Burlington Electric Department

Smartlight

Profile #3, 1992

Executive Summary

In 1990 the voters of Burlington, Vermont authorized the Burlington Electric Department (BED) to issue an $11 million bond to invest in energy efficiency. Many voters took the opportunity to make it clear that they favored energy efficiency over the prospect of buying additional increments of Hydro-Quebec's James Bay power, another element in the resource plan.

As part of its overall efficiency initiative BED staff opted to employ a lightbulb leasing mechanism that had been pioneered at Taunton, Mass. Municipal Lighting Plant. There, Joe Desmond had a rather elegant idea. By leasing customers compact fluorescent lamps wouldn't it be possible for a utility to offer positive cash flow for customers (where bill savings were greater than lease payments), while at the same time providing savings for the utility at low cost? The "Smartlight" program has been refined in Burlington and is the largest program of its kind in the country.

In the first fifteen months of the program BED had distributed almost 25,000 bulbs to over five thousand residential customers. After 20 months BED had installed 26,602 bulbs, averaging 3.4 lamps per customer, for estimated savings of 1,300 MWh/year. Burlington Electric, with a total of 33,647 energy-efficient lamps distributed in the community, is now in the process of extending leasing to commercial lighting.

BED's Smartlight Program also was able to effectively use college students on summer vacation to educate sustomers about energy efficiency and the leasing mechanism, and to install the lamps in appropriate applications. Selct students were retained during the school year to perform installations.

One of the interesting lessons learned from Burlington's Smartlight program is that the lease payments themselves have been a relatively insignificant aspect of the program. BED program managers feel that the point is the education of their customers, and their commitment to have the lamps only in cost effective sockets. The profile concludes with a discussion of the relative merits of the leasing concept versus direct installation programs for residential lighting.

BED provides a fascinating case study of an innovative, positive cash flow, DSM implementation strategy. Costs of the program are somewhat elusive, as lamps placed today have a net present value in terms of lease payments. This, however, is offset in part by attrition rates of the lamps. Finally, the savings data is complicated by the fact that a certain percentage of installed lamps maintain active leases, while another subset are likely in service but their leases have been broken.

Smartlight Program

Utility:	Burlington Electric Department
Sector:	Residential
Measures:	Compact Fluorescent Lamps
Mechanism:	Positive customer cash flow through lease payments.
History:	Begun in 1990, continuing to present.

1991 Program Data

Energy savings:	517,632 kWh
Lifecycle energy savings:	2,240,783 kWh
Peak capacity savings:	450 kW winter
Net cost:	$256,781

1990-1992 (1Q) Data

Energy savings:	1,627,840 kWh
Lifecycle energy savings:	7,046,775 kWh
Peak capacity savings:	1.25 MW winter
Net cost:	$810,901
Participation:	38%

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.

Burlington Electric Department is a municipal utility in Burlington, Vermont. Burlington is a small city, located on Lake Champlain, only 60 miles from the Canadian border, consisting of 38,700 residents and approximately 8,000 students. There are four colleges within the city limits of Burlington, including the University of Vermont. (As such there is an unusually high apartment turnover rate.) The City is 10 square miles in area and the utility claims that its 180 employees can get to any part of its service territory in 15 minutes.

BED's system peak has decreased 14.5% over the past 10 years. The city is switching to a summer peaking utility, currently the summer peak is 97% of its previous winter peak. Summer peak has increased 21% over the same 10-year period.[R#4] In 1990 BED's system peak was 60.7 MW, a 6.6% reduction from the previous year's peak of 65 MW. This reduction was primarily due to weather patterns, although some of the decline was likely due to BED's school efficiency initiative.[R#4,10] In 1991, the system peak fell to 58.9 MW -- due in large part to the recession.[R#3]

BED owns 55 MW of installed generating capacity including 50% of the 52 MW McNeil wood-fired generating station, the largest wood-burning facility in the world. In 1990 BED added gas-burning capabilities to the plant and since then has been buying natural gas on an interruptible basis from Vermont Gas, although BED has been unable to buy gas in the winter months. When gas is used at McNeil the plant's output is highly competitive in the New England Power Pool mix, and as such BED has sold more power from McNeil than it would have been able to do with the wood-only capability.

BED also owns 3.6% of Vermont Yankee Nuclear Power Corporation, and nuclear power from Vermont Yankee currently provides 28% of BED's energy. The remainder comes from Hydro-Quebec (25.7%), a coal-fired plant in New Hampshire (15%), the New York Power Authority (7%), McNeil with wood (9%), McNeil with gas (6.5%), non-utility generation (3.8%), and BED's #2 oil turbine (1.5%). BED also calculates that DSM currently provides about 4% of the previous year's energy requirements.

Between 1991 and 2001 nearly 50% of BED's supply mix will vanish as power contracts end. In addition, access to transmission is becoming more limited and expensive.[R#1] Thus former Manager of Power Resources, Jim Lauzon, noted, "We are strongly motivated to make DSM work."

BED 1991 STATISTICS

Number of Customers	18,114	
Energy Sales	34,050	MWh
Revenue from Energy Sales	$35.365	million
Winter Peak Demand	58.9	MW
Generating Capacity	55.0	MW
Average Electric Rates		
Residential	9.84	¢/kWh
Small General	12.60	¢/kWh
Large General	7.30	¢/kWh

Additional energy and capacity available from NEPOOL.

All of the above from [R#3]

Utility DSM Overview

BED conducted demand-side management on a very limited basis in the 1970s. Streetlighting was standardized to high-performance sodium lamps in the 70s. In 1981 Burlington voters passed, and BED issued, a $2 million bond to pay for weatherization and water heater controls and wraps that were installed at no cost to customers. In 1986 the "Power Miser" program was launched in which electric hot water heaters were switched on and off at periods of peak demand via radio-controlled devices. The result of this program was that BED put switches on over 50% of electric hot water heaters and cut peak by more than 3 MW.[R#10]

Since 1990 BED has also invested in energy efficiency improvements in the city's schools and assisted them in the conversion to natural gas space heating systems. These measures are expected to save the schools over $300,000 in energy bills annually.

In July of 1988 BED published its first formal Least-Cost Integrated Power Plan. The plan called for the commencement of a residential lighting program following the lease concept implemented by the Taunton Municipal Lighting Plant in Taunton, Massachusetts.

In the fall of 1989 BED's "Smartlight" leasing program was launched. Compact fluorescent lamps (CFLs) became available for $0.20 per month for all BED residential customers. Smartlight was designed to be a part of BED's Neighbor$ave program, a more comprehensive direct installation program for water heater insulation jackets, high-performance showerheads, faucet aerators, outlet gaskets, and plug covers, all free to customers. In addition to these measures, customers are able to lease CFLs. As a complement to the Smartlight program, lighting demonstration projects, with published savings, were completed at Burlington's City Hall, Church Street Center, and the Community Boathouse.

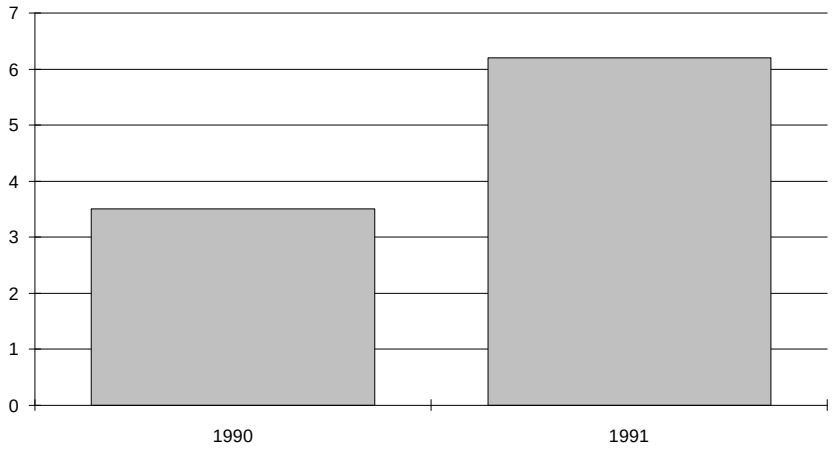
Burlington is an exceptionally environmentally and socially "conscious" community. A survey conducted by BED in the fall of 1990 found that customers were willing to have a 5-10% rate increase to purchase more environmentally-benign resources. (BED's one-page survey, using bill stuffer questionnaires, asked general questions such as whether you support energy conservation and will pay more for it, and garnered an unusually high response rate (30-40%) from the community. The utility expected to get on the order of 1,000 responses and received 6-7,000.)[R#10] On March 6, 1990 Burlington's voters overwhelmingly approved a $11.3 million bond for conservation and DSM programs knowing it would raise rates by 4% to pay for it. This came in the light of the strong opposition to further hydroelectric development by Hydro-Quebec in the James Bay region.

Utility DSM Overview Table	Annual DSM Expenditure	Annual Energy Savings (GWh)	Annual Winter Capacity Savings (MW)
1990	$906,742	3.5	5
1991	$1,364,717	6.2	6
1992 (1Q)	$412,046	N/A	N/A

One fascinating barrier that BED has overcome is that the utility recognizes that its income is not as important as the savings that it can provide to its customers, or what the utility refers to as its 18,000 "consumer-owners." In 1990, the Department ended the year with a net income of $362,570, $854,000 less than the previous year.[R#1] The primary reason stated for the change was a decrease in operating revenues resulting from reduced kilowatt and kilowatt-hour sales, due "in large part to DSM programs". This assertion is questionable. According to insiders, as soon as BED lost revenue because of the DSM program, BED's financial analysts started to "blame" all their financial woes on DSM. This highlights the typical tension between finance officers, who are horrified by dips in sales, and advocates of energy efficiency as a socially responsible and desirable utility strategy. (Continued page 6)

ANNUAL DSM EXPENDITURE ($1,000)

ANNUAL DSM ENERGY SAVINGS (GWH)



ANNUAL DSM CAPACITY SAVINGS (MW)

ENERGY EFFICIENCY PROGRAMS IN BURLINGTON, VERMONT

• Neighbor$ave: Begun in 1990 this program brings energy saving devices, including Smartlights, into residents' homes. Trained student employees install energy and water saving measures at no cost. In addition, they review household energy usage and provide information on other energy saving opportunities. In two years BED has served over 45% of its residential customers.

• Heat Exchange: Begun in 1990 with the assistance of a U.S. Department of Energy grant of $125,000 for a pilot fuel switching program, BED offers assistance and financial subsidies to consumers to convert from electric heating to other sources. As of March 23, 1992 BED had facilitated 600 such conversions and the utility plans to provide this service to about 1,500 customers over the next five years. This will save the city almost 4 MW of electric demand, and 9 million kilowatt-hours annually.[R#4,5] BED's commitment to the fuel switching program is highlighted in the brochure that promotes the program: "You could be enjoying tremendous savings on your heating costs. How? By switching your electric heating system to another heating fuel through Burlington Electric's Heat Exchange program. We'll guide you every step of the way -- it'll be a lot easier than you think!"[R#11]

• Top 10 Program: Begun in 1991, this program brings a customized menu of energy-saving measures to the city's largest commercial and industrial electric customers. BED will work closely with company management to provide positive cash flow financing of demand-side management measures. Though directed to a small group of customers, this program is planned to save from 5-7 MW of electrical demand, and about 25 million kWh annually.

• Energy Advantage: Begun in 1991, this program is designed to promote energy-efficiency for commercial customers. The program offers direct installation and positive cash flow financing for a wide range of measures that are customized for each business. When delivered to 2,500 commercial customers, this program is planned to save over 3 MW and about 11 million kWh annually. Rebates are also available for those customers who opt to do the work themselves or install more expensive systems. After the equipment is installed and the savings verified by BED, rebates are provided.

PROJECTED SAVINGS

BED's residential and commercial efficiency programs are projected to save 11 MW in the next five years, nearly 45,000,000 kilowatt hours annually, enough power to light up 6,250 Burlington homes, saving the Burlington economy about $28.5 million over the next 18 years![R#1]

Program Overview

Smartlight was initiated by BED as a stand-alone, mail-order program that was subsequently amalgamated into BED's Neighbor$ave program. Program planners at BED are quick to point out that this evolution is perhaps the key lesson learned: Smartlight works better as a subset of Neighbor$ave than it does as a stand-alone program.

The mail-order Smartlight program was fulfilled first using the United Parcel Service to deliver the lamps,... then BED switched to bicycle delivery for a period of time! This quickly became history, as crews of trained college students went door-to-door with an armful of energy efficiency measures.

As characterized by Sean Foley of Burlington Electric Department, "Neighbor$ave is a demand-side management program designed to cost effectively save a little energy for a large number of a utility's residential customers within a short period of time. By helping these customers save money and by enrolling them in energy efficiency, a utility can operate other programs targeted to large users knowing that they will have the support of a majority of their customers." Alan Yandow, Manager of Customer Services and Marketing, makes the useful distinction that Neighbor$ave is the "delivery program," and Smartlight is one unique component of Neighbor$ave.

Neighbor$ave is a door-to-door program, which uses trained college students to install a variety of efficiency items in customers' homes and to provide energy efficiency information. These items include compact fluorescent bulbs, water-efficient faucet aerators and showerheads, and water heater insulation jackets. In December, 1989 BED decided to do a 4-week pilot for the program. The pilot successfully reached 250 customers and the full-scale program was initiated in May, 1989.

Neighbor$ave's bulb initiative was begun in May of 1990. By the end of 1990, 15,594 lamps had been installed in 4,234 homes. The average number of bulbs per household was 3.3, and the average cost of all the measures installed (bulbs, aerators, showerheads, wraps, etc.) was $86 per household. Data presented by BED suggests that 10% of the total bulbs leased in 1990 (1,500 bulbs) were returned. Staff suggests that this high return rate was due to the less effective Smartlight program, and this information was a powerful justification for combining Smartlight with Neighbor$ave. Customers who received bulbs via the mail- order service often found that they were too big or too long to fit in their lamps and lamp sockets, and returned them. One of the attributes of Neighbor$ave is that installers actually install the lamps. Once Smartlight was subsumed into Neighbor$ave, the number of returned lamps dropped off dramatically.

BED's least-cost plan projected that a compact fluorescent leasing program could expect to install 5,000 bulbs over a 36-month period, and when finished would save 390 MWh/year. Remarkably, over five thousand bulbs, the target for three years, were placed within three months!

In June of 1989 BED revised its projections. More ambitious targets were announced which projected a 14% penetration rate at 3.5 bulbs per customer for a total of 8,000 bulbs saving 629 MWh/year. After 10 months BED had installed 16,523 bulbs, averaging 3.4 bulbs/customer, and annual savings as a result of the placed lamps were revised to 1,000 MWh. Annual energy savings by the end of 1991 were 1,359 MWh.

THE LEASING DELIVERY MECHANISM

In October of 1989 the Smartlight began after delays associated with obtaining approval from the City of Burlington Electric Commission and the Vermont Public Service Board. From the onset of the program to the present, residential customers have been able to lease any of BED's compact fluorescent lamps for 20¢ per month. For any lamp that is used for one and a half hours a day or more, leasing is a breakeven or better financial proposition. After 60 months or $12.00 worth of payments, the lease fee stops, effectively completing the customer's payback of the lamp.

LEASE PROVISIONS

- If a bulb breaks or burns out, upon return to BED the lease fee stops. A new bulb, with a new lease, is then issued.
- If customers don't like the bulb, they can return it at any time and the lease stops. A two-month break-in period is given before the lease starts, so they don't have to pay for it until they have tried it out and decided to keep it.
- If the customer moves, the lease fee is stopped whether the bulb is returned or not.

BED's intent with the lease mechanism was to give people a sense of ownership of their actions, to insure that the bulbs were installed and used in cost-effective applications. Recouping cash was low on BED's list of objectives. While the lease fee provisions seem riddled with concessions, they were designed to allow for maximum participation and ease in accounting.[R#4,5,10]

MARKETING

BED started to make Smartlight known in the community with a teaser advertisement, "Smartlight is Coming", followed by an ad campaign announcing Smartlight's arrival. In addition, a multidimensional, yet rather simple, campaign was launched to raise the program's visibility and garner its acceptance in Burlington.

- Brochures with a postage paid reply card were mailed to all residential customers. Initially the program only offered Philips SL18 bulbs, and the brochures contained a punch out of the SL18 so that customers could check their fixtures for a fit, as SL18s (like many compact fluorescents) have longer stems and bulkier bases than incandescents.
- Stickers with the program logo were placed everywhere and displays were set up in the schools as part of Public Power Week.
- The community boathouse, a highly visible building, was retrofitted as a model of lighting efficiency.
- A working display was set up in the lobby of the utility to educate walk-in bill payers (a common occurrence in small towns), and the display was used by the staff to assist customers participating in the program.
- Articles were placed in the consumer newsletter, as were advertisements in the local papers. Ads were also placed on local buses.
- Bill stuffers were sent out after 6 weeks to keep high visibility among customers.
- TV and radio campaigns emphasized the advantages of participating to the customers. Posters used quotes from program participants.
- A doorhanger with a postage paid return card was circulated through the city.

NEIGHBOR$AVE BECOMES THE DELIVERY MECHANISM

In 1990 BED elected to make Smartlight a part of its more comprehensive Neighbor$ave program. BED staff stress that Neighbor$ave is a powerful delivery mechanism, and that the Smartlight's evolution into Neighbor$ave was a marked improvement. More bulbs were placed as they were physically installed by the college students. Rather than relying on residents to place the lamps and to address issues of sizing, or needing a larger harp, using Neighbor$ave, BED staff made sure that the lamps were well suited for each application.

At the peak of the program, during the summers of 1990 and 1991, four marketers used a specially created database program which contained a copy of BED's main customer identification and location file to contact residents and offer them the Neighbor$ave service. The program allowed for scheduling crews at customer's convenience, and also has the capability to print a mailing label after three failed telephone attempts to contact the customer. A postcard was then sent to the customer asking him or her to call the utility.

Two person crews, made up mostly of students, visited the homes. They carried out several tasks in addition to

promoting and installing the compact fluorescents.

- Wrap/repair water heater from 1982 program
- Install showerheads/aerators in bathroom and kitchen
- Vacuum refrigerator and air conditioner coils
- Collect necessary data to evaluate this program and to assist in the design of future programs. Gather appliance inventory, demographic, and housing stock data.
- Speak with customers and leave a standard package of information, as well as specialized informational brochures written especially for this program as applicable.

INSTALLED MEASURES

Burlington began its Smartlight program with a larger, more varied product line than was used in Taunton where the lamps used were limited to Philips SL18s.

Currently BED is offering 9-10 lighting products as part of the leasing program. (Philips, Osram, Panasonic, Sylvania, etc.) Lamps are leased for five years and BED has developed the software to add the number of bulbs to the customer's monthly bill for the duration of the lease.

Burlington Electric buys lamps in bulk orders of thousands of lamps. BED does this to get the bulk price, but then the distributor delivers the lamps in small quantities. At the beginning of the program there were shortages of lamps. When the utility was unable to buy 27 watt Panasonic lamps, Seventh Generation (a "green," mail-order catalog) lent several hundred lamps to BED. BED now buys lamps locally to stimulate local distribution networks. In addition to the lamps that BED provides, the utility also provides larger harps and lamp extenders that allow the lamps to fit in more applications. These special adaptors are provided at no cost to customers.

STAFFING REQUIREMENTS

It is difficult to break out the number of staff required to administer the Smartlight program since it is part of Neighbor$ave. The Neighbor$ave program is carried out by college students in the summer who conduct the door-to-door effort. These students tend to have credibility and are well-liked by the community. BED reports numerous letters and calls from customers who "raved about the program and the fine young people who came to visit them."

For the full-scale Neighbor$ave program thirty students on summer vacation were hired as installers and telemarketers. This included 24 field personnel, 4 telemarketers, and two supervisors. While most of the actual work associated with Neighbor$ave is carried out by the college students, these workers have to be overseen by BED staff. BED estimates suggest that Smartlight, as a component of Neighbor$ave, requires one full-time equivalent. About three-quarters of the time is spent in the implementation of the program, the other quarter attributed to monitoring and evaluation. Thus the one full-time equivalent staff oversees the program and a variable number of field personnel and telemarketers. [R#5]

BED uses a comprehensive four-day training program for both telemarketers and installers. The program covers basic energy efficiency theory, familiarity with products and installation techniques, customer relations and how to efficiently perform a visit, scheduling, and maintaining forms to ensure program accountability. (Incidentally, installers use their own vehicles and insurance to drive to the customer's home.) Delivery of the Smartlights was originally carried out by United Parcel Service and then switched briefly to a bicycle courier service before Smartlight was subsumed into the Neighbor$ave program.)

Neighbor$ave employed six installation crews at the peak of the program, the summers of 1990 and 1991. Currently, with approximately 30% of all eligible households retrofitted, BED has only two crews who are responsible for both telemarketing and installation. At this time BED plans no more door-to-door marketing. This strategy was used only when all other marketing methods proved insufficient to maintain the level of visits desired by BED.

MONITORING

One of the clear advantages of leasing programs is that when they are fine-tuned they provide a built-in data recording mechanism. Data collected from the CFL leasing program is entered into a database on a daily basis, which then triggers a line item on customers bills for lease payments, and reports on the program's progress can be issued to management on a real-time basis. In addition, during the summer door-to-door campaigns, weekly reports on the success ratio of each installer were issued and used to identify individuals who could be helped by additional training. Quality control checks were randomly made by the program's coordinator. Follow-up telephone calls were made to participating customers to obtain feedback on the products and installers.

EVALUATION

Overall, BED has focused its attention on installing 33,000 lamps, not on evaluating the program. Sean Foley, Director of Resource Planning, has done some initial billing analysis but he notes that the effort has been muddled by several factors. First, residential lighting accounts for a small fraction of electricity use in the home, and thus variations in customer bills are hard to explicitly attribute to CFL installations. Second, the recession in Vermont appears to have had profound effects on electricity use -- far greater impacts than forecasts had suggested. Third, fuel switching has also occurred in a number of houses and is a far greater factor than lighting. These factors all have served to bury, or at least muddle, the savings data on leasing. Currently BED is only required to furnish summary statements of its DSM programs to the City's Electric Commission and thus no systematic process or impact evaluations are in progress or planned for either Smartlight or the Neighbor$ave program.

Critics of the program, claim that "absolutely no monitoring and evaluation has been completed that gives an accurate look at the success of BED's program." While we question the assertion, the critics raise key points and posit some useful suggestions.Perhaps BED ought to fully evaluate the pros and cons of leasing by testing two similar neighborhoods for savings. By using a control group that is entitled to lease lamps, and establishing a test group entitled to direct installation, several interesting questions could be answered. What are the comparative levels of participation? What was the penetration for the two groups in terms of lamps installed in homes? What were the relative attrition rates?[R#6] Subsequent Results Center profiles will allow for such comparisons.

A former BED official, Jim Lauzon, believes in the critics' purist argument. True, all compact fluorescents will save money over their lifetimes. But BED, like most utilities, is not a bottomless pit full of money. BED's program designers -- siting real economic constraints -- have focused on saving 80% of the lighting energy in 100% of the homes rather than 100% of the lighting energy in 10-20% of the homes![R#10]

DATA QUALITY

• An overriding analytical barrier to the Smartlight data is that its delivery mechanism changed in midstream. At first Smartlight was a "stand-alone" program. Now it is part of Neighbor$ave -- and its costs and participation and penetration rates in particular are hard to ascertain in isolation. Breaking out the data has been somewhat problematic. Also, the high turnover of apartments muddles the analysis of participation rates.

• The savings and cost data presented only account for 1990 through the second quarter of 1992. Program impacts in 1989, while relatively insignificant, are excluded from the tables but do appear in the text where total Smartlights and total number of participants (and thus participation rates) are presented.

• Energy savings values presented are based on engineering estimates that each Smartlight installed will result in annual savings of 64 kWh. (This suggests that each lamp -- with a 10,000-hour technical lifetime -- is used 3 hours per day.) The estimates of daily lamp use were based on survey information obtained from the first 1,500-2,000 program participants. Unlike direct installation programs the leasing mechanism likely promotes a certain degree of accuracy from customers. Customers have an incentive not to overestimate their lamp use since each leased lamp must be placed in a

socket that is used for at least one and one-half hours a day in order for the lease to break even. Nevertheless a more thorough analysis in the future will reveal more accurate duty factors and address free ridership (totally omitted from this analysis) and winter as well as summer peak coincidence factors.

• Peak capacity savings are not routinely reported for Smartlights by BED. For the purpose of presenting transferable information, however, BED reports winter capacity savings using a rather crudely determined winter peak coincidence factor of 80%.

• Determining the number of lamps in service, actually providing kWh and kW savings for BED, is elusive. While lamps with active leases are most certainly being used and providing savings, a certain number of lamps are in use that are not leased but have been left by former tenants, or moved by tenants to a new location. BED uses an attrition factor of 20% per year beginning in year two for both active and inactive lamps. This attrition factor is used to calculate cumulative and lifecycle energy savings, cumulative peak capacity savings, and could be used -- but is not for this profile -- to determine the theoretical potential for lease income.

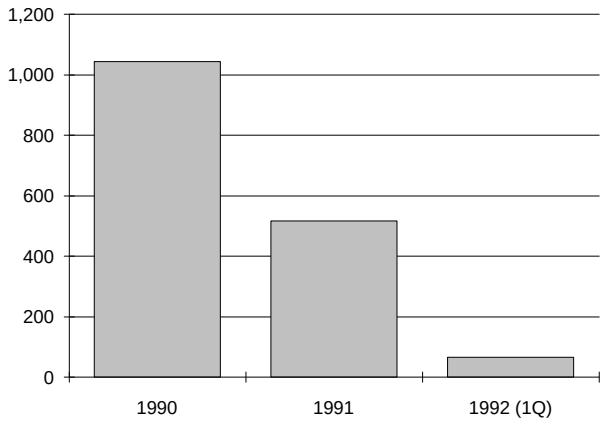
• When tenants do move, effectively cancelling their "active lamp leases," BED notifies these customers that they have a choice to either reuse, leave, or return their Smartlights. Bulbs in lamps and other mobile applications are to be returned to BED or used in a new apartment. Customers with Smartlights in stationary lamp fixtures, such as ceiling fixtures, are encouraged to leave bulbs in place for the next tenants. Many customers drop off their Smartlights at BED's offices. Others simply take their Smartlights with them to their next home. Invariably some must leak out of the BED service territory, some stay in Vermont and others move on.

BED staff feel that "inactive" bulbs have a strong purpose of their own for educating others and providing avoided energy services in new locations. BED notifies new tenants that their apartment may well have one or more Smartlights. As such, an undetermined number of "inactive" lamps are still in use. BED assumes that 50% of "inactive" lamps (discussed later) are indeed in service and providing savings of 64 kWh/ year. Note that all "returned" bulbs are omitted from the analysis.

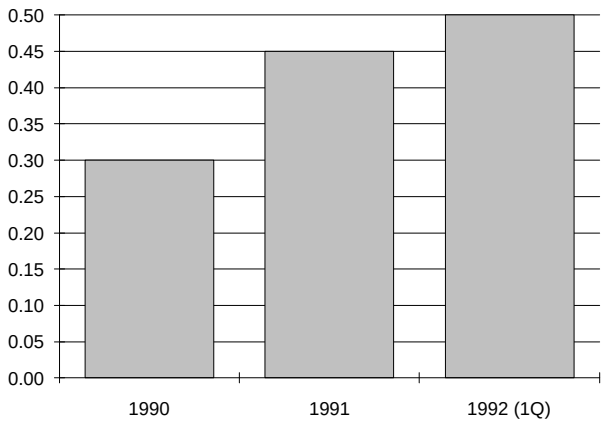
Program Savings

Savings Overview Table	Annual Energy Savings (kWh)	Cumulative Energy Savings (kWh)	Lifecycle Energy Savings (kWh)	Winter Peak Capacity Savings (MW)	Cumulative Winter Peak Capacity Savings (MW)
1990	1,043,296	1,043,296	4,516,336	0.30	0.30
1991	517,632	1,352,269	2,240,783	0.45	0.75
1992 (1Q)	66,912	1,148,727	289,656	0.50	1.25
Total	1,627,840	3,544,292	7,046,775	1.25	

ANNUAL ENERGY SAVINGS (MWH)

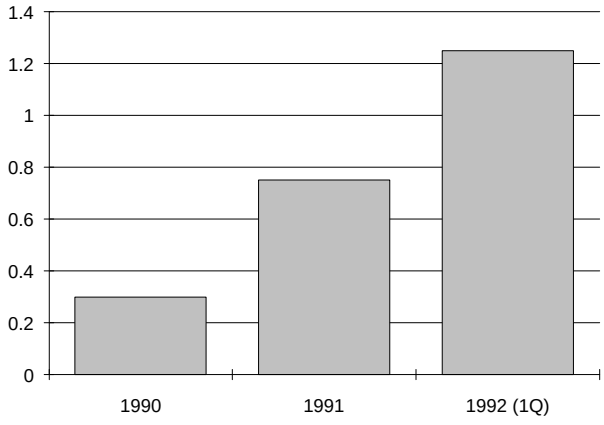


ANNUAL PEAK CAPACITY SAVINGS (MW)



CUMULATIVE ENERGY SAVINGS (MWH)

CUMULATIVE PEAK CAPACITY SAVINGS (MW)



The table on the previous page presents annual, cumulative, and lifecycle savings for both active and inactive lamps using a 20%/per year attrition factor for the lamp's assumed nine-year life beginning in the second year. Since the program's inception in 1989, the Smartlight program's "active" leased compact fluorescent lamps have resulted in first-year savings of 1,391,808 kWh, and will result in lifecycle savings of 6,025,013 kWh. In addition, "inactive bulbs" have provided 236,032 kWh in first-year savings since the program's inception, and will save 1,021,761 kWh over nine years assuming the same attrition factor. Thus total first-year savings for both active and inactive lamps was 1,627,840 kWh, and lifecycle savings will be on the order of 7,046,775 kWh. Smartlight has also resulted in total program winter peak capacity savings of 1.25 MW since the program's inception in 1989.[R#12]

Active Bulbs Summary	Active Bulbs Placed	New Active Participants	Bulbs per Participant	Annual Energy Savings (kWh)	Annual Energy Savings (kWh / Participant)
1990	13,603	2,560	5.31	870,592	340
1991	7,111	1,420	5.01	455,104	320
1992 (1Q)	1,033	275	3.76	66,112	240
Total	21,747	4,255		1,391,808	

Inactive Bulbs Summary	Inactive Bulbs	Inactive Participants	Bulbs per Participant	Annual Energy Savings (kWh)	Annual Energy Savings (kWh / Inactive Participant)
1990	5,397	978	5.52	172,704	177
1991	1,954	385	5.08	62,528	162
1992 (1Q)	25	6	4.17	800	133
Total	7,376	1,369		236,032	

PARTICIPATION AND PENETRATION RATES

As of March 30, 1992, 5,624 homes in Burlington have participated in the Smartlight program since its inception in 1989 for an overall participation rate of 38%. (Some 4,255 households have participated in the program since 1990.)[R#9] Currently 98% of new Neighbor$ave households now lease lamps. Tom Buckley, Director of Energy Services, attributes this marked increase in effectiveness to the popularity of the program, the skill of BED employees who implement the program, and the public's acceptance of the compact fluorescent lamp technology. (Since the inception of Neighbor$ave, 70% of its households have leased lightbulbs.)

A total of 33,671 bulbs have been placed as a result of the Smartlight leasing program. (Approximately two-thirds, or 22,999, were placed as part of the Neighbor$ave program (68%).) Of the total, 65% of the lamps, or 21,747, are still active and saving 64 kWh each per year. Of all Smartlight participants the total number of lamps per home is calculated to be between 3.8 and 5.3.[R#12]

Of all the total number of Smartlights distributed, 7,376 (or 22%) are currently inactive. Since September 1, 1991 this percentage of inactive bulbs as a fraction of the total has dropped to 6.4% (126 inactive of 1,967 bulbs total).Currently 1,335 total locations, or 24%, are inactive.[R#9] Note that for the purposes of calculating the program savings BED accounts for all active lamps and assumes that 50% of inactive lamps are providing savings as well.

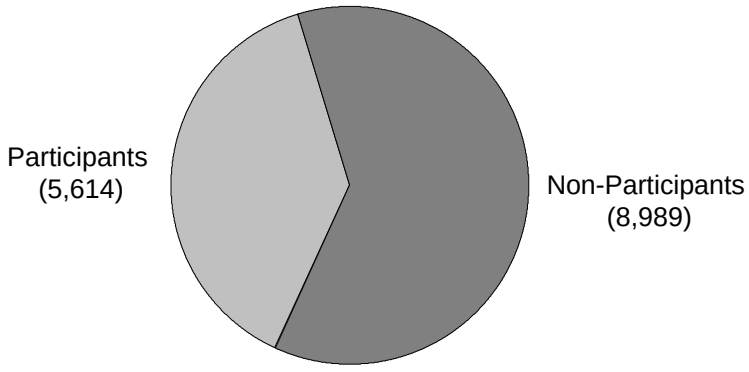
Of the 33,671 total bulbs, 4,548 bulbs, or 13.5%, have been returned since the program's inception. This return rate is falling. Since September 1, 1991, 2,093 bulbs have been placed, with only 138 (or 6.6%) returned.[R#9]

BULB SUMMARY [R#9]

Active	21,747
Inactive	7,376
Returned	4,548
Total Smartlights	33,671

MEASURE LIFETIME

BED assumes that CFLs will have a technical lifetime of 9 years based on 64 kWh annual savings per bulb installed, or a 3-hour per day average duty cycle for 9 years. (This is based on 57-watt savings per lamp.) However, BED also assumes an attrition rate of 20% per year beginning in the second year due to tenants moving, accidents resulting in broken lamps, etc. Note that BED only collects lease payments for a maximum of five years.



Costs Overview Table	Gross Program Cost	Actual Smartlight Income	Net Program Cost	Net Cost per Participant	Net Cost per Active Bulb Placed
1990	$546,931	$15,962	$530,969	$207	$39
1991	$298,669	$41,887	$256,781	$181	$36
1992 (1Q)	$35,386	$12,235	$23,151	$84	$22
Total	$880,985	$70,085	$810,901		

Leasing certainly has not been an absolutely no-cost DSM program for BED. BED pays for marketing and implementation of Smartlights, monitoring and evaluation, and for a portion of the cost of the lamps that is unrecovered from the lease. As part of the more comprehensive Neighbor$ave treatment, BED has paid the costs of taking the bulbs door-to-door, explaining their costs and benefits, and explaining to customers how the lease fee works.

The amount of the lease fee was rather crudely concocted. Joe Desmond, who pioneered the leasing concept at Taunton Municipal Lighting Plant in Massachusetts, and Tom Buckley of BED, "kicked around" a few calculations over dinner one night in San Francisco some years ago and arrived on a 20 cent/month lease fee. It was based on a simple calculation: the lamps cost about $12 and the lease fee could run for five years for a total of 60 months. Furthermore, assuming an average duty factor of 4-5 hours per day, the technical life of the lamp would expire in about five years. Thus Desmond and Buckley calculated that the lease fee would about cover the cost of the lamps and would not attempt to cover the costs of administering the program.

INCOME FROM SMARTLIGHTS

The total income from the leased lamps in the Smartlight program since its inception and through the end of February of 1992 has been $70,085.[R#12] In 1991 BED recovered

only $15,962 from Smartlight lease fees.[R#9] In 1991, BED recovered a total of $41,887, and for the first two months of 1992, BED recovered $12,235 on the program.[R#12] The apparent discrepancy between number of active lamps placed in 1990 and 1991, and the amount of income for both of those years was a function of several factors. Most of the lamps installed in 1990 were done so in the summer. BED designed the program such that customers have a two-month grace period before they are billed for the lamps. Second, BED's billing procedure was delayed by one or two months. Thus many of the installed lamps did not begin to show income until late in 1990, and into 1991 — skewing the installation/income data. (The accounting was straightened out by September of 1990.) When Smartlight was subsumed into Neighbor$ave in 1991, there was another 1-2 month billing hiatus as BED was overwhelmed with installed lamps and the need to develop more complex tracking systems. Buckley reports that by the summer of 1991 (what he calls "the big push" to distribute Smartlights) BED was properly accounting and billing for the lamps, and by September 1991 Smartlights were entered into BED's database on a real-time basis.[R#5]

If the net present value of Smartlight income is factored into the net cost of the Smartlight program, the cost would be lower. However, the assumptions that would affect the net present value of lease payments, including attrition rates and the cost of capital, further complicate the issue. For the purposes of the program costs and resulting cost of saved energy, only the actual Smartlight income to date is presented as a conservatism.

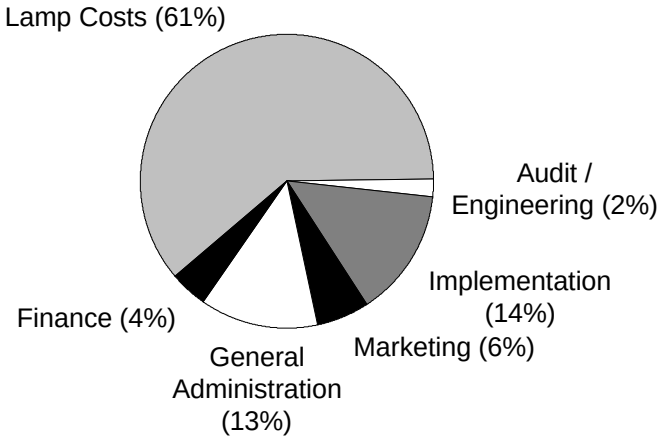
SUBSIDIZING SMARTLIGHTS

Although the original financial expectation for the program was to at least cover the costs of the lamps, BED still subsidizes the costs of the lamps for several reasons:

1. BED buys the lamps for an average of $15 including harps and extenders, not the $12 that was assumed.

2. BED does not expect to recover lamps when tenants move (Taunton attempted to mandate that customers return lamps.)

3. BED must account for lamps that are broken or stolen. These are direct losses that must be paid by the utility.



Cost of Saved Energy Table (¢/kWh)	Discount Rates						
	3%	4%	5%	6%	7%	8%	9%
1990	6.54	6.84	7.16	7.48	7.81	8.15	8.49
1991	6.37	6.67	6.98	7.29	7.61	7.94	8.27
1992 (1Q)	4.44	4.65	4.87	5.09	5.31	5.54	5.77

COST EFFECTIVENESS

The justification of BED's DSM programs included an analysis of lost revenues that would occur as a function of the program's success. Both Smartlight and Neighbor$ave are considered cost effective programs. The Vermont Public Service Board, which regulates BED's rates and tariffs, approved the leasing program. Smartlight was specifically approved as a line item on customer's bills.[R#5]

BED used two methods to screen its DSM programs for cost effectiveness. The first method focused specifically on the avoided costs of capacity and energy. Capacity was based on the marginal power plant type; energy was based on a weighted average for all the utility's generation options. The second test involved the value of generation if it could be sold. If DSM programs were highly successful, then BED's share of Vermont Yankee could be sold. In the longer term, successful DSM programs could result in avoided purchases of additional Hydro-Quebec capacity. If BED's DSM efforts passed either of the two tests for cost effectiveness – then the programmatic investment was considered prudent and warranted.

COST PER PARTICIPANT

Smartlight has cost BED between $22 and $39 per active lamp between 1990 and the first quarter of 1992, for an average of $33 per lamp, and less when the value of inactive lamps is included.[R#12] In terms of cost per participant, including both active and inactive lamps, Smartlight has cost between $84-207, for an average cost of $144 per participant. Note that these numbers are based on extrapolating the costs of Smartlight from the more comprehensive Neighbor$ave costs. Both Sean Foley and Tom Buckley are concerned that the numbers are approximations that were developed in the absence of tracking systems explicitly developed to break out the delivery costs of Smartlight from Neighbor$ave.[R#4,5]

PROGRAM COST PER ACTIVE PARTICIPANT

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%	7,641,000	181,000	37,000	4,000
B	10,000	1.20%	8,148,000	70,000	24,000	18,000
	Controlled Emissions					
A	9,400	2.50%	7,641,000	18,000	37,000	0
B	10,000	1.20%	8,148,000	7,000	24,000	1,000
C	10,000		8,148,000	47,000	23,000	1,000
	Atmospheric Fluidized Bed Combustion					
A	10,000	1.10%	8,148,000	21,000	12,000	6,000
B	9,400	2.50%	7,641,000	18,000	15,000	1,000
	Integrated Gasification Combined Cycle					
A	10,000	0.45%	8,148,000	14,000	2,000	6,000
B	9,010		7,330,000	5,000	2,000	0
Gas	**Steam**					
A	10,400		4,445,000	0	10,000	0
B	9,224		3,860,000	0	24,000	1,000
	Combined Cycle					
1. Existing	9,000		3,860,000	0	15,000	0
2. NSPS*	9,000		3,860,000	0	7,000	0
3. BACT*	9,000		3,860,000	0	1,000	0
Oil	**Steam--#6 Oil**					
A	9,840	2.00%	6,433,000	97,000	12,000	11,000
B	10,400	2.20%	6,823,000	97,000	14,000	7,000
C	10,400	1.00%	6,823,000	14,000	12,000	4,000
D	10,400	0.50%	6,823,000	41,000	14,000	2,000
	Combustion Turbine					
#2 Diesel	13,600	0.30%	8,538,000	17,000	26,000	1,000
Refuse Derived Fuel						
Conventional	15,000	0.20%	10,137,000	26,000	34,000	8,000

Avoided Emissions Based on 3,544,292 kWh Saved (1990 - 1992 1Q)

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 FOLLOWING TABLES

1. The purpose of the previous page is to allow any user of this profile to apply BED's level of avoided emissions saved through its Smartlight 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. The purpose of the table on the following page is to present the avoided emissions that resulted from the Smartlight program based on BED's marginal power plant, a #2 diesel turbine.

3. 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.

4. 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.

5. 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.

BED AVOIDED EMISSIONS

Determining the type of capacity that has been and will be avoided in the long term as a result of the success of BED's Smartlight is not a straightforward task. Like many utilities BED faces two basic issues. First, it is capacity rich and can use the McNeil station discussed in the utility overview section

* Acronyms used in the table

TSP = Total Suspended Particulates

NSPS = New Source Performance Standards

BACT = Best Available Control Technology

for whatever capacity and energy needs it has at any given time. Second, BED is part of the New England Power Pool and power transfers throughout the pool make it complicated to specify a certain power plant as the marginal capacity. Nevertheless, for the winter peaking situation that BED now faces, a diesel turbine can be identified as the marginal power plant. [R#5]

In the long term BED faces two interrelated issues surrounding types of marginal capacity: BED may opt to purchase hydroelectricity from Quebec to replace nuclear capacity that BED will lose when the Vermont Yankee nuclear plant reaches its retirement. It is clear that BED's success with DSM will allow both of these contentious power plant types to be avoided for as long as possible.

In the short term, the marginal power plant type identified by BED is a #2 fuel oil diesel turbine and average emissions for this type of gas turbine are used to present guidelines for the amount of basic air pollutants that are avoided through Smartlight. BED specifies the maximum sulfur content for the #2 fuel oil (1.3%) while the table below is based on 0.3% sulfur content – thus applying a conservatism to the environmental benefit as it relates to SO_x. [R#11]

Smartlight Avoided Emissions	Marginal Plant Heat Rate (BTU/kWh)	% Sulfur in #2 Diesel Fuel	CO2 (lbs)	SO2 (lbs)	NOx (lbs)	TSP *(lbs)
1990	13,600	0.30%	2,513,000	5,000	8,000	0
1991	13,600	0.30%	1,247,000	2,000	4,000	0
1992 (1Q)	13,600	0.30%	161,000	0	0	0
Total			3,921,000	7,000	12,000	0

Avoided emissions based on BED's marginal plant: #2 Diesel Combustion Turbine

THE LEASING MECHANISM

There is a healthy debate between proponents and critics of leasing programs. The proponents believe that by charging even a nominal fee for an energy efficiency measure customers will assign a higher value to the measure. Customers will make sure it is installed in a "profitable" location and will take care of the equipment. A more philosophical question is if an efficiency measure is unquestionably in a customer's economic interest why can't the customer pay at least part of its cost? (Why should the utility have to pay 100% of the cost?) The leasing program is a clever way of overcoming a basic barrier to energy efficiency: customers do not have the cash to pay the high upfront costs of energy efficiency. Leasing provides a "positive cash flow" while implementing energy efficiency.

Many academics including professors at Harvard University have argued for years that customers who reap the benefits of energy efficiency measures ought to pay for their costs -- rather than having their costs borne by all the utility's ratepayers. The debate rages on. Leasing is a mechanism that bears witness to the fact that customers with the help of their utility can have energy efficiency and a positive cash flow in the process. But questions about penetration rates bear careful examination.

The critics of the leasing concept argue quite effectively that if the utility pays the full cost of the measure, and if this cost is less than the long run avoided marginal cost, that a giveaway program is clearly cost effective and can place more lamps per home. Rather than seek customer contribution for the measures, utilities can use direct installation to garner maximum attainable savings.

BED's Smartlight program may have another structural problem as it is part of Neighbor$ave. Customers may only take the free measures and decline taking leased lights. This represents a lost opportunity. The utility spends the money to "get in the door" and often misses the opportunity to install lamps. It may be too costly for the utility to return to each customer who has declined the energy-efficient lighting, and to then install the measures. Recent data from BED on participation rates shows a sophistication of the program in addressing this valid concern.

BED has maintained its position on leasing and the program's implementation has borne witness to many of the assumptions that staff had at the inception of the program. Charging for CFLs encourages the customer to install the bulbs only where they will be used at a minimum level of 1.5 hours per day. When that duty factor is attained the savings pay for the lease fee. BED agrees that more bulbs per home could possibly be installed without a lease fee, but the cost-effectiveness of the program would suffer. The more lamps you install, the less savings are accrued for each lamp. In other words, installing CFLs in the most used sockets is most cost effective. As you install more than five lamps per home, the savings per lamp typically suffer, as does the cost effectiveness of the program.

Of the twenty-five percent of the Neighbor$ave participants who did not lease lightbulbs only 10% said the lease fee was the reason![R#5] Thus only 2.5% of the participating households rejected the leasing mechanism due to the money. The rest declined to take the lamps because of a myriad of other reasons: Some people claimed they don't like the CFL light output. Others found the lamps ugly, or too heavy, and/or too big. Others perceived that the light output was diminished.

GENERAL COMMENTS

- The same number of bulbs were installed in rental units as in owner-occupied units on average, for both single and multi-family housing. This came as a pleasant surprise to BED staff.

- BED used Taunton's pioneering efforts with leasing as a means of jumpstarting their leasing program. BED's program has gone beyond some of the limitations experienced in Taunton, for instance offering a greater variety of lamps. Also instead of using direct mail pieces exclusively to promote the program, BED expanded Taunton's program by going door-to-door and actually installing the bulbs. Happily, Taunton now plans to follow BED and run a Neighbor$ave program.

• The BED staff can attest to the fact that setting up a leasing program is not without challenge! BED has worked through the complexities of setting up an effective tracking system while focusing its primary attention to getting lamps into use in the community. Once the tracking system was put in place at BED it has been highly effective, essentially catching up with the effectiveness of getting lamps into use. BED can now easily track lamps when a customer moves and when they are returned.

• Based on its success in the residential sector, BED is now moving to the commercial sector with lighting efficiency programs, based on the lease mechanism, for both small and large commercial customers.

TRANSFERABILITY

Perhaps what can be gleaned from this discussion is that leasing makes sense in some instances, largely determined by the capacity situation, and to a lesser extent regulatory situation, at hand. For utilities that are capacity constrained, perhaps a direct installation approach makes more sense for capturing savings. On the other hand, for utilities with surplus capacity that are limited in the amount of money that they spend, leasing may be a highly desirable approach for garnering savings at low cost.

Perhaps the brightest note that the program has provided is a renewed and strengthened sense of community that the Smartlight and other BED DSM programs have had. "People are remarkably honest", noted Tom Buckley, and the Smartlight program has brought this out and reinforced the faith in community for many of the BED staff. "You can count the crooks and read about them in the papers - but Smartlight has shown BED that the community does respond to volunteerism in this DSM program." One good example of this has been the return of "inactive" lamps. While returning "inactive" Smartlights is only encouraged -- many more than BED had ever expected take the initiative to return the lamps to BED's headquarters!

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