Northeast Utilities
Energy Conscious Construction
Profile # 6, 1992

Executive Summary

Northeast Utilities' Energy Conscious Construction (ECC) Program provides building owners and designers with the education, technical assistance, and direct financial incentives to incorporate energy-efficient design principles and technologies into new construction and major renovation projects. For buildings less than 50,000 ft^2, the ECC program provides "prescriptive" incentives: predetermined rebates for a variety of efficiency measures. For buildings larger than 50,000 ft^2, the much larger part of the program, the ECC program offers a comprehensive approach including the provision of technical experts who work with the building owner's design team to build in energy efficiency through careful building design coupled with state of the art, energy-efficient lighting and HVAC systems. This has resulted in participating buildings that use an average of 25% less energy than non-participating buildings.

The ECC program was redesigned in 1988 as a result of the New England Collaborative process. At that time the program's incentives were increased and now NU pays the entire incremental cost of the efficiency upgrades. Also in that year NU published their Energy and Economics Guidebook which explains how new construction can be energy-efficient without higher costs. Education has been perhaps the most significant success of the program. The educational component has focused on the design professionals who participate in the projects. These designers learn, in the most direct way, that energy-efficient design is technically, aesthetically, and fiscally sound.

The ECC program is currently being offered through NU's operating subsidiaries in Connecticut and Western Massachusetts. The data presented in this profile reflects only the costs and savings at the far larger Connecticut Light and Power program. The CL&P ECC program saved 11 GWh and 2.67 MW of summer peak capacity, 1.79 MW winter peak, in 1990 at a total cost of $3.8 million. Though much of the data regarding participation is preliminary, the ECC program appears to be capturing a significant portion of the new commercial construction market. In 1991, some 12 million square feet of new buildings were commissioned in the CL&P service territory, and ECC signed contracts with 8.5 million square feet.

Energy Conscious Construction (ECC)

Utility:	Northeast Utilities (NU)
Sector:	Commercial and industrial
Measures:	Building envelope, commercial refrigeration, HVAC, lighting, motors
Mechanism:	Design assist., incentives, education
History:	Evolved from a program begun in 1983; operating in current form since 1988; planned through 2006.

1990 CL&P Program Data

Energy savings:	11,111,000 kWh
Peak capacity savings:	2.67 MW summer, 1.79 MW winter
Lifecycle energy savings:	199,998,000 kWh
Cost:	$3,825,690

1988 - 1990 CL&P Program Data

Energy savings:	13,986,504 kWh
Peak capacity savings:	3.23 MW summer, 2.25 MW winter
Lifecycle energy savings:	251,757,072 kWh
Cost:	$5,970,187

Conventions

For the entire 1992 profile series all dollar values have been adjusted to 1990 U.S. dollar levels unless otherwise specified. Inflation and exchange rates were derived from the U.S. Department of Labor's Consumer Price Index and the International Monetary Fund's International Financial Statistics Yearbook: 1991.

The Results Center uses three conventions for presenting program savings. **Annual savings** refer to the annualized value of increments of energy and capacity installed in a given year, or what might be best described as the first full-year effect of the measures installed in a given year. **Cumulative savings** represent the savings in a given year for all measures installed to date. **Lifecycle savings** are calculated by multiplying the annual savings by the assumed average measure lifetime. **Caution:** cumulative and lifecycle savings are theoretical values that usually represent only the technical measure lifetimes and are not adjusted for attrition unless specifically stated.

Northeast Utilities (NU) is a holding company which maintains three electric operating subsidiaries:

- The Connecticut Light and Power Company (CL&P),
- Western Massachusetts Electric Company (WMECO), and
- Holyoke Water Power Company.

NU, was formed on July 1, 1966 and was comprised of CL&P and WMECO. NU is currently in the process of acquiring the assets and the operating business of the bankrupt Public Service Company of New Hampshire (PSNH). The acquisition is expected to be completed in 1992. It will add 5,445 square miles to NU's existing service territory of 5,890 square miles (4,400 square miles in Connecticut and 1,490 square miles in Massachusetts).

The existing service territory is divided into six operating regions, five in Connecticut and one in Massachusetts. Generally, each region is further subdivided into three districts. Each of which has its own management office and personnel. Districts generally contain between three and twenty towns, with a total of 25,000 to 120,000 customers in each district.[R#7] Most of these divisions existed as the service territories of NU's predecessor utilities. In the next few years, the regions and possibly the districts will be restructured.

NU's service territory is undergoing a transition from a heavy manufacturing base to a high-tech and service-related base. The commercial sector is thus becoming NU's fastest growing load component, both in numbers of customers and in demand per facility. While the commercial sector represents less than 10% of NU's total customers, it accounts for more than 30% of total electric sales. Data from 1990 illustrates the large growth of the commercial sector. Commercial electricity consumption rose 2.5% in 1990, much larger than the rise in total electric sales which was a modest one-fifth of one percent. [R#8] In 1991, however, commercial and total electric sales dropped by 0.9% and 1.1% respectively. [R#13]

NU 1991 STATISTICS

Number of Customers	1,264,928	
Energy Sales	29,300	GWh
Energy Sales Revenue	$2.753	billion
Summer Peak Demand	5,000	MW
Net Capacity Available	5,941	MW
Reserve Margin	18.81	%
Average Electric Rates		
Residential	10.45	¢/kWh
Commercial	9.30	¢/kWh
Industrial	8.50	¢/kWh

All of the above from [R#9]

Utility DSM Overview

In 1980, NU began offering conservation services under an umbrella DSM program called, The 80's and 90's Program. The program was mostly informational and geared to the residential sector. In 1986 NU shifted the focus of its umbrella DSM program to the commercial and industrial sectors and changed its name to Energy Alliance. The utility came to understand that the commercial and industrial sectors had the potential for achieving greater energy savings with fewer buildings (customers) and at lower cost per kWh than did the residential sector. Later, during the rate case proceedings of 1988, the now famous New England Collaborative Process was born. In Connecticut, CL&P entered into an ongoing, collaborative DSM program planning process with the following organizations:

- The Connecticut Office of the Consumer Counsel;
- The Energy Division, Office of Policy and Management;
- The Prosecutorial Division of the Department of Public Utility Control; and
- The Conservation Law Foundation of New England.

The first year of the collaborative process, 1988, was a very important transition year for Energy Alliance. Virtually all DSM programs were reviewed and redesigned.

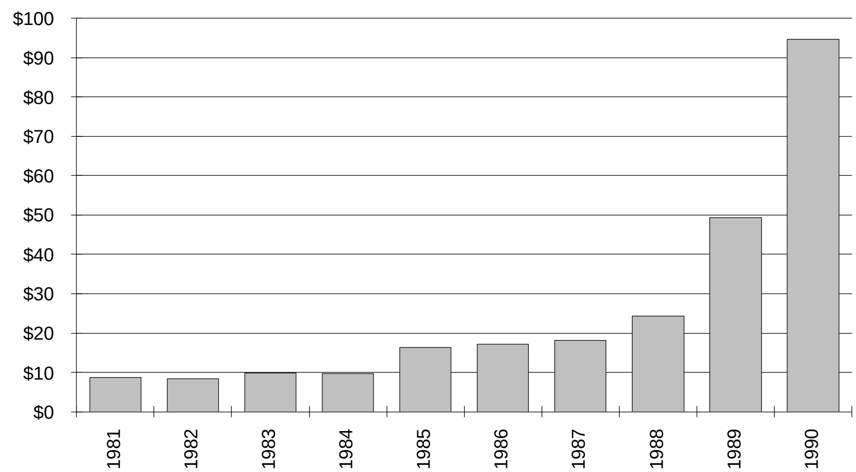
The collaborative's program planning concentrates on three large customer groups: 1) residential, 2) low-income residential, and 3) commercial/industrial. Services formerly offered under separate programs have, in many cases, been packaged into comprehensive programs aimed at specific target customer groups within each market sector. This approach allows for better target marketing of customers who have similar efficiency needs, barriers, and adoption requirements.

The primary issues addressed by the collaborative include DSM program design, implementation, cost effectiveness, recovery of DSM expenditures, program monitoring and evaluation, and resource planning.

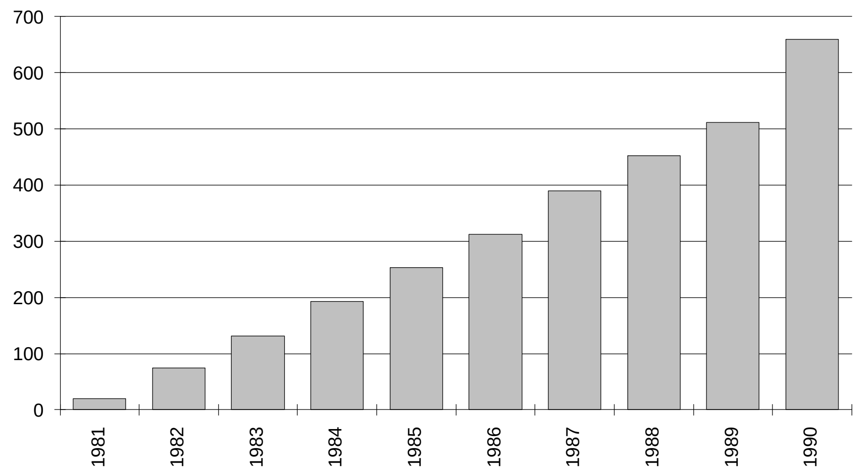
NU is pursuing DSM from a position of surplus capacity. The need for additional capacity is not projected to occur until 2005. By the summer of 2001 and the winter of 2001/02, DSM resources are projected to provide 875 MW and 946 MW, respectively, 9.8% and 10.1% of the total required capacity. By the summer of 2011 and the winter of 2011/12, DSM resources are projected to provide 1,270 MW and 1,305 MW, respectively (11.3% and 11.2% of the total required capacity). [R#13]

Utility DSM Overview Table	Annual DSM Expenditure ($1000)	Cumulative DSM Energy Savings (GWh)	Cumulative DSM Summer Capacity Savings (MW)	Cumulative DSM Winter Capacity Savings (MW)
1981	$0	20.60	2.20	4.50
1982	$8,775	74.70	11.90	16.70
1983	$8,462	131.90	22.10	29.30
1984	$9,816	192.70	33.40	43.40
1985	$9,645	253.60	45.50	56.80
1986	$16,344	312.30	57.80	70.10
1987	$17,098	390.03	68.11	88.64
1988	$18,047	452.81	176.83	137.01
1989	$24,240	510.96	188.43	149.15
1990	$49,351	659.48	217.87	177.88
1991	$94,632			
Total	$256,409	2999.09	824.14	773.48

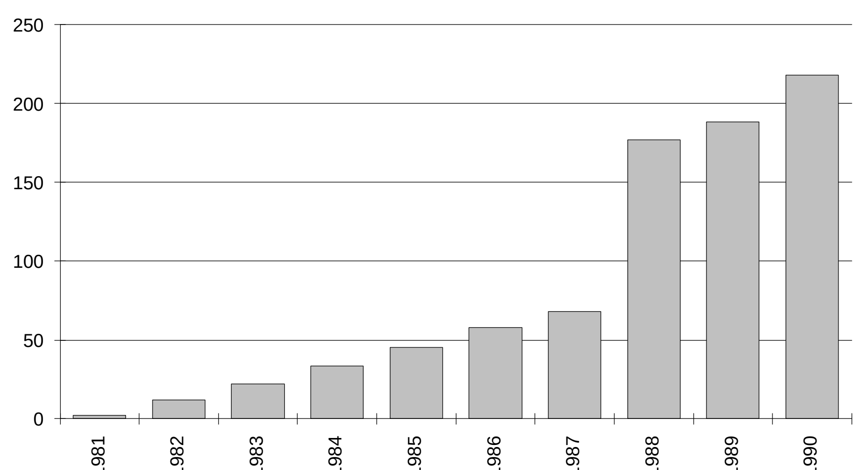
ANNUAL DSM EXPENDITURE ($1,000,000)



CUMULATIVE DSM ENERGY SAVINGS (GWH)



CUMULATIVE DSM SUMMER CAPACITY SAVINGS (MW)



CL&P DSM PROGRAMS 1991

RESIDENTIAL

Spectrum
- Electric Heat-Single Family
- Electric Heat-Multifamily
- Public Housing Authority
- Domestic Hot Water
- Neighborhood Program
- Lighting Catalog
- Appliance Labeling
- Appliance Pick-up

Energy Value Water Heating
Energy Value Home
Residential Conservation Services
Energy Conservation Loan Program
Operation Solar
Customer Assistance Programs
- Weatherization Residential Assistance Partnership (WRAP)
- Energy Care
- NU-Neighborhood Housing Services

Revolving Loan Program
Conservation Education

COMERCIAL / INDUSTRIAL

Energy Saver Lighting Rebate Program
Energy Action Program
Energy Conscious Construction
Energy CHECK Conservation Services
State Buildings Program
Farm Share
Connecticut Hospital Association Loan Fund
Customer Initiated Program
Streetlight Conversion
Time-of-Day (TOD) Rates
Interruptible Rates
Technical Training

The Energy Conscious Construction program is designed to increase the electric energy efficiency of new, nonresidential construction, as well as that of major renovations of existing nonresidential facilities. A variety of incentives exist to encourage the design, specification, and installation of additional electricity saving measures in these facilities.

The ECC program is divided into two areas, The Prescriptive Area and The Comprehensive Area. These areas are designed to provide a qualifying construction or renovation project with the appropriate level of assistance to produce the maximum cost-effective energy savings benefit. The Prescriptive Area, offering a menu of efficiency measures and incentives for their installation, is available to small projects, less than 50,000 ft^2, that are in any stage of design or construction (although early participation is encouraged). The Comprehensive Area, taking advantage of every step within the design process, is able to capture savings opportunities that would be too expensive to pursue during later design stages or actual construction. Within the Comprehensive Area, utility personnel and/or their representatives work directly with a building owner's design team, assisting them in properly considering the full range of efficiency measures. The owner and design team maintain complete control of the project but have the benefit of access to the technical assistance and resources of the Northeast Utilities' personnel.

The ECC program evolved from the Energy Value Building Program which began in 1983. This was an informational program aimed at educating builders, designers, and building owners about energy efficiency in construction. The program reached few customers.

In 1985-1986 the name of the program was changed to Energy Conscious Construction. In addition to information, the program provided free DOE-2 simulations of building designs for projects whose designers would speak with NU personnel about energy-efficient construction. Still, the program was not widely received.

In 1988, the collaborative process began, which led to a redesign of the ECC program. On Sept 31, 1988, the redesigned ECC program went into effect. A major change was the inclusion of incentives to pay the full incremental design and construction costs of the efficiency measures. Also that year, NU produced the Energy and Economics Guidebook which explained how the efficiency of a new office building could be increased without increasing its construction costs. The guidebook was designed to be a marketing aid for the ECC program. The book was, and still is, widely distributed and well regarded.

The redesigned ECC program effectively began in January of 1989 with the "brainstorming" of the first Comprehensive project. Current planning and approved funding for the program extend to 2006. It is not known whether the program will continue beyond that point, as NU does not do DSM planning beyond a fifteen year horizon.

Programs similar to ECC are operated at the New England Electric System (NEES) and the Bonneville Power Administration (BPA). According to NU personnel, NEES's Design 2000 Program is similar to ECC's Prescriptive Area, and BPA's Energy Edge Program is similar to ECC's Comprehensive Area.

MARKETING AND DELIVERY

The ECC program utilizes a direct, one-on-one marketing approach emphasizing personal contact and respect for customers and design professionals. All personnel involved with delivering the program are involved with marketing it, as well. The Program Administrators, part of the central staff, market the program to the design community, architects, and engineers. Field personnel at the regional and district levels market the ECC program to building owners.

The central staff try to be present at large gatherings of designers. Several times each year a representative of the central staff speaks at a large design conference. Staff members also attend trade shows such as the one sponsored by the Boston Society of Architects where ECC maintained an information booth.

Marketing literature includes: 1) a straight-forward informational pamphlet geared toward building owners and facility managers; 2) an artfully designed, more aesthetically and philosophically sophisticated pamphlet directed toward engineers and architects; and 3) a guidebook entitled, Energy and Economics, Strategies for Office Building Design. The guidebook provides information on the energy and cost impacts of various efficiency measures on a hypothetical 50,000 ft^2 office building.

In the past, the ECC program has run advertisements in trade publications. Program personnel believe that although advertisements increase customer awareness of the program they do not generate tangible leads for future projects. For this reason, recent budget cuts have scaled back such advertising efforts.

PRESCRIPTIVE AREA

The Prescriptive Area offers a menu of energy-efficiency measures and incentives to building owners and designers. This program area is available for buildings smaller than 50,000 ft^2, grocery stores with self-contained refrigerated cases, any size nonair-conditioned space, and initial tenant improvements where the building envelope is already in place. Projects may be in any phase of design or construction to participate.

The utility provides general and technical support in the design and installation of approved efficiency measures. Prior to installation, a contract listing selected measures and their corresponding incentives is signed by the building owner and the utility. Incentive payments are made only for measures that are listed in the contract, installed after the contract is signed, and verified by a utility representative to be functioning properly. When required, owners are responsible for commissioning (the process of verifying that all equipment and controls are properly installed and properly functioning under all operating conditions) their facilities.

COMPREHENSIVE AREA

The Comprehensive Area utilizes a team approach whereby NU personnel work directly with a building owner's design team throughout the design process of a new construction or major renovation project. Technical support and financial incentives, provided by NU, encourage the designers to proceed with the most comprehensive, cost-effective package of energy-efficiency measures possible. This program area is available to nonresidential buildings larger than 50,000 ft^2 and grocery stores of any size that contain centrally operated refrigeration systems. Participation in the Comprehensive Area affects each step of the design process. Projects must, therefore, enter the program as early as possible (ideally, during the schematic design phase).

The utility and the design team sign an agreement to initiate the comprehensive process. The utility then facilitates an initial brainstorming session with the building owner and the members of the design team. During this session, which can last between three and eight hours, the team identifies a base building design and several alternative, energy-efficient designs.

Next, parametric computer simulations (DOE-2.1 D or comparable) are performed to calculate the effect of each efficiency measure on the projected energy use performance of the baseline building design. Most frequently a consulting firm, on retainer to NU, performs the simulations. However, the design team can elect to perform the simulations and be reimbursed by NU. Reimbursement is based upon the size of the building.

While the simulations are being performed, the design team prepares its estimates of the incremental costs to design, procure, and install the efficiency measures included in the alternative designs. The incremental cost is defined as the difference between the cost of the baseline design and the cost of the more efficient design. For a measure such as an occupancy sensor, which would not be part of the baseline design, the entire hardware, wiring, and design cost is acceptable to include in the incremental cost estimate.

Commissioning (see description above) can also be included when it is appropriate.

Cost estimates need not be detailed itemizations. For example, a lighting cost estimate may be given simply as dollars per watts per square foot. Regardless of how the estimates are presented, NU requires the design team to submit a description of the methodology by which they were calculated. This aids NU's review of the estimates.

Upon receipt of the cost estimates, the first cost-effectiveness test, called the "screening cap," is performed. This test compares the incremental cost estimate for each measure to its effect on the energy use performance of the base building design, as determined by the computer simulations described above. The estimated incremental costs of a measure divided by the product of its lifetime and the annual electric energy savings which it produces, may not exceed 3.6¢/kWh in order to pass the screening test. Measures that pass this test are included in interactive computer simulations which determine the combined effect of the measures on the building.

In addition to electric energy saving measures, the owner and the design team can request parametric simulations of other energy related measures. In these cases, the building owner or design team may wish to know how non-electric measures, such as switching heating fuel from oil to natural gas or increasing the efficiency of a non-electrically fired burner, may affect building energy use performance. While efficiency measures such as these are encouraged by NU, only measures which save electric energy are eligible for incentives.

Next, interactive simulations progressively combine the measures that have passed the screening test. The measures are added to the interactive simulation in the order of their priority, as determined by the design team. After each measure is added, a simulation is performed. If the combination results in a cost per lifetime kWh saved of less than the program cap, then the next most desirable measure is added and another interactive simulation run is performed. This process is repeated until the program cap is reached or no measures remain. Once the program cap is reached, the remaining measures are ineligible, and the measures included in the last successful simulation become part of the alternative building design.

The building owner then signs a contract with the utility stating agreement to proceed with the alternative design. The contract stipulates which measures are to be installed, the estimated annual and lifetime energy savings they will produce, the design and installation incentives available for their installation, what will be considered proper operation for the measures, and what commissioning functions the owner must perform. Once construction and any necessary commissioning are completed, a utility representative verifies the installation of the measures.

Finally, incentives are paid for those measures found to be properly installed and functioning. Generally installation incentives are paid to the owner, and design incentives are paid to the architect who distributes them to the rest of the design team. The contract between NU and the owner can, however, be written so as to distribute the incentives in any way that the owner wishes.

Incentives are based on the estimated incremental costs submitted by the design team. NU program staff, as well as independent consultants, review the estimates to determine that they fall within acceptable limits. From previous experience, program staff have a good sense of the appropriate range of the incremental costs of the most common measures. If a cost is not included in the estimate, an incentive will not be paid to reimburse the owner for that cost.

Some limits, or "caps", apply to the incentives. The total incentive, both the design and installation incentives, is capped at 3.6¢/kWh saved over the lifecycle of the installed measures. Of this total, the design incentive is capped at 2¢/kWh saved during the measures' first year of operation. Once approved by NU, an incentive is not changed throughout the project. If the estimated costs, upon which the incentives are based, are later found to be higher or lower than actual costs, the customer will still receive the agreed upon incentive.

In addition to the incentive for the incremental design cost of the efficiency measures, the design team receives a $1,000 honorarium for its participation in the entire brainstorming process and can also earn a performance-based bonus incentive. The performance-based incentive awards the design team the greater of $500 or 30% of the estimated design incentive if the chosen energy-efficient building design results in 20% less annual electric energy consumption than the baseline design.

INFORMATIONAL AREA

For customers not wanting to participate in either of the incentive areas, discussed above, NU offers free DOE-2 simulations through the Informational Area. The service is presented in such a way as to encourage the customer to participate in either the Prescriptive or Comprehensive Areas as well.

The Informational Area also offers activities, such as seminars and training, for architects and engineers. Topics have included HVAC, lighting, and ASHRAE 90.1 (which is being adopted as part of the State of Connecticut building code). The Informational Area is often used to support and to market the other program areas; however, many of its activities have been suspended due to temporary cost reduction initiatives adopted throughout NU in mid-1991.

INSTALLED MEASURES

PRESCRIPTIVE AREA

The Prescriptive Area offers an extensive menu of efficiency measures. These include:

- Interior Lighting — an incentive is available for each full tenth watt reduction below the power density of the baseline lighting design. This incentive varies for different building uses and types.
- Automatic Lighting Controls — incentives are available for each fixture controlled by an on/off occupancy sensor, a step daylighting control, or a continuous daylighting control. Each type of control has a different incentive value.
- Exit Sign Fixtures — incentives vary for each fixture type and maximum wattage.
- Building Envelope Insulation — an incentive is available for the installation of ceiling insulation in buildings that are totally electrically heated. The incentive increases with the R-value of the insulation.
- Energy-Efficient Motors — incentives are available for installing energy-efficient motors for use on circulator pumps, fans, and blowers of HVAC systems. The incentives increase with the horsepower and the nominal efficiency of the motor.
- HVAC Equipment, including air conditioners, heat pumps, and fan cooling units — incentives vary with the cooling capacity and the Seasonal Energy Efficiency Ratio (SEER), Energy Efficiency Ratio (EER), Heating Seasonal Performance Factor (HSPF), or Coefficient of Performance (COP) rating.

COMPREHENSIVE AREA

Within the Comprehensive Area all energy efficiency measures are eligible for consideration. Only those measures whose incremental costs are less than or equal to the program cap (3.6¢ per lifetime kWh saved) are eligible for incentives. Beyond the program cap, measures are considered not cost-effective.

In the sample of 24 Comprehensive Area projects analyzed by the September 1991 process evaluation, HVAC measures — motors, speed controls, and system changes — were the type most often considered, followed by lighting and building envelope improvements. Most projects included at least one improvement (reduction) to the lighting power density (W/ft^2) and a lighting control measure. Most also included at least two HVAC system improvements — chiller efficiency improvements, variable speed drive installations, or high efficiency motor installations. Less than 15% of the projects included in the sample contracted for improvements to the building envelope.

STAFFING REQUIREMENTS

The central staff includes four program administrators. The senior program administrator is responsible for the administrative tasks involved with the program's operation. The other three program administrators work mostly within the Comprehensive Area and directly with the building owners' design teams to facilitate the technical aspects of the brainstorming process. These three also have the responsibility of marketing the program to the design community.

The field staff includes seven regional field representatives, who work exclusively with the ECC Program, and several district consultants. These personnel are almost entirely responsible for managing the Prescriptive Area projects and market the ECC Program to building owners. District personnel have a general knowledge of all NU DSM programs, including ECC, and pursue leads within their districts.

Outside consultants, working for NU central staff, provide additional technical support to Comprehensive projects in areas such as lighting, HVAC, cost estimate review, and building simulation.

Program staff tend to have much experience with the delivery of DSM programs. Although marketing and sales skills are important, few have such backgrounds. All members of the central staff have backgrounds in architecture or engineering. This experience is a valuable asset when working with clients in the Comprehensive Area.

Staff job training includes studying the ECC program implementation manuals and attending a two-hour training seminar. The process evaluation reports that many, especially field personnel, would like specialized technical training in areas relevant to ECC, i.e. lighting, HVAC, motors and energy simulation. They believe this would help them to more effectively market the program and service the customers.

Program Administrator Don Flynn believes that much of the success of ECC relies upon the designers' positive perception of the staff and the trust that the designers have in the staff. In such a situation more training would always be better. It is his impression that the regional and district personnel need to know "the ins and outs" of how the ECC program operates but that they do not require extensive technical knowledge. They can therefore be trained in-house. The central staff, on the other hand, are required to have specialized technical knowledge. Their needs are more likely to require training outside the utility. In the past, program administrators have attended a one-week course concerning HVAC at the University of Wisconsin. A few program administrators have also received lighting training from manufacturers such as Sylvania or GE. At present, however, there is little money in the budget for training, due to company-wide budget restrictions.

PROGRAM ACTION TEAM

The Program Action Team (PAT), consisting of central staff and regional personnel, meets monthly to discuss current issues of concern to those administering the ECC program. The senior program administrator heads the PAT. Other members include one or two program administrators from each region, representatives from the Corporate Communications Department, and representatives from the Demand Program Planning and Evaluation Group. The regional program administrators are responsible for administering the ECC program in the field. The representatives from Corporate Communications handle advertising, program brochures, etc. The representatives from the Demand Program Planning and Evaluation Group develop the program's data tracking system, coordinate process evaluations, and provide input as to the incentive structures and levels.

A PAT meeting might include discussion of issues such as: 1) the development of marketing materials based on case histories; 2) changes in tax law which affect incentive payments; 3) regional program budgets and forecasts; and 4) future organizational changes within the utility and how they might affect ECC program delivery.

Monitoring and Evaluation

MONITORING

The original intent of the ECC Program included complete end-use metering for each project within the Comprehensive Area. However, money to accomplish this has never been allocated.

A small office building that was designed in conjunction with the Comprehensive Area of the ECC Program is being completely monitored to measure its actual energy use and compare it to the simulated results. Ninety-nine percent of the building's energy consumption can be identified. (The monitored data was not released to the owner of the building until after the first heating season, so as not to influence the sample.) The data showed that the building was not operating as intended. Fred Wajcs, Senior Program Administrator, is concerned that this could be a problem throughout the program. A major factor in this problem is that proper commissioning of buildings has not been understood by most building owners and designers and has only recently been well defined and required by NU.

A spreadsheet, developed for load forecasting purposes, has been in operation since late July 1990. It contains energy savings based upon both the contract and the actual installation for projects within the ECC program.

EVALUATION

NU has a staff which performs program evaluations. This staff mostly supports rate case applications. They also oversee the work of independent consultants in completing independent evaluations of NU programs. One such evaluation was a process evaluation of the ECC program. The evaluation was performed by an independent consultant and completed in September of 1991. The final report of the evaluation included analyses of participant surveys and an assessment of the ECC program's effectiveness.

The findings of the process evaluation suggest that the ECC program is meeting its goal of beginning to shift the attitudes and standard practices of designers and building owners toward energy efficiency. Of the program participants surveyed, 84% reported that participation in the ECC program increased their understanding of energy-efficient design. Almost half (47%) indicated that they will continue to incorporate efficiency strategies in future projects, even without the help of the ECC program. "Owners were often quite vocal about enjoying their new found knowledge and were able to talk about the types of improvements they had financed through the program and how those improvements had significantly cut their operating costs," the evaluation reported. "One owner stated that his lighting bill is about half of what it used to be [despite the fact] that his new building is twice the size."

According to the process evaluation, approximately one-third of all efficiency measures considered during the brainstorming meeting to be worthy of further analysis were included in the final design. Of the remaining two-thirds, one-third dropped out due to owner concerns such as equipment reliability and maintenance; and the remaining third did not meet the incentive cap or was analyzed for information only.

Participants and non-participants, who were interviewed as part of the process evaluation, reported that they wanted to see evidence that ECC works and that earlier program participants are satisfied with the results. The evaluation included the recommendation that providing feedback to customers and design teams about the success and performance of ECC building projects should be a high priority for NU. It suggested that information about successful projects be published in relevant publications and/or be included in program brochures.

Overall, the results of the process evaluation suggest that program participants are pleased with the program; 22% reported being extremely satisfied, 46% very satisfied, and 25% satisfied. A small percentage of participants reported that the utility needs to improve in certain areas, such as timeliness (3%), staff expertise (1%), paperwork (4%) and payment procedures (7%).

Another evaluation, not yet complete, includes a preliminary report which will present and discuss approximately one year's worth of data from the monitoring project discussed above. The preliminary report was scheduled to be available in April, 1992, with further, more detailed analyses to be presented in November, 1992.

Also important to program monitoring and evaluation is the ECC program tracking system. This system was installed in a test environment in late 1989. As reported in the April 1990 Annual Report on Conservation and Load Management (C&LM) activities, the system "collects and maintains data on customer and building characteristics, energy use, estimated and actual delivery process milestones, estimated and actual measure subsidy costs, engineering support data, and program management cost data. The ECC system is further supplemented by on-line retrieval capabilities through a subscription to the "Dodge Report" (McGraw Hill) database of new construction statistics for the service territory and region."

DATA QUALITY

No centralized data base or data processing system has existed for ECC. Data has therefore been maintained in a variety of places and by many people. NU is currently in the process of developing a centralized data base which will include ECC data. Without this system in place, The Results Center has only been able to analyze the ECC Program in its entirety and has not been able to analyze its components, its effects on individual participants, nor its participation.

The only concern about the quality of the data available from NU is in the accuracy of the savings estimates. These are based on the interactive computer simulations of the final building designs and may not reflect the actual operation of the buildings. NU has begun to address this concern with their published commissioning guidelines and the monitoring project discussed above.

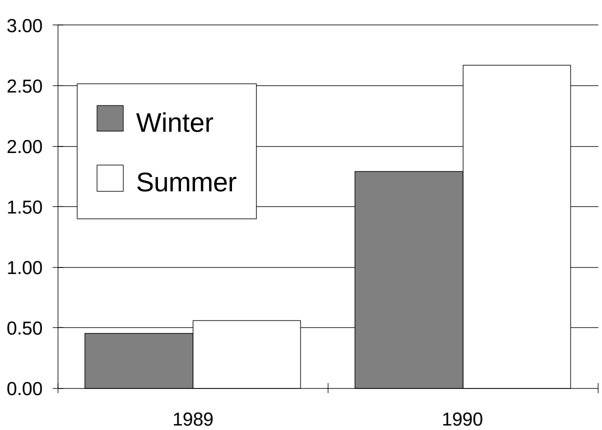
Program Savings

Costs Overview Table	Annual Energy Savings (kWh)	Cumulative Energy Savings (kWh)	Lifecycle Energy Savings (kWh)	Annual Summer Capacity Savings (MW)	Cumulative Summer Capacity Savings (MW)	Annual Winter Capacity Savings (MW)	Cumulative Winter Capacity Savings (MW)
1989 [R#4]	2,875,504	2,875,504	51,759,072	0.56	0.56	0.46	0.46
1990 [R#5]	11,111,00	13,986,504	199,998,000	2.67	3.23	1.79	2.25
Total	13,986,50	16,862,008	251,757,072	3.23		2.25	

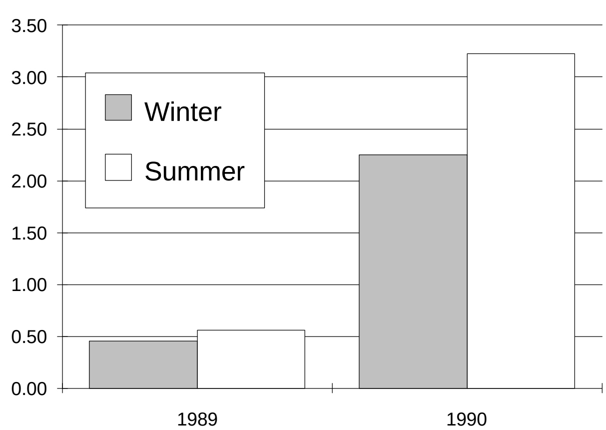
ANNUAL ENERGY SAVINGS (GWH)

CUMULATIVE ENERGY SAVINGS (GWH)

ANNUAL PEAK CAPACITY SAVINGS (MW)



CUMULATIVE PEAK CAPACITY SAVINGS (MW)



As of its first two full years of operation (1989-1990) in its current form, the ECC Program had accumulated total energy savings of 13,986,504 kWh and deferred the need for 3.23 MW of additional summer peak load. [R#3,4,5]

Note: The ECC Program was operational for part of 1988, but no savings were realized until 1989.

MEASURE LIFETIME

Participants in the Energy Conscious Construction Program include many different measures in their projects. Northeast Utilities has published a list of the lifetimes of most measures and determined that the average lifetime of all measures implemented is 18 years. [R#4,5]

PARTICIPATION

Senior Program Administrator Fred Wajcs estimates participation to be 20% - 25% of all new, non-residential construction projects in NU's service territory. In 1991 there were 12 million square feet of new, non-residential construction permits issued in NU's service territory. In the same time period, the ECC Program signed contracts for 8.5 million square feet. While this may appear to be 70% participation, Mr. Wajcs cautions that it is difficult to compare the number of ECC contracts signed during a given year to the number of building permits issued during the same year. Of the contracts signed in a year, some projects may have building permits issued in that year but others may have had permits issued the previous year or may not have permits issued until the next year.

Further, it is also unclear what constitutes participation. The ECC program is designed to assist building owners and their designers to construct new facilities with as much attention to energy use as possible. Many projects utilize the program to its fullest extent and adopt a large number of energy-saving strategies. Other projects make relatively few alterations to their original designs. Program personnel believe that there are different levels of participation but have not yet developed criteria to differentiate between them.

Cost of the Program

The current ECC Program expended a total of $5,970,187 between 1988 (start-up costs) and 1990.

Cost Overview Table	Expense Cost	Payroll Cost	Total Program Cost
1988 [R#3]	$419,831	$118,216	$538,046
1989 [R#4]	$1,226,683	$379,768	$1,606,451
1990 [R#5]	$3,465,428	$360,262	$3,825,690
Total	$5,111,942	$858,245	$5,970,187

COST EFFECTIVENESS

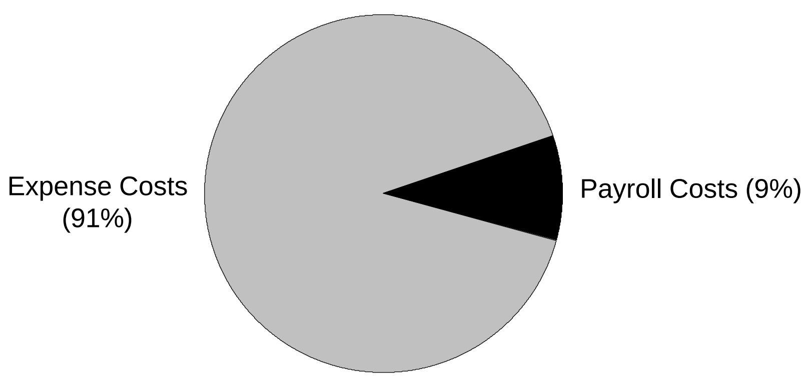
Prior to implementation, the ECC program was screened, from a revenue requirements perspective, for cost-effectiveness as compared to alternative supply-side investments. The incentive levels offered have been set to provide long-term benefits to NU's ratepayers and to provide program participants with a means to offset the incremental costs of DSM measures. [R#3] The program's 1990 cost of saved energy, calculated at a 5% discount rate, is 2.95¢ which is significantly less than NU's commercial sector electricity rate of 9.3¢/kWh.

FREE RIDERSHIP

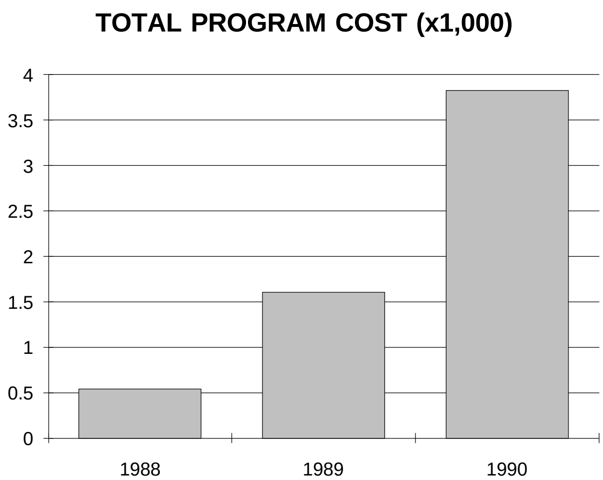
According to the September 1991 Process Evaluation, NU staff and retained consultants do not consider free ridership to be a significant problem for the ECC program. Interviews conducted by the evaluators with owners, architects, and engineers participating in the same projects produced widely varying responses to the question of what measures they might have included in their facilities in the absence of the ECC program. Often participants would change their answer to the question after some discussion.

In the light of this uncertainty, the process evaluation reports that of those participants surveyed:

- 32% would not have installed any measures without the program,
- 6% would have installed all the measures without the program,
- 47% would have installed some measures, but not others, or would have installed less efficient but similar types of measures, and
- 15% do not know what they would have done without the program.



The process evaluation suggested that free ridership was most likely to occur with lighting systems, but that this might be "a necessary incentive to get participants to consider other efficiency measures." Program personnel reportedly believe that free ridership was more likely in the Prescriptive Area than in the Comprehensive Area. Establishing an acurate "standard practice" baseline is seen as the most important task



in minimizing free ridership. The maximum baseline parameters for the CL&P program have been established using ASHRAE/IES 90.1-1989 and a survey of current building practices. The evaluation further suggests, "Program administrators should plan how to determine when it's time to update program guidelines and how to institute more stringent baselines for the program."

COST PER PARTICIPANT

Both costs and savings per participant or per square foot of participants' space are not yet available for the ECC program. Although costs and savings are reported annually, program participation usually requires more than one year for most participants. At present there is no way to accurately attribute costs and savings to the correct participants.

COST COMPONENTS

The Annual Report on Conservation and Load Management reports an "Expense Cost" and a "Payroll Cost." The payroll cost includes the salaries of NU program personnel. The expense cost includes salaries of non-NU program personnel (2 of 4 Program Administrators and some District and Regional personnel) as well as all other utility expenditures for the ECC Program such as: incentive payments to participants, payments to consultants, travel expenses for program personnel, training, etc. For the 1990 program year the expense cost accounted for 90.6% of the total program costs. The payroll cost for NU personnel accounted for only 9.4%. [R#5]

Cost of Saved Energy Table (¢/kWh)	Discount Rates						
	3%	4%	5%	6%	7%	8%	9%
1989	4.06	4.41	4.78	5.16	5.55	5.96	6.38
1990	2.50	2.72	2.95	3.18	3.42	3.67	3.93

1990 Administrative cost of saved energy at 5% = 0.28

Environmental Benefit Statement

Marginal Power Plant	Heat Rate BTU/kWh	% Sulfur in Fuel	CO2 (lbs)	SO2 (lbs)	NOx (lbs)	TSP* (lbs)
Coal	**Uncontrolled Emissions**					
A	9,400	2.50%	36,354,000	862,000	174,000	17,000
B	10,000	1.20%	38,766,000	334,000	113,000	83,000
	Controlled Emissions					
A	9,400	2.50%	36,354,000	86,000	174,000	1,000
B	10,000	1.20%	38,766,000	33,000	113,000	6,000
C	10,000		38,766,000	223,000	111,000	6,000
	Atmospheric Fluidized Bed Combustion					
A	10,000	1.10%	38,766,000	102,000	56,000	28,000
B	9,400	2.50%	36,354,000	86,000	70,000	5,000
	Integrated Gasification Combined Cycle					
A	10,000	0.45%	38,766,000	69,000	11,000	28,000
B	9,010		34,871,000	25,000	8,000	2,000
Gas	**Steam**					
A	10,400		21,145,000	0	48,000	0
B	9,224		18,363,000	0	115,000	5,000
	Combined Cycle					
1. Existing	9,000		18,363,000	0	70,000	0
2. NSPS*	9,000		18,363,000	0	33,000	0
3. BACT*	9,000		18,363,000	0	5,000	0
Oil	**Steam--#6 Oil**					
A	9,840	2.00%	30,605,000	464,000	55,000	52,000
B	10,400	2.20%	32,459,000	460,000	69,000	33,000
C	10,400	1.00%	32,459,000	66,000	55,000	17,000
D	10,400	0.50%	32,459,000	193,000	69,000	11,000
	Combustion Turbine					
#2 Diesel	13,600	0.30%	40,621,000	81,000	126,000	7,000
Refuse Derived Fuel						
Conventional	15,000	0.20%	48,225,000	124,000	164,000	36,000

Avoided Emissions Based on 16,862,008 kWh Saved (1990 - 1991)

In addition to the traditional costs and benefits there are several hidden environmental costs of electricity use that are incurred when one considers the whole system of electrical generation from the mine-mouth to the wall outlet. These costs, which to date have been considered externalities, are real and have profound long term effects and are borne by society as a whole. Some environmental costs are beginning to be factored into utility resource planning. Because energy efficiency programs present the opportunity for utilities to avoid environmental damages, environmental considerations can be considered a benefit in addition to the direct dollar savings to customers from reduced electricity use.

The environmental benefits of energy efficiency programs can include avoided pollution of the air, the land, and the water. Because of immediate concerns about urban air quality, acid deposition, and global warming, the first step in calculating the environmental benefit of a particular DSM program focuses on avoided air pollution. Within this domain we have limited our presentation to the emission of carbon dioxide, sulfur dioxide, nitrous oxides, and particulates. (Dollar values for environmental benefits are not presented given the variety of values currently being used in various states.)

HOW TO USE THE TABLE

1. The purpose of the previous page is to allow any user of this profile to apply NU's level of avoided emissions saved through its Energy Conscious Construction Program to a particular situation. Simply move down the left-hand column to your marginal power plant type, and then read across the page to determine the values for avoided emissions that you will accrue should you implement this DSM program. Note that several generic power plants (labelled A, B, C,...) are presented which reflect differences in heat rate and fuel sulfur content.

2. All of the values for avoided emissions presented in both tables includes a 10% credit for DSM savings to reflect the avoided transmission and distribution losses associated with supply-side resources.

3. Various forms of power generation create specific pollutants. Coal-fired generation, for example, creates bottom ash (a solid waste issue) and methane, while garbage-burning plants release toxic airborne emissions including dioxin and furans and solid wastes which contain an array of heavy metals. We recommend that when calculating the environmental benefit for a particular program that credit is taken for the air pollutants listed below, plus air pollutants unique to a form of marginal generation, plus key land and water pollutants for a particular form of marginal power generation.

4. All the values presented represent approximations and were drawn largely from "The Environmental Costs of Electricity" (Ottinger et al, Oceana Publications, 1990). The coefficients used in the formulas that determine the values in the tables presented are drawn from a variety of government and independent sources.

*** Acronyms used in the table**

TSP = Total Suspended Particulates
NSPS = New Source Performance Standards
BACT = Best Available Control Technology

Lessons Learned

The ECC program has its greatest ability to influence the efficiency of a facility, when it is employed early in the design process. Generally, the earlier, the better. The process evaluation suggests that this should be stressed to owners and design teams in all marketing and informational/promotional materials. From the customer's point of view, early entry into ECC allows them to make the fullest use of the program and to install the greatest number of efficiency measures.

The time of entry into the program also affects participants' views of how much incentive they should be paid for designing in improved energy efficiency measures. If the participants enter the program at an early stage of the design process, efficiency measures are part of the initial building design and thus their incremental design time (and thus cost) is perceived to be small. If the participants enter late, previously completed designs have to be altered, and the perception of the incremental design time is greater, as is the incentive that the participant expects to compensate for that time.

The description of efficiency measures to be included in a project must be clear and carefully drafted. The wording must remain consistent throughout the ECC process and must be as well defined as possible. This will help to ensure that the utility, the building owner, and the design team all have the same understanding of which measures are to be included in the project. It will also aid the utility in accurately performing design reviews and on-site inspections.

Credibility and trust must be established with the architects and engineers. Once this is established, these professionals must then understand and appreciate their role in the ECC process so that their satisfaction and interest in the program is maintained.

Some trends have begun to emerge regarding the suitability of various measures to the Comprehensive Area of the ECC program. Lighting improvements that reduce power consumption are the most successful at passing the program's cost effectiveness tests. This is primarily due to recent advancements in lighting technology and the interactive effect that a reduced lighting load has on reducing a building's cooling load. Other improvements such as those to the building envelope (insulation and glazing) often exceed the program's cost effectiveness cap. While these measures are highly cost effective by standard definitions and save energy, most buildings that participate in ECC are not electrically heated; therefore, the energy these measures save is non-electric. NU bases its incentives strictly on the amount of electric energy a measure saves, regardless of how much non-electric energy it saves.

Every project is different and therefore larger projects, typically all those included in the Customized Area, require individualized computer simulations that incorporate all of the significant variables, such as orientation, occupancy schedules, size, shape, etc., to determine which efficiency measures are most appropriate. Measures that may at first seem to be practical can, through simulation, be found to be undesirable. One such example is insulation. In many commercial buildings, the cooling load is much greater than the heating load. For some of these buildings, adding additional insulation can actually increase the energy use by "trapping" heat, within the building, that must then be mechanically removed.

It is not enough to simply verify that the hardware called for in an efficiency measure is installed. It is essential to verify that the system is calibrated and functioning in the field as intended. This process, called "commissioning," is a stipulation in the incentive contracts for all appropriate measures — generally all those involving control functions. The monitored small office building discussed in the Monitoring and Evaluation section was not commissioned which may be one reason that it is not operating as intended.

Commissioning is an area of strong concern for NU. According to NU's Fred Wajcs, no one had attempted to standardize commissioning until ASHRAE established its guidelines in 1989. These guidelines, he reports, were an important first step but needed improvement. In response to its own need and the perceived void of helpful information, NU published its own commissioning guidelines in June of 1991. Proper commissioning, with NU requirements as a minimum, will help to ensure that buildings achieve their simulated savings.

The ECC Program is designed to interrupt the flow of the design process as little as possible. However, participants themselves can cause delays in the process. This happens most frequently when the participants improperly report cost estimates (some design teams do not fully understand NU's concept of incremental costs) and have to recalculate them. A delay can also occur when the team does not include the methodology by which it arrived at its estimates and must then resubmit the estimates and methodology. In some cases, the design team simply does not submit its cost estimates to NU at the agreed upon time and thus causes delay.

TRANSFERABILITY

In general, the ECC program appears to be highly transferable. According to Senior Program Administrator Fred Wajcs and Program Administrator Don Flynn, there are two areas of special concern to the transferability of the ECC Program.

First, Don Flynn places a great deal of emphasis on the need to determine accurate, demographically specific baseline building standards. As stated before, NU uses ASHRAE 90.1. Other utilities will have to carefully examine standard building practices in their service territories before setting their own standards.

Second, Fred Wajcs firmly believes that the success of this program in other territories will be dependent on the desire of the people implementing the program and their willingness to work with the architectural and engineering communities in their area.

The ECC program is subject to a different incentive mechanism in each operating subsidiary's service territory.

THE MASSACHUSETTS INCENTIVE

The incentive mechanism available for WMECO's DSM programs is based on the savings that the programs produce for ratepayers. The Massachusetts Department of Public Utilities (DPU) approved WMECO's incentive structure based upon the idea that an "incentive bonus should not be based only on dollars spent since this rewards the Company for spending money rather than producing savings."[R#2] The Massachusetts DPU, therefore, allows WMECO to collect an incentive based upon measured energy and capacity savings.

Prior to each program year, the incremental values of each kWh and kW saved are set, as well as a target savings level for the program. The utility can only earn an incentive if it has achieved at least 50% of the target savings. Beyond 50%, WMECO earns a fixed amount for each measured kWh and kW saved. The incentive structure is designed so that if WMECO achieves 50% above the threshold, which equals 100% of the target savings level, it will receive the full target incentive. If WMECO achieves 150% of the target savings level, it will have doubled the amount of savings on which an incentive is available and, similarly, it will have also doubled the incentive which it will earn (provided its expenditures have not exceeded its budget). If WMECO spends more than it has budgeted for the program, the threshold before which it can earn an incentive rises proportionately. The value of each kWh and kW saved is constant throughout the program year, regardless of threshold increases. Programs that do not meet the threshold are simply ineligible for incentives; there is no further penalty.

THE CONNECTICUT INCENTIVE

NU and the Connecticut Department of Public Utility Control are in the process of finalizing a modified shared savings plan for DSM programs implemented by CL&P. The plan is a product of the New England Collaborative Process. It will allow CL&P to earn a bonus above its normal rate of return on its aggregate demand-side management expenditures.

The bonus rate of return is a function of the "aggregate performance score" (APS). The APS is a relationship between achieved and planned results for all DSM programs added together. The relationship is the ratio of the sum of weighted, achieved results to the sum of weighted, planned results, multiplied by 100. The greater the value of the APS, the higher the rate of return that CL&P is allowed on its DSM expenditures.

Program specific weighting factors are applied to the results of each program before they are added to the aggregate to insure that the utility does not shift monies away from less cost effective programs. To insure that no programs have a disproportionate affect on the APS, a maximum value is placed on the weighting factors. Programs which exceed this maximum or have negative weighting factors default to zero and are functionally excluded from the APS score. For the 1991-1992 program year, the maximum weighting factor was ten.

Also determined prior to the program year are the minimum performance standards (MPS) which each program must achieve. These standards help to insure that all programs are implemented to the full intent of their design. CL&P is assessed a "penalty" for programs that do not meet the MPS. In cases in which CL&P has implemented a program as designed and yet the program has not met its MPS for reasons outside of CL&P's control, the collaborative can waive the MPS if it so chooses.

Although termed a penalty, the "incentive penalty" only prevents program expenditures from earning a bonus rate of return. These expenditures are still eligible to receive the normal rate of return that the DPUC has approved for capital expenditures. Therefore, the "penalty" is actually just the absence of a reward. The utility loses no revenue.

The net bonus incentive payment is calculated by taking into account both the "gross bonus incentive payment" and the "incentive penalty." These values are calculated at the end of each program year. First, the APS is calculated to determine the bonus rate of return that CL&P can earn on its total DSM expenditures for that year. The bonus rate of return is then added to the normal rate of return and applied to the entire DSM expenditure, yielding the gross bonus incentive payment. Next, the same rate of return is applied to the total of all expenditures for all programs that did not meet the MPS. This value is the incentive penalty. The penalty is subtracted from the gross bonus incentive payment to yield the net bonus incentive payment. This is the utility's reward for implementing its DSM programs in the program year.

All of the above from [R#5,15,16].

References

1. Nancy Benner, "Lessons Learned in Demand-Side Planning for Connecticut Light and Power's New Building Program: Commercial Sector," Demand-Side Management Strategies for the 90s, Proceedings: Fourth National Conference on Utility DSM Programs, pages 10-1 through 10-9, EPRI CU-6367, Volume 1, Research Project 2548-6, April 1989.

2. The Commonwealth of Massachusetts Department of Public Utilities, "D.P.U 91-44, Petition of Western Massachusetts Electric Company for approval by the Department of Public Utilities in accordance with 220 CMR 9.00, of its application for cost recovery and Preapproval of its 1991 Conservation and Load Management Programs," July 1, 1991.

3. CL&P, "Conservation and Load Management Programs, Annual Report," April 1989.

4. CL&P, "Conservation and Load Management Programs, Annual Report," April 1990.

5. CL&P, "Conservation and Load Management Programs, Annual Report for 1990," April 1991.

6. Dethman & Associates, "Northeast Utilities Energy Conscious Construction Program Process Evaluation," September 1991.

7. Jeff Kotkin, Corporate Communications Officer, Northeast Utilities, personal communication, March 1992.

8. Northeast Utilities, "Annual Report," 1990.

9. Northeast Utilities, "Annual Report," 1991.

10. Northeast Utilities, "Application of the Connecticut Light and Power Company to Amend Rate Schedules Phase II, Docket 90-12-03, Conservation Budget and Incentive Proposal Compliance with Order No. 4," September 13, 1991.

11. Northeast Utilities, "Application of the Connecticut Light and Power Company to Amend Rate Schedules – Phase II, Docket 90-12-03, Response to Department's Letter Concerning Compliance with Order No. 4," November 22, 1991.

12. Northeast Utilities, "Conservation and Load Management Evaluation Plan 1990-1994," Jan. 1990.

13. Northeast Utilities, "1992 Forecast of Loads and Resources for 1992-2011," March 1, 1992.

14. ORNL/CON-220, "A Review of Utility Conservation Programs for the Commercial Building Sector," January 1988, pages 27, B-57.

15. State of Connecticut Department of Public Utility Control, "Application of the Connecticut Light and Power Company to Amend Rate Schedules – Phase II, Docket 90-12-03, Decision," August 1, 1991.

16. State of Connecticut DPUC, "Application of the Connecticut Light and Power Company to Amend Rate Schedules – Phase II, Docket 90-12-03, Decision," October 30, 1991.

17. Fred Wajcs, "Energy Conscious Construction: A Program for Commercial Construction," Demand-Side Management Strategies in Transition, Proceedings, Third National Conference on Utility DSM Programs, pages 29-1 through 29-6, June 1987.

18. Fred Wajcs, Senior Program Administrator, ECC, personal communications, February - April 1992.

- Special thanks to Don Flynn for his patience and help throughout the development of this profile.