cost ($)	Unit rebate ($)	Total rebate ($)
Sales average	0.75	---	---	7%	0.00		---	---	---	---	---	---
Low rebate	0.63	$50	$40	14%	0.13	20	39	1,134	9,072	265,410	7,200	210,643
High rebate	0.56	$80	$65	2%	0.21	20	50	245	14,364	70,039	11,700	57,049
SUBTOTAL				23%				1,379		335,449		267,692
TOTAL				100%				4,198		835,217		675,613
AVERAGE							28.29		5,628		4,553	

Notes:

1. Efficiency targets developed by ACEEE based on current sales revised to account for proposed 1992 NY State standards. Low rebate set at approximately top 20% of sales, high rebate at top 5%. [Block, 1990]
2. Estimated incremental cost of $4.20/(0.01 kW/ton)/ton. [Block, 1990]
3. Rebate levels set at approximately 80% of incremental cost. Rebate should be split approximately 80% to buyer, 20% to dealer. [ACEEE estimate]
4. Estimated penetration of rebates: 30% no rebate, 60% low rebate, 10% high rebate. [ACEEE estimate]
5. Rebated unit is assumed to result in 10% greater savings than minimum required to meet appropriate rebate level. [ACEEE estimate]
6. Re-sizing is assumed to result in average reduction of 10% in chiller capacity. Estimate is 40% of average reduction found possible in [Miller et.al., 1989].
7. Total demand reduction, incremental cost, and rebate calculated as: total annual chiller sales 50 HP x participation x total annual sales x unit reduction, cost, or rebate. Total annual chiller sales greater than 50 HP = 212 units in 1988 [U.S. Census Bureau, 1989b]
8. Breakdown of sales between chiller types ACEEE estimate. [Block, 1990]
9. Base case capacity estimates from [Xenergy, 1988b].
10. Rebate targets and levels should be reviewed with local distributors before being used in an actual program.

HVAC Rebate Program - Packaged Systems (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	Replacement	
TECHNOLOGY:		
Technology description	High efficiency packaged air conditioners and heat pumps.	
Incremental equip. cost	$168/unit	From attached worksheet.
Incremental install. cost	$0	Installation cost same as conventional unit.
Incremental annual O&M	$0	Approximately the same as for conventional units.
Annual kWh savings/unit	1,970 for cooling 1,327 for heating	Cooling savings: 1.97 peak reduction (from attached worksheet) * 1000 full load op hrs/yr (based on a review of a number of estimates from utilities in similar climate zones). Heating savings: 1.97 peak kW * 1500 full load op hrs (estimate by Jim Block, Enerlogic) * 45% (% of new packaged system capacity in heat pumps -- derived from attached spreadsheet).
Measure life	20	From Miller et al., 1989.
Replacement rate	0%	When equipment needs replacement, it is eligible for a rebate again, and hence replacement savings are captured as participants in out years of program.
Load shape	Commercial cooling + heating	Load shapes modified to reduce winter peak impacts to allow for fact that air source heat pumps do not save at time of winter peak but water source heat pumps do save at time of winter peak.
PARTICIPATION:		
# eligible in 1991	4,419	Based on sales of unitary & split system A/C and heat pumps 65 MBtu/hr and greater. 337,088 units sold in U.S. in 1988 (U.S. Census Bureau, 1989b) * 8.44% NY share (based on commercial employment from U.S. Census Bureau, 1989d) * 19.12% NiMo share (based on comm'l floor area from Miller et al., 1989) * 75% for existing buildings (new building savings accounted for in another program) * 1.027^3 (growth from 1988-91 -- see below).
Annual growth rate	2.7%	Growth rate in cooling energy use from NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	10,20,30,50%-->end	Ramp up over 3 years to 50% participation (70% participation achieved by Northern States Power chiller rebate program (Northern States Power, 1988), but we assume participation will be slightly lower for packaged systems because of the much larger quantity of units sold each year).
Free rider proportion	15%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$134	From attached worksheet. Specific rebate schedule also on attached worksheet. This rebate is split 80% to the customer and 20% to the dealer.
Staff -- number	4	1 program manager and 3 technical/field staff (ACEEE estimate).
Marketing costs ($1000's)	$50-->end	ACEEE estimate.

PACKAGED EQUIPMENT EFFICIENCIES, REBATES, AND SALES BREAKDOWN

Packaged A/C = 45% of base sales

	Efficiency target (EER)	Incremental cost ($/ton)	Rebate level ($/ton)	Estimated particpation (% of sales)	Demand reduction efficiency (Change in EER)	Demand reduction sizing (tons)	Unit reduction (kW)	Total reduction (kW)	Unit inc. cost ($)	Total inc. cost ($)	Unit rebate ($)	Total rebate ($)
Sales average	9.00	---	---	23%	---	---	---	---	---	---	---	---
Low rebate	9.50	$15	$12	18%	0.55	1.20	2	1,784	162	118,944	130	95,155
High rebate	10.00	$35	$28	5%	1.10	1.20	3	538	378	69,384	302	55,507
SUBTOTAL				45%				2,322		188,327		150,662

Air-source heat pumps = 20% of base sales

	Efficiency target (EER)	Incremental cost ($/ton)	Rebate level ($/ton)	Estimated particpation (% of sales)	Demand reduction efficiency (Change in EER)	Demand reduction sizing (tons)	Unit reduction (kW)	Total reduction (kW)	Unit inc. cost ($)	Total inc. cost ($)	Unit rebate ($)	Total rebate ($)
Sales average	9.00	---	---	10%	---	---	---	---	---	---	---	---
Low rebate	9.50	$15	$12	8%	0.55	0.80	2	528	108	35,243	86	28,194
High rebate	10.00	$35	$28	2%	1.10	0.80	2	172	252	20,558	202	16,447
SUBTOTAL				20%				701		55,801		44,641

Water-source heat pumps = 35% of base sales

	Efficiency target (EER)	Incremental cost ($/ton)	Rebate level ($/ton)	Estimated particpation (% of sales)	Demand reduction efficiency (Change in EER)	Demand reduction sizing (tons)	Unit reduction (kW)	Total reduction (kW)	Unit inc. cost ($)	Total inc. cost ($)	Unit rebate ($)	Total rebate ($)
Sales average	10.50	---	---	18%	---	---	---	---	---	---	---	---
Low rebate	11.00	$15	$12	14%	0.55	0.80	1	756	108	61,674	86	49,340
High rebate	11.50	$35	$28	3%	1.10	0.80	2	242	252	35,977	202	28,781
SUBTOTAL				35%				998		97,651		78,121
TOTAL				100%				4,020		341,779		273,424
AVERAGE (per participant)							1.97		167.58		134.06	

Notes:

1. Efficiency targets developed by ACEEE based on current sales revised to account for proposed 1992 NY State standards. Low rebate set at approximately top 20% of sales, high rebate at top 5%. [Block, 1990] Actual rebate levels should vary by equipment size.
2. Estimated incremental cost of $15/ton and $35/ton to meet low and high rebate levels, respectively. [Block, 1990]
3. Rebate levels set at approximately 80% of incremental cost. Rebate should be split approximately 80% to buyer, 20% to dealer.
4. Estimated penetration of rebates: 50% no rebate, 40% low rebate, 10% high rebate. [ACEEE estimate]
5. Rebated unit is assumed to result in 10% greater savings than minimum required to meet appropriate rebate level. [ACEEE estimate]
6. Re-sizing is assumed to result in average reduction of 10% in chiller capacity. Estimate is 40% of average reduction found possible in [Miller et.al., 1989].
7. Total demand reduction, incremental cost, and rebate based on estimate of total sales of unitary and split system A/C and heat pumps 65 kBtu/hr and greater in NMPC service territory in 1988. For calculation details see program spreadsheet. Total annual packaged A/C and heat pump sales greater than 65 kBtu/hr and greater = 4,080 units in 1988 [U.S. Bureau of the Census, 1989b].
8. Estimated average capacity of unitary and split system A/C equipment greater than 65 kBtu/hr is 12 tons. [U.S. Bureau of the Census, 1989b]
9. Estimated average capacity of heat pump equipment is 8 tons. [Xenergy, 1988, p. 4-25]

Commercial Refrigeration Efficency Program (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	Replacement	
TECHNOLOGY:		
Technology description	Multiple technologies	Listed on attached worksheet.
Equip. & install. cost	Average of $16,516	From attached worksheet.
Incremental annual O&M	$0	Approximately the same as for conventional chillers.
Annual kWh savings/unit	42,579	From attached worksheet.
Measure life	10	From Gordon et al., 1988.
Replacement rate	0%	When equipment needs replacement, it is eligible for a rebate again, and hence replacement savings are captured as participants in out years of program.
Load shape	Commercial refrigeration	
PARTICIPATION:		
# eligible in 1991	1,489	Based on annual sales of refrigeration compressors of 15 hp or more: 117,347 units sold in U.S. in 1988 (U.S. Census Bureau, 1989b) * 8.44% NY share (based on commercial employment from U.S. Census Bureau, 1989d) * 19.12% NiMo share (based on comm'l floor area from Miller et al., 1989) * 75% for existing buildings (new building savings accounted for in another program) * 1.016^3 (growth from 1988-91 -- see below).
Annual growth rate	1.6%	Growth rate in commercial floor area from NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	10,35,70%-->end	Ramp up over 3 years to 70% participation as was achieved by Northern States Power chiller rebate program (Northern States Power, 1988).
Free rider proportion	20%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	70% of measure cost	Incentive needed to make measure payback attractive to customers.
Staff -- number	3	1 program manager and 2 technical/field staff (ACEEE estimate).
Marketing costs ($1000's)	$50-->end	ACEEE estimate.

Commercial Refrigeration Efficiency Program

Retrofit measure	Penetration (%/yr)	Number customers adopting	Unit peak savings (kW)	Total peak savings (kW)	Unit energy savings (kWh/yr)	Total energy savings (MWh/yr)	Unit eqpt. cost ($)	Total eqpt. cost ($000)	Unit incentive ($)	Total incentive ($000)
Oversized evaporative condensor	40%	568	3.37	1,917	29,203	16,587	$13,146	$7,467	$9,202	$5,227
Anti-condensate heater controls	60%	852	1.59	1,355	7,314	6,232	$2,100	$1,789	$1,470	$1,252
Refrigerated case covers	25%	355	2.25	799	6,375	2,263	$3,250	$1,154	$2,275	$808
External liquid-suction heat exchange for low & very-low temperature refrigeration	40%	568	0.73	417	6,148	3,492	$2,524	$1,433	$1,767	$1,003
High efficiency compressors	10%	142	1.23	174	10,647	1,512	$15,443	$2,193	$10,810	$1,535
High eff. multiplex compressors	10%	142	0.85	120	7,433	1,055	$8,663	$1,230	$6,064	$861
Variable speed compressors	30%	426	0.00	0	26,250	11,183	$2,700	$1,150	$1,890	$805
Total	70%	994		4,782		42,324		$16,416		$11,492
Average			4.81		42,579		$16,516		$11,561	

Notes:

1. Penetration estimates indicate level of saturation of each measure. Measure implementation will overlap, resulting in adoption of at least one measure by 70% of potential customers. [ACEEE estimate]
2. Number customers adopting is the penetration multiplied by the total annual sales of refrigeration compressors for replacement market in NY state. Annual sales calculated from weighted national sales data. Weighting factors are: NY State accounts for 8.44% of U.S. commercial sector employment [U.S. Bureau of the Census, 1989d], NMPC accounts for 19.12% of NY commercial floorspace [Miller et.al., 1989], total U.S. sales of refrigeration compressors 15 HP and greater is 117,347 units in 1988. [U.S. Bureau of the Census, 1989b]. ACEEE estimates that 75% of annual sales are for the replacement market. Thus: 117,347 x 8.44% x 19.12% x 75% = 1,420 units.
3. Average compressor capacity is 30 HP [U.S. Bureau of the Census, 1989b].
4. Measure costs and savings from draft study of supermarket refrigeration systems in Massachusetts prepared for New England Electric System. All measure costs and savings adjusted to 30 HP baseline unit.
5. Incentive payments uniformly set at 50% of incremental equipment costs.

Motor Rebate Program (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2005	Program is operated for a 15 year period -- equivalent to the average life of a motor.
Program type	Replacement	
TECHNOLOGY:		
Technology description	High efficiency motors	Most major manufacturers produce two major lines of motors -- a standard line and a high efficiency line. This program promotes use of the high efficiency line when existing motors burn out.
Incremental equip. cost	$251/motor	From attached worksheet.
Incremental install. cost	$0	Installation cost same as conventional motor.
Incremental annual O&M	$0	Approximately the same as for conventional motors.
Annual kWh savings/unit	1,585/motor	1472 kWh/motor from attached worksheet, plus 113 additional savings from reduced oversizing. Lovins et. al. (1989) estimate that available energy savings from correcting oversizing problems amounts of 23% of the energy savings available from high efficiency motors. We assume that as a result of motor audits and other educational efforts, 1/3 of oversizing problems are corrected for motors rebated thru this program (1472*23%/3=113).
Measure life	15	From Gordon et al., 1988.
Replacement rate	50%	ACEEE estimate.
Load shape	Total industrial	Motors primarily used for general industrial and comm'l ventilation. Comm'l ventilation load shape very similar to total ind'l load shape.
PARTICIPATION:		
# eligible in 1991	34,753	44,182 in 1988 (from attached worksheet) * 75% (based on estimate that 25% of motors are for new construction and 75% for existing buildings) * 1.016^3 (growth in sales from 1988-91).
Annual growth rate	1.6%	From NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	5,15,30,50%-->end	First two years are based on BC Hydro experience (Kristin Schwartz, personal communication). Remaining years are ACEEE estimates.
Free rider proportion	50,30,20,16% growing by 1%/yr thru 2005	Wisconsin Electric estimates 50% free riders in first year, 30% in second (Wisconsin Electric, 1988). Other utilities have made similar estimates (Nadel, 1990a). Fourth year estimate based on current sales shares of high efficiency motors for new motors (20% in 1988, rising ~2%/yr according to NEMA and DOE data) and rewound motors (near zero). We assume that new and rewound motors each account for 50% of the rebates, and therefore the free rider pct. equals 50% of the sales share of efficient motors among new motor purchases (e.g., for 1994: (20%+(6 yrs since 1988 * 2%)) /2) = 16.

Motor Rebate Program (Niagara Mohawk) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Rebate/unit	$163/motor to customer $16/motor to dealer	Customer rebate from attached spreadsheet. Dealer rebate is 10% of customer rebate.
Staff -- number	4	1 central staffperson plus 3 field staff to do motor audits & inspections (ACEEE estimate).
Marketing costs ($1000's)	$100,$100,$50,$50,$20-->end	BC Hydro (a much larger company) spend $111,000 in 1st yr for indirect costs (Nadel, 1990a). Remaining years are ACEEE estimates.

SUPPORTING DATA FOR MOTOR REBATE PROGRAM - NIAGARA MOHAWK

Motor Horse-power	Annual Sales U.S.(1)	NY (2)	NiMo (3)	Sales for Which High Effic. Model Avail. (4)	Avg. Motor Size (5)	Average Annual Op. Hrs (6)	Avg Effic. (7) Std.	High Eff	Percent Savings (8)	Avg kW Savings Per Motor (9)	Avg kWh Savings Per Motor (10)	Motor Costs (11) Std.	High Eff	Rewind	Incre-mental Cost (12)	Annual User Savings (13)	Rebate (14)
1-5	1,154,483	91,204	34,384	27,507	1.34	2,352	71.39	82.75	13.7%	0.14	339	$149	$190	$120	$42	$20	$21
6-20	470,211	37,147	14,004	11,203	8.61	2,928	82.81	90.45	8.4%	0.49	1,439	$308	$391	$190	$201	$86	$114
21-50	144,658	11,428	4,308	3,447	25.9	3,568	87.47	93.15	6.1%	1.01	3,608	$730	$909	$335	$574	$216	$358
51-125	70,298	5,554	2,094	1,675	80.6	4,163	89.62	94.95	5.6%	2.82	11,757	$2,287	$2,792	$700	$2,092	$705	$1,386
126-200	14,661	1,158	437	349	195	4,163	91.63	95.75	4.3%	5.12	21,329	$5,656	$7,505	$1,100	$6,405	$1,280	$5,125
Total	1,854,311	146,491	55,227	44,182													
Wtd Avg					9.64					0.44	1,472	$359	$454	$184	$251	$88	$163

Notes:

1. From U.S. Census Bureau, Current Industrial Reports, Motors and Generators, 1988.
2. 7.9% of national sales, based on New York proportion of U.S non-agricultural employment. Employment data from U.S. Census Bureau, Statistical Abstract of the U.S. - 1989.
3. 37.7% of NY sales based on industrial electricity use by motors and 45% of commercial electricity use (from Miller et al., 1989, pp. 28, 30, 73-4). 45% is proportion of comm'l use due to motors (Lovins et al., 1989, p. 28).
4. Assuming approximately 20% of motors cannot be replaced with high efficiency motors (ACEEE estimate based on data from several field surveys).
5. From Miller et al., 1989, p. 32.
6. Average of values estimated by the Arthur D. Little in 1980 and by Xenergy (for Wisconsin Electric industrial customers) in 1989. Values from R.I. study of commercial and industrial motors are even higher.
7. Average nominal efficiency for motor nearest in size to average motor size. Based on average nominal efficiency for 1800 rpm ODP and TEFC motors produced by six major manufacturers. Avg. efficiency multiplied by .98 based on estimates that half the rebates displace rewound motors, and these rewound motors have an average efficiency ~4% lower than new standard motors due to the fact that standard motors have (1) improved in efficiency ~1.8% in last ten years, and (2) rewinding has reduced motor efficiency by 1.8-3.4 percentage points (from Lovins et al., 1989, pp. 83, 397).
8. (Efficient motor efficiency - Std motor efficiency)/Efficient motor efficiency
9. Motor Hp * .746 kW/Hp * .75 avg. load * (1/std eff) * Pct. savings.
10. kW savings * Operating hours.
11. Average cost difference for motor nearest in size to average motor. Based on 1800 rpm TEFC and ODP motors produced by 6 major manufacturers. Costs based on suggested list prices minus a 33% discount (Based on info in Stout and Gilmore, 1989). Rewind costs from Seton, Johnson and Odell, 1987, p. 39.
12. For 1-5 hp class, difference between std. and high efficiency motor cost. For other classes, difference between high efficiency motor cost and rewind cost.
13. Average kWh savings * $.06/kWh.
14. Incremental cost minus value of one year's savings to user.

Adjustable Speed Drive Rebate Program (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2005	Same as Motor Rebate program.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Adjustable speed drive	Electronic control which can continuously vary motor speed to match the load. When motor operates at less than full speed, energy is saved.
Equip. & install. cost	$24,986	From Miller et al., 1989 -- assumes an avg. motor size of 81 hp.
Change in equip. cost	-2%/year	Based on ACEEE analysis which found that over 1986-90 period, price declined by 4-5%/year.
Incremental annual O&M	$0	Drive requires maintenance but due to soft-start capabilities, drive can reduce motor maintenance costs. These two factors are assumed to balance each other out (a conservative assumption).
Annual kWh savings/unit	54,610	From Miller et al., 1989.
Measure life	15	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Total industrial	Motors primarily used for general industrial and comm'l ventilation. Comm'l ventilation load shape very similar to total ind'l load shape.
PARTICIPATION:		
# eligible in 1991	20,677	2606 GWh savings potential from ASDs in 1986 (from Miller et al., 1989) * 40% (approximate % of C&I motors which represent good applications for ASDs) / 54,610 kWh avg. savings/ASD (see above) * 1.016^5 (growth from 1986-91).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l ASD applications).
Annual participation rate	0.5,1,2,3-->end	First year similar to NEES estimate for first full year of its program. Remaining years ACEEE estimates.
Free rider proportion	10%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	80% for first 5 years, 60% thereafter	Initial rebate designed to help establish ASD market. Thereafter, a smaller rebate should be sufficient.
Staff -- number	3	Based on current BC Hydro staffing for promotion of ASDs.
Marketing costs ($1000's)	$100,$50-->end	ACEEE estimate -- includes initial education/promotion campaign.

C&I Custom Measure Program (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Any reasonable efficiency measure proposed by a customer.	
Equip. & install. cost	$18,670	$9335 avg. rebate paid by Wisconsin Electric (WEPCo) in first 21 months of program (Clippert, 1989) * 200% (assuming WEPCo rebate on avg. pays 50% of measure costs). Note: Avg. kWh/C&I customer nearly identical for WEPCo and NiMo.
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	82,300	Based on avg. project in first 21 months of WEPCo program (Clippert, 1989).
Measure life	10	Average for a wide array of measures (from Nadel, 1990a).
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	148,540	146,201 C&I customers in 1990 (from NiMo data submission) * 1.016 (growth from 1990-91 -- from NYSEO REF II forecast). Many small C&I customers will not participate in this program but are included here because available data on participation rates are based on all C&I customers, including small customers.
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l custom applications).
Annual participation rate	0.3,0.5,0.5,0.3-->end	Based on WEPCo experience for measures not encouraged thru other programs examined in this study. Participation rate reduced in year 4 to account for impact of direct installation programs on demand for custom rebates.
Free rider proportion	30%	From Wisconsin Electric, 1989.
UTILITY COSTS:		
Rebate/unit	50% of measure cost	Based on WEPCo and other custom measure programs.
Staff -- number	5,9,9,6-->end	Assumes 1 staffperson per 100 applications to review applications, conduct inspections and provide TA. Also includes a full-time program manager.
Marketing costs ($1000's)	$100-->end	ACEEE estimate.

C&I Audit Program (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	1996	Program operates until direct installation programs have fully ramped up.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Audits encourage O&M and other rapid-payback measures. Small customers get a walk-thru audit, medium customers a basic computerized audit, and large customers an enhanced audit.	
Equip. & install. cost	$411	Derived from avg. savings/customer (see below) assuming that the average measure has a 1 year payback at a retail rate of $.07/kWh. PG&E found that the avg. measure implemented after an audit had a simple payback of approx. 0.9 years (Kowalczyk, 1983).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	5,866	117,313 avg. pre-program electricity use by eligible customers (derived from Flaim, 1990) * 5% savings (typical savings -- net of a control group of non-participants -- for programs without extensive financial incentives as reported in Nadel, 1990a).
Measure life	5	From Nadel, 1990a.
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	90,225	83,341 customers in 1986 using >5000 kWh/yr * 1.016^5 (growth during 1986-91 -- from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l low-cost measures opportunities).
Annual participation rate	3,6,8%-->end	Based on Southern California Edison experience (from Nadel, 1990a).
Free rider proportion	0%	Savings are net savings which have already been adjusted for impact of free riders.
UTILITY COSTS:		
Audit cost	$450/audit	Weighted average assuming 67% of customers get walk-thru audit @ $200, 25% get basic computerized audit @ $600, and 8% get enhanced @ $2000 (based on data in Xenergy, 1990).
Audit follow-up cost	$150/annual visit to a customer	Assumed to be 33% of the cost of a full audit (based on 1/2 day/follow-up including office and field work). Customers receive follow-up visits for 3 yrs. after the initial audit.
Staff -- number	2,3,4,4,4,4,2,2,2	ACEEE estimate for central office administration and field staff supervision. Field staff included in audit cost.
Marketing costs ($1000's)	$100,$200,$250-->1996	ACEEE estimate. Based roughly on projected NYSEG marketing costs (NYSEG, 1989), scaled up to size of this program.

Small C&I Lighting Direct Installation - Reflectors, Ballasts, HID Upgrades, & Compact Fluor. Fixtures (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Program will require a year of planning (1991) before beginning.
End year	2002	Time needed to serve all eligible customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description		See Lighting Rebate program for description of technologies.
Equipment cost	$2,325/customer	Based on New England Electric (NEES) Small C&I program (Obeiter, 1989). Costs and savings are reduced by 15% based on ACEEE analysis which indicates that avg NiMo small C&I customer is only 85% the size of the typical customer assumed by NEES.
Installation cost	$875/customer	
Incremental annual O&M	-$47/customer	For compacts: 18 bulbs/customer (assuming 75% of compacts noted in Obeiter, 1989, are fixtures & not bulbs) * 1.5 incandescents displaced/yr * $1.33 labor costs to replace a bulb * .85 NiMo/NEES scaling factor (see above). 1.5 and $1.33 are from Compact Fluorescent Rebate program. For reflectors: $234 4' & 8' lamp costs (from Obeiter, 1989) * 67% suitable for reflectors (from Miller et al., 1989) * 50% less lamps used / 6 yr avg. lamp life * 1.5 retail/wholesale mark-up (lamp price based on wholesale price to utility, not retail price to customer) * .85 NiMo/NEES scaling factor (see above).
Annual kWh savings/unit	11,486/customer	Based on NEES estimates from Pastuszek, 1990. These estimates are reduced by 15% (see above).
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Measures are replaced when lighting system renovated. At this time building will be handled by Commercial Renovation program.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	83,584 customers	77,207 customers in 1986 using 5-250 MWh/yr (from Flaim, 1990) * 1.016^5 (growth during 1986-91 - from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from Small C&I program).
Annual participation rate	2,5,7%-->end	First two years based on NEES Small C&I program plans. Subsequent yrs based on a steady rate of ~5000/yr until 70% of buinesses are reached. 70% based on SMUD and NEES experience as described in Nadel, 1990a.
Free rider proportion	12%	Based on NEES estimate (Nadel, 1988).
UTILITY COSTS:		
Incentive	100% of measure cost	
Staff -- number	1 in planning yr,9,9,11-->end. For entire program, of which reflectors, etc. allocated 89%.	Based on NEES experience. Share allocated to program components based on energy savings.

Small C&I Lighting Direct Installation - Reflectors, Ballasts, HID Upgrades, & Compact Fluor. Fixtures (Niagara Mohawk) CONTINUED

VARIABLE	ASSUMPTION	NOTES
Marketing costs ($1000's)	$225,$325-->end. For entire program, of which reflectors, etc. allocated 89%.	Based on NEES estimates in Obeiter, 1989. Share allocated to program components based on energy savings.

Small C&I Lighting Direct Installation - Compact Fluorescent Bulbs (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Program will require a year of planning (1991) before beginning.
End year	2002	Time needed to serve all eligible customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent bulbs	Screw-in fluorescent bulbs which can be substituted for incandescent bulbs.
Equipment cost	$69/customer	Based on New England Electric (NEES) Small C&I program (Obeiter, 1989). Costs and savings are reduced by 15% based on ACEEE analysis which indicates that avg NiMo small C&I customer is only 85% the size of the typical customer assumed by NEES.
Installation cost	$3/customer	
Incremental annual O&M	-$10/customer	6 bulbs/customer (assuming 25% of compacts noted in Obeiter, 1989, are bulbs & not fixtures) * 1.5 incandescents displaced/yr * $1.33 labor costs to replace a bulb * .85 NiMo/NEES scaling factor (see above). 1.5 and $1.33 are from Compact Fluorescent Rebate program.
Annual kWh savings/unit	679/customer	Based on NEES estimates from Pastuszek, 1990. These estimates are reduced by 15% (see above).
Measure life	3	10,000 hr rated life / 3500 op hrs/yr.
Replacement rate	0%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	83,584 customers	77,207 customers in 1986 using 5,000-250,000 kWh/yr (from Flaim, 1990) * 1.016^5 (growth during 1986-91 -- from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from Small C&I program).
Annual participation rate	2,5,7%-->end	First two years based on NEES Small C&I program plans. Subsequent yrs based on a steady rate of ~5000/yr until 70% of buinesses are reached. 70% based on SMUD and NEES experience as described in Nadel, 1990a.
Free rider proportion	12%	Based on NEES estimate (Nadel, 1988).
UTILITY COSTS:		
Incentive	100% of measure cost	
Staff -- number	1 in planning yr,9,9,11-->end. For entire program, of which compact bulbs allocated 5%.	Based on NEES experience. Share allocated to program components based on energy savings.
Marketing costs ($1000's)	$225,$325-->end. For entire program, of which compact bulbs allocated 5%.	Based on NEES estimates in Obeiter, 1989. Share allocated to program components based on energy savings.

Small C&I Lighting Direct Installation - Occupancy Sensors (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Program will require a year of planning (1991) before beginning.
End year	2002	Time needed to serve all eligible customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Occupancy sensors	Infrared or ultrasonic sensors which turn lights on when someone enters a room and off after they leave the room.
Equipment cost	$69/customer	Based on New England Electric (NEES) Small C&I program (Obeiter, 1989). Costs and savings are reduced by 15% based on ACEEE analysis which indicates that avg NiMo small C&I customer is approx. 85% the size of the typical customer assumed by NEES.
Installation cost	$69/customer	
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	777/customer	Based on NEES estimates from Pastuszek, 1990. These estimates are reduced by 15% (see above).
Measure life	10	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	83,584 customers	77,207 customers in 1986 using 5,000-250,000 kWh/yr (from Flaim, 1990) * 1.016^5 (growth during 1986-91 -- from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from Small C&I program).
Annual participation rate	2,5,7%-->end	First two years based on NEES Small C&I program plans. Subsequent yrs based on a steady rate of ~5000/yr until 70% of buinesses are reached. 70% based on SMUD and NEES experience as described in Nadel, 1990a.
Free rider proportion	12%	Based on NEES estimate (Nadel, 1988).
UTILITY COSTS:		
Incentive	100% of measure cost	
Staff -- number	1 in planning yr,9,9,11-->end. For entire program, of which occupancy sensors allocated 6%.	Based on NEES experience. Share allocated to program components based on energy savings.
Marketing costs ($1000's)	$225,$325-->end. For entire program, of which occupancy sensors allocated 6%.	Based on NEES estimates in Obeiter, 1989. Share allocated to program components based on energy savings.

Medium/Large C&I Direct Installation Program (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1993	Last program to start-up -- in interim, customers can participate in audit & rebate programs.
End year	2011	Period required to reach 70% cumulative participation rate.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Comprehensive audits identify conservation measures. Utility then provides financing and arranging assistance.	
Equip. & install. cost	$23,940	114 MWh saved/customer (see below) * $.21/kWh saved (based on a similar program operated by Puget Power -- France, 1989).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	114,400	1,144 avg. annual pre-program MWh/customer (derived from Flaim, 1990) * 10% savings. Based on savings (net of a control group of non-participants) for similar programs operated by Puget P&L, BPA and NU as reported in Nadel, 1990a. Other programs operated by BPA and Boston Edison have achieved savings of approximately 20% by actively encouraging participants to implement all cost-effective measures. On the other hand, due to the impact of concurrent rebate programs for lighting and other improvements, savings opportunities for this prototypical program are lower than for those programs with savings in the 20% range. Allowing for the savings from other concurrent programs, we estimate that average savings of 10% can be achieved by this program if customers are encouraged to implement all cost-effective measures. Savings in the early years of the program are likely to be greater than 10% (because the impact of other programs will be minimal), while savings in the latter years of the program are likely to average less than 10% (because many measures will have been implemented through other programs).
Measure life	10	From Nadel, 1990a - for programs which promote a wide array of measures.
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	6,641	6,134 customers in 1986 using >250,000 kWh/yr * 1.016^5 (growth during 1986-91 -- from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l conservation opportunities).
Annual participation rate	1,2,3,4%-->end	ACEEE estimate assuming that in order to provide high quality services, only 250-300 customers can be served each year. Cumulative participation rate of 70% based on several limited scale programs reported in Nadel, 1990a.

Medium/Large C&I Direct Installation Program (Niagara Mohawk) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
Free rider proportion	0%	Savings are net savings which have already been adjusted for impact of free riders.
UTILITY COSTS:		
Incentives	70% of measure costs	Based on Puget Power program which has paid an average of ~66% (France, 1989).
Staff, administration & marketing costs	27.5% of incentive costs	Based on Puget Power program as reported in Haeri et al., 1988.

Commercial New Construction (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Need a full year (1991) for planning before program start-up.
End year	2010	
Program type	New construction	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed prevailing construction practice. At a minimum measures must exceed building code requirements.	
Design & construction cost:		$.34/kWh based on Energy Edge program as summarized in Anderson and Benner, 1985. Assumed to increase 25% after code changes in 2000 (rough ACEEE estimate -- add'l analysis needed to confirm). $.34/kWh * 2.0 kWh saved/sq.ft. (see below) = $.69/sq.ft.
1992-2000	$.34/kWh saved = $.69/sq.ft.	
2001-2010	$.42/kWh saved = $.73/sq.ft.	
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit		15.85 weighted avg. kWh/sq.ft. for new buildings before program and before 1991 code change (from NYSEO REF II forecast) minus 14% avg. savings due to code change (from Eric Noble, NYSEO, personal communication) * 15% savings due to program. Estimated savings from Energy Edge program are 29% relative to NW Model Conservation Stds (Anderson and Benner, 1988). These stds. are roughly similar to new NY code. Savings at half this level are assumed for this full-scale program (a similar assumption is made by NEES). Baseline declines 15% after code revisions, but % savings assumed to remain the same, and hence kWh savings decline 15% after code revisions.
1992-2000	2.0 kWh/sq.ft.	
2001-2010	1.7 kWh/sq.ft.	
Measure life	30	Based on estimates in Gordon et al., 1988.
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	27.98 million sq.ft.	From NYSEO REF II forecast.
Annual growth rate	1.6%	From NYSEO REF II forecast.
Annual participation rate	8,18,28,38,48,58,60%-->end	First year based on New England Electric first year participation rate. Subsequent years based on New England Electric and Northeast Utilities projections. 1990a).
Free rider proportion	0%	Savings are net savings which have already been adjusted for impact of free riders.
UTILITY COSTS:		
Design & construction incentives	90% of design & construction costs	Similar to Energy Edge, New England Electric, & Northeast Utilities programs.
Technical assistance costs	$310,$490,$670,$850,$1030, $1210-->end	Based on New England Electric 1990 budget for consultants and training (Obeiter, 1989). Assumed to increase by $180,000/yr until peak participation reached (based on assumption that repeat program participants require only half the level of assistance as new participants).
Staff -- number	1 (in program planning yr.), 5,7,9,11,13,15,16-->end	ACEEE estimate.
Marketing costs ($1000's)	$280-->end	Based on New England Electric 1990 budget (Obeiter, 1989).

Commercial Renovation - Lighting (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Need a full year (1991) for planning before program start-up.
End year	2010	
Program type	Remodeling	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed prevailing construction practice. At a minimum measures must exceed building code requirements.	
Incremental equip. cost	$0.40/sq.ft.	ACEEE estimate. Until 1995, costs and savings are based on converting 3-lamp fixtures with energy-saving lamps and magnetic ballasts to 2- or 3-lamp fixtures with electronic ballasts, T8 lamps, and improved fixture spacing (based on data in worksheets for NEES Design 2000 program). As of 1995, when new ballast efficiency standards are assumed to take effect, costs and savings based on a weighted average of the following measures: T8 lamps with 3- and 4-lamp ballasts (7-10% savings @ <$.05/ sq.ft.); 2-lamp fixtures with improved spacing (up to 35% savings @<$.10/sq.ft.); very high efficiency fixtures (approx. 35% savings @$.80/sq.ft.); and lighting controls (5-60% savings @~$.30/sq.ft.). Costs and savings from NEES Design 2000 program worksheets and lighting equipment manufacturers.
Incremental design costs	$0.04/sq.ft.	Assumed to be 10% of equipment costs, as used by Wisconsin Electric. NEES uses 6%.
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit:		For 1992: 7.58 weighted avg. kWh/sq.ft. for lighting in existing buildings before program and before 1991 code change (from NYSEO REF II forecast) * 40% savings (see note above under equipment costs). For 1995: 7.58 minus assumed 15% avg. savings due to ballast efficiency std revision in 1995 (ACEEE estimate) * 40%.
1992-1994	3.0 kWh/sq.ft.	
1995-2010	2.6 kWh/sq.ft.	
Measure life	20	Based on estimates in Gordon et al., 1988.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	14.4 million sq.ft.	736.6 million sq.ft. (from NYSEO REF II forecast) * 39% remodeled over 20 years (from attached spreadsheet) / 20 years.
Annual growth rate	1.6%	From NYSEO REF II forecast.
Annual participation rate	8,18,28,38,48,58,60%-->end	Assumed to be same as Commercial New Construction program.
Free rider proportion	10%	ACEEE estimate.
UTILITY COSTS:		
Design & construction incentives	100% of design and construction costs	Utility pays all costs because many remodeled facilities are tenant occupied and in these situations building owner generally has no incentive to invest in energy efficiency.

VARIABLE	ASSUMPTION	NOTES
Technical assistance costs	$100,$160,$220,$280,$340, $400-->end	33% of the values used for new construction program. Floor area served by the renovation program is approximately 50% of the floor area served by the New Construction program. Also, since only lighting is involved, technical assistance will be less extensive.
Staff -- number	2,3,4,5,6,7-->end	ACEEE estimate.
Marketing costs ($1000's)	$140-->end	50% of values used for New Construction program (see Technical Assistance note above).

Commercial Remodeling - Lighting Worksheet (Niagara Mohawk)

NiMo:	Light	% of FA	Wtd Avg	% remodel	% of FA	Wtd Avg
Offices	8.02	21%	1.68	53%	21%	11%
Restaurant	12.33	3%	0.37	55%	3%	2%
Retail	8.5	16%	1.36	55%	16%	9%
Grocery	12.87	3%	0.39	5%	3%	0%
Warehouse	4.52	8%	0.36	0%	8%	0%
Schools	6.43	12%	0.77	30%	12%	4%
Colleges	9.85	8%	0.79	30%	8%	2%
Health	10.19	6%	0.61	50%	6%	3%
Hotel	6.71	3%	0.20	43%	3%	1%
Misc	5.23	20%	1.05	36%	20%	7%
		Sum ==>	7.58		Sum ==>	39%

Source: Floor area and kWh/sf from NY State Energy Office CEDMS Model.
Proportion of space renovated over 20 years from Katz et al., 1989 prepared for BPA.

Industrial New Construction/Modernization (Niagara Mohawk)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	New construction & remodeling	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed prevailing practice in new manufacturing facilities.	
Design & construction cost	$58,712/customer	358 MWh saved/customer (see below) * $.164/kWh saved (average cost of industrial measures with a levelized cost less than $.05/kWh (real basis) as identified for Northeast Utilities (NU) service territory -- Synergic Resources Corp. (SRC), 1989).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	358 MWh/customer	3580 MWh/yr average use by NiMo industrial customers (from NiMo data filing) * 10% savings (rough ACEEE estimate based on discussions with Gail Katz at Momentum Engineering).
Measure life	10	From Nadel, 1990a.
Replacement rate	50%	ACEEE estimate.
Load shape	Total industrial	
PARTICIPATION:		
# eligible in 1991	2,170 customers	From NiMo data filing.
Annual growth rate	2.3%	Growth rate in ind'l elec. sales from NYSEO REF II forecast.
Annual participation rate	1,2%-->end	Rough ACEEE estimate based on discussions with Gail Katz, Momentum Engineering.
Free rider proportion	20%	Based on SRC estimate for NU program (SRC, 1989).
UTILITY COSTS:		
Design & construction incentives	80% of design & construction costs	
Technical consultant costs	10% of measure costs	ACEEE estimate.
Staff -- number	2-->end	ACEEE estimate.
Marketing costs ($1000's)	$100-->end	Based on SRC estimate for NU program (SRC, 1989).

Residential Energy Fitness - Lighting (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Based on # of customers that can be effectively served in a year.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent lightbulbs	Compact fluorescents replace standard incandescent lightbulbs and reduce electricity use per lamp by approximately 75%.
Equipment cost	$36.96/household	4 bulbs replaced/household (other utility programs range from 3.4-5.5) * $11/bulb (typical bulk purchase price for 2-piece compact fluorescents) * 84% measure acceptance rate (based on Michigan Energy Fitness experience -- Kushler et al., 1989).
Installation cost	$18.20/household	2 people/HH for 1 hour and 1 lead person for every six teams (Kushler et al., 1989, and Egel, 1986) * $10/hr * 84% of labor costs assigned to lighting portion of program based on the lighting portion of total program electricity savings.
Incremental annual O&M	$0	Compact fluorescent lamps last longer and need to be changed less often, but we assume resident labor is free.
Annual kWh savings/unit	306	4 lamps * 57 watts * 1600 hours * 84% penetration. Based on replacing 75 watt bulbs with 18 watt bulbs which will be used 1600 hours/year (White, 1989). Penetration rate for compact fluorescents based on Michigan experience (Kushler et al., 1989).
Measure life (in years)	6	Based on 10,000 hour life and 1600 hours/year use (White, 1989).
Replacement rate	0%	Bulb replacement will occur thru the Lighting Coupon program.
Load shape	Residential lighting	
PARTICIPATION:		
# eligible in 1991	3,176,173 households	3,161,000 res'l customers in 1990 * 1.0048 growth rate (from NYSEO Ref II forecast)
Annual growth rate	0.2%	Based on NYSEO REF II forecast, but excluding 50% of customers served by Residential New Construction program (under assumption that due to efforts to promote compact fluorescent fixtures thru New Construction program, opportunities for compact fluorescent retrofits will be reduced by 50%). See Table A-4.
Annual participation rate	2, 2.5, 3, 4%=> end	First year rate based on 1st year of similar NEES program. Program to double in size over a three year timespan. On a cumulative basis, program will serve 47.5% of eligible homes (based on participation rates achieved by Michigan and NEES programs in targeted communities -- Nadel, 1990b).
Free rider proportion	10%	Based on Michigan program (Kushler et al., 1989).
UTILITY COSTS:		
Cost/Unit	$55.16 household	Utility pays all equipment and installation costs (see above).

VARIABLE	ASSUMPTION	NOTES
Staff -- number	13.4	Based on 8 full time utility and 8 full time contractor staff * 84% (lighting portion of program costs -- see above). Based on NEES Energy Fitness Program (Obeiter, 1989) times four since this program will be considerably larger.
Marketing costs	$6.97/participant	$8.30/participant * 84% (lighting portion of program). Based on NEES experience ($8.30/participant -- New England Electric, 1990b) and Santa Monica Energy Fitness ($6.04/participant -- Egel, 1986).

Residential Energy Fitness - Water Heating (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Based on # of customers that can be effectively served in a year.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Hot water conservation measures	Water heater wraps, pipe wrap, low-flow showerheads, faucet aerators, and reseting the water heater thermostat to 120 degrees F (with customer permission).
Equipment cost	$12.72/household with electric water heat	From Residential Energy Fitness in worksheet NiMo section of this appendix.
Installation cost	$49.24/household with electric water heat	2 people/HH for 1 hour and 1 lead person for every six teams (Kushler et al., 1989 & Egel, 1986) * $10/hr * 12.5% of labor costs assigned to water heating portion of program based on hot water portion of total Energy Fitness electricity savings / 5.5% electric water heat saturation rate (from Miller et al., 1989).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	827	From Residential Energy Fitness in worksheet NiMo section of this appendix.
Measure life (in years)	10	ACEEE estimate. Some measures (low-flow showerheads and pipe wrap) will probably last more than 10 yrs on average, while other measures (water heater wraps and thermostat setback) will last less than 10 yrs on average.
Replacement rate	0%	Majority of savings are due to water heater wrap and thermostat setback. When new water heaters are purchased, due to impact of efficiency standards, high insulation levels will be a standard feature. Plumbers unlikely to reset thermostat.
Load shape	Residential water heating	
PARTICIPATION:		
# eligible in 1991	174,690 households	3,161,000 residential customers in 1990 * 1.0048 growth rate from NYSEO Ref II forecast) * 5.5% electric water heater satuuration rate.
Annual growth rate	-0.10%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because hot water retrofit measures will be incorporated into New Construction program).
Annual participation rate	2, 2.5, 3, 4%=> end	First year rate based on 1st year of similar NEES program. Program to double in size over a three year timespan. On a cumulative basis, program will serve 47.5% of eligible homes (based on participation rates achieved by Michigan and NEES programs in targeted communities -- Nadel, 1990b).
Free rider proportion	10%	Based on Michigan program (Kushler et al., 1989).
UTILITY COSTS:		
Cost/Unit	$61.96	Utility pays all equipment and installation costs (see above).

VARIABLE	ASSUMPTION	NOTES
Staff -- number	2	Based on 8 full time utility and 8 full time contractor staff * 12.5% (hot water portion of program costs -- see above). Based on NEES Energy Fitness Program (Obeiter, 1989) times four since this program will be considerably larger.
Marketing costs	$18.86/participant	$8.30/participant * 12.5% (hot water portion of program) / 5.5% (electric water heater saturation rate). Based on NEES experience ($8.30/participant -- New England Electric, 1990b) and Santa Monica Energy Fitness ($6.04/participant -- Egel, 1986).

Residential Energy Fitness - Weatherization (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Based on # of customers that can be effectively served in a year.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Infiltration reduction measures	Rope caulk, weatherstripping, plastic storm windows, and outlet gaskets.
Equipment cost	$23.52/household with electric heat	From Residential Energy Fitness worksheet in NiMo section of this appendix.
Installation cost	$14.58/household with electric heat	2 people/HH for 1 hour and 1 lead person for every six teams (Kushler et al., 1989 & Egel, 1986) * $10/hr * 3.5% of labor costs assigned to weatherization portion of program based on space heating portion of total Energy Fitness electricity savings/ 5.2% electric space heating saturation rate (Miller et al., 1989).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	253	4.5% (based on estimates from Dunsworth, 1984, and Massachusetts Audubon Society, 1986) * 5662 (avg. annual space heat use for Con Ed space heat customers--from Miller et al., 1989).
Measure life (in years)	9	Based on a weighted average of the estimated life of each weatherization measure and the expected savings (Outlet gaskets 1% savings * 20 yrs + Weatherstripping 1.75% savings * 10 years + Caulking and Plastic Storm windows 1.75% savings * 1 year) / 4.5% total savings.
Replacement rate	50%	ACEEE estimate. Note: At time of replacement, equipment costs are increased by 50% to account for the fact that the initial purchase by the utility was at wholesale prices, but the repurchase is by consumers at retail prices.
Load shape	Residential space heating	
PARTICIPATION:		
# eligible in 1991	165,161 households	3,161,000 residential customers in 1990 * 1.0048 growth rate from NYSEO Ref II forecast) * 5.2% electric space heating saturation rate.
Annual growth rate	-.10%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because infiltration reduction measures will be incorporated into New Construction program).
Annual participation rate	2, 2.5, 3, 4%=> end	First year rate based on 1st year of similar NEES program. Program to double in size over a three year timespan. On a cumulative basis, program will serve 47.5% of eligible homes (based on participation rates achieved by Michigan and NEES programs in targeted communities -- Nadel, 1990b).
Free rider proportion	10%	Based on Michigan program (Kushler et al., 1989).

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Cost/Unit	$38.10	Utility pays all equipment and installation costs (see above).
Staff -- number	0.56	Based on 8 full time utility and 8 full time contractor staff * 3.5% (weatherization portion of program costs -- see above). Based on NEES Energy Fitness Program (Obeiter, 1989) times four since this program will be considerably larger.
Marketing costs	$5.59/participant	$8.30/participant * 3.5% (weatherization portion of program) / 5.2% (electric space heat saturation rate). Based on NEES experience ($8.30/participant -- New England Electric, 1990b) and Santa Monica Energy Fitness ($6.04/participant -- Egel, 1986).

Residential Lighting Coupon/Catalog (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Program runs as long as Energy Fitness program.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent lightbulbs	Compact fluorescents replace standard incandescent lightbulbs and reduce electricity use per lamp by approximately 75%.
Equipment cost	$52.00/household thru 1996, $42.00/household thereafter.	4 bulbs purchased/household (other utility programs range from 3.4-5.5) * $13/bulb (average of utility bulk-purchase price of $11 (see Energy Fitness - Lighting program) and typical retail cost of $15 (based on Energy Federation, 1989). Beginning in year 7, replacement bulbs dominate the program and we assume that half the customers will purchase replacement lamps (to go with existing ballasts) at $6 each, and half will purchase lamp/ballast combinations at a retail cost of $15. Thus, costs/household = 4 lamps/household * (6+15)/2 = $42.
Mailing cost	$0.82/household	$1.64 estimated warehousing, processing and mailing costs (estimate from Rockville mailing) * 50% of bulbs that are mailed (as opposed to sold thru stores).
Incremental annual O&M	-$6	Due to longer lifetime of compact fluorescent bulbs, each year two incandescent lamps are saved per socket. Savings/household = 4 compacts * 2 incandescents saved/socket * $.75 avg. incandescent cost.
Annual kWh savings/unit	365	4 bulbs * 57 watts * 1600 hours. Based on replacing 75 watt bulbs with 18 watt bulbs which will be used 1600 hours/year (White, 1989).
Measure life (in years)	6	Based on 10,000 hour life and 1600 hours/year use (White, 1989).
Replacement rate	80% during program, 50% after program ends	ACEEE estimate.
Load shape	Residential lighting	
PARTICIPATION:		
# eligible in 1991	3,176,173 households	From NYSEO REF II forecast.
Annual growth rate	0.2%	Based on NYSEO REF II forecast, but excluding 50% of customers served by Residential New Construction program (under assumption that due to efforts to promote compact fluorescent fixtures thru New Construction program, opportunities for compact fluorescent retrofits will be reduced by 50%).
Annual participation rate	2,4,6,8%-->yr 6. Thereafter 80% of Energy Fitness and Residential Lighting program participants from 6 yrs ago.	Program will reach 36% participation after 6 years. Wisconsin Electric served 7% in 1 year with a similar mail order program. A coupon program in Sweden served ~20% of customers after 2 years (Nadel, 1990b).
Free rider proportion	0% first 6 yrs, 25% thereafter	Due to present lack of product availability, free riders assumed to zero until bulbs need replacement. Beginning in year 7, program emphasizes replacement of burned-out bulbs, and free riders estimated to be 25% (ACEEE estimate).

Residential Lighting Coupon/Catalog (Consolidated Edison) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Cost/Unit	$40.82/household thru 1996, $39.82 thereafter.	Customers pay $3/bulb and the utility pays remaining costs.
Staff -- number	4	ACEEE estimate.
Marketing costs	$3/participant	Based on Central Maine Power program (Schick et al., 1990).

Residential Water Heating Retrofit (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	Start and end dates coincide with Energy Fitness program since marketing of these programs is closely linked.
End year	2003	
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Hot water conservation measures	Water heater wraps, pipe wrap, low-flow showerheads, faucet aerators, and reseting the water heater thermostat to 120 degrees F (with customer permission).
Equipment cost	$12.72/household with electric water heat	From Residential Energy Fitness worksheet in NiMo section of this appendix.
Installation cost	$10/household	1 person * 1 hour * $10/hour (ACEEE estimate based on total program costs reported by several utilities).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	827	From Residential Energy Fitness worksheet in NiMo section of this appendix.
Measure life (in years)	10	ACEEE estimate. Some measures (low-flow showerheads and pipe wrap) will probably last more than 10 yrs on average, while other measures (water heater wraps and thermostat setback) will last less than 10 yrs on average.
Replacement rate	0%	Majority of savings are due to water heater wrap and thermostat setback. When new water heaters are purchased, due to impact of efficiency standards, high insulation levels will be a standard feature. Plumbers unlikely to reset thermostat.
Load shape	Residential water heating	
PARTICIPATION:		
# eligible	Electric water heat households served by Energy Fitness * 1.105	Eligible households are those that were not reached by Energy Fitness when Energy Fitness served their community. Since 47.5% of households are served by Energy Fitness, number eligible for this program = Energy Fitness participants * 52.5%/47.5%.
Annual growth rate in number eligible	-0.10%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because hot water retrofit measures will be incorporated into New Construction program).
Annual participation rate	60% of households eligible each year	Based on experience by Seattle City Light and NEES (Nadel, 1990b).
Free rider proportion	12%	ACEEE estimate based on NEES evaluation of their water heater wrap program (New England Electric, 1988) which estimated that 12% of the customers had wrapped their water heaters on their own.
UTILITY COSTS:		
Direct costs/unit	$22.72/household	Utility pays all equipment and installation costs (see above).

Residential Water Heating Retrofit (Consolidated Edison) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
Staff -- number	0.5	Based on NEES Water Heater Wrap program prorated to size of this program.
Installation contractor administrative costs	$75,000/year	ACEEE estimate for a program of this size based on total program costs of $55/participant reported by Central Maine Power (Central Maine Power, 1989) and BC Hydro (Schick et al., 1990).
Marketing costs	$6.88/participant	From Schick et al., 1990.

House Doctor (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	Start and end dates coincide with Energy Fitness program since marketing of these programs is closely linked.
End year	2003	
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Infiltration reduction measures	Trained crew identifies and seals heat leaks with the aid of a blower door.
Cost/home	$150	Based on Jacobson et al. (1990) who report an average cost of less than $200/house. This cost assumes that the majority of the homes served are apartments.
Annual O&M	$0	Little maintenance required.
Annual kWh svgs/unit	462/home	7.5% of heating and cooling use. Proctor and deKieffer (1988) report 10.6% average heating savings with an experienced crew and good quality control. Jacobson et al. (1990) estimate 5 - 5.5% savings. We choose 7.5% to take into account that (1) some savings have been achieved in some homes through the Energy Fitness program, and (2) training and quality control in a large-scale program will probably not be as good as in the Proctor and deKieffer program. Average heating use of 5,672 kWh/yr and cooling use of 487 kWh/year assumed for Con Ed (from Miller et al., 1989).
Measure life (years)	13	From Nadel & Heineman, 1986.
Replacement rate	0%	Measures which fail will be in hard to reach places, and thus, few homeowners are likely to replace failed measures.
Load shape	Residential space heating and cooling	Analyzed savings by end-use (see above) with the appropriate load shape.
PARTICIPATION:		
# eligible in 1991	165,161 households	3,176,173 residential customers (from NYSEO REF II forecast) * 5.2% electric space heating saturation rate.
Annual growth rate	-.10%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because infiltration reduction measures will be incorporated into New Construction program).
Annual participation rate	2,3,4,5%-->end	ACEEE estimate. Program cumulative participation rate totals 59%. Based on Hood River - 85% penetration (Brown et al., 1987), TVA - 62% penetration over 13 years and Central Maine Power - 50% penetration (Schick et al, 1990).
Free rider proportion	10%	Very few customers would use the blower door on their own. 10% free rider estimate captures overlap between House Doctor work and conventional caulking and weatherstripping work that may be done by some homeowners.

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Utility rebate/unit	$141.50	The utility pays $141.50, and the customer $8.50 (see Customer costs/unit).
Staff -- number	1,2,2,3-->end	ACEEE estimate.
Marketing costs (1000's)	$100,$124,$149,$174-->end	$15/house + $50,000. NEES program mktg costs averaged $30/home (Jacobson et at., 1990), but we assume that marketing is needed for only half of the participants because the other half are assumed to be Energy Fitness program referrals.
CUSTOMER COSTS:		
Customer costs/Unit	$8.50	Each participant (except low income) is charged a $10 fee. This fee is designed to ensure that the customer places value on the work being performed. Because low income participants (assumed to be 15% of the participants) pay nothing, the average customer cost is $10 * (1-15%) = $8.50.

Home Insulation (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	Start and end dates coincide with Energy Fitness program since marketing of these programs is closely linked.
End year	2003	
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Insulation and other energy-saving capital improvements	Includes attic, wall, and basement insulation, window repairs (and replacements where needed), and attic ventilation improvements.
Total Cost	$310/household	Includes materials, labor & arranging services: ~$520/home for materials and labor (Jacobson et al., 1990), and $100 for arranging services (Jacobson et al. found these costs averaged $65/insulation contract) * 50% to allow for fact that Con Ed apartments are considerably smaller than homes served in Jacobson et al. program.
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	564/household	Based on engineering estimates of energy savings from insulation improvements in NEES weatherization program (Jacobson et al., 1990)* 5672/13,322 ratio of Con Ed/NiMo avg space htg elec use.
Measure life (in years)	20	From Miller et al., 1989.
Replacement rate	0%	Measures will most likely be replaced during remodeling, which will be subject to building codes, & therefore replacement will occur via another avenue. In addition degradation of insulation is difficult for the homeowner to see, therefore, few customers would know that something had to be corrected, let alone actually do the work.
PARTICIPATION:		
# eligible in 1991	165,161 households	3,176,173 residential customers (from NYSEO REF II forecast) * 5.2% electric space heating saturation rate.
Annual growth rate	-1.04	Demolition rate from NYSEO REF II forecast. We assume that new electrically heated homes will not need insulation upgrades.
Annual participation rate	0.7%, 1.05%, 1.40%, 1.75% --> end	Based on House Doctor participation * 35%. 35% assumes that 50% of electrically heated homes need upgrades (based on NEES pilot program experience -- Jacobson et al., 1990) and 70% of those will participate (ACEEE estimate).
Free rider proportion	10%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$217/household	The customer pays 30% ($93) and the utility 70% ($217) of $310. This cost-share has proven very effective in BPA's weatherization program (Schick et al., 1990).
Staff -- number	1,2,2,3--> end	ACEEE estimate.
Marketing costs ($1000's)	$67,$76,$85,$93-->end	$15/house + $50,000. NEES program mktg costs averaged $30/home (Jacobson et at., 1990), but we assume that marketing is needed for only half of the participants because the other half are assumed to be Energy Fitness program referrals.

Residential Refrigerator Rebate Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2002	Units of qualifying efficiency mandated in 2003 thru appliance efficiency standards.
Program type	Replacement & new	
TECHNOLOGY:		
Technology description	Very high efficiency refrigerators	Refrigerators meeting level 5 standards recently studied by DOE (1989). Includes vacuum panel insulation which dramatically reduces CFC's.
Incremental purchase cost	$200 until 5% of households reached, $100 thereafter.	DOE (1989) estimates $100 cost to manufacturer. This is doubled for first 5% of the refrigerator stock assuming manufacturers need to recover R&D expenses. Thereafter it is assumed manufacturers cover expenses (thus profit/unit is the same as at present.
Incremental annual O&M	$0	Same as present models.
Annual kWh savings/unit	197	From U.S. DOE, 1989a relative to 1993 efficiency standards. Due to the number of apartments in Con Ed's territory, refrigerators in Con Ed's territory are probably smaller than the national average. The difference in savings is likely to be small (ACEEE, 1989) and is ignored.
Measure life	19	From U.S. DOE, 1989a.
Replacement rate	0%	Since qualifying units are assumed to be mandated as of 2003, the program cannot take credit for any replacements.
Load shape	Residential refrigeration	
PARTICIPATION:		
# eligible in 1991	232,680 refrigerators	(3,176,173 residential customers * 1.08 refrig./customer / 19 year avg refrig life) + (3,176,173 customers * 1.52% new construction rate * 1.08 refrig./customer). Life from DOE, 1989. Number refrig/hh from Miller et al., 1989. Remaining figures from NYSEO REFII forecast.
Annual growth rate	0.48%	Growth in # residential customers -- from NYSEO REFII forecast.
Annual participation rate	0,0,1,5,15,30,50,100%-->end	ACEEE estimates. 100% participation from 1998-2002 assumes that this type of program is offered by several utilities, and as a result, qualifying efficiency levels mandated in 1998 -- 5 years sooner than if program were not offered.
Free rider proportion	0%	Without utility-led effort, qualifying units would not be manufactured.
UTILITY COSTS:		
Rebate/unit	100% of incremental cost	Utility pays full incremental cost in order to stimulate manufacturers to produce & consumers to buy qualifying models.
Staff -- number	.5,.5,4.5,6.5,8.5,8.5, 8.5,0-->end	ACEEE estimate -- .50 each year for planning & evaluation; 4-8 staff to promote program (after qualifying models available) and process rebates.

Residential Refrigerator Rebate Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Marketing costs ($1000's)	50,100,400,400,300,200,200,0,-->end	ACEEE estimate. Assumes heavy marketing as soon as qualifying units available, with reduced marketing after market established.

Residential Heat Pump Water Heater Rebate Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Will take a year of effort (1991) to convince local dlrs to stock units.
End year	2010	
Program type	Replacement & new	
TECHNOLOGY:		
Technology description	Heat pump water heaters	Water heaters which use a heat pump to supply heat and not an electric resistance coil.
Incremental purchase cost	$750/unit	From Geller, 1988.
Incremental annual O&M	$0	Units require annual oiling and occasional vacuuming (Bernie Mittelstaedt, DEC Int'l, personal communication). These are no cost measures which can be done by the homeowner.
Annual kWh savings/unit	2,972	13.99 kWh/day/.945 energy factor of high efficiency standard water heater * 365 days/yr * 55% savings. 13.99*365/EF formula developed by DOE for water heater labeling program. This applies to a family of four and not to the "average" family of approx. 2 people. National efficiency standards require a .88 EF in 1990 (Geller, 1988). We assume here that this rises to approx. .94 when the standards are revised effective 1995. 55% savings from Moore, 1981 based on his review of independent research results.
Measure life	13	13 yr life is standard for conventional water heaters (U.S. DOE, 1982). Heat pump water heaters should have the same life because the weak part of heat pump water heaters is the tank and most heat pump water heater manufacturers purchase tanks from producers of standard water heaters (Bernie Mittelstaedt, DEC Int'l, personal communication).
Replacement rate	50% after program ends.	ACEEE estimate. During program, replacement units are included as program participants.
Load shape	Residential water heating	
PARTICIPATION:		
# eligible in 1991	17,348 water heaters	(3,176,173 residential customers * 5.5% with electric water heaters / 13 year avg life) + (3,176,173 customers * 1.52% new home construction rate * 8.1% with electric water heaters). 5.5% from Miller et al., 1989. Remaining figures from NYSEO REFII forecast.
Annual growth rate	0.48%	Growth in # residential customers -- from NYSEO REFII forecast.
Annual participation rate	1,3,5,7,10,15,20,25,30,35, 40%-->end	ACEEE estimate. Participation in first two years is similar to participation in first two years of a pilot BPA program which combined high rebates and high promotion (Major and Cody, 1987). Participation rates beyond first two years have yet to be demonstrated in actual practice. These rates assume that few 1-person households will purchase heat pump water heaters.
Free rider proportion	0%	Due to high cost of technology without incentives, free riders in the residential sector are assumed to be zero.

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Rebate/unit	$650/unit	Same rebate as presently paid by Wisconsin Electric.
Staff -- number	1.5	ACEEE estimate. In early years staff emphasizes personal marketing to distributors, plumbers, and builders. In latter years, more effort is devoted to handling rebate requests.
Marketing costs ($1000's)	$50,$250,$250,$150,$100-->end	ACEEE estimate. Assumes a major marketing campaign in first few years of program.

Residential New Construction (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Will take a year to plan program (1991) before it can begin.
End year	2010	
Program type	New construction	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed local building code and prevailing construction practices.	
Incremental construction cost	$950	From attached worksheet.
Incremental annual O&M	$0	Approximately the same as a conventional house.
Annual kWh savings/unit	1,872/home	From attached worksheet.
Measure life	30+	ACEEE estimate.
Replacement rate	Not applicable	Measure life is greater than the 30 year analysis period.
Load shape	Residential space heating, cooling, water heating, & lighting	Analyzed savings by end-use (from attached worksheet) with the appropriate load shape.
PARTICIPATION:		
# eligible in 1991	3,923 electrically heated homes	From NYSEO REF II forecast. Based on a 0.48% annual growth rate plus a 1.04% replacement rate for existing homes. Also includes a 8.1% saturation rate for electric heat in new homes in the Con Ed service territory.
Annual growth rate	0.48%	Growth in # residential customers -- from NYSEO REFII forecast.
Annual participation rate	5,15,25,35,45,50%-->end	ACEEE estimate. Several utilities have achieved participation rates of over 40% with BPA's Super Good Cents program including one utility with a participation rate over 70% (Schick et al., 1990).
Free rider proportion	0%	It is assumed that only a few homes currently meet the program's standards, and these homes are more than compensated for by efficient homes built in the latter years of the program for which builders do not bother to apply for incentives.
UTILITY COSTS:		
Incentive/unit	$693/home	From attached worksheet.
Builder training	$50 in planning year, $50,$25,$12.5-->end	ACEEE estimate. These figures are approximately 1/2 of those for a similar program planned by New England Electric because we assume that 75% of the costs of a Con Ed program will be borne by the gas side of the company
Inspections	$150/home	From Lou Gougoun, Retrotec, personal communication. We assume that 100% of the homes are inspected in the first 2 yrs, 50% in the 3rd yr, 25% in the 4th yr, and 10% thereafter.
Staff -- number	0.5 in planning year, 1,1.5-->end	ACEEE estimate. Gas side of company will pay 3x this amount.
Marketing costs ($1000's)	$50-->end	ACEEE estimate. Gas side of company will pay 3x this amount.

Residential New Construction

Worksheet to Calculate Average Costs, Savings and Incentive -- Con Ed

	Single Family	2-4 Family	5 + Family	Weighted Average	Notes
% of new homes	6%	26%	68%	100%	For new homes in Con Ed territory from SEO REF II forecast.
Elec. saturation in new homes	6.1%	8.2%	8.2%	8.1%	For new homes in Con Ed territory from SEO REF II forecast.
Space heat					
kWh savings due to program	3805	1650	1,177	1,421	For NEES residential new construction program from NEES, 1990. Savings are relative to Mass. building code which is very similar to NY building code. 5+ unit savings prorated from single family home savings based on data for Con Ed in Miller et al., 1989.
Water heat					
kWh savings due to program	65	65	65	65	For NEES residential new construction program from NEES, 1990.
Central air conditioning					
kWh savings due to program	258	176	80	113	For NEES residential new construction program from NEES, 1990. Assumes half the floor area is cooled with either central or room A/C. 5+ unit savings prorated from single family home savings based on data for Con Ed in Miller et al., 1989.
Lighting					
kWh savings due to program	273	273	273	273	For NEES residential new construction program from NEES, 1990.
Measure costs	$1,600	$1,100	$850	$950	Based on program being planned by seven Mass. utilities (Mark Kelley, personal communication). Cost for 5+ unit buildings prorated based on space heat savings relative to 2-4 unit building.
Incentive payments	$1,200	$850	$600	$693	Based on Mass. program (Mark Kelley, personal communication). Mass. program plans to pay incentives for electrically heated single-family homes of $1300 for the first 10 homes a builder builds, and $1000/home thereafter. Incentives for multi-family homes are $900 for first ten homes, and $650 thereafter. In addition, an average incentive of $100/unit for efficient lighting is planned.

NOTE: Weighted averages based on data for Con Ed territory as summarized in first two lines of this worksheet.

Submetering - Condo/Coop (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	One year to plan program (1991).
End year	2001	Work spread over ten years.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Submeters	Install submeters in master-metered apartments. Building manager pays utility, but then bills individual tenants for their share of use. When tenants have to pay directly for their electricity use, on average, electricity use is reduced.
Total Cost	$512/apartment	A. Joseph Kleinmann, Quadlogic Controls, personal communication.
Incremental annual O&M	$50	Kleinmann, personal communication. Includes equipment maintenance and replacement as needed.
Annual kWh savings/unit	1,203 kWh/apartment	1345 kWh/yr from Con Edison, 1990 * (1-11.8%). 11.8% is T&D losses that were included in the 1345 estimate.
Measure life (in years)	infinite	Equipment replacement costs included in O&M costs.
Load shape	Residential submetering	From Con Edison, 1990.
PARTICIPATION:		
# eligible in 1991	200,000 apartments	From Con Edison, 1990.
Annual growth rate	0%	SEO estimate -- master metering generally not allowed in new construction (Manwell & Rizzuto, 1989).
Annual participation rate	5%-->end	No experience upon which to base estimate. We assume a cumulative penetration of 50% as midpoint of 0-100% range, where <10% is likely if no inducements for conversion provided, and 100% likely if mandated by State or City.
Free rider proportion	0%	Very little conversions happening now -- Kleinmann, personal communication.
UTILITY COSTS:		
Rebate/unit	$512/apartment	Utility pays all initial costs. Building manager pays O&M costs.
Administrative costs	$100/apartment	Derived from Con Edison, 1990. Includes staff and marketing.
Start-up costs ($1000's)	$340	$490,000 budgeted by Con Ed for 1990 & 1991, minus direct administrative costs of $100/apt. * 1500 scheduled for 1991 (from Con Edison, 1990).

Submetering - Rental Apartments (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1995	Assume takes several years to work out legal issue of how rent control regulations are affected by submetering.
End year	2004	Work spread over ten years.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Submeters	Install submeters in master-metered apartments. Building manager pays utility, but then bills individual tenants for their share of use. When tenants have to pay directly for their electricity use, on average, electricity use is reduced.
Total Cost	$512/apartment	A. Joseph Kleinmann, Quadlogic Controls, personal communication.
Incremental annual O&M	$50	Kleinmann, personal communication. Includes equipment maintenance and replacement as needed.
Annual kWh savings/unit	902 kWh/apartment	1203 kWh savings from Condo/Coop program * 75%, where 75% accounts for fact typical rental tenant is less affluent than a condo/coop tenant (SEO estimate).
Measure life (in years)	infinite	Equipment replacement costs included in O&M costs.
Load shape	Residential submetering	From Con Edison, 1990.
PARTICIPATION:		
# eligible in 1991	200,000 apartments	From Con Edison, 1988.
Annual growth rate	0%	SEO estimate -- master metering generally not allowed in new construction (Manwell & Rizzuto, 1989).
Annual participation rate	5%-->end	No experience upon which to base estimate. We assume a cumulative penetration of 50% as midpoint of 0-100% range, where <10% is likely if no inducements for conversion provided, and 100% likely if mandated by State or City.
Free rider proportion	0%	Very little conversions happening now -- Kleinmann, personal communication.
UTILITY COSTS:		
Rebate/unit	$512/apartment	Utility pays all initial costs. Building manager pays O&M costs.
Administrative costs	$100/apartment	Derived from Con Edison, 1990. Includes staff and marketing.
Start-up costs ($1000's)	$250, spread over 1991-94 period	SEO estimate. Many program issues resolved in development of condo/coop program, so start-up expenses for this program will be lower.

Lighting Rebate Program - Commercial Compact Fluorescent Bulbs (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Need other program approaches to reach add'l customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent bulbs	Screw-in fluorescent bulbs which can be substituted for incandescent bulbs.
Equipment cost	$9/lamp	Typical price for a medium-sized commercial customer.
Installation cost	$1.33/lamp	From Nadel et al., 1989.
Incremental annual O&M	-$2/lamp	$1.33 installation cost (see above) * 1.5 incandescent lamps not replaced each year (assumes long-life incandescent lamps w/ a 2000 hr life are replaced). Replacement lamp costs are not included because (a) these are highly variable, and (b) compacts are equally likely to save money per socket-yr as to cost money (Nadel et al., 1989).
Annual kWh savings/unit	218/lamp	83 Watts for an avg incandescent lamp (from Xenergy, 1988) * 75% savings * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	3	10,000 hr rated life / 3500 op hrs/yr.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	217,917 customers	212,780 customers in 1989 using >5000 kWh/yr * 1.012^2 (growth during 1989-91 -- from NYSEO REF II forecast).
# lamps/participant	3.7	5,196 GWh used for comm'l ltg in Con Ed territory in 1986 (from Miller et al., 1989) * 21.5% incandescent share (from Nadel et al., 1989) / 83 avg Watts/lamp (see above) / 3500 avg. annual op hrs/lamp * 80% of fixtures for which replacement is appropriate (from Xenergy, 1989) * 25% of sockets which get compact bulbs, & not fixtures (ACEEE estimate) / 205,300 customers in 1986.
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from compact fluorescent bulbs).
Annual participation rate	2,6,4,4,2,2,1%-->end	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to decline beginning in year 3 due to impact of direct installation programs.
Free rider proportion	5%	Based on New England Electric estimate (Nadel, 1990a).
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	1.3	26 for Lighting Rebate program * 5% compact bulb share of program (ACEEE estimate).
Marketing costs ($1000's)	$10	5% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Commercial Compact Fluorescent Fixtures (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent fixtures	Two-piece compact fluorescent lamps or fixture inserts in which bulb can be replaced w/o replacing ballast.
Equipment cost	$17/lamp	Typical price for a medium-sized commercial customer -- fixture inserts cost more than this amount but two-piece screw-in units cost less.
Installation cost	$1.33/lamp	From Nadel et al., 1989.
Incremental annual O&M	-$2/lamp	$1.33 installation cost (see above) * 1.5 incandescent lamps not replaced each year (assumes long-life incandescent lamps w/ a 2000 hr life are replaced). Replacement lamp costs are not included because (a) these are highly variable, and (b) compacts are equally likely to save money per socket-yr as to cost money (Nadel et al., 1989).
Annual kWh savings/unit	218/lamp	83 Watts for an avg incandescent lamp (from Xenergy, 1988) * 75% savings * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	15	50,000 hr ballast life / 3500 op hrs/yr.
Replacement rate	0%	Units will often be removed at time of building remodeling. Savings accounted for in Commercial Renovation program.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	217,917 customers	212,780 customers in 1989 using >5000 kWh/yr * 1.012^2 (growth during 1989-91 -- from NYSEO REF II forecast).
# fixtures/customer	11.2	5,196 GWh used for comm'l ltg in Con Ed territory in 1986 (from Miller et al., 1989) * 21.5% incandescent share (from Nadel et al., 1989) / 83 avg Watts/lamp (see above) / 3500 avg. annual op hrs/lamp * 80% of fixtures for which replacement is appropriate (from Xenergy, 1989) * 75% of sockets which get compact fixtures & not bulbs (ACEEE estimate) / 205,300 customers in 1986.
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from compact fluorescent fixtures).
Annual participation rate	2,6,4,4,2,2,1%-->end	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to decline beginning in year 3 due to impact of direct installation programs.
Free rider proportion	5%	Based on New England Electric estimate (Nadel, 1990a).

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	3.9	26 for Lighting Rebate program * 15% compact fixture share of program (ACEEE estimate).
Marketing costs ($1000's)	$30	15% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Commercial Reflectors (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Reflectors	Reflectors reduce the amount of light trapped in a fixture and thereby allow less lamps to be used per fixture.
Equip. & install. cost	$45/fixture	From Miller et al., 1989.
Incremental annual O&M	-$.67/fixture	Save 2 lamps/fixture * $2/lamp / 6 yr avg lamp life.
Annual kWh savings/unit	280/fixture	160 Watts/fixture * 50% savings * 3500 op hrs/yr. 160 Watts/fixture assumes customers use a 4-lamp fixture with either energy-saving lamps or ballasts. 3500 op hrs from Nadel et al., 1989.
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Measure life ends when fixture is replaced. Savings from fixture replacements accounted for in Commercial Renovation program.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	212,917 customers	212,780 customers in 1989 using >5000 kWh/yr * 1.012^2 (growth during 1989-91 -- from NYSEO REF II forecast).
# fixtures/customer	62.1	1560 million sq.ft. of comm'l space in 1988 (from NYSEO REF II forecast) / 80 sq.ft./typical fixture (ACEEE estimate) / 210,257 customers in 1988 (see above) * 67% of fixtures which are appropriate for reflectors (from Miller et al., 1989).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from reflectors).
Annual participation rate	1,3,2,2,1,1,0.5%-->end	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to decline beginning in year 3 due to impact of direct installation programs.
Free rider proportion	15%	Based on New England Electric estimate (Nadel, 1990a).
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	5.2	26 for Lighting Rebate program * 20% reflector share of program (ACEEE estimate).
Marketing costs ($1000's)	$40	20% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Electronic Ballasts & T8 Lamps (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	1994	Assume that revised ballast efficiency standards, which take effect in 1995, will require electronic ballasts or equivalent.
Program type	Replacement	
TECHNOLOGY:		
Technology description	Electronic ballasts & T8 lamps	High frequency ballasts and narrow diameter lamps use less energy than conventional low frequency ballasts and standard diameter lamps.
Equipment cost	$18/ballast	$16/ballast + $1/lamp * 2 lamps/ballast (Miller et al., 1989).
Incremental install. cost	$0	Installation cost same as conventional ballast.
Incremental annual O&M	$0	Avg. O&M cost approximately same as with conventional equipment.
Annual kWh savings/unit	80.5/ballast	23 Watts/ballast (from Sylvania fixture test data & Triad/Utrad catalog data) * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Assume that revised ballast efficiency standards, which take effect in 1995, will require electronic ballasts or equivalent.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	2,279,046 ballasts	57,863,000 ballasts sold in U.S. in 1988 (from U.S. Census Bureau, 1989a) * 8053/102310 NY share of U.S. C&I employment (from U.S. Census Bureau, 1989d) * 1752/3672 Con Ed share of NY comm'l floorspace (from Miller et al., 1989) * 1.012^3 (from NYSEO REF II forecast -- used to adjust 1988 sales to 1991).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from electronic ballasts/T8 lamps).
Annual participation rate	5,10,20,40%	ACEEE estimate.
Free rider proportion	5%	Electronic ballasts presently account for less than 2% of U.S. ballast sales (U.S. Census Bureau, 1989a).
UTILITY COSTS:		
Rebate/unit	$16/T8 ballast	ACEEE suggestion based on measure cost.
Staff -- number	5.2	26 for Lighting Rebate program * 20% ballast share of program (ACEEE estimate).
Marketing costs ($1000's)	$40	20% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Post-1995 Ballast Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1995	Program begins where first ballast program leaves off.
End year	1999/2012	Program offers rebates through 1999 to accelerate shift in market towards 3- and 4-lamp ballasts. Without program, it will take until 2012 for 3- and 4- lamp ballasts to reach full market share.
Program type	Replacement	
TECHNOLOGY:		
Technology description	3- & 4- lamp electronic ballasts and T8 lamps	3- and 4-lamp ballasts are more efficient than 1- and 2-lamp ballasts which are widely used at present. T8 narrow diameter lamps are more efficient than the standard diameter lamps.
Equipment cost	-$16/ballast	Based on 4 T8 lamps @ incremental cost of $1 each plus $40 cost of 4-lamp ballast minus $60 cost of two 2-lamp ballasts. Costs from manufacturers.
Incremental install. cost	$6.67	No add'l labor costs for 4-lamp fixtures. When two 2-lamp fixtures are wired to the same ballast, add'l labor & mat'l costs approx. $20 (Alden Hathway, Sylvania, personal communication). Assuming these latter cases account for 1/3 of applications, avg. cost is $20/3.
Incremental annual O&M	$1.47/ballast	ACEEE analysis based on data from manufacturers.
Annual kWh savings/unit	59.5/ballast	17 Watts/ballast (avg. for 3- and 4-lamp ballasts based on Sylvania & Lithonia fixture test data) * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Assume these measures are standard practice when initial units need replacement.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1995	1,046,236 ballasts	2,279,046 ballasts in 1991 (from pre-1995 ballast program) * 1.005^4 (sales growth from 1991-95) * 60% (because use of 3- and 4-lamp ballasts reduce number of ballasts sold) * 75% (because 25% of ballasts go to new construction, which is served by another program).
Annual growth rate	1.2%	From NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	25,35,45,55,65,60,70,80%->end	ACEEE estimate.
Free rider proportion	15%, growing by 5%/yr until	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$5/T8 ballast	ACEEE suggestion - enough to catch purchaser's attention.
Staff -- number	4 thru 1999	ACEEE estimate.
Marketing costs ($1000's)	$200,$100,$100,$100,$100	ACEEE estimate. Includes start-up marketing campaign.

Lighting Rebate Program - HID Retrofits (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Metal halide & sodium vapor fixtures	Replace incandescent and mercury vapor fixtures with higher efficiency HID fixtures.
Equip. & install. cost	$200/fixture	Based on data from Clarke PUD industrial lighting program (Wolfe and McAllister, 1989).
Incremental annual O&M	$0	O&M costs vary widely depending on lamp life & cost. Typically, mercury vapor lamps have the lowest O&M cost, followed by sodium vapor, metal halide, & incandescent. On average, we assume O&M costs will be unchanged by the retrofit.
Annual kWh savings/unit	1000/fixture	(400 Watt mercury vapor - 150 Watt high pressure sodium) * 4000 op hrs/yr (from White, 1989).
Measure life	15	From Nadel et al., 1989.
Replacement rate	0%	Measure life ends when fixture is replaced. In new construction, use of HID fixtures a common practice.
Load shape	Synethesized load shape	Load shape estimated by blending commercial lighting load shape with limited data on load shape of outdoor lighting.
PARTICIPATION:		
Participation - number fixtures/yr	37157,55744,37157,18579, 18579,9289==>end	Based on results of New England Electric program in first two years (White, 1989; John Eastman, personal communication) adjusted by ratio of Con Ed/NEES 1987 C&I sales. Results for year 3-10 are ACEEE estimates and assume that after several years participation drops off from peak levels, and then continues to drop due to the impact of concurrent direct installation program.
Annual growth rate	0%	Assumed to be a stable market because use of high efficiency HID lamps is common in new construction.
Free rider proportion	10%	Based on New England Electric estimate (Nadel, 1990a).
UTILITY COSTS:		
Rebate	$600/kW saved	Approximate rebate paid by New England Electric in 1988 and 1989.
Staff -- number	5.2	26 for Lighting Rebate program * 20% HID share of program (ACEEE estimate).
Marketing costs ($1000's)	$40	20% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Commercial Occupancy Sensors (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Occupancy sensors	Infrared or ultrasonic sensors which turn lights on when someone enters a room and off after they leave the room.
Equip. & install. cost	$0.42/sq.ft.	Avg. of a $65 control for a 125 sq.ft. room and a $115 control for a 350 sq.ft. room (from Miller et al., 1989).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	2.625/sq.ft.	120 Watts/fixture * 50% savings * 3500 op hrs/yr. 120 Watts/fixture assumes half of fixtures were previously fitted with reflectors. Previous use of efficient magnetic ballasts also assumed. 50% savings from Miller et al., 1989.
Measure life	10	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	Load shape modified to increase savings during lunch, early morning, and evening hours and decrease savings at other hours.
PARTICIPATION:		
# eligible in 1991	217,917 customers	212,780 customers in 1989 using >5000 kWh/yr * 1.012^2 (growth during 1989-91 -- from NYSEO REF II forecast).
Suitable sq.ft./customer	1,113	1,560 million sq.ft. of comm'l space in 1988 (from NYSEO REF II forecast) / 210,257 customers in 1988 (see above) * 15% of sq.ft. which is suitable for occupancy sensors (from Miller et al., 1989).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from occupancy sensors).
Annual participation rate	1,2,2,2,1,1,1,1,0.5,0.5%	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to level off beginning in year 3 and decline in year 5 due to impact of direct installation programs.
Free rider proportion	5%	ACEEE estimate based on data cited in Nadel, 1990a.
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	2.6	26 for Lighting Rebate program * 10% for occupancy sensor share of program (ACEEE estimate).
Marketing costs ($1000's)	$20	10% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Daylighting Controls (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Daylighting controls	Light sensing controls which dim artificial lights in proportion to the amount of daylight that is available.
Equip. & install. cost	$60/fixture	From Miller et al., 1989.
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	150/fixture	120 Watts/fixture * 50% savings * 2496 op hrs/yr. 120 Watts/fixture assumes half of fixtures were previously fitted with reflectors. Previous use of efficient magnetic ballasts also assumed. 50% savings from Miller et al., 1989. Avg. op hrs/yr assumes that typical fixture operates 6 days/week and that dimming savings are achieved for an avg of 8 daylit hours/day.
Measure life	10	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	Load shape modified to include only savings during daylit hours.
PARTICIPATION:		
# eligible in 1991	217,917 customers	212,780 customers in 1989 using >5000 kWh/yr * 1.012^2 (growth during 1989-91 -- from NYSEO REF II forecast).
Suitable fixtures/customer	23	1,560 million sq.ft. of comm'l space in 1988 (from NYSEO REF II forecast) / 210,257 customers in 1988 (see above) / 80 sq.ft./fixture * 25% of sq.ft. which is suitable for occupancy sensors (from Miller et al., 1989).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from daylighting controls).
Annual participation rate	0.5,1,1.5,2,2,1%-->end	ACEEE estimate based on some of the most successful programs around the U.S. Participation rate stabilizes in year 5 and drops in year 6 due to impact of direct installation programs.
Free rider proportion	5%	ACEEE estimate based on data cited in Nadel, 1990a.
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	2.6	26 for Lighting Rebate program * 10% for occupancy sensor share of program (ACEEE estimate).
Marketing costs ($1000's)	$20	10% of Lighting Rebate program marketing budget (ACEEE estimate).

HVAC Rebate Program - Chillers (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	Replacement	
TECHNOLOGY:		
Technology description	High efficiency chilers	
Incremental equip. cost	$5628/chiller	From chiller worksheet in NiMo section of appendix.
Incremental install. cost	$0	Installation cost same as conventional chiller.
Incremental annual O&M	$0	Approximately the same as for conventional chillers.
Annual kWh savings/unit	33,948	28.29 peak reduction (from NiMo worksheet) * 1200 full load op hrs/yr (based on Con Ed, 1989 and Applied Energy Group, 1989).
Measure life	20	From Miller et al., 1989.
Replacement rate	0%	When equipment needs replacement, it is eligible for a rebate again, and hence replacement savings are captured as participants in out years of program.
Load shape	Commercial cooling	
PARTICIPATION:		
# eligible in 1991	572	Based on sales of chillers of 50 hp or more: 12,067 chillers sold in U.S. in 1988 (U.S. Census Bureau, 1989b) * 8.44% NY share (based on commercial employment from U.S. Census Bureau, 1989d) * 47.71% Con Ed share (based on comm'l floor area from Miller et al., 1989) * 75% for existing buildings (new building savings accounted for in another program) * 1.45 (to add in rotary chillers to sales estimates -- based on estimates by Jim Block, Enerlogic, personal communication) * 1.027^3 (growth from 1988-91 -- see below).
Annual growth rate	2.7%	Growth rate in cooling energy use from NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	10,30,50,70%-->end	Ramp up over 3 years to 70% participation as achieved by Northern States Power (1988).
Free rider proportion	15%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$4,553/chiller	From NiMo worksheet. Specific rebate schedule also on attached worksheet. This rebate is split 80% to the customer and 20% to the dealer.
Staff -- number	6	2 central staffpersons, 2 technical staff (to work on sizing issues), and 2 field people (ACEEE estimate).
Marketing costs ($1000's)	$144,$147,$151,$124 growing at 2.7%-->end	$200/eligible customer plus material development of $90,000 spread over first 3 yrs (ACEEE estimate).

HVAC Rebate Program - Packaged Systems (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	Replacement	
TECHNOLOGY:		
Technology description	High efficiency packaged air conditioners and heat pumps.	
Incremental equip. cost	$168/unit	From packaged system worksheet in NiMo section of appendix.
Incremental install. cost	$0	Installation cost same as conventional unit.
Incremental annual O&M	$0	Approximately the same as for conventional units.
Annual kWh savings/unit	2,364 for cooling 1,327 for heating	Cooling savings: 1.97 peak reduction (from NiMo worksheet) * 1200 full load op hrs/yr (based on Con Ed, 1989 and Applied Energy Group, 1989). Heating savings: 1.97 peak kW * 1500 full load op hrs (estimate by Jim Block, Enerlogic) * 45% (% of new packaged system capacity in heat pumps -- derived from NiMo worksheet).
Measure life	20	From Miller et al., 1989.
Replacement rate	0%	When equipment needs replacement, it is eligible for a rebate again, and hence replacement savings are captured as participants in out years of program.
Load shape	Commercial cooling + heating	Load shapes modified to reduce winter peak impacts to allow for fact that air source heat pumps do not save at time of winter peak but water source heat pumps do save at time of winter peak.
PARTICIPATION:		
# eligible in 1991	11,027	Based on sales of unitary & split system A/C and heat pumps 65 MBtu/hr and greater. 337,088 units sold in U.S. in 1988 (U.S. Census Bureau, 1989b) * 8.44% NY share (based on commercial employment from U.S. Census Bureau, 1989d) * 47.71% Con Ed share (based on comm'l floor area from Miller et al., 1989) * 75% for existing buildings (new building savings accounted for in another program) * 1.027^3 (growth from 1988-91 -- see below).
Annual growth rate	2.7%	Growth rate in cooling energy use from NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	10,20,30,50%-->end	Ramp up over 3 years to 50% participation (70% participation achieved by Northern States Power chiller rebate program (Northern States Power, 1988), but we assume participation will be slightly lower for packaged systems because of the much larger quantity of units sold each year).
Free rider proportion	15%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$134	From NiMo worksheet. Specific rebate schedule also on NiMo worksheet. This rebate is split 80% to the customer and 20% to the dealer.
Staff -- number	8	1 program manager and 7 technical/field staff (ACEEE estimate).
Marketing costs ($1000's)	$100-->end	ACEEE estimate.

Commercial Refrigeration Efficency Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	Replacement	
TECHNOLOGY:		
Technology description	Multiple technologies	Listed on worksheet in NiMo section of this appendix.
Equip. & install. cost	Average of $16,516	From NiMo worksheet.
Incremental annual O&M	$0	Approximately the same as for conventional chillers.
Annual kWh savings/unit	42,579	From NiMo worksheet.
Measure life	10	From Gordon et al., 1988.
Replacement rate	0%	When equipment needs replacement, it is eligible for a rebate again, and hence replacement savings are captured as participants in out years of program.
Load shape	Commercial refrigeration	
PARTICIPATION:		
# eligible in 1991	3,673	Based on annual sales of refrigeration compressors of 15 hp or more: 117,347 units sold in U.S. in 1988 (U.S. Census Bureau, 1989b) * 8.44% NY share (based on commercial employment from U.S. Census Bureau, 1989d) * 47.71% Con Ed share (based on comm'l floor area from Miller et al., 1989) * 75% for existing buildings (new building savings accounted for in another program) * 1.012^3 (growth from 1988-91 -- see below).
Annual growth rate	1.2%	Growth rate in commercial floor area from NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	10,35,70%-->end	Ramp up over 3 years to 70% participation as was achieved by Northern States Power chiller rebate program (Northern States Power, 1988).
Free rider proportion	20%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	70% of measure cost	Incentive needed to make measure payback attractive to customers.
Staff -- number	6	1 program manager and 5 technical/field staff (ACEEE estimate).
Marketing costs ($1000's)	$100-->end	ACEEE estimate.

Motor Rebate Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2005	Program is operated for a 15 year period -- equivalent to the average life of a motor.
Program type	Replacement	
TECHNOLOGY:		
Technology description	High efficiency motors	Most major manufacturers produce two major lines of motors -- a standard line and a high efficiency line. This program promotes use of the high efficiency line when existing motors burn out.
Incremental equip. cost	$251/motor	From attached worksheet.
Incremental install. cost	$0	Installation cost same as conventional motor.
Incremental annual O&M	$0	Approximately the same as for conventional motors.
Annual kWh savings/unit	1,585/motor	1472 kWh/motor from attached worksheet plus 113 kWh additional savings from reduced oversizing. Lovins et. al. (1989) estimate that available energy savings from correcting oversizing problems amounts to 23% of the energy savings available from high efficiency motors. We assume that as a result of motor audits and other educational efforts, 1/3 of oversizing problems are corrected for motors rebated thru this program (1472*23%/3=113).
Measure life	15	From Gordon et al., 1988.
Replacement rate	50%	ACEEE estimate.
Load shape	Total industrial	Motors primarily used for general industrial and comm'l ventilation. Comm'l ventilation load shape very similar to total ind'l load shape.
PARTICIPATION:		
# eligible in 1991	25,143	32,345 in 1988 (from attached worksheet) * 75% (based on estimate that 25% of motors are for new construction and 75% for existing buildings) * 1.012^3 (growth in sales from 1988-91).
Annual growth rate	1.2%	From NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	5,15,30,50%-->end	First two years are based on BC Hydro experience (Kristin Schwartz, personal communication). Remaining years are ACEEE estimates.
Free rider proportion	50,30,20,16% growing by 1%/yr thru 2005	Wisconsin Electric estimates 50% free riders in first year, 30% in second (Wisconsin Electric, 1988). Other utilities have made similar estimates (Nadel, 1990a). Fourth year estimate based on current sales shares of high efficiency motors for new motors (20% in 1988, rising ~2%/yr according to NEMA and DOE data) and rewound motors (near zero). We assume that new and rewound motors each account for 50% of the rebates, and therefore the free rider pct. equals 50% of the sales share of efficient motors among new motor purchases (e.g., for 1994: (20%+(6 yrs since 1988 * 2%)) /2) = 16.

Motor Rebate Program (Consolidated Edison) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Rebate/unit	$163/motor to customer $16/motor to dealer	Customer rebate from attached spreadsheet. Dealer rebate is 10% of customer rebate.
Staff -- number	3	1 central staffperson plus 2 field staff to do motor audits & inspections (ACEEE estimate).
Marketing costs ($1000's)	$100,$100,$50,$50,$20-->end	BC Hydro (a much larger company) spend $111,000 in 1st yr for indirect costs (Nadel, 1990a). Remaining years are ACEEE estimates.

SUPPORTING DATA FOR MOTOR REBATE PROGRAM - CONSOLIDATED EDISON

Motor Horsepower	Annual Sales			Sales for Which High Effic. Model Avail. (4)	Avg. Motor Size (5)	Average Annual Op. Hrs (6)	Avg Effic. (7)		Percent Savings (8)	Avg kW Savings Per Motor (9)	Avg kWh Savings Per Motor (10)	Motor Costs (11)			Incremental Cost (12)	Annual User Savings (13)	Rebate (14)
	U.S.(1)	NY (2)	ConEd(3)				Std.	High Eff				Std.	High Eff	Rewind			
1-5	1,154,483	91,204	25,172	20,138	1.34	2,352	71.39	82.75	13.7%	0.14	339	$149	$190	$120	$42	$20	$21
6-20	470,211	37,147	10,252	8,202	8.61	2,928	82.81	90.45	8.4%	0.49	1,439	$308	$391	$190	$201	$86	$114
21-50	144,658	11,428	3,154	2,523	25.9	3,568	87.47	93.15	6.1%	1.01	3,608	$730	$909	$335	$574	$216	$358
51-125	70,298	5,554	1,533	1,226	80.6	4,163	89.62	94.95	5.6%	2.82	11,757	$2,287	$2,792	$700	$2,092	$705	$1,386
126-200	14,661	1,158	320	256	195	4,163	91.63	95.75	4.3%	5.12	21,329	$5,656	$7,505	$1,100	$6,405	$1,280	$5,125
Total	1,854,311	146,491	40,431	32,345													
Wtd Avg					9.64					0.44	1,472	$359	$454	$184	$251	$88	$163

Notes:

1. From U.S. Census Bureau, Current Industrial Reports, Motors and Generators, 1988.
2. 7.9% of national sales, based on New York proportion of U.S non-agricultural employment. Employment data from U.S. Census Bureau, Statistical Abstract of the U.S. - 1989.
3. 27.6% of NY sales based on industrial electricity use by motors and 45% of commercial electricity use (from Miller et al., 1989, pp. 28, 30, 73-4). 45% is proportion of comm'l use due to motors (Lovins et al., 1989, p. 28).
4. Assuming approximately 20% of motors cannot be replaced with high efficiency motors (ACEEE estimate based on data from several field surveys).
5. From Miller et al., 1989, p. 32.
6. Average of values estimated by the Arthur D. Little in 1980 and by Xenergy (for Wisconsin Electric industrial customers) in 1989. Values from R.I. study of commercial and industrial motors are even higher.
7. Average nominal efficiency for motor nearest in size to average motor size. Based on average nominal efficiency for 1800 rpm ODP and TEFC motors produced by six major manufacturers. Avg. efficiency multiplied by .98 based on estimates that half the rebates displace rewound motors, and these rewound motors have an average efficiency ~4% lower than new standard motors due to the fact that standard motors have (1) improved in efficiency ~1.8% in last ten years, and (2) rewinding has reduced motor efficiency by 1.8-3.4 percentage points (from Lovins et al., 1989, pp. 83, 397).
8. (Efficient motor efficiency - Std motor efficiency)/Efficient motor efficiency
9. Motor Hp * .746 kW/Hp * .75 avg. load * (1/std eff) * Pct. savings.
10. kW savings * Operating hours.
11. Average cost difference for motor nearest in size to average motor. Based on 1800 rpm TEFC and ODP motors produced by 6 major manufacturers. Costs based on suggested list prices minus a 33% discount (Based on info in Stout and Gilmore, 1989). Rewind costs from Seton, Johnson and Odell, 1987, p. 39.
12. For 1-5 hp class, difference between std. and high efficiency motor cost. For other classes, difference between high efficiency motor cost and rewind cost.
13. Average kWh savings * $.06/kWh.
14. Incremental cost minus value of one year's savings to user.

Adjustable Speed Drive Rebate Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2005	Same as Motor Rebate program.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Adjustable speed drive	Electronic control which can continuously vary motor speed to match the load. When motor operates at less than full speed, energy is saved.
Equip. & install. cost	$24,986	From Miller et al., 1989 -- assumes an avg. motor size of 81 hp.
Change in equip. cost	-2%/year	Based on ACEEE analysis which found that over 1986-90 period, price declined by 4-5%/year.
Incremental annual O&M	$0	Drive requires maintenance but due to soft-start capabilities, drive can reduce motor maintenance costs. These two factors are assumed to balance each other out (a conservative assumption).
Annual kWh savings/unit	54,610	From Miller et al., 1989.
Measure life	15	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Total industrial	Motors primarily used for general industrial and comm'l ventilation. Comm'l ventilation load shape very similar to total ind'l load shape.
PARTICIPATION:		
# eligible in 1991	15,643	2012 GWh savings potential from ASDs in 1986 (from Miller et al., 1989) * 40% (approximate % of C&I motors which represent good applications for ASDs) / 54,610 kWh avg. savings/ASD (see above) * 1.012^5 (growth from 1986-91).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l ASD applications).
Annual participation rate	0.5,1,2,3-->end	First year similar to NEES estimate for first full year of its program. Remaining years ACEEE estimates.
Free rider proportion	10%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	80% for first 5 years, 60% thereafter	Initial rebate designed to help establish ASD market. Thereafter, a smaller rebate should be sufficient.
Staff -- number	3	Based on current BC Hydro staffing for promotion of ASDs.
Marketing costs ($1000's)	$100,$50-->end	ACEEE estimate -- includes initial education/promotion campaign.

C&I Custom Measure Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Any reasonable efficiency measure proposed by a customer.	
Equip. & install. cost	$7,095	$9,335 avg. rebate paid by Wisconsin Electric (WEPCo) in first 21 months of program (Clippert, 1989) * 200% (assuming WEPCo rebate on avg. pays 50% of measure costs * 38% ratio of Con Ed/WEPCo avg. kWh/C&I customer).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	31,274	Based on avg. project in first 21 months of WEPCo program (Clippert, 1989) * 38% Con Ed/WEPCo ratio.
Measure life	10	Average for a wide array of measures (from Nadel, 1990a).
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	412,064	402,350 C&I customers in 1989 (from Con Ed data filing) * 1.012^2 (growth from 1990-91 -- from NYSEO REF II forecast). Many small C&I customers will not participate in this program but are included here because available data on participation rates are based on all C&I customers, including small customers.
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l custom applications).
Annual participation rate	0.3,0.5,0.5,0.3-->end	Based on WEPCo experience for measures not encouraged thru other programs examined in this study. Participation rate reduced in year 4 to account for impact of direct installation programs on demand for custom rebates.
Free rider proportion	30%	From Wisconsin Electric, 1989.
UTILITY COSTS:		
Rebate/unit	50% of measure cost	Based on WEPCo and other custom measure programs.
Staff -- number	7,11,11,7-->end	Assumes 1 staffperson per 200 applications to review applications, conduct inspections and provide TA. Also includes a full-time program manager.
Marketing costs ($1000's)	$150-->end	ACEEE estimate.

C&I Audit Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	1996	Program operates until direct installation programs have fully ramped up.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Audits encourage O&M and other rapid-payback measures. Small customers get a walk-thru audit, medium customers a basic computerized audit, and large customers an enhanced audit.	
Equip. & install. cost	$430	Derived from avg. savings/customer (see below) assuming that the average measure has a 1 year payback at a retail rate of $.07/kWh. PG&E found that the avg. measure implemented after an audit had a simple payback of approx. 0.9 years (Kowalczyk, 1983).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	6,138	122,756 avg. pre-program electricity use by eligible customers (derived from Con Ed data) * 5% savings (typical savings -- net of a control group of non-participants -- for programs without extensive financial incentives as reported in Nadel, 1990a).
Measure life	5	From Nadel, 1990a.
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	217,917	212,780 customers in 1989 using >5000 kWh/yr * 1.012^2 (growth during 1989-91 -- from NYSEO REF II forecast).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l low-cost measures opportunities).
Annual participation rate	3,6,8%-->end	Based on Southern California Edison experience (from Nadel, 1990a).
Free rider proportion	0%	Savings are net savings which have already been adjusted for impact of free riders.
UTILITY COSTS:		
Audit cost	$450/audit	Weighted average assuming 67% of customers get walk-thru audit @ $200, 25% get basic computerized audit @ $600, and 8% get enhanced @ $2000 (based on data in Xenergy, 1990).
Audit follow-up cost	$150/annual visit to a customer	Assumed to be 33% of the cost of a full audit (based on 1/2 day/follow-up including office and field work). Customers receive follow-up visits for 3 yrs. after the initial audit.
Staff -- number	4,6,8,8,8,8,4,4,4	ACEEE estimate for central office administration and field staff supervision. Field staff included in audit cost.
Marketing costs ($1000's)	$200,$400,$500-->1996	ACEEE estimate. Based roughly on projected NYSEG marketing costs (NYSEG, 1989), scaled up to size of this program.

Small C&I Lighting Direct Installation - Reflectors, Ballasts, HID Upgrades, & Compact Fluor. Fixtures (Con Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Program will require a year of planning (1991) before beginning.
End year	2002	Time needed to serve all eligible customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description		See Lighting Rebate program for description of technologies.
Equipment cost	$2,325/customer	Based on New England Electric (NEES) Small C&I program (Obeiter, 1989). Costs and savings are reduced by 15% based on ACEEE analysis which indicates that avg Con Ed small C&I customer is only 85% the size of the typical customer assumed by NEES.
Installation cost	$875/customer	
Incremental annual O&M	-$47/customer	For compacts: 18 bulbs/customer (assuming 75% of compacts noted in Obeiter, 1989, are fixtures & not bulbs) * 1.5 incandescents displaced/yr * $1.33 labor costs to replace a bulb * .85 NiMo/NEES scaling factor (see above). 1.5 and $1.33 are from Compact Fluorescent Rebate program. For reflectors: $234 4' & 8' lamp costs (from Obeiter, 1989) * 67% suitable for reflectors (from Miller et al., 1989) * 50% less lamps used / 6 yr avg. lamp life * 1.5 retail/wholesale mark-up (lamp price based on wholesale price to utility, not retail price to customer) * .85 NiMo/NEES scaling factor (see above).
Annual kWh savings/unit	11,486/customer	Based on NEES estimates from Pastuszek, 1990. These estimates are reduced by 15% (see above).
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Measures are replaced when lighting system is renovated. At this time building will be handled by Commercial Renovation program.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	207,615 customers	202,721 customers in 1989 using 5-250 MWh/yr (Con Ed Data) * 1.012^2 (growth during 1989-91 - from NYSEO REF II forecast).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from Small C&I program).
Annual participation rate	2,5,7%-->end	First two years based on NEES Small C&I program plans. Subsequent yrs based on a steady rate of ~5000/yr until 70% of buinesses are reached. 70% based on SMUD and NEES experience as described in Nadel, 1990a.
Free rider proportion	12%	Based on NEES estimate (Nadel, 1988).
UTILITY COSTS:		
Incentive	100% of measure cost	
Staff -- number	2.5 in planning yr, 22.5, 22.5, 27.5-->end. For entire program, of which reflectors, etc. allocated 89%.	Based on NEES experience, but scaled to Con Ed based on # customers eligible. Share allocated to program components based on energy savings.

Small C&I Lighting Direct Installation - Reflectors, Ballasts, HID Upgrades, & Compact Fluor. Fixtures (Con Edison) CONTINUED

VARIABLE	ASSUMPTION	NOTES
Marketing costs ($1000's)	$562,$812-->end. For entire program, of which reflectors, etc. allocated 89%.	Based on NEES estimates in Obeiter, 1989, but scaled to Con Ed based on # customers elibgible. Share allocated to program components based on energy savings.

Small C&I Lighting Direct Installation - Compact Fluorescent Bulbs (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Program will require a year of planning (1991) before beginning.
End year	2002	Time needed to serve all eligible customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent bulbs	Screw-in fluorescent bulbs which can be substituted for incandescent bulbs.
Equipment cost	\$69/customer	Based on New England Electric (NEES) Small C&I program (Obeiter, 1989). Costs and savings are reduced by 15% based on ACEEE analysis which indicates that avg Con Ed small C&I customer is only 85% the size of the typical customer assumed by NEES.
Installation cost	\$3/customer	
Incremental annual O&M	-\$10/customer	6 bulbs/customer (assuming 25% of compacts noted in Obeiter, 1989, are bulbs & not fixtures) * 1.5 incandescents displaced/yr * \$1.33 labor costs to replace a bulb * .85 Con Ed/NEES scaling factor (see above). 1.5 and \$1.33 are from Compact Fluorescent Rebate program.
Annual kWh savings/unit	679/customer	Based on NEES estimates from Pastuszek, 1990. These estimates are reduced by 15% (see above).
Measure life	3	10,000 hr rated life / 3500 op hrs/yr.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	207,615 customers	202,721 customers in 1989 using 5,000-250,000 kWh/yr (from Con Ed data) * 1.012^2 (growth during 1989-91 -- from NYSEO REF II forecast).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from Small C&I program).
Annual participation rate	2,5,7%-->end	First two years based on NEES Small C&I program plans. Subsequent yrs based on a steady rate of ~5000/yr until 70% of buinesses are reached. 70% based on SMUD and NEES experience as described in Nadel, 1990a.
Free rider proportion	12%	Based on NEES estimate (Nadel, 1988).
UTILITY COSTS:		
Incentive	100% of measure cost	
Staff -- number	2.5 in planning yr, 22.5, 22.5, 27.5-->end. For entire program, of which compact bulbs allocated 5%.	Based on NEES experience but scaled to Con Ed based on # customers eligible. Share allocated to program components based on energy savings.
Marketing costs (\$1000's)	\$562,\$812-->end. For entire program, of which compact bulbs allocated 5%.	Based on NEES estimates in Obeiter, 1989 but scaled to Con Ed based on # customers eligible. Share allocated to program components based on energy savings.

Small C&I Lighting Direct Installation - Occupancy Sensors (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Program will require a year of planning (1991) before beginning.
End year	2002	Time needed to serve all eligible customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Occupancy sensors	Infrared or ultrasonic sensors which turn lights on when someone enters a room and off after they leave the room.
Equipment cost	$69/customer	Based on New England Electric (NEES) Small C&I program (Obeiter, 1989). Costs and savings are reduced by 15% based on ACEEE analysis which indicates that avg Con Ed small C&I customer is approx. 85% the size of the typical customer assumed by NEES.
Installation cost	$69/customer	
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	777/customer	Based on NEES estimates from Pastuszek, 1990. These estimates are reduced by 15% (see above).
Measure life	10	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	207,615 customers	202,721 customers in 1989 using 5,000-250,000 kWh/yr (from Con Ed data) * 1.012^2 (growth during 1989-91 -- from NYSEO REF II forecast).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from Small C&I program).
Annual participation rate	2,5,7%-->end	First two years based on NEES Small C&I program plans. Subsequent yrs based on a steady rate of ~5000/yr until 70% of buinesses are reached. 70% based on SMUD and NEES experience as described in Nadel, 1990a.
Free rider proportion	12%	Based on NEES estimate (Nadel, 1988).
UTILITY COSTS:		
Incentive	100% of measure cost	
Staff -- number	2.5 in planning yr, 22.5, 22.5, 27.5->end. For entire program, of which occupancy sensors allocated 6%.	Based on NEES experience, but scaled to Con Ed based on # customers eligible. Share allocated to program components based on energy savings.
Marketing costs ($1000's)	$562,$812-->end. For entire program, of which occupancy sensors allocated 6%.	Based on NEES estimates in Obeiter, 1989, but scaled to Con Ed based on # customers eligible. Share allocated to program components based on energy savings.

Medium/Large C&I Direct Installation Program (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1993	Last program to start-up -- in interim, customers can participate in audit & rebate programs.
End year	2011	Period required to reach 70% cumulative participation rate.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Comprehensive audits identify conservation measures. Utility then provides financing and arranging assistance.	
Equip. & install. cost	$40,257	191.7 MWh saved/customer (see below) * $.21/kWh saved (based on a similar program operated by Puget Power -- France, 1989).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	191,700	1,917 avg. annual pre-program MWh/customer (derived from Con Ed data) * 10% savings. Based on savings (net of a control group of non-participants) for similar programs operated by Puget P&L, BPA and NU as reported in Nadel, 1990a. Other programs operated by BPA and Boston Edison have achieved savings of approximately 20% by actively encouraging participants to implement all cost-effective measures. On the other hand, due to the impact of concurrent rebate programs for lighting and other improvements, savings opportunities for this prototypical program are lower than for those programs with savings in the 20% range. Allowing for the savings from other concurrent programs, we estimate that average savings of 10% can be achieved by this program if customers are encouraged to implement all cost-effective measures. Savings in the early years of the program are likely to be greater than 10% (because the impact of other programs will be minimal), while savings in the latter years of the program are likely to average less than 10% (because many measures will have been implemented through other programs).
Measure life	10	From Nadel, 1990a - for programs which promote a wide array of measures.
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	10,302	10,302 customers in 1989 using >250,000 kWh/yr * 1.012^2 (growth during 1989-91 -- from NYSEO REF II forecast).
Annual growth rate	0.5%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l conservation opportunities).
Annual participation rate	1,2,3,4%-->end	ACEEE estimate assuming that in order to provide high quality services, only 250-300 customers can be served each year. Cumulative participation rate of 70% based on several limited scale programs reported in Nadel, 1990a.

Medium/Large C&I Direct Installation Program (Consolidated Edison) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
Free rider proportion	0%	Savings are net savings which have already been adjusted for impact of free riders.
UTILITY COSTS:		
Incentives	70% of measure costs	Based on Puget Power program which has paid an average of ~66% (France, 1989).
Staff, administration & marketing costs	27.5% of incentive costs	Based on Puget Power program as reported in Haeri et al., 1988.

Commercial Renovation - Lighting (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Need a full year for planning before program start-up.
End year	2010	
Program type	Remodeling	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed prevailing construction practice. At a minimum measures must exceed building code requirements.	
Incremental equip. cost	$.29/sq.ft.	$0.40 estimate for NiMo programs * 5.48/7.58 Con Ed/NiMo ratio of lighting watts/sq.ft. (from NiMo comm'l renovation worksheet in NiMo section of this appendix and from Con Ed worksheet attached)
Incremental design costs	$0.029/sq.ft.	Assumed to be 10% of equipment costs, as used by Wisconsin Electric. NEES uses 6%.
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit:		For 1992: 5.48 weighted avg. kWh/sq.ft. for lighting in existing buildings before program and before 1991 code change (from NYSEO REF II forecast) * 40% savings (see note above under equipment costs). For 1995: 5.48 minus assumed 15% avg. savings due to ballast efficiency std revision in 1995 (ACEEE estimate) * 40% savings (see note in NiMo worksheet).
1992-1994	2.2 kWh/sq.ft.	
1995-2010	1.9 kWh/sq.ft.	
Measure life	20	Based on estimates in Gordon et al., 1988.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	31.5 million sq.ft.	1617.2 million sq.ft. (from NYSEO REF II forecast) * 39% remodeled over 20 yrs (from attached spreadsheet) / 20 yrs.
Annual growth rate	1.2%	From NYSEO REF II forecast.
Annual participation rate	8,18,28,38,48,58,60%-->end	Assumed to be same as Commercial New Construction program.
Free rider proportion	10%	ACEEE estimate.
UTILITY COSTS:		
Design & construction incentives	100% of design and construction costs	Utility pays all costs because many remodeled facilities are tenant occupied and in these situations building owner generally has no incentive to invest in energy efficiency.
Technical assistance costs	$150,$240,$330,$420,$510, $600-->end	ACEEE estimate based on values used for new construction program. Floor area served by the renovation program is approximately 50% of the floor area served by New Construction program. Also, since only lighting is involved, technical assistance will be less extensive.
Staff -- number	3,4.5,6,7.5,9,10.5-->end	ACEEE estimate.
Marketing costs ($1000's)	$210-->end	50% of values used for New Construction program (ACEEE estimate).

Commercial Remodeling - Lighting Worksheet (Consolidated Edison)

	Light	% of FA	Wtd Avg	% remodel	% of FA	Wtd Avg
Offices	8.78	38%	3.34	53%	38%	20%
Restaurant	9.66	2%	0.19	55%	2%	1%
Retail	7.46	11%	0.82	55%	11%	6%
Grocery	12.27	2%	0.25	5%	2%	0%
Warehouse	0.94	16%	0.15	0%	16%	0%
Schools	6.75	2%	0.14	30%	2%	1%
Colleges	7.56	2%	0.15	30%	2%	1%
Health	4.19	4%	0.17	50%	4%	2%
Hotel	3.26	3%	0.10	43%	3%	1%
Misc	0.89	20%	0.18	36%	20%	7%
		Sum ==>	5.48		Sum ==>	39%

Commercial New Construction (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Need a full year for planning (1991) before program start-up.
End year	2010	
Program type	New construction	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed prevailing construction practice. At a minimum measures must exceed building code requirements.	
Design & construction cost:		$.34/kWh based on Energy Edge program as summarized in Anderson and Benner, 1985. Assumed to increase 25% after code changes in 2000 (rough ACEEE estimate -- add'l analysis needed to confirm). $.34/kWh * 1.65 kWh saved/sq.ft. (see below) = $.56/sq.ft.
1992-2000	$.34/kWh saved = $.56/sq.ft.	
2001-2010	$.42/kWh saved = $.59/sq.ft.	
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit		12.77 weighted avg. kWh/sq.ft. for new buildings before program and before 1991 code change (from NYSEO REF II forecast) minus 14% avg. savings due to code change (from Eric Noble, NYSEO, personal communication) * 15% savings due to program. Estimated savings from Energy Edge program are 29% relative to NW Model Conservation Stds (Anderson and Benner, 1988). These stds. are roughly similar to new NY code. Savings at half this level are assumed for this full-scale program (a similar assumption is made by NEES). Baseline declines 15% after code revisions, but % savings assumed to remain the same, and hence kWh savings decline 15% after code revisions.
1992-2000	1.65 kWh/sq.ft.	
2001-2010	1.40 kWh/Sq.ft.	
Measure life	30	Based on estimates in Gordon et al., 1988.
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	54.33 million sq.ft.	From NYSEO REF II forecast.
Annual growth rate	1.2%	From NYSEO REF II forecast.
Annual participation rate	8,18,28,38,48,58,60%-->end	First year based on New England Electric first year participation rate. Subsequent years based on New England Electric and Northeast Utilities projections. 1990a).
Free rider proportion	0%	Savings are net savings which have already been adjusted for impact of free riders.
UTILITY COSTS:		
Design & construction incentives	90% of design & construction costs	Similar to Energy Edge, New England Electric, & Northeast Utilities programs.
Technical assistance costs	$682,$1078,$1474,$1870,$2266 $2662-->end	Based on New England Electric 1990 budget for consultants and training (Obeiter, 1989) scaled up to reflect greater new comm'l sq. ft. in Con Ed service area. Assumed to increase by $396,000/yr until peak participation reached (based on assumption that repeat program participants require only half the level of assistance as new participants).

Commercial New Construction (Consolidated Edison) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
Staff -- number	1.5 (in program planning yr.), 7.5,10.5,13.5,16.5, 19.5,22.5,24-->end	ACEEE estimate.
Marketing costs ($1000's)	$420-->end	Based on New England Electric 1990 budget (Obeiter, 1989) scaled up to reflect greater new comm'l sq.ft. in Con Ed service area.

Industrial New Construction/Modernization (Consolidated Edison)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	New construction & remodeling	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed prevailing practice in new manufacturing facilities.	
Design & construction cost	$21,484/customer	131 MWh saved/customer (see below) * $.164/kWh saved (average cost of industrial measures with a levelized cost less than $.05/kWh (real basis) as identified for Northeast Utilities (NU) service territory -- Synergic Resources Corp. (SRC), 1989).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	131 MWh/customer	1313 MWh/yr average use by Con Ed industrial customers (from EIA, 1989) * 10% savings (rough ACEEE estimate based on discussions with Gail Katz at Momentum Engineering).
Measure life	10	From Nadel, 1990a.
Replacement rate	50%	ACEEE estimate.
Load shape	Total industrial	
PARTICIPATION:		
# eligible in 1991	1,149 customers	1,066 in 1987 (from EIA, 1989) * 1.019^4 (see below).
Annual growth rate	1.9%	Growth rate in ind'l elec. sales from NYSEO REF II forecast.
Annual participation rate	1,2%-->end	Rough ACEEE estimate based on discussions with Gail Katz, Momentum Engineering.
Free rider proportion	20%	Based on SRC estimate for NU program (SRC, 1989).
UTILITY COSTS:		
Design & construction incentives	80% of design & construction costs	
Technical consultant costs	10% of measure costs	ACEEE estimate.
Staff -- number	1-->end	ACEEE estimate.
Marketing costs ($1000's)	$50-->end	Based on SRC estimate for NU program (SRC, 1989) prorated for Con Ed based on ind'l kWh use.

Residential Energy Fitness - Lighting (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Based on # of customers that can be effectively served in a year.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent lightbulbs	Compact fluorescents replace standard incandescent lightbulbs and reduce electricity use per lamp by approximately 75%.
Equipment cost	$36.96/household	4 bulbs replaced/household (other utility programs range from 3.4-5.5) * $11/bulb (typical bulk purchase price for 2-piece compact fluorescents) * 84% measure acceptance rate (based on Michigan Energy Fitness experience -- Kushler et al., 1989).
Installation cost	$17.12/household	2 people/HH for 1 hour and 1 lead person for every six teams (Kushler et al., 1989, and Egel, 1986) * $10/hr * 79% of labor costs assigned to lighting portion of program based on the lighting portion of total program electricity savings.
Incremental annual O&M	$0	Compact fluorescent lamps last longer and need to be changed less often, but we assume resident labor is free.
Annual kWh savings/unit	306	4 lamps * 57 watts * 1600 hours * 84% penetration. Based on replacing 75 watt bulbs with 18 watt bulbs which will be used 1600 hours/year (White, 1989). Penetration rate for compact fluorescents based on Michigan experience (Kushler et al., 1989).
Measure life (in years)	6	Based on 10,000 hour life and 1600 hours/year use (White, 1989).
Replacement rate	0%	Bulb replacement will occur thru the Lighting Coupon program.
Load shape	Residential lighting	
PARTICIPATION:		
# eligible in 1991	921,576 households	912,000 res'l customers in 1990 * 1.0105 growth rate (from NYSEO Ref II forecast)
Annual growth rate	0.8%	Based on NYSEO REF II forecast, but excluding 50% of customers served by Residential New Construction program (under assumption that due to efforts to promote compact fluorescent fixtures thru New Construction program, opportunities for compact fluorescent retrofits will be reduced by 50%). See Table A-4.
Annual participation rate	2, 2.5, 3, 4%=> end	First year rate based on 1st year of similar NEES program. Program to double in size over a three year timespan. On a cumulative basis, program will serve 47.5% of eligible homes (based on participation rates achieved by Michigan and NEES programs in targeted communities -- Nadel, 1990b).
Free rider proportion	10%	Based on Michigan program (Kushler et al., 1989).
UTILITY COSTS:		
Cost/Unit	$54.08 household	Utility pays all equipment and installation costs (see above).

VARIABLE	ASSUMPTION	NOTES
Staff -- number	6.3	Based on 4 full time utility and 4 full time contractor staff * 79% (lighting portion of program costs -- see above). Based on NEES Energy Fitness Program (Obeiter, 1989) times two since this program will be approximately twice as large.
Marketing costs	$6.56/participant	$8.30/participant * 79% (lighting portion of program). Based on NEES experience ($8.30/participant -- New England Electric, 1990b) and Santa Monica Energy Fitness ($6.04/participant -- Egel, 1986).

Residential Energy Fitness - Water Heating (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Based on # of customers that can be effectively served in a year.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Hot water conservation measures	Water heater wraps, pipe wrap, low-flow showerheads, faucet aerators, and reseting the water heater thermostat to 120 degrees F (with customer permission).
Equipment cost	$12.72/household with electric water heat	From Residential Energy Fitness worksheet in NiMo section of this appendix.
Installation cost	$46.43/household with electric water heat	2 people/HH for 1 hour and 1 lead person for every six teams (Kushler et al., 1989 & Egel, 1986) * $10/hr * 15% of labor costs assigned to water heating portion of program based on hot water portion of total Energy Fitness electricity savings / 7% electric water heat saturation rate (from Miller et al., 1989).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	827	From Residential Energy Fitness worksheet in NiMo section of this appendix.
Measure life (in years)	10	ACEEE estimate. Some measures (low-flow showerheads and pipe wrap) will probably last more than 10 yrs on average, while other measures (water heater wraps and thermostat setback) will last less than 10 yrs on average.
Replacement rate	0%	Majority of savings are due to water heater wrap and thermostat setback. When new water heaters are purchased, due to impact of efficiency standards, high insulation levels will be a standard feature. Plumbers unlikely to reset thermostat.
Load shape	Residential water heating	
PARTICIPATION:		
# eligible in 1991	64,510 households	912,000 residential customers in 1990 * 1.0105 growth rate from NYSEO Ref II forecast) * 7% electric water heater satuuration rate.
Annual growth rate	0.5%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because hot water retrofit measures will be incorporated into New Construction program).
Annual participation rate	2, 2.5, 3, 4%=> end	First year rate based on 1st year of similar NEES program. Program to double in size over a three year timespan. On a cumulative basis, program will serve 47.5% of eligible homes (based on participation rates achieved by Michigan and NEES programs in targeted communities -- Nadel, 1990b).
Free rider proportion	10%	Based on Michigan program (Kushler et al., 1989).
UTILITY COSTS:		
Cost/Unit	$59.15	Utility pays all equipment and installation costs (see above).

VARIABLE	ASSUMPTION	NOTES
Staff -- number	1.2	Based on 4 full time utility and 4 full time contractor staff * 15% (hot water portion of program costs -- see above). Based on NEES Energy Fitness Program (Obeiter, 1989) times two since this program will be approximately twice as large.
Marketing costs	$17.79/participant	$8.30/participant * 15% (hot water portion of program) / 7% (electric water heater saturation rate). Based on NEES experience ($8.30/participant -- New England Electric, 1990b) and Santa Monica Energy Fitness ($6.04/participant -- Egel, 1986).

Residential Energy Fitness - Weatherization (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Based on # of customers that can be effectively served in a year.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Infiltration reduction measures	Rope caulk, weatherstripping, plastic storm windows, and outlet gaskets.
Equipment cost	$23.52/household with electric heat	From Residential Energy Fitness worksheet in NiMo section of this appendix.
Installation cost	$26.00/household with electric heat	2 people/HH for 1 hour and 1 lead person for every six teams (Kushler et al., 1989 & Egel, 1986) * $10/hr * 6% of labor costs assigned to weatherization portion of program based on space heating portion of total Energy Fitness electricity savings/ 5% electric space heating saturation rate (Miller et al., 1989).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	474	4.5% (based on estimates from Dunsworth, 1984, and Massachusetts Audubon Society, 1986) * 10,538 (avg. annual space heat use for LILCo space heat customers--from Miller et al., 1989).
Measure life (in years)	9	Based on a weighted average of the estimated life of each weatherization measure and the expected savings (Outlet gaskets 1% savings * 20 yrs + Weatherstripping 1.75% savings * 10 years + Caulking and Plastic Storm windows 1.75% savings * 1 year) / 4.5% total savings.
Replacement rate	50%	ACEEE estimate. Note: At time of replacement, equipment costs are increased by 50% to account for the fact that the initial purchase by the utility was at wholesale prices, but the repurchase is by consumers at retail prices.
Load shape	Residential space heating	
PARTICIPATION:		
# eligible in 1991	46,079 households	912,000 residential customers in 1990 * 1.0105 growth rate from NYSEO Ref II forecast) * 5% electric space heating saturation rate.
Annual growth rate	0.5%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because infiltration reduction measures will be incorporated into New Construction program).
Annual participation rate	2, 2.5, 3, 4%=> end	First year rate based on 1st year of similar NEES program. Program to double in size over a three year timespan. On a cumulative basis, program will serve 47.5% of eligible homes (based on participation rates achieved by Michigan and NEES programs in targeted communities -- Nadel, 1990b).
Free rider proportion	10%	Based on Michigan program (Kushler et al., 1989).

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Cost/Unit	$49.52	Utility pays all equipment and installation costs (see above).
Staff -- number	0.48	Based on 4 full time utility and 4 full time contractor staff * 6% (weatherization portion of program costs -- see above). Based on NEES Energy Fitness Program (Obeiter, 1989) times two since this program will be approximately twice as large.
Marketing costs	$9.96/participant	$8.30/participant * 6% (weatherization portion of program) / 5% (electric space heat saturation rate). Based on NEES experience ($8.30/participant -- New England Electric, 1990b) and Santa Monica Energy Fitness ($6.04/participant -- Egel, 1986).

Residential Lighting Coupon/Catalog (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2003	Program runs as long as Energy Fitness program.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent lightbulbs	Compact fluorescents replace standard incandescent lightbulbs and reduce electricity use per lamp by approximately 75%.
Equipment cost	$52.00/household thru 1996, $42.00/household thereafter.	4 bulbs purchased/household (other utility programs range from 3.4-5.5) * $13/bulb (average of utility bulk-purchase price of $11 (see Energy Fitness - Lighting program) and typical retail cost of $15 (based on Energy Federation, 1989). Beginning in year 7, replacement bulbs dominate the program, and we assume that half the customers will purchase replacement lamps (to go with existing ballasts) at $6 each, and half will purchase lamp/ballast combinations at a retail cost of $15. Thus, costs/household = 4 lamps/household 8 (6+15)/2 = $42.
Mailing cost	$0.82/household	$1.64 estimated warehousing, processing and mailing costs (estimate from Rockville mailing) * 50% of bulbs that are mailed (as opposed to sold thru stores).
Incremental annual O&M	-$6	Due to longer lifetime of compact fluorescent bulbs, each year two incandescent lamps are saved per socket. Savings/household = 4 compacts * 2 incandescents saved/socket * $.75 avg. incandescent cost.
Annual kWh savings/unit	365	4 bulbs * 57 watts * 1600 hours. Based on replacing 75 watt bulbs with 18 watt bulbs which will be used 1600 hours/year (White, 1989).
Measure life (in years)	6	Based on 10,000 hour life and 1600 hours/year use (White, 1989).
Replacement rate	80% during program, 50% after program ends	ACEEE estimate.
Load shape	Residential lighting	
PARTICIPATION:		
# eligible in 1991	921,576 households	From NYSEO REF II forecast.
Annual growth rate	0.8%	Based on NYSEO REF II forecast, but excluding 50% of customers served by Residential New Construction program (under assumption that due to efforts to promote compact fluorescent fixtures thru New Construction program, opportunities for compact fluorescent retrofits will be reduced by 50%).
Annual participation rate	2,4,6,8%-->yr 6. Thereafter 80% of Energy Fitness and Residential Lighting program participants from 6 yrs ago.	Program will reach 36% participation after 6 years. Wisconsin Electric served 7% in 1 year with a similar mail order program. A coupon program in Sweden served ~20% of customers after 2 years (Nadel, 1990b).
Free rider proportion	0% first 6 yrs, 25% thereafter	Due to present lack of product availability, free riders assumed to zero until bulbs need replacement. Beginning in year 7, program emphasizes replacement of burned-out bulbs, and free riders estimated to be 25% (ACEEE estimate).

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Cost/Unit	$40.82/household thru 1996, $39.82 thereafter.	Customers pay $3/bulb and the utility pays remaining costs.
Staff -- number	2	ACEEE estimate.
Marketing costs	$3/participant	Based on Central Maine Power program (Schick et al., 1990).

Residential Water Heating Retrofit (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	Start and end dates coincide with Energy Fitness program since marketing of these programs is closely linked.
End year	2003	
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Hot water conservation measures	Water heater wraps, pipe wrap, low-flow showerheads, faucet aerators, and reseting the water heater thermostat to 120 degrees F (with customer permission).
Equipment cost	$12.72/household with electric water heat	From Residential Energy Fitness worksheet in NiMo section of this appendix.
Installation cost	$10/household	1 person * 1 hour * $10/hour (ACEEE estimate based on total program costs reported by several utilities).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	827	From Residential Energy Fitness worksheet in NiMo section of this appendix.
Measure life (in years)	10	ACEEE estimate. Some measures (low-flow showerheads and pipe wrap) will probably last more than 10 yrs on average, while other measures (water heater wraps and thermostat setback) will last less than 10 yrs on average.
Replacement rate	0%	Majority of savings are due to water heater wrap and thermostat setback. When new water heaters are purchased, due to impact of efficiency standards, high insulation levels will be a standard feature. Plumbers unlikely to reset thermostat.
Load shape	Residential water heating	
PARTICIPATION:		
# eligible	Electric water heat households served by Energy Fitness * 1.105	Eligible households are those that were not reached by Energy Fitness when Energy Fitness served their community. Since 47.5% of households are served by Energy Fitness, number eligible for this program = Energy Fitness participants * 52.5%/47.5%.
Annual growth rate in number eligible	0.5%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because hot water retrofit measures will be incorporated into New Construction program).
Annual participation rate	60% of households eligible each year	Based on experience by Seattle City Light and NEES (Nadel, 1990b).
Free rider proportion	12%	ACEEE estimate based on NEES evaluation of their water heater wrap program (New England Electric, 1988) which estimated that 12% of the customers had wrapped their water heaters on their own.
UTILITY COSTS:		
Direct costs/unit	$22.72/household	Utility pays all equipment and installation costs (see above).

VARIABLE	ASSUMPTION	NOTES
Staff -- number	0.25	Based on NEES Water Heater Wrap program prorated to size of this program.
Installation contractor administrative costs	$37,500/year	ACEEE estimate for a program of this size based on total program costs of $55/participant reported by Central Maine Power (Central Maine Power, 1989) and BC Hydro (Schick et al., 1990).
Marketing costs	$6.88/participant	From Schick et al., 1990.

House Doctor (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	Start and end dates coincide with Energy Fitness program since marketing of these programs is closely linked.
End year	2003	
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Infiltration reduction measures	Trained crew identifies and seals heat leaks with the aid of a blower door.
Cost/home	$250	Based on experience reported by Proctor & deKieffer (1988) and Jacobson et al. (1990). This cost assumes some of the homes served are apartments.
Annual O&M	$0	Little maintenance required.
Annual kWh svgs/unit	843/home	7.5% of heating and cooling use. Proctor and deKieffer (1988) report 10.6% average heating savings with an experienced crew and good quality control. Jacobson et al. (1990) estimate 5 - 5.5% savings for a smaller amount of work. We choose 7.5% to take into account that (1) some savings have been achieved in some homes through the Energy Fitness program, and (2) training and quality control in a large-scale program will probably not be as good as in the Proctor and deKieffer program. Average heating use of 10,538 kWh/yr and cooling use of 712 kWh/year assumed for LILCo (from Miller et al., 1989).
Measure life (years)	13	From Nadel & Heineman, 1986.
Replacement rate	0%	Measures which fail will be in hard to reach places, and thus, few homeowners are likely to replace failed measures.
Load shape	Residential space heating and cooling	Analyzed savings by end-use (see above) with the appropriate load shape.
PARTICIPATION:		
# eligible in 1991	46,079 households	921,576 residential customers (from NYSEO REF II forecast) * 5% electric space heating saturation rate.
Annual growth rate	0.5%	Based on NYSEO REF II forecast, but excluding all customers served by Residential New Construction program (because infiltration reduction measures will be incorporated into New Construction program).
Annual participation rate	2,3,4,5%-->end	ACEEE estimate. Program cumulative participation rate totals 59%. Based on Hood River - 85% penetration (Brown et al., 1987), TVA - 62% penetration over 13 years and Central Maine Power - 50% penetration (Schick et al, 1990).
Free rider proportion	10%	Very few customers would use the blower door on their own. 10% free rider estimate captures overlap between House Doctor work and conventional caulking and weatherstripping work that may be done by some homeowners.

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Utility rebate/unit	$233	The utility pays $233, and the customer $17 (see Customer costs/unit).
Staff -- number	.5,1,1,1.5-->end	ACEEE estimate.
Marketing costs (1000's)	$64,$71,$78,$85-->end	$15/house + $50,000. NEES program mktg costs averaged $30/home (Jacobson et at., 1990), but we assume that marketing is needed for only half of the participants because the other half are assumed to be Energy Fitness program referrals.
CUSTOMER COSTS:		
Customer costs/Unit	$17	Each participant (except low income) is charged a $20 fee. This fee is designed to ensure that the customer places value on the work being performed. Because low income participants (assumed to be 15% of the participants) pay nothing, the average customer cost is $20 * (1-15%) = $17.

Home Insulation (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	Start and end dates coincide with Energy Fitness program since marketing of these programs is closely linked.
End year	2003	
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Insulation and other energy-saving capital improvements	Includes attic, wall, and basement insulation, window repairs (and replacements where needed), and attic ventilation improvements.
Total Cost	$525/household	Includes materials, labor & arranging services: ~$520/home for materials and labor (Jacobson et al., 1990), and $100 for arranging services (Jacobson et al. found these costs averaged $65/insulation contract) * 85% to allow for fact that a typical LILCo home is somewhat smaller than homes served in Jacobson et al. program.
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	1048/household	Based on engineering estimates of energy savings from insulation improvements in NEES weatherization program (Jacobson et al., 1990)* 10,538/13,322 ratio of LILCo/NiMo avg space htg elec use.
Measure life (in years)	20	From Miller et al., 1989.
Replacement rate	0%	Measures will most likely be replaced during remodeling, which will be subject to building codes, & therefore replacement will occur via another avenue. In addition degradation of insulation is difficult for the homeowner to see, therefore, few customers would know that something had to be corrected, let alone actually do the work.
PARTICIPATION:		
# eligible in 1991	46,079 households	921,576 residential customers (from NYSEO REF II forecast) * 5% electric space heating saturation rate.
Annual growth rate	-0.42%	Demolition rate from NYSEO REF II forecast. We assume that new electrically heated homes will not need insulation upgrades.
Annual participation rate	0.7%, 1.05%, 1.40%, 1.75% --> end	Based on House Doctor participation * 35%. 35% assumes that 50% of electrically heated homes need upgrades (based on NEES pilot program experience -- Jacobson et al., 1990) and 70% of those will participate (ACEEE estimate).
Free rider proportion	10%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$367.50/household	The customer pays 30% ($157.50) and the utility 70% ($367.50) of $525. This cost-share has proven very effective in BPA's weatherization program (Schick et al., 1990).
Staff -- number	1,1,2--> end	ACEEE estimate.
Marketing costs ($1000's)	$30,$32,$35,$37-->end	$15/house + $25,000. NEES program mktg costs averaged $30/home (Jacobson et at., 1990), but we assume that marketing is needed for only half of the participants because the other half are assumed to be Energy Fitness program referrals.

Residential Refrigerator Rebate Program (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2002	Units of qualifying efficiency mandated in 2003 thru appliance efficiency standards.
Program type	Replacement & new	
TECHNOLOGY:		
Technology description	Very high efficiency refrigerators	Refrigerators meeting level 5 standards recently studied by DOE (1989). Includes vacuum panel insulation which dramatically reduces CFC's.
Incremental purchase cost	$200 until 5% of households reached, $100 thereafter.	DOE (1989) estimates $100 cost to manufacturer. This is doubled for first 5% of the refrigerator stock assuming manufacturers need to recover R&D expenses. Thereafter it is assumed manufacturers cover expenses (thus profit/unit is the same as at present.
Incremental annual O&M	$0	Same as present models.
Annual kWh savings/unit	197	From U.S. DOE, 1989a relative to 1993 efficiency standards.
Measure life	19	From U.S. DOE, 1989a.
Replacement rate	0%	Since qualifying units are assumed to be mandated as of 2003, the program cannot take credit for any replacements.
Load shape	Residential refrigeration	
PARTICIPATION:		
# eligible in 1991	77,564 refrigerators	(921,576 residential customers * 1.25 refrig./customer / 19 year avg refrig life) + (921,576 customers * 1.47% new construction rate * 1.25 refrig./customer). Life from DOE, 1989. Number refrig/hh from Miller et al., 1989. Remaining figures from NYSEO REFII forecast.
Annual growth rate	1.05%	Growth in # residential customers -- from NYSEO REFII forecast.
Annual participation rate	0,0,1,5,15,30,50,100%-->end	ACEEE estimates. 100% participation from 1998-2002 assumes that this type of program is offered by several utilities, and as a result, qualifying efficiency levels mandated in 1998 -- 5 years sooner than if program were not offered.
Free rider proportion	0%	Without utility-led effort, qualifying units would not be manufactured.
UTILITY COSTS:		
Rebate/unit	100% of incremental cost	Utility pays full incremental cost in order to stimulate manufacturers to produce & consumers to buy qualifying models.
Staff -- number	.25,.25,2,2,3,4,4,0-->end	ACEEE estimate.
Marketing costs ($1000's)	21,42,170,170,128,85,85, 0-->end	ACEEE estimate. Assumes heavy marketing as soon as qualifying units available, with reduced marketing after market established.

Residential Heat Pump Water Heater Rebate Program (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Will take a year of effort (1991) to convince local dlrs to stock units.
End year	2010	
Program type	Replacement & new	
TECHNOLOGY:		
Technology description	Heat pump water heaters	Water heaters which use a heat pump to supply heat and not an electric resistance coil.
Incremental purchase cost	$750/unit	From Geller, 1988.
Incremental annual O&M	$0	Units require annual oiling and occaisional vacuuming (Bernie Mittelstaedt, DEC Int'l, personal communication). These are no cost measures which can be done by the homeowner.
Annual kWh savings/unit	2,972	13.99 kWh/day/.945 energy factor of high efficiency standard water heater * 365 days/yr * 55% savings. 13.99*365/EF formula developed by DOE for water heater labeling program. This applies to a family of four and not to the "average" family of approx. 2 people. National efficiency standards require a .88 EF in 1990 (Geller, 1988). We assume here that this rises to approx. .94 when the standards are revised effective 1995. 55% savings from Moore, 1981 based on his review of independent research results.
Measure life	13	13 yr life is standard for conventional water heaters (U.S. DOE, 1982). Heat pump water heaters should have the same life because the weak part of heat pump water heaters is the tank and most heat pump water heater manufacturers purchase tanks from producers of standard water heaters (Bernie Mittelstaedt, DEC Int'l, personal communication).
Replacement rate	50% after program ends.	ACEEE estimate. During program, replacement units are included as program participants.
Load shape	Residential water heating	
PARTICIPATION:		
# eligible in 1991	7,631 water heaters	(921,576 residential customers * 7% with electric water heaters / 13 year avg life) + (921,576 customers * 1.47% new home construction rate * 19.7% with electric water heaters). 7% from Miller et al., 1989. Remaining figures from NYSEO REFII forecast.
Annual growth rate	1.05%	Growth in # residential customers -- from NYSEO REFII forecast.
Annual participation rate	1,3,5,7,10,15,20,25,30,35, 40%-->end	ACEEE estimate. Participation in first two years is similar to participation in first two years of a pilot BPA program which combined high rebates and high promotion (Major and Cody, 1987). Participation rates beyond first two years have yet to be demonstrated in actual practice. These rates assume that few 1-person households will purchase heat pump water heaters.
Free rider proportion	0%	Due to high cost of technology without incentives, free riders in the residential sector are assumed to be zero.

Residential Heat Pump Water Heater Rebate Program (Long Island Lighting) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Rebate/unit	$650/unit	Same rebate as presently paid by Wisconsin Electric.
Staff -- number	1	ACEEE estimate. In early years staff emphasizes personal marketing to distributors, plumbers, and builders. In latter years, more effort is devoted to handling rebate requests.
Marketing costs ($1000's)	$25,$125,$125,$75,$50-->end	ACEEE estimate. Assumes a major marketing campaign in first few years of program.

Residential New Construction (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Will take a year to plan program (1991) before it can begin.
End year	2010	
Program type	New construction	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed local building code and prevailing construction practices.	
Incremental construction cost	$1,260	From attached worksheet.
Incremental annual O&M	$0	Approximately the same as a conventional house.
Annual kWh savings/unit	3,066/home	From attached worksheet.
Measure life	30+	ACEEE estimate.
Replacement rate	Not applicable	Measure life is greater than the 30 year analysis period.
Load shape	Residential space heating, cooling, water heating, & lighting	Analyzed savings by end-use (from attached worksheet) with the appropriate load shape.
PARTICIPATION:		
# eligible in 1991	2,669 electrically heated homes	From NYSEO REF II forecast. Based on a 1.05% annual growth rate plus a .42% replacement rate for existing homes. Also includes a 19.7% saturation rate for electric heat in new homes in the LILCo service territory.
Annual growth rate	1.05%	Growth in # residential customers -- from NYSEO REFII forecast.
Annual participation rate	5,15,25,35,45,50%-->end	ACEEE estimate. Several utilities have achieved participation rates of over 40% with BPA's Super Good Cents program including one utility with a participation rate over 70% (Schick et al., 1990).
Free rider proportion	0%	It is assumed that only a few homes currently meet the program's standards, and these homes are more than compensated for by efficient homes built in the latter years of the program for which builders do not bother to apply for incentives.
UTILITY COSTS:		
Incentive/unit	$936/home	From attached worksheet.
Builder training	$20 in planning year, $20,$20,$10,$5-->end	ACEEE estimate. These figures are approximately 20% of those for a similar program planned by New England Electric because LILCo has fewer new homes & because we assume that costs of a LILCo program will be split between the gas and electric sides of the company.
Inspections	$150/home	From Lou Gougoun, Retrotec, personal communication. We assume that 100% of the homes are inspected in the first 2 yrs, 50% in the 3rd yr, 25% in the 4th yr, and 10% thereafter.
Staff -- number	0.33 in planning year, .67,1-->end	ACEEE estimate. Matching resources provided by gas side of Company
Marketing costs ($1000's)	$33-->end	ACEEE estimate. Matching resources provided by gas side of Company

Residential New Construction
Worksheet to Calculate Average Costs, Savings and Incentive -- LILCo

	Single Family	2-4 Family	5 + Family	Weighted Average	Notes
% of new homes	63%	12%	24%	99%	For new homes in LILCo territory from SEO REF II forecast.
Elec. saturation in new homes	15.2%	27.7%	27.7%	19.7%	For new homes in LILCo territory from SEO REF II forecast.
Space heat					
kWh savings due to program	3805	1650	1,177	2,545	For NEES residential new construction program from NEES, 1990. Savings are relative to Mass. building code which is very similar to NY building code. 5+ unit savings prorated from single family home savings based on data for LILCo in Miller et al., 1989.
Water heat					
kWh savings due to program	65	65	65	65	For NEES residential new construction program from NEES, 1990.
Central air conditioning					
kWh savings due to program	258	176	80	183	For NEES residential new construction program from NEES, 1990. Assumes half the floor area is cooled with either central or room A/C. 5+ unit savings prorated from single family home savings based on data for LILCo in Miller et al., 1989.
Lighting					
kWh savings due to program	273	273	273	273	For NEES residential new construction program from NEES, 1990.
Measure costs	$1,600	$1,100	$850	$1,260	Based on program being planned by seven Mass. utilities (Mark Kelley, personal communication). Cost for 5+ unit buildings prorated based on space heat savings relative to 2-4 unit building.
Incentive payments	$1,200	$850	$600	$936	Based on Mass. program (Mark Kelley, personal communication). Mass. program plans to pay incentives for electrically heated single-family homes of $1300 for the first 10 homes a builder builds, and $1000/home thereafter. Incentives for multi-family homes are $900 for first ten homes, and $650 thereafter. In addition, an average incentive of $100/unit for efficient lighting is planned.

NOTE: Weighted averages based on data for LILCo territory as summarized in first two lines of this worksheet.

Lighting Rebate Program - Commercial Compact Fluorescent Bulbs (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Need other program approaches to reach add'l customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent bulbs	Screw-in fluorescent bulbs which can be substituted for incandescent bulbs.
Equipment cost	$9/lamp	Typical price for a medium-sized commercial customer.
Installation cost	$1.33/lamp	From Nadel et al., 1989.
Incremental annual O&M	-$2/lamp	$1.33 installation cost (see above) * 1.5 incandescent lamps not replaced each year (assumes long-life incandescent lamps w/ a 2000 hr life are replaced). Replacement lamp costs are not included because (a) these are highly variable, and (b) compacts are equally likely to save money per socket-yr as to cost money (Nadel et al., 1989).
Annual kWh savings/unit	218/lamp	83 Watts for an avg incandescent lamp (from Xenergy, 1988) * 75% savings * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	3	10,000 hr rated life / 3500 op hrs/yr.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	78,913 customers	77,747 customers in 1990 using >5000 kWh/yr * 1.015 (growth during 1989-91 -- from NYSEO REF II forecast).
# lamps/participant	3.3	1,615 GWh used for comm'l ltg in LILCo territory in 1986 (from Miller et al., 1989) * 21.5% incandescent share (from Nadel et al., 1989) / 83 avg Watts/lamp (see above) / 3500 avg. annual op hrs/lamp * 80% of fixtures for which replacement is appropriate (from Xenergy, 1989) * 25% of sockets which get compact bulbs, & not fixtures (ACEEE estimate) / 73,252 customers in 1986.
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from compact fluorescent bulbs).
Annual participation rate	2,6,4,4,2,2,1%-->end	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to decline beginning in year 3 due to impact of direct installation programs.
Free rider proportion	5%	Based on New England Electric estimate (Nadel, 1990a).
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	0.4	8 for Lighting Rebate program * 5% compact bulb share of program (ACEEE estimate).
Marketing costs ($1000's)	$3.75	5% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Commercial Compact Fluorescent Fixtures (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent fixtures	Two-piece compact fluorescent lamps or fixture inserts in which bulb can be replaced w/o replacing ballast.
Equipment cost	$17/lamp	Typical price for a medium-sized commercial customer -- fixture inserts cost more than this amount but two-piece screw-in units cost less.
Installation cost	$1.33/lamp	From Nadel et al., 1989.
Incremental annual O&M	-$2/lamp	$1.33 installation cost (see above) * 1.5 incandescent lamps not replaced each year (assumes long-life incandescent lamps w/ a 2000 hr life are replaced). Replacement lamp costs are not included because (a) these are highly variable, and (b) compacts are equally likely to save money per socket-yr as to cost money (Nadel et al., 1989).
Annual kWh savings/unit	218/lamp	83 Watts for an avg incandescent lamp (from Xenergy, 1988) * 75% savings * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	15	50,000 hr ballast life / 3500 op hrs/yr.
Replacement rate	0%	Units will often be removed at time of building remodeling. Savings accounted for in Commercial Renovation program.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	78,913 customers	77,747 customers in 1989 using >5000 kWh/yr * 1.015 (growth during 1989-91 -- from NYSEO REF II forecast).
# fixtures/customer	9.8	1,615 GWh used for comm'l ltg in LILCo territory in 1986 (from Miller et al., 1989) * 21.5% incandescent share (from Nadel et al., 1989) / 83 avg Watts/lamp (see above) / 3500 avg. annual op hrs/lamp * 80% of fixtures for which replacement is appropriate (from Xenergy, 1989) * 75% of sockets which get compact fixtures & not bulbs (ACEEE estimate) / 73,252 customers in 1986.
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from compact fluorescent fixtures).
Annual participation rate	2,6,4,4,2,2,1%-->end	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to decline beginning in year 3 due to impact of direct installation programs.
Free rider proportion	5%	Based on New England Electric estimate (Nadel, 1990a).

Lighting Rebate Program - Commercial Compact Fluorescent Fixtures (Long Island Lighting) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	1.2	8 for Lighting Rebate program * 15% compact fixture share of program (ACEEE estimate).
Marketing costs ($1000's)	$11.25	15% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Commercial Reflectors (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Reflectors	Reflectors reduce the amount of light trapped in a fixture and thereby allow less lamps to be used per fixture.
Equip. & install. cost	$45/fixture	From Miller et al., 1989.
Incremental annual O&M	-$.67/fixture	Save 2 lamps/fixture * $2/lamp / 6 yr avg lamp life.
Annual kWh savings/unit	280/fixture	160 Watts/fixture * 50% savings * 3500 op hrs/yr. 160 Watts/fixture assumes customers use a 4-lamp fixture with either energy-saving lamps or ballasts. 3500 op hrs from Nadel et al., 1989.
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Measure life ends when fixture is replaced. Savings from fixture replacements accounted for in Commercial Renovation program.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	78,913 customers	77,747 customers in 1990 using >5000 kWh/yr * 1.015 (growth during 1990-91 -- from NYSEO REF II forecast).
# fixtures/customer	65.1	604 million sq.ft. of comm'l space in 1990 (from NYSEO REF II forecast) / 80 sq.ft./typical fixture (ACEEE estimate) / 77,747 customers in 1990 (see above) * 67% of fixtures which are appropriate for reflectors (from Miller et al., 1989).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from reflectors).
Annual participation rate	1,3,2,2,1,1,0.5%-->end	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to decline beginning in year 3 due to impact of direct installation programs.
Free rider proportion	15%	Based on New England Electric estimate (Nadel, 1990a).
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	1.6	8 for Lighting Rebate program * 20% reflector share of program (ACEEE estimate).
Marketing costs ($1000's)	$15	20% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Electronic Ballasts & T8 Lamps (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	1994	Assume that revised ballast efficiency standards, which take effect in 1995, will require electronic ballasts or equivalent.
Program type	Replacement	
TECHNOLOGY:		
Technology description	Electronic ballasts & T8 lamps	High frequency ballasts and narrow diameter lamps use less energy than conventional low frequency ballasts and standard diameter lamps.
Equipment cost	$18/ballast	$16/ballast + $1/lamp * 2 lamps/ballast (Miller et al., 1989).
Incremental install. cost	$0	Installation cost same as conventional ballast.
Incremental annual O&M	$0	Avg. O&M cost approximately same as with conventional equipment.
Annual kWh savings/unit	80.5/ballast	23 Watts/ballast (from Sylvania fixture test data & Triad/Utrad catalog data) * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Assume that revised ballast efficiency standards, which take effect in 1995, will require electronic ballasts or equivalent.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	718,533 ballasts	57,863,000 ballasts sold in U.S. in 1988 (from U.S. Census Bureau, 1989a) * 8053/102310 NY share of U.S. C&I employment (from U.S. Census Bureau, 1989d) * 554/3672 LILCo share of NY comm'l floorspace (from Miller et al., 1989) * 1.015^3 (from NYSEO REF II forecast -- used to adjust 1988 sales to 1991).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from electronic ballasts/T8 lamps).
Annual participation rate	5,10,20,40%	ACEEE estimate.
Free rider proportion	5%	Electronic ballasts presently account for less than 2% of U.S. ballast sales (U.S. Census Bureau, 1989a).
UTILITY COSTS:		
Rebate/unit	$16/T8 ballast	ACEEE suggestion based on measure cost.
Staff -- number	1.6	8 for Lighting Rebate program * 20% ballast share of program (ACEEE estimate).
Marketing costs ($1000's)	$15	20% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Post-1995 Ballast Program (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1995	Program begins where first ballast program leaves off.
End year	1999/2012	Program offers rebates through 1999 to accelerate shift in market towards 3- and 4-lamp ballasts. Without program, it will take until 2012 for 3- and 4- lamp ballasts to reach full market share.
Program type	Replacement	
TECHNOLOGY:		
Technology description	3- & 4- lamp electronic ballasts and T8 lamps	3- and 4-lamp ballasts are more efficient than 1- and 2-lamp ballasts which are widely used at present. T8 narrow diameter lamps are more efficient than the standard diameter lamps.
Equipment cost	-$16/ballast	Based on 4 T8 lamps @ incremental cost of $1 each plus $40 cost of 4-lamp ballast minus $60 cost of two 2-lamp ballasts. Costs from manufacturers.
Incremental install. cost	$6.67	No add'l labor costs for 4-lamp fixtures. When two 2-lamp fixtures are wired to the same ballast, add'l labor & mat'l costs approx. $20 (Alden Hathway, Sylvania, personal communication). Assuming these latter cases account for 1/3 of applications, avg. cost is $20/3.
Incremental annual O&M	$1.47/ballast	ACEEE analysis based on data from manufacturers.
Annual kWh savings/unit	59.5/ballast	17 Watts/ballast (avg. for 3- and 4-lamp ballasts based on Sylvania & Lithonia fixture test data) * 3500 op hrs/yr (from Nadel et al., 1989).
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Assume these measures are standard practice when initial units need replacement.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1995	333,813 ballasts	718,533 ballasts in 1991 (from pre-1995 ballast program) * 1.008^4 (sales growth from 1991-95) * 60% (because use of 3- and 4-lamp ballasts reduce number of ballasts sold) * 75% (because 25% of ballasts go to new construction, which is served by another program).
Annual growth rate	1.5%	From NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	25,35,45,55,65,60,70,80%->end	ACEEE estimate.
Free rider proportion	15%, growing by 5%/yr until	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$5/T8 ballast	ACEEE suggestion - enough to catch purchaser's attention.
Staff -- number	1.5 thru 1999	ACEEE estimate.
Marketing costs ($1000's)	$75,$37.5,$37.5,$37.5,$37.5	ACEEE estimate. Includes start-up marketing campaign.

Lighting Rebate Program - HID Retrofits (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Metal halide & sodium vapor fixtures	Replace incandescent and mercury vapor fixtures with higher efficiency HID fixtures.
Equip. & install. cost	$200/fixture	Based on data from Clarke PUD industrial lighting program (Wolfe and McAllister, 1989).
Incremental annual O&M	$0	O&M costs vary widely depending on lamp life & cost. Typically, mercury vapor lamps have the lowest O&M cost, followed by sodium vapor, metal halide, & incandescent. On average, we assume O&M costs will be unchanged by the retrofit.
Annual kWh savings/unit	1000/fixture	(400 Watt mercury vapor - 150 Watt high pressure sodium) * 4000 op hrs/yr (from White, 1989).
Measure life	15	From Nadel et al., 1989.
Replacement rate	0%	Measure life ends when fixture is replaced. In new construction, use of HID fixtures a common practice.
Load shape	Synethesized load shape	Load shape estimated by blending commercial lighting load shape with limited data on load shape of outdoor lighting.
PARTICIPATION:		
Participation - number fixtures/yr	9336,14006,9336,4668,4668, 2334-->end	Based on results of New England Electric program in first two years (White, 1989; John Eastman, personal communication) adjusted by ratio of LILCo/NEES 1987 C&I sales. Results for years 3-10 are ACEEE estimates and assume that after several years participation drops off from peak levels, and then continues to drop due to the impact of concurrent direct installation program.
Annual growth rate	0%	Assumed to be a stable market because use of high efficiency HID lamps is common in new construction.
Free rider proportion	10%	Based on New England Electric estimate (Nadel, 1990a).
UTILITY COSTS:		
Rebate	$600/kW saved	Approximate rebate paid by New England Electric in 1988 and 1989.
Staff -- number	1.6	8 for Lighting Rebate program * 20% HID share of program (ACEEE estimate).
Marketing costs ($1000's)	$15	20% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Commercial Occupancy Sensors (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Occupancy sensors	Infrared or ultrasonic sensors which turn lights on when someone enters a room and off after they leave the room.
Equip. & install. cost	$0.42/sq.ft.	Avg. of a $65 control for a 125 sq.ft. room and a $115 control for a 350 sq.ft. room (from Miller et al., 1989).
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	2.625/sq.ft.	120 Watts/fixture * 50% savings * 3500 op hrs/yr. 120 Watts/fixture assumes half of fixtures were previously fitted with reflectors. Previous use of efficient magnetic ballasts also assumed. 50% savings from Miller et al., 1989.
Measure life	10	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	Load shape modified to increase savings during lunch, early morning, and evening hours and decrease savings at other hours.
PARTICIPATION:		
# eligible in 1991	78,913 customers	77,747 customers in 1990 using >5000 kWh/yr * 1.015 (growth during 1990-91 -- from NYSEO REF II forecast).
Suitable sq.ft./customer	1165	604 million sq.ft. of comm'l space in 1990 (from NYSEO REF II forecast) / 77,747 customers in 1990 (see above) * 15% of sq.ft. which is suitable for occupancy sensors (from Miller et al., 1989).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from occupancy sensors).
Annual participation rate	1,2,2,2,1,1,1,1,0.5,0.5%	ACEEE estimate based on experience at New England Electric (John Eastman, personal communication) and other utilities. Participation rate assumed to level off beginning in year 3 and decline in year 5 due to impact of direct installation programs.
Free rider proportion	5%	ACEEE estimate based on data cited in Nadel, 1990a.
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	0.8	8 for Lighting Rebate program * 10% for occupancy sensor share of program (ACEEE estimate).
Marketing costs ($1000's)	$7.5	10% of Lighting Rebate program marketing budget (ACEEE estimate).

Lighting Rebate Program - Daylighting Controls (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Daylighting controls	Light sensing controls which dim artificial lights in proportion to the amount of daylight that is available.
Equip. & install. cost	$60/fixture	From Miller et al., 1989.
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	150/fixture	120 Watts/fixture * 50% savings * 2496 op hrs/yr. 120 Watts/fixture assumes half of fixtures were previously fitted with reflectors. Previous use of efficient magnetic ballasts also assumed. 50% savings from Miller et al., 1989. Avg. op hrs/yr assumes that typical fixture operates 6 days/week and that dimming savings are achieved for an avg of 8 daylit hours/day.
Measure life	10	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	Load shape modified to include only savings during daylit hours.
PARTICIPATION:		
# eligible in 1991	78,913 customers	77,747 customers in 1990 using >5000 kWh/yr * 1.015 (growth during 1990-91 -- from NYSEO REF II forecast).
Suitable fixtures/customer	24.3	604 million sq.ft. of comm'l space in 1990 (from NYSEO REF II forecast) / 77,747 customers in 1990 (see above) / 80 sq.ft./fixture * 25% of sq.ft. which is suitable for occupancy sensors (from Miller et al., 1989).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from daylighting controls).
Annual participation rate	0.5,1,1.5,2,2,1%-->end	ACEEE estimate based on some of the most successful programs around the U.S. Participation rate stabilizes in year 5 and drops in year 6 due to impact of direct installation programs.
Free rider proportion	5%	ACEEE estimate based on data cited in Nadel, 1990a.
UTILITY COSTS:		
Rebate/unit	80% of measure cost	ACEEE suggestion based on limited data on rebate levels needed to achieve high participation rates as discussed in Nadel, 1990a.
Staff -- number	0.8	8 for Lighting Rebate program * 10% for occupancy sensor share of program (ACEEE estimate).
Marketing costs ($1000's)	$7.5	10% of Lighting Rebate program marketing budget (ACEEE estimate).

HVAC Rebate Program - Chillers (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	Replacement	
TECHNOLOGY:		
Technology description	High efficiency chilers	
Incremental equip. cost	$5628/chiller	From chiller worksheet in NiMo section of appendix.
Incremental install. cost	$0	Installation cost same as conventional chiller.
Incremental annual O&M	$0	Approximately the same as for conventional chillers.
Annual kWh savings/unit	33,948	28.29 peak reduction (from NiMo worksheet) * 1200 full load op hrs/yr (based on Con Ed, 1989 and Applied Energy Group, 1989).
Measure life	20	From Miller et al., 1989.
Replacement rate	0%	When equipment needs replacement, it is eligible for a rebate again, and hence replacement savings are captured as participants in out years of program.
Load shape	Commercial cooling	
PARTICIPATION:		
# eligible in 1991	202	Based on sales of chillers of 50 hp or more: 12,067 chillers sold in U.S. in 1988 (U.S. Census Bureau, 1989b) * 8.44% NY share (based on commercial employment from U.S. Census Bureau, 1989d) * 16.8% LILCo share (based on comm'l floor area from Miller et al., 1989) * 75% for existing buildings (new building savings accounted for in another program) * 1.45 (to add in rotary chillers to sales estimates -- based on estimates by Jim Block, Enerlogic, personal communication) * 1.027^3 (growth from 1988-91 -- see below).
Annual growth rate	2.7%	Growth rate in cooling energy use from NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	10,30,50,70%-->end	Ramp up over 3 years to 70% participation as achieved by Northern States Power (1988).
Free rider proportion	15%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$4,553/chiller	From NiMo worksheet. Specific rebate schedule also on attached worksheet. This rebate is split 80% to the customer and 20% to the dealer.
Staff -- number	3	1 central staffperson, 1 technical staff (to work on sizing issues), and 1 field person (ACEEE estimate).
Marketing costs ($1000's)	$61,$62,$64,$50 Growing at 2.7%-->end	$200/eligible customer plus material development of $45,000 spread over first 3 yrs (ACEEE estimate).

HVAC Rebate Program - Packaged Systems (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	Replacement	
TECHNOLOGY:		
Technology description	High efficiency packaged air conditioners and heat pumps.	
Incremental equip. cost	$168/unit	From packaged system worksheet in NiMo section of appendix.
Incremental install. cost	$0	Installation cost same as conventional unit.
Incremental annual O&M	$0	Approximately the same as for conventional units.
Annual kWh savings/unit	2,364 for cooling 1,327 for heating	Cooling savings: 1.97 peak reduction (from NiMo worksheet) * 1200 full load op hrs/yr (based on Con Ed, 1989 and Applied Enegy Group, 1989). Heating savings: 1.97 peak kW * 1500 full load op hrs (estimate by Jim Block, Enerlogic) * 45% (% of new packaged system capacity in heat pumps -- derived from NiMo worksheet).
Measure life	20	From Miller et al., 1989.
Replacement rate	0%	When equipment needs replacement, it is eligible for a rebate again, and hence replacement savings are captured as participants in out years of program.
Load shape	Commercial cooling + heating	Load shapes modified to reduce winter peak impacts to allow for fact that air source heat pumps do not save at time of winter peak but water source heat pumps do save at time of winter peak.
PARTICIPATION:		
# eligible in 1991	3,883	Based on sales of unitary & split system A/C and heat pumps 65 MBtu/hr and greater. 337,088 units sold in U.S. in 1988 (U.S. Census Bureau, 1989b) * 8.44% NY share (based on commercial employment from U.S. Census Bureau, 1989d) * 16.8% LILCo share (based on comm'l floor area from Miller et al., 1989) * 75% for existing buildings (new building savings accounted for in another program) * 1.027^3 (growth from 1988-91 -- see below).
Annual growth rate	2.7%	Growth rate in cooling energy use from NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	10,20,30,50%-->end	Ramp up over 3 years to 50% participation (70% participation achieved by Northern States Power chiller rebate program (Northern States Power, 1988), but we assume participation will be slightly lower for packaged systems because of the much larger quantity of units sold each year).
Free rider proportion	15%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	$134	From NiMo worksheet. Specific rebate schedule also on NiMo worksheet. This rebate is split 80% to the customer and 20% to the dealer.
Staff -- number	4	1 program manager and 3 technical/field staff (ACEEE estimate).
Marketing costs ($1000's)	$50-->end	ACEEE estimate.

Commercial Refrigeration Efficency Program (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	Replacement	
TECHNOLOGY:		
Technology description	Multiple technologies	Listed on worksheet in NiMo section of this appendix.
Equip. & install. cost	Average of $16,516	From NiMo worksheet.
Incremental annual O&M	$0	Approximately the same as for conventional chillers.
Annual kWh savings/unit	42,579	From NiMo worksheet.
Measure life	10	From Gordon et al., 1988.
Replacement rate	0%	When equipment needs replacement, it is eligible for a rebate again, and hence replacement savings are captured as participants in out years of program.
Load shape	Commercial refrigeration	
PARTICIPATION:		
# eligible in 1991	1,305	Based on annual sales of refrigeration compressors of 15 hp or more: 117,347 units sold in U.S. in 1988 (U.S. Census Bureau, 1989b) * 8.44% NY share (based on commercial employment from U.S. Census Bureau, 1989d) * 16.8% LILCo share (based on comm'l floor area from Miller et al., 1989) * 75% for existing buildings (new building savings accounted for in another program) * 1.015^3 (growth from 1988-91 -- see below).
Annual growth rate	1.5%	Growth rate in commercial floor area from NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	10,35,70%-->end	Ramp up over 3 years to 70% participation as was achieved by Northern States Power chiller rebate program (Northern States Power, 1988).
Free rider proportion	20%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	70% of measure cost	Incentive needed to make measure payback attractive to customers.
Staff -- number	3	1 program manager and 2 technical/field staff (ACEEE estimate).
Marketing costs ($1000's)	$50-->end	ACEEE estimate.

Motor Rebate Program (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2005	Program is operated for a 15 year period -- equivalent to the average life of a motor.
Program type	Replacement	
TECHNOLOGY:		
Technology description	High efficiency motors	Most major manufacturers produce two major lines of motors -- a standard line and a high efficiency line. This program promotes use of the high efficiency line when existing motors burn out.
Incremental equip. cost	$251/motor	From attached worksheet.
Incremental install. cost	$0	Installation cost same as conventional motor.
Incremental annual O&M	$0	Approximately the same as for conventional motors.
Annual kWh savings/unit	1,585/motor	1472 kWh/motor from attached worksheet, plus 113 additional savings from reduced oversizing. Lovins et. al. (1989) estimate that available energy savings from correcting oversizing problems amounts to 23% of energy savings available from high efficiency motors. We assume that as a result of motor audits and other educational efforts, 1/3 of oversizing problems are corrected for motors rebated thru this program (1472*23%/3=113).
Measure life	15	From Gordon et al., 1988.
Replacement rate	50%	ACEEE estimate.
Load shape	Total industrial	Motors primarily used for general industrial and comm'l ventilation. Comm'l ventilation load shape very similar to total ind'l load shape.
PARTICIPATION:		
# eligible in 1991	9,467	12,071 in 1988 (from attached worksheet) * 75% (based on estimate that 25% of motors are for new construction and 75% for existing buildings) * 1.015^3 (growth in sales from 1988-91).
Annual growth rate	1.5%	From NYSEO REFII forecast (new construction is taken out in line above, so no allowance must be made here).
Annual participation rate	5,15,30,50%-->end	First two years are based on BC Hydro experience (Kristin Schwartz, personal communication). Remaining years are ACEEE estimates.
Free rider proportion	50,30,20,16% growing by 1%/yr thru 2005	Wisconsin Electric estimates 50% free riders in first year, 30% in second (Wisconsin Electric, 1988). Other utilities have made similar estimates (Nadel, 1990a). Fourth year estimate based on current sales shares of high efficiency motors for new motors (20% in 1988, rising ~2%/yr according to NEMA and DOE data) and rewound motors (near zero). We assume that new and rewound motors each account for 50% of the rebates, and therefore the free rider pct. equals 50% of the sales share of efficient motors among new motor purchases (e.g., for 1994: (20%+(6 yrs since 1988 * 2%)) /2) = 16.

VARIABLE	ASSUMPTION	NOTES
UTILITY COSTS:		
Rebate/unit	$163/motor to customer $16/motor to dealer	Customer rebate from attached spreadsheet. Dealer rebate is 10% of customer rebate.
Staff -- number	2	1 central staffperson plus 1 field staff to do motor audits & inspections (ACEEE estimate).
Marketing costs ($1000's)	$50,$50,$25,$25,$10-->end	BC Hydro (a much larger company) spend $111,000 in 1st yr for indirect costs (Nadel, 1990a). Remaining years are ACEEE estimates.

SUPPORTING DATA FOR MOTOR REBATE PROGRAM - LONG ISLAND LIGHTING COMPANY

Motor Horse-power	Annual Sales U.S. (1)	Annual Sales NY (2)	Annual Sales LILCo (3)	Sales for Which High Effic. Model Avail. (4)	Avg. Motor Size (5)	Average Annual Op. Hrs (6)	Avg Effic. (7) Std.	Avg Effic. (7) High Eff	Percent Savings (8)	Avg kW Savings Per Motor (9)	Avg kWh Savings Per Motor (10)	Motor Costs (11) Std.	Motor Costs (11) High Eff	Motor Costs (11) Rewind	Incre-mental Cost (12)	Annual User Savings (13)	Rebate (14)
1-5	1,154,483	91,204	9,394	7,515	1.34	2,352	71.39	82.75	13.7%	0.14	339	$149	$190	$120	$42	$20	$21
6-20	470,211	37,147	3,826	3,061	8.61	2,928	82.81	90.45	8.4%	0.49	1,439	$308	$391	$190	$201	$86	$114
21-50	144,658	11,428	1,177	942	25.9	3,568	87.47	93.15	6.1%	1.01	3,608	$730	$909	$335	$574	$216	$358
51-125	70,298	5,554	572	458	80.6	4,163	89.62	94.95	5.6%	2.82	11,757	$2,287	$2,792	$700	$2,092	$705	$1,386
126-200	14,661	1,158	119	95	195	4,163	91.63	95.75	4.3%	5.12	21,329	$5,656	$7,505	$1,100	$6,405	$1,280	$5,125
Total	1,854,311	146,491	15,089	12,071													
Wtd Avg					9.64					0.44	1,472	$359	$454	$184	$251	$88	$163

Notes:

1. From U.S. Census Bureau, Current Industrial Reports, Motors and Generators, 1988.
2. 7.9% of national sales, based on New York proportion of U.S non-agricultural employment. Employment data from U.S. Census Bureau, Statistical Abstract of the U.S. - 1989.
3. 10.3% of NY sales based on industrial electricity use by motors and 45% of commercial electricity use (from Miller et al., 1989, pp. 28, 30, 73-4). 45% is proportion of comm'l use due to motors (Lovins et al., 1989, p. 28).
4. Assuming approximately 20% of motors cannot be replaced with high efficiency motors (ACEEE estimate based on data from several field surveys).
5. From Miller et al., 1989, p. 32.
6. Average of values estimated by the Arthur D. Little in 1980 and by Xenergy (for Wisconsin Electric industrial customers) in 1989. Values from R.I. study of commercial and industrial motors are even higher.
7. Average nominal efficiency for motor nearest in size to average motor size. Based on average nominal efficiency for 1800 rpm ODP and TEFC motors produced by six major manufacturers. Avg. efficiency multiplied by .98 based on estimates that half the rebates displace rewound motors, and these rewound motors have an average efficiency ~4% lower than new standard motors due to the fact that standard motors have (1) improved in efficiency ~1.8% in last ten years, and (2) rewinding has reduced motor efficiency by 1.8-3.4 percentage points (from Lovins et al., 1989, pp. 83, 397).
8. (Efficient motor efficiency - Std motor efficiency)/Efficient motor efficiency
9. Motor Hp * .746 kW/Hp * .75 avg. load * (1/std eff) * Pct. savings.
10. kW savings * Operating hours.
11. Average cost difference for motor nearest in size to average motor. Based on 1800 rpm TEFC and ODP motors produced by 6 major manufacturers. Costs based on suggested list prices minus a 33% discount (Based on info in Stout and Gilmore, 1989). Rewind costs from Seton, Johnson and Odell, 1987, p. 39.
12. For 1-5 hp class, difference between std. and high efficiency motor cost. For other classes, difference between high efficiency motor cost and rewind cost.
13. Average kWh savings * $.06/kWh.
14. Incremental cost minus value of one year's savings to user.

Adjustable Speed Drive Rebate Program (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2005	Same as Motor Rebate program.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Adjustable speed drive	Electronic control which can continuously vary motor speed to match the load. When motor operates at less than full speed, energy is saved.
Equip. & install. cost	$24,986	From Miller et al., 1989 -- assumes an avg. motor size of 81 hp.
Change in equip. cost	-2%/year	Based on ACEEE analysis which found that over 1986-90 period, price declined by 4-5%/year.
Incremental annual O&M	$0	Drive requires maintenance but due to soft-start capabilities, drive can reduce motor maintenance costs. These two factors are assumed to balance each other out (a conservative assumption).
Annual kWh savings/unit	54,610	From Miller et al., 1989.
Measure life	15	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Total industrial	Motors primarily used for general industrial and comm'l ventilation. Comm'l ventilation load shape very similar to total ind'l load shape.
PARTICIPATION:		
# eligible in 1991	5,303	672 GWh savings potential from ASDs in 1986 (from Miller et al., 1989) * 40% (approximate % of C&I motors which represent good applications for ASDs) / 54,610 kWh avg. savings/ASD (see above) * 1.015^5 (growth from 1986-91).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l ASD applications).
Annual participation rate	0.5,1,2,3-->end	First year similar to NEES estimate for first full year of its program. Remaining years ACEEE estimates.
Free rider proportion	10%	ACEEE estimate.
UTILITY COSTS:		
Rebate/unit	80% for first 5 years, 60% thereafter	Initial rebate designed to help establish ASD market. Thereafter, a smaller rebate should be sufficient.
Staff -- number	1.5	Based on current BC Hydro staffing for promotion of ASDs but scaled to LILCo.
Marketing costs ($1000's)	$50,$25-->end	ACEEE estimate -- includes initial education/promotion campaign.

C&I Custom Measure Program (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2000	Program will have served most customers who are interested in rebates. Other program approaches needed to reach other customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Any reasonable efficiency measure proposed by a customer.	
Equip. & install. cost	$11,015	$9,335 avg. rebate paid by Wisconsin Electric (WEPCo) in first 21 months of program (Clippert, 1989) * 200% (assuming WEPCo rebate on avg. pays 50% of measure costs * 59% ratio of LILCo/WEPCo avg. kWh/C&I customer.
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	48,557	Based on avg. project in first 21 months of WEPCo program (Clippert, 1989) * 59% LILCO/WEPCo ratio.
Measure life	10	Average for a wide array of measures (from Nadel, 1990a).
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	98,283	95,400 C&I customers in 1989 (LILCo data filing) * 1.015^2 (growth from 1989-91 -- from NYSEO REF II forecast). Many small C&I customers will not participate in this program but are included here because available data on participation rates are based on all C&I customers, including small customers.
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l custom applications).
Annual participation rate	0.3,0.5,0.5,0.3-->end	Based on WEPCo experience for measures not encouraged thru other programs examined in this study. Participation rate reduced in year 4 to account for impact of direct installation programs on demand for custom rebates.
Free rider proportion	30%	From Wisconsin Electric, 1989.
UTILITY COSTS:		
Rebate/unit	50% of measure cost	Based on WEPCo and other custom measure programs.
Staff -- number	3,4,4,3-->end	Assumed 1 staffperson per 150 applications to review applications, conduct inspections and provide TA. Also includes a full-time program manager.
Marketing costs ($1000's)	$75-->end	ACEEE estimate.

C&I Audit Program (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	1996	Program operates until direct installation programs have fully ramped up.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Audits encourage O&M and other rapid-payback measures. Small customers get a walk-thru audit, medium customers a basic computerized audit, and large customers an enhanced audit.	
Equip. & install. cost	$377	Derived from avg. savings/customer (see below) assuming that the average measure has a 1 year payback at a retail rate of $.07/kWh. PG&E found that the avg. measure implemented after an audit had a simple payback of approx. 0.9 years (Kowalczyk, 1983).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	5,390	107,798 avg. pre-program electricity use by eligible customers (derived from LILCo data) * 5% savings (typical savings -- net of a control group of non-participants -- for programs without extensive financial incentives as reported in Nadel, 1990a).
Measure life	5	From Nadel, 1990a.
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	78,913	77,747 customers in 1990 using >5000 kWh/yr * 1.015 (growth during 1990-91 -- from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l low-cost measures opportunities).
Annual participation rate	3,6,8%-->end	Based on Southern California Edison experience (from Nadel, 1990a).
Free rider proportion	0%	Savings are net savings which have already been adjusted for impact of free riders.
UTILITY COSTS:		
Audit cost	$450/audit	Weighted average assuming 67% of customers get walk-thru audit @ $200, 25% get basic computerized audit @ $600, and 8% get enhanced @ $2000 (based on data in Xenergy, 1990).
Audit follow-up cost	$150/annual visit to a customer	Assumed to be 33% of the cost of a full audit (based on 1/2 day/follow-up including office and field work). Customers receive follow-up visits for 3 yrs. after the initial audit.
Staff -- number	2,3,4,4,4,4,2,2,2	ACEEE estimate for central office administration and field staff supervision. Field staff included in audit cost.
Marketing costs ($1000's)	$100,$200,$250-->1996	ACEEE estimate. Based roughly on projected NYSEG marketing costs (NYSEG, 1989), scaled up to size of this program.

Small C&I Lighting Direct Installation - Reflectors, Ballasts, HID Upgrades, & Compact Fluor. Fixtures (LILCo)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Program will require a year of planning (1991) before beginning.
End year	2002	Time needed to serve all eligible customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description		See Lighting Rebate program for description of technologies.
Equipment cost	$2,325/customer	Based on New England Electric (NEES) Small C&I program (Obeiter, 1989). Costs and savings are reduced by 15% based on ACEEE analysis which indicates that avg LILCo small C&I customer is only 85% the size of the typical customer assumed by NEES.
Installation cost	$875/customer	
Incremental annual O&M	-$47/customer	For compacts: 18 bulbs/customer (assuming 75% of compacts noted in Obeiter, 1989, are fixtures & not bulbs) * 1.5 incandescents displaced/yr * $1.33 labor costs to replace a bulb * .85 NiMo/NEES scaling factor (see above). 1.5 and $1.33 are from Compact Fluorescent Rebate program. For reflectors: $234 4' & 8' lamp costs (from Obeiter, 1989) * 67% suitable for reflectors (from Miller et al., 1989) * 50% less lamps used / 6 yr avg. lamp life * 1.5 retail/wholesale mark-up (lamp price based on wholesale price to utility, not retail price to customer) * .85 LILCo/NEES scaling factor (see above).
Annual kWh savings/unit	11,486/customer	Based on NEES estimates from Pastuszek, 1990. These estimates are reduced by 15% (see above).
Measure life	15	From Miller et al., 1989.
Replacement rate	0%	Measures are replaced when lighting system is renovated. At this time building will be handled by Commercial Renovation program.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	73,709 customers	72,620 customers in 1990 using 5-250 MWh/yr (LILCo data) * 1.015 (growth during 1990-91 - from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from Small C&I program).
Annual participation rate	2,5,7%-->end	First two years based on NEES Small C&I program plans. Subsequent yrs based on a steady rate of ~5000/yr until 70% of buinesses are reached. 70% based on SMUD and NEES experience as described in Nadel, 1990a.
Free rider proportion	12%	Based on NEES estimate (Nadel, 1988).
UTILITY COSTS:		
Incentive	100% of measure cost	
Staff -- number	1 in planning yr, 9,9, 11-->end. For entire program, of which reflectors, etc. allocated 89%.	Based on NEES experience, but scaled to LILCo based on # customers eligible. Share allocated to program components based on energy savings.

Small C&I Lighting Direct Installation - Reflectors, Ballasts, HID Upgrades, & Compact Fluor. Fixtures (LILCo) CONTINUED

VARIABLE	ASSUMPTION	NOTES
Marketing costs ($1000's)	$225,$325-->end. For entire program, of which reflectors, etc. allocated 89%.	Based on NEES estimates in Obeiter, 1989, but scaled to LILCo based on # customers elibgible. Share allocated to program components based on energy savings.

Small C&I Lighting Direct Installation - Compact Fluorescent Bulbs (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Program will require a year of planning (1991) before beginning.
End year	2002	Time needed to serve all eligible customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Compact fluorescent bulbs	Screw-in fluorescent bulbs which can be substituted for incandescent bulbs.
Equipment cost	$69/customer	Based on New England Electric (NEES) Small C&I program (Obeiter, 1989). Costs and savings are reduced by 15% based on ACEEE analysis which indicates that avg LILCo small C&I customer is only 85% the size of the typical customer assumed by NEES.
Installation cost	$3/customer	
Incremental annual O&M	-$10/customer	6 bulbs/customer (assuming 25% of compacts noted in Obeiter, 1989, are bulbs & not fixtures) * 1.5 incandescents displaced/yr * $1.33 labor costs to replace a bulb * .85 LILCo/NEES scaling factor (see above). 1.5 and $1.33 are from Compact Fluorescent Rebate program.
Annual kWh savings/unit	679/customer	Based on NEES estimates from Pastuszek, 1990. These estimates are reduced by 15% (see above).
Measure life	3	10,000 hr rated life / 3500 op hrs/yr.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	73,709 customers	72,620 customers in 1990 using 5,000-250,000 kWh/yr (from LILCo data) * 1.015 (growth during 1990-91 -- from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from Small C&I program).
Annual participation rate	2,5,7%-->end	First two years based on NEES Small C&I program plans. Subsequent yrs based on a steady rate of ~5000/yr until 70% of businesses are reached. 70% based on SMUD and NEES experience as described in Nadel, 1990a.
Free rider proportion	12%	Based on NEES estimate (Nadel, 1988).
UTILITY COSTS:		
Incentive	100% of measure cost	
Staff -- number	1 in planning yr, 9, 9,11-->end. For entire program, of which compact bulbs allocated 5%.	Based on NEES experience but scaled to LILCo based on # customers eligible. Share allocated to program components based on energy savings.
Marketing costs ($1000's)	$225$325-->end. For entire program, of which compact bulbs allocated 5%.	Based on NEES estimates in Obeiter, 1989 but scaled to LIlCo based on # customers eligible. Share allocated to program components based on energy savings.

Small C&I Lighting Direct Installation - Occupancy Sensors (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Program will require a year of planning (1991) before beginning.
End year	2002	Time needed to serve all eligible customers.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Occupancy sensors	Infrared or ultrasonic sensors which turn lights on when someone enters a room and off after they leave the room.
Equipment cost	$69/customer	Based on New England Electric (NEES) Small C&I program (Obeiter, 1989). Costs and savings are reduced by 15% based on ACEEE analysis which indicates that avg LILCo small C&I customer is approx. 85% the size of the typical customer assumed by NEES.
Installation cost	$69/customer	
Incremental annual O&M	$0	Little maintenance required.
Annual kWh savings/unit	777/customer	Based on NEES estimates from Pastuszek, 1990. These estimates are reduced by 15% (see above).
Measure life	10	From Miller et al., 1989.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	73,709 customers	72,620 customers in 1990 using 5,000-250,000 kWh/yr (from LILCo data) * 1.015 (growth during 1990-91 -- from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these can no longer benefit from Small C&I program).
Annual participation rate	2,5,7%-->end	First two years based on NEES Small C&I program plans. Subsequent yrs based on a steady rate of ~5000/yr until 70% of buinesses are reached. 70% based on SMUD and NEES experience as described in Nadel, 1990a.
Free rider proportion	12%	Based on NEES estimate (Nadel, 1988).
UTILITY COSTS:		
Incentive	100% of measure cost	
Staff -- number	1 in planning yr, 9,9 11-->end. For entire program, of which occupancy sensors allocated 6%.	Based on NEES experience, but scaled to LILCo based on # customers eligible. Share allocated to program components based on energy savings.
Marketing costs ($1000's)	$225,$325-->end. For entire program, of which occupancy sensors allocated 6%.	Based on NEES estimates in Obeiter, 1989, but scaled to LILCo based on # customers eligible. Share allocated to program components based on energy savings.

Medium/Large C&I Direct Installation Program (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1993	Last program to start-up -- in interim, customers can participate in audit & rebate programs.
End year	2011	Period required to reach 70% cumulative participation rate.
Program type	Retrofit	
TECHNOLOGY:		
Technology description	Comprehensive audits identify conservation measures. Utility then provides financing and arranging assistance.	
Equip. & install. cost	$23,121	110.1 MWh saved/customer (see below) * $.21/kWh saved (based on a similar program operated by Puget Power -- France, 1989).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	110,100	1,101 avg. annual pre-program MWh/customer (derived from LILCo data) * 10% savings. Based on savings (net of a control group of non-participants) for similar programs operated by Puget P&L, BPA and NU as reported in Nadel, 1990a. Other programs operated by BPA and Boston Edison have achieved savings of approximately 20% by actively encouraging participants to implement all cost-effective measures. On the other hand, due to the impact of concurrent rebate programs for lighting and other improvements, savings opportunities for this prototypical program are lower than for those programs with savings in the 20% range. Allowing for the savings from other concurrent programs, we estimate that average savings of 10% can be achieved by this program if customers are encouraged to implement all cost-effective measures. Savings in the early years of the program are likely to be greater than 10% (because the impact of other programs will be minimal), while savings in the latter years of the program are likely to average less than 10% (because many measures will have been implemented through other programs).
Measure life	10	From Nadel, 1990a - for programs which promote a wide array of measures.
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	5,282	5,127 customers in 1989 using >250,000 kWh/yr * 1.015^2 (growth during 1989-91 -- from NYSEO REF II forecast).
Annual growth rate	0.8%	From NYSEO REFII forecast minus 20% (assumes 40% of customers participate in Comm'l New Construction program and half of these do not have add'l conservation opportunities).
Annual participation rate	1,2,3,4%-->end	ACEEE estimate assuming that in order to provide high quality services, only 250-300 customers can be served each year. Cumulative participation rate of 70% based on several limited scale programs reported in Nadel, 1990a.

Medium/Large C&I Direct Installation Program (Long Island Lighting) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
Free rider proportion	0%	Savings are net savings which have already been adjusted for impact of free riders.
UTILITY COSTS:		
Incentives	70% of measure costs	Based on Puget Power program which has paid an average of ~66% (France, 1989).
Staff, administration & marketing costs	27.5% of incentive costs	Based on Puget Power program as reported in Haeri et al., 1988.

Commercial New Construction (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Need a full year for planning (1991) before program start-up.
End year	2010	
Program type	New construction	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed prevailing construction practice. At a minimum measures must exceed building code requirements.	
Design & construction cost:		$.34/kWh based on Energy Edge program as summarized in Anderson and Benner, 1985. Assumed to increase 25% after code changes in 2000 (rough ACEEE estimate -- add'l analysis needed to confirm).
1992-2000	$.34/kWh saved = $.48/sq.ft.	$.34/kWh * 1.4 kWh saved/sq.ft. (see below) = $.48/sq.ft.
2001-2010	$.42/kWh saved = $.50/sq.ft.	$.34/KwH * 1.2 KWh saved/sq.ft. (see below) * 1.25 = $.50/sq.ft.
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit		10.95 weighted avg. kWh/sq.ft. for new buildings before program and before 1991 code change (from NYSEO REF II forecast) minus 14% avg. savings due to code change (from Eric Noble, NYSEO, personal communication) * 15% savings due to program. Estimated savings from Energy Edge program are 29% relative to NW Model Conservation Stds (Anderson and Benner, 1988). These stds. are roughly similar to new NY code. Savings at half this level are assumed for this full-scale program (a similar assumption is made by NEES). Baseline declines 15% after code revisions, but % savings assumed to remain the same, and hence kWh savings decline 15% after code revisions.
1992-2000	1.4 kWh/sq.ft.	
2001-2010	1.2 kWh/sq.ft.	
Measure life	30	Based on estimates in Gordon et al., 1988.
Replacement rate	50%	ACEEE estimate.
Load shape	Total commercial	
PARTICIPATION:		
# eligible in 1991	22.8 million sq.ft.	From NYSEO REF II forecast.
Annual growth rate	1.5%	From NYSEO REF II forecast.
Annual participation rate	8,18,28,38,48,58,60%-->end	First year based on New England Electric first year participation rate. Subsequent years based on New England Electric and Northeast Utilities projections. 1990a).
Free rider proportion	0%	Savings are net savings which have already been adjusted for impact of free riders.
UTILITY COSTS:		
Design & construction incentives	90% of design & construction costs	Similar to Energy Edge, New England Electric, & Northeast Utilities programs.
Technical assistance costs	$255,$405,$555,$705,$855, $1005-->end	Based on New England Electric 1990 budget for consultants and training (Obeiter, 1989) scaled down to reflect fewer new comm'l ft. in LILCo service area. Assumed to increase by $150,000/yr until peak participation reached (based on assumption that repeat program participants require only half the level of assistance as new participants).

Commercial New Construction (Long Island Lighting) - CONTINUED

VARIABLE	ASSUMPTION	NOTES
Staff -- number	.8 (in program planning yr), 4, 5.6, 7.2, 8.8, 10.4, 12, 13-->end	ACEEE estimate.
Marketing costs ($1000's)	$225-->end	Based on New England Electric 1990 budget (Obeiter, 1989) scaled down to reflect new comm'l sq.ft. in LILCo service area.

Commercial Renovation - Lighting (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1992	Need a full year for planning (1991) before program start-up.
End year	2010	
Program type	Remodeling	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed prevailing construction practice. At a minimum measures must exceed building code requirements.	
Incremental equip. cost	$0.21/sq.ft.	$0.40 estimate for NiMo programs * 3.93/7.58 LILCo/NiMo ratio of lighting watts/sq.ft. (from NiMo comm'l renovation worksheet in NiMo section of this appendix and from LILCo worksheet attached).
Incremental design costs	$0.021/sq.ft.	Assumed to be 10% of equipment costs, as used by Wisconsin Electric. NEES uses 6%.
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit: 1992-1994 1995-2010	 1.57 kWh/sq.ft. 1.34 kWh/sq.ft.	For 1992: 3.93 weighted avg. kWh/sq.ft. for lighting in existing buildings before program and before 1991 code change (from NYSEO REF II forecast) * 40% savings (see note above under equipment costs). For 1995: 3.93 minus assumed 15% avg. savings due to ballast efficiency std revision in 1995 (ACEEE estimate) * 40% savings (see note in NiMo worksheet).
Measure life	20	Based on estimates in Gordon et al., 1988.
Replacement rate	50%	ACEEE estimate.
Load shape	Commercial lighting	
PARTICIPATION:		
# eligible in 1991	12.0 million sq.ft.	613.1 million sq.ft. (from NYSEO REF II forecast) * 39% remodeled over 20 years (from attached spreadsheet) / 20 years.
Annual growth rate	1.5%	From NYSEO REF II forecast.
Annual participation rate	8,18,28,38,48,58,60%-->end	Assumed to be same as Commercial New Construction program.
Free rider proportion	10%	ACEEE estimate.
UTILITY COSTS:		
Design & construction incentives	100% of design and construction costs	Utility pays all costs because many remodeled facilities are tenant occupied and in these situations building owner generally has no incentive to invest in energy efficiency.
Technical assistance costs	$50,$80,$110,$140,$170, $200-->end	ACEEE estimate based on participation & savings relative to those estimated for NiMo.
Staff -- number	2,2,3,3,4-->end	ACEEE estimate.
Marketing costs ($1000's)	$90-->end	ACEEE estimate.

Commercial Remodeling - Lighting Worksheet (Long Island Lighting)

	Light	% of FA	Wtd Avg	% remodel	% of FA	Wtd Avg
Offices	5.65	24%	1.36	53%	24%	13%
Restaurant	5.81	2%	0.12	55%	2%	1%
Retail	3.89	17%	0.66	55%	17%	9%
Grocery	8.38	3%	0.25	5%	3%	0%
Warehouse	1.74	10%	0.17	0%	10%	0%
Schools	2.87	11%	0.32	30%	11%	3%
Colleges	11.26	4%	0.45	30%	4%	1%
Health	2.57	8%	0.21	50%	8%	4%
Hotel	4.88	1%	0.05	43%	1%	0%
Misc	1.75	20%	0.35	36%	20%	7%
		Sum ==>	3.93		Sum ==>	39%

Source: Floor area and kWh/sf from NY State Energy Office CEDMS Model.
Proportion of space renovated over 20 years from Katz et al., 1989 prepared for BPA.

Industrial New Construction/Modernization (Long Island Lighting)

VARIABLE	ASSUMPTION	NOTES
Start year	1991	
End year	2010	
Program type	New construction & remodeling	
TECHNOLOGY:		
Technology description	Efficiency measures which exceed prevailing practice in new manufacturing facilities.	
Design & construction cost	$51,168/customer	312 MWh saved/customer (see below) * $.164/kWh saved (average cost of industrial measures with a levelized cost less than $.05/kWh (real basis) as identified for Northeast Utilities (NU) service territory -- Synergic Resources Corp. (SRC), 1989).
Incremental annual O&M	$0	Assumed to be same as existing equipment.
Annual kWh savings/unit	312 MWh/customer	3,119 MWh/yr average use by LILCo industrial customers * 10% savings (rough ACEEE estimate based on discussions with Gail Katz at Momentum Engineering). 3,119 = 1,834 GWh ind'l sales in 1987 (from NYSEO REF II forecast)/588 ind'l customers in 1987 (from EIA 1989)
Measure life	10	From Nadel, 1990a.
Replacement rate	50%	ACEEE estimate.
Load shape	Total industrial	
PARTICIPATION:		
# eligible in 1991	644 customers	588 in 1987 (from EIA, 1989) * 1.023 (short-term gorwth rate from NYSEO-REF II forecast).
Annual growth rate	3.3%	Long-term growth rate in ind'l elec. sales from NYSEO REF II forecast.
Annual participation rate	1,2%-->end	Rough ACEEE estimate based on discussions with Gail Katz, Momentum Engineering.
Free rider proportion	20%	Based on SRC estimate for NU program (SRC, 1989).
UTILITY COSTS:		
Design & construction incentives	80% of design & construction costs	
Technical consultant costs	10% of measure costs	ACEEE estimate.
Staff -- number	1-->end	ACEEE estimate.
Marketing costs ($1000's)	$50-->end	Based on SRC estimate for NU program (SRC, 1989) prorated for LILCo based on ind'l kWh use.

Appendix B

Utility Long-Run Avoided Costs and Retail Rates

Table B-1
Niagara Mohawk Inputs

Long Run Avoided Costs

On-peak 8 am to 10 pm weekdays; all other hours off-peak
Winter: Nov-March; Summer: June-Sept; Swing: other months

Marginal energy costs: Using DPS PROMOD outputs, SEO disaggregated the PSC-issued estimated annual average:

For 1991 Energy (in cents):

	Winter	Summer	Swing
On-peak	4.068	3.625	3.872
Off-peak	3.136	2.869	2.992

Capacity Costs: PSC estimates, annualized:

For 1991 Generation Capacity (in dollars/kw), dissagregated as per NiMo:
Winter: 32.59 Summer: 21.72

For 1991 Transmission Capacity:
Winter: 28.03 Summer: None, as COMPASS permits only one season

Growth: All these values follow the PSC pattern of escalation through 2008, and are then extrapolated at the 2000-2008 average

Retail Electricity Rates Escalated to 1991 (at 3.6%):

	Customer Charge $	Demand $/kw	Energy cents/kwh
Residential (tariff)	5.84	0	6.862
Small C&I(SC-2 rates blended by SEO)	10.816	5.377	6.319
Large C&I(SC-3 rates blended by SEO)	183.465	6.703	4.424
All C&I(SC-2 and SC-3 rates blended by SEO)	14.929	6.299	4.983

Growth: Averages 4.2% through 2008, 3.55% thereafter

Table B-2
Con Edison Inputs

Long Run Avoided Costs

On-peak: 8 am to 10 pm weekdays; all other hours off-peak
Summer: June-Sept; Winter: all other months

Marginal Energy Costs: Using disaggregation by ConEd of the PSC-issued estimated annual average (DSM filings):

For 1991 Energy (in cents):

	Summer	Winter
On-peak	3.79	4.04
Off-peak	2.92	3.16

Capacity Costs: PSC estimates, annualized:

For 1991 Generation Capacity (in dollars/kw), disaggregated as per ConEd:
Summer: 51.6 Winter: 2.72
For 1991 Transmission Capacity:
Summer: 31.536 Winter: None, as COMPASS permits only one season

Growth: All these values follow the PSC pattern of escalation through 2008, and are then extrapolated at the 2000-2008 average

Retail Electricity Rates for 1991: Used "Marginal Revenues" defined, calculated/blended, and published by ConEd

Time period definitions as above under LRACs

	Demand $/kw		Energy cents/kwh	
	Summer	Winter	Summer	Winter
Residential	0	0	14	12.36
All C&I,				
On-peak	26.13	15.36	6.617	6.682
Off-peak	0	0	5.372	5.514

Growth: Averages 4.4% through 2008, 4.68% thereafter

Table C-1

Estimated Baseline Conservation in the Residential Sector of New York State: 1986 - 2008

Type	Measure Description	Potential Savings (GWh/yr)	Percent Achieved by 2008	Savings In 2008 (GWh/yr)
FRE	Current Sales Average (1986)	373	100%	373
REF	Current Sales Average (1986)	1,876	100%	1876
REF	Best Current (1988)	1,865	50%	933
REF	Near-Term Advanced	781	5%	39
EWH	Traps & Blankets (EF=0.9)	265	15%	40
FRE	Best Current (1988)	259	100%	259
FRE	Near-Term Advanced	129	10%	13
ESH1	Infiltration Reduction	593	10%	59
RAN	Improved Oven	212	5%	11
ESH2	Storm Windows	112	25%	28
ESH2	Low-Emissivity Film	35	5%	2
RAN	Improved Cooktop	74	5%	4
LTG	Tungsten Halogen Lamps-300h/y	697	10%	70
LTG	Energy Saving Lamps-20hr/y	82	35%	29
LTG	Energy Saving Lamps 1,240h/y	98	35%	34
EWH	Front Loading Clothes Washer	447	5%	22
LTG	Compact Fluorescents-1,240h/y	1,102	10%	110
ESH1	Heat Pump #1 (HSPF=7)*	236	50%	118
LTG	IRF Lamps-300h/y	813	5%	41
LTG	Compact Fluorescents- 620h/y	918	5%	46
ESH1	Heat Pump #2 (HSPF=8)*	23	15%	3
ECD	Heatpump Clothes Dryer	858	3%	26
ESH1	Low-Emissivity Film	163	3%	5
RAC	RAC: 8.5 EER	144	100%	144
CAC	Window Film	76	3%	2
RAC	RAC: 10.0 EER	87	15%	13
CAC	CAC: 10.0 SEER	79	100%	79
RAC	RAC: 12.0 EER	91	0%	0
CAC	VARIABLE SPEED DRIVE	55	15%	8
CAC	CAC: 12.0 SEER	47	5%	2
ESH1	Add 3" Fiberglass in Roof/Ceiling	25	10%	3
CAC	CAC: 14.0 SEER	37	0%	0
		=========		======
		12,652		4,391

Notes:

* "Potential Savings" from Miller et al., 1989.
* "Percent Achieved" estimated by ACEEE based on minimum efficiency standards for appliances, utility program free rider proportions, and recent sales data for high efficiency equipment.
* Includes market-driven conservation and savings from first-tier appliance standards.

Table C-2

Estimated Baseline Conservation in the Commercial Sector of New York State: 1986 - 2008

Type	Measure Description	Potential Savings (GWh/yr)	Percent Achieved by 2008	Savings in 2008 (GWh/yr)
LTG	Delamping	141	25%	35
REF	Floating Head Press. Control	172	80%	138
REF	Refrig. Compressor Eff.	214	20%	43
HVAC	Reset Supply Air Temperature	1,182	25%	296
LTG	Reflectors	4,142	15%	621
HVAC	Fan Motor Efficiency	309	25%	77
LTG	High-efficiency Ballast	513	100%	513
HVAC	VAV Conversion	2,776	25%	694
HVAC	Economizer	301	60%	181
LTG	Energy-Saving Fluorescents	593	65%	385
HVAC	Pump Motor Efficiency	23	25%	6
HVAC	VSD on Fan Motor	3,261	10%	326
LTG	Occupancy Sensors	500	5%	25
HVAC	Re-size Chillers	2,260	5%	113
REF	Refrigerated Case Covers	54	75%	41
LTG	Daylighting Controls	1,660	5%	83
LTG	VHE Bulbs & Ballasts	1,085	25%	271
HVAC	VSD on Pump Motor	212	10%	21
Shell	Window Films (S&W)	196	10%	20
Shell	Low-E Windows (N)	85	10%	9
Shell	Low-E Windows (All)	319	10%	32
Shell	Roof Insulation	16	5%	1
		=========		=========
		20,014		3,929

Notes:

* "Potential Savings" from Miller et al., 1989.
* "Percent Achieved" estimated by ACEEE based on minimum efficiency standards for ballasts, utility program free rider proportions, and recent sales data for high efficiency equipment.
* Includes market-driven conservation and savings from first-tier ballast standards.

Table C-3

Estimated Baseline Conservation in the Industrial Sector of New York State: 1986 - 2008

Type	Measure Description	Potential Savings (GWh/yr)	Percent Achieved by 2008	Savings in 2008 (GWh/yr)
MOT	21-50 HP: retire	25	25%	6
MOT	>125 HP: retire	8	25%	2
MOT	51-125 HP: retire	10	25%	3
LTG	Energy saving lamp	184	50%	92
MOT	5.1-20 HP: retire	64	25%	16
LTG	Metal halide lamp	66	20%	13
LTG	High-efficiency ballast	57	100%	57
MOT	>125 HP: VSD	1,472	15%	221
MOT	1-5 HP: retire	7	10%	1
LTG	High-pressure sodium	216	20%	43
MOT	21-50 HP: rebuild	72	5%	4
MOT	51-125 HP: VSD	1,078	10%	108
MOT	5.1-20 HP: rebuild	34	20%	7
MOT	51-125 HP: rebuild	122	5%	6
MOT	21-50 HP: VSD	557	5%	28
MOT	>125 HP: rebuild	111	3%	3
MOT	<1 HP: retire	1	5%	0
MOT	5.1-20 HP: VSD	375	3%	11
MOT	1-5 HP: VSD	25	3%	1
		========		========
		4,484		621

Notes:

* "Potential savings" from Miller et al., 1989.
* "Percent achieved" estimated by ACEEE based on utility program free rider proportions, and recent sales data for high efficiency equipment.

Table C-4
Estimated Savings in New York State from Revised Appliance Efficiency Standards

Product	Effective Year of Standard	Standard Level Assumed	Annual Sales (1000's)	# Years Affected by Standards Thru 2000	# Years Affected by Standards Thru 2008	kWh Saved Per Unit	Total GWh Savings In 2000	Total GWh Savings In 2008	Summer Peak MW to GWh Ratio	Summer MW Savings In 2000	Summer MW Savings In 2008	Winter Peak MW to GWh Ratio	Winter MW Savings In 2000	Winter MW Savings In 2008
Refrigerators	1993	DOE Level 3	563	7	15	224	882	1891	0.172	152	326	0.087	77	164
Refrigerators	2003	DOE Level 5	563	0	5	197	0	554	0.172	0	96	0.087	0	48
Freezers	1993	DOE Level 3	88	7	15	117	72	155	0.146	11	23	0.135	10	21
Freezers	2003	DOE Level 5	88	0	5	124	0	55	0.146	0	8	0.135	0	7
Clothes washers	1993	DOE Level 3	481	7	15	41	137	293	0.167	23	49	0.290	40	85
Electric clothes dryers	1993	DOE Level 3	244	7	13	145	248	460	0.167	41	77	0.290	72	133
Dishwashers	1993	DOE Level 3	289	7	12	33	67	115	0.167	11	19	0.290	19	33
Electric water heaters	1995	EF >= .94	281	5	13	152	214	556	0.079	17	44	0.203	43	113
Room air conditioners	1995	EER >= 10	416	5	13	20	41	105	1.502	61	158	0.000	0	0
Ranges	1995	See notes	163	5	13	135	110	285	0.245	27	70	0.167	18	48
Central air conditioners	1999	SEER >= 14	117	1	9	282	33	298	2.018	67	601	0.000	0	0
Central heat pumps	1999	HSPF >= 9	31	1	9	1734	53	476	0.328	17	156	0.371	20	177
Ballasts	1995	Electronic	5,748	5	13	14	402	1046	0.276	111	288	0.153	62	160
TOTAL							2,258	6,289		538	1,914		360	989

Notes:

* Annual sales generally from U.S. Census Bureau reports for 1988. N.Y. sales calculated based on N.Y. share of U.S. commercial employment (for ballasts) or households (for other equipment). N.Y. central air conditioner and heat pump sales estimated by ACEEE based on U.S. Census and NYSEO data. Room air conditioner sales are for N.Y. in 1988 & 1989 -- from AHAM.
* Number of years affected by standards is the year being analyzed (e.g. 2008) minus the year the standards take effect, up to the average rated life of that appliance.
* Refrigerator and freezer standards from DOE, 1989a. Clothes washer, clothes dryer and dishwasher standards from DOE, 1989b. Range standard from Miller, et al., 1989, p. 132. Ballast standard requires either an electronic or hybrid electronic/magnetic ballast.
* Unit energy savings estimated by ACEEE based on data from DOE, 1989a; DOE, 1989b; Miller et al., 1989; and Geller and Miller, 1988.
* Total energy savings equals annual sales times number of years affected by standards times unit savings.
* Peak MW to GWh ratios for New York State from Miller et al., 1989. These ratios subject to some uncertainty, & will vary by utility.
* Savings are calculated at the end-user level and do not include adjustments for T&D losses or reserve margin requirements.

Table C-5
Rough Estimate of Savings in New York from Ammendments to Commercial Building Code

New commercial floor area (millions): 1991-2000	1,589
Average kWh/ft2 before 1991 code change	12.60
Percent savings due to code change	14%

GWh savings in 2000 due to code change	2,803
New commercial floor area (millions): 2001-2008	1,744
Average kWh/ft2 before 2001 code change	10.84
Percent savings due to code change	15%

GWh savings in 2008 due to 2008 code change	2,835

GWh savings in 2008 due to both code changes	5,638

Notes:
* New commercial floor area and average baseline kWh/ft2 derived from NYSEO Reference II forecast
* Percent savings due to 1991 code change based on a preliminary estimate provided by Eric Noble, NYSEO.
* Percent savings due to 2001 code change projected by ACEEE based on savings for Commercial New Construction program analyzed in this study.

Table C-6
Estimated Savings from Lamp, Luminaire, Motor and Commercial HVAC Standards in New York State 15 Years After Standards Take Effect

Product	Annual Sales (million)	Percent Covered by Stds	Average Life (years)	Watt Saved Per Unit	Aggregate Savings After 15 Yrs. (MW)	Average Annual Op.Hrs.	Aggregate Savings After 15 Yrs. (GWh/yr)
Lamps							
Fluorescent	36.3	87%	5	3.5	550	3,500	1,930
Gen'l service incand.	62.4	90%	1	6.3	350	1,000	350
Reflector incand.	7.9	90%	1	25	180	2,000	360
High wattage incand.	1.9	90%	1	130	220	1,550	340
HID	1.3	35%	6	145	410	3,500	1,440
Luminaires	3.5	90%	15	5.4	260	3,500	910
Motors	0.15	64%	15	265	380	2,676	1,020
Comm'l packaged HVAC	0.027	36%	15	937	130	1,100	140
TOTAL					2,480		6,490

Notes:
* Number installed based on sales in 1988 as reported to the U.S. Census Bureau. New York share of sales based on New York share of C&I employment in the U.S.
* Percent covered by standards based on studies of standards in Massachusetts and U.S. Census Bureau data.
* Average measure life estimated from manufacturers catalogs. Measure life capped at 15 years (the period of time included in the analysis).
* Savings per unit from studies on the impact of standards in Massachusetts and New York. These figures are net of current sales of improved efficiency products.
* kW savings are non-coincident and are the product of all of the previous columns.
* Average operating hours are based on studies of standards in Massachusetts and New York.
* kWh savings are at the end-user level and are product of kW savings and operating hours.
* Totals may not add due to rounding.

Table C-7
Computation of Overlap Between New Standards and Utility Programs

	Overlap in 2008 (GWh)
HID standards:	
Savings from NiMo, Con Ed and LILCo HID rebates	147
5% of savings from NiMo, Con Ed & LILCo Small C&I Direct Installation - General program (5% is ACEEE estimate of HID share of savings)	140
5% of savings from NiMo, Con Ed & LILCo Medium/Lg C&I Direct Installation program (5% is ACEEE estimate of HID share of savings)	103

Subtotal	389
Multiplier to adjust for other NY utilities (based on C&I kWh sales)	128%

Total - HID lamps	497
Motor standards:	
50% of savings from motor efficiency standards - based on participation rate in Motor Rebate program	510
Commercial packaged HVAC equipment standards:	
25% of savings from packaged HVAC equipment standards - new construction proportion of market, for which building code sets minimum efficiency levels (ACEEE estimate)	35
37.5% of savings from packaged HVAC equipment standards - based on participation rate in HVAC Packaged System Rebate program for the 75% of market not affected by building code	53

Total - packaged equipment	88
	=====
Grand total	1,095