Burlington Electric Department
Heat Exchange
Profile #39, 1992

Executive Summary

Burlington Electric Department (BED) is currently engaged in the pioneering DSM practice of promoting the cost effective substitution of alternate fuels for electricity. Three discrete BED projects are presented in this profile as the Heat Exchange Program. The program includes 1) a DOE pilot fuel switching program that resulted in the conversions of 44 residences to natural gas space heating using direct vent gas-fired space heaters; 2) a fuel switching project at the Northgate Housing complex that resulted in conversions of 336 units ; and 3) the full-scale fuel switching program that is currently active in Burlington.

In March of 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. As a result of the publicity surrounding the bond issue, over 1,000 buildings were signed up to participate in the Heat Exchange program even before it had begun!

Heat Exchange begins with a free energy audit conducted by a contractor and a BED energy services specialist. After the audit, a report is sent to the customer outlining cost effective measures to be implemented and their prices and projected annual savings. A summary of weatherization work, if necessary, required to meet BED minimum standards is also provided. There are two forms of financing available: a loan or a cash rebate. If the customer finances the work with a loan from BED, BED oversees the work. If the customer finances the project independently to receive the rebate, the customer is responsible for work arrangements and payment of the contractors.

Space heaters comprise 54% of the heating units installed as a result of the Heat Exchange program, while central heating systems make up the other 46%. A strong majority (66%) of the domestic hot water units installed are integrated systems. Most of the weatherization measures involved as part of Heat Exchange are in the form of air sealing. To date, BED's Heat Exchange program has accounted for total annual energy savings of 7,952 MWh and 1.9 MW.

Out of an eligible population of 2,336 homes with electric space heat, 753 housing units have completed Heat Exchange conversions. Thus the program's participation rate to date has been 32%. BED projects that 61% of customers with primary electric space heat and 50% of customers with electric water heaters will fuel switch over the 5-8 year life of the program.

Since the program's inception BED has spent a total of $825,799 on the Heat Exchange program, while its customers have spent more than $2,570,000 on installation costs. Thus BED has paid 24% of the societal cost of the program to date resulting in an admirably low cost of saved energy, calculated at a 5% real discount rate, of 1.24 ¢/kWh.

Heat Exchange Program

Utility:	Burlington Electric Department
Sector:	Residential
Measures:	Fuel conversion of space and water heating systems and weatherization
Mechanism:	Free energy audit coupled with rebate or loan for conversions
History:	Six month pilot project in 1989. Northgate Housing Project conversion (1989-1990). Full scale program began in 1991 and continues to present.

Cumulative Program Data

Energy savings:	8.0 GWh
Lifecycle energy savings:	119 GWh
Capacity savings:	1.9 MW
Utility cost:	$825,800
Participant cost:	$2,570,000
Number of Conversions:	753
Participation rate:	32%

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.

Utility Overview

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#4,2] 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 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

[R#3] Note: additional energy and capacity available from NEPOOL.

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%).

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."

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 the Department 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#2]

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. (See Profile #3) Compact fluorescent lamps (CFLs) became available for $0.20 per month for all BED residential customers. Smartlight is incorporated into BED's Neighbor$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#2] 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	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. It must be noted, however, that several general economic indicators were in a down-turn during that period. Neighboring investor-owned utilities reported decreased sales of 2.4% which they attributed to the economy.

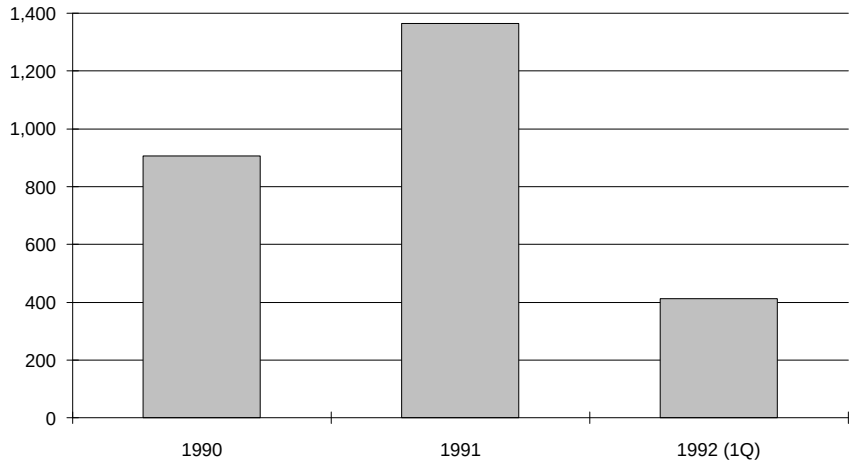
OTHER ENERGY EFFICIENCY PROGRAMS IN BURLINGTON, VERMONT

For detailed descriptions of BED's other DSM programs, Neighbor$ave, The Top 10 Program, and Energy Advantage, see Profile #3.

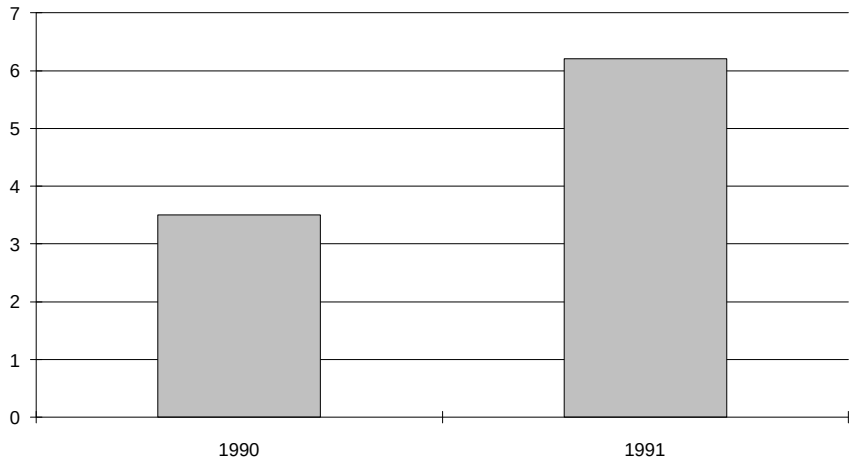
PROJECTED SAVINGS

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]

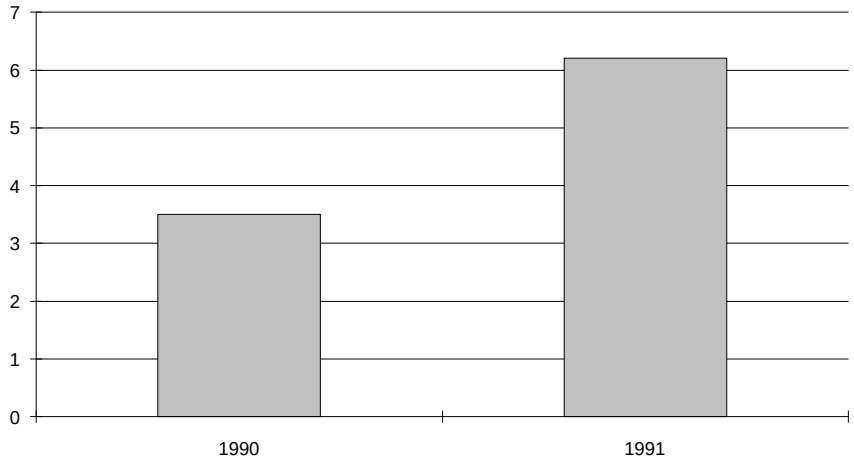
ANNUAL DSM EXPENDITURE ($1,000)



ANNUAL ENERGY SAVINGS (GWH)



ANNUAL CAPACITY SAVINGS (MW)



Program Overview

Burlington Electric is currently engaged in the pioneering DSM practice of promoting the cost effective substitution of alternate fuels for electricity. For the purposes of this profile, three discrete BED projects will all be discussed as one program, what BED calls the Heat Exchange Program. The three elements are 1) a DOE pilot fuel switching program that resulted in the conversions of 44 residences to natural gas space heating using direct vent gas-fired space heaters; 2) a fuel switching project at the Northgate Housing complex that resulted in conversions of 336 units and also had the added feature of a tenant energy specialist with the direct responsibility of monitoring the success of the conversions; and 3) the full scale fuel switching program that is continuing to the present.

Prior to the beginning of Heat Exchange, BED started to get involved with fuel switching in 1987 when the Burlington School Board (BSB) designed and implemented a heating conversion program. BED played a supportive planning role, sitting on the school board committee and supplying design analysis, but did not provide direct incentives to the program. The BSB heating conversion program did, however, serve as an icebreaker for BED's involvement with fuel switching, since BED considered itself, "a concerned party involved in a city-wide effort."[R#5]

DOE PILOT PROGRAM

In September 1989, the U.S. Department of Energy (DOE) awarded BED a $125,000 grant for the development and implementation of a pilot program for residential heating fuel switching. BED hoped to test the application of one fuel switching technology, and then to use the lessons learned to develop a full-scale DSM program for this end use. BED wanted to create a program that would deal with concerns that other small utilities might have which would impede their involvement with DSM programs. These worries include: lost revenues, maintenance of the utility-customer relationship, the need for predictable and significant savings, the belief that DSM programs cannot be implemented quickly, and the impact of these programs on utility staff.[R#8]

With the DOE grant money, BED designed a pilot program that used supplemental fuel switching, so that the installed heating units were not designed to replace the customer's total heating load. Utility control of the remaining electric heating units was limited to peak hours. Reliability was ensured by cycling on and off all or almost all remaining electric heat during peak times. The installation phase of the project was limited to six months, in order to realize program savings quickly. BED paid for all installation costs, removing a large barrier to participation. Naturally participants still had to pay their heating bills.[R#8]

A total of 48 direct-vent gas fired space heaters with load control switches were installed in 44 residences accounting for total installation costs of $94,602. The average cost of the program per residence was $2,150. The pilot program resulted in an approximate reduction of 154 kW of winter peak demand. Only two customer complaints were registered in the program's 16-month operation.[R#8]

NORTHGATE HOUSING PROJECT

Northgate was the first tenant-organized buyout under Housing and Urban Development Corporation (a federal agency) Housing Preservation Guidelines. Through creative financing and a strong effort by the residents, community funds were raised from nine sources to buy the project and create Northgate Housing Inc. As part of the buyout the Northgate task force raised a total of $8.1 million which was spent on building rehabilitation, with approximately $2.1 million spent on energy efficiency improvements. Included in the improvements was the replacement of electric baseboard heaters with natural gas-fired, hydronic baseboard heaters. This fuel switching, or "heat exchange", took place from September 1989 through August 1990. BED contributed $267,000 directly to the effort.

In September 1990, the U.S. Department of Energy awarded a second grant to BED for $54,800 to support the efforts with energy efficiency at Northgate and to use it as a fuel substitution demonstration. The purpose of the grant was to document and disseminate the success of Northgate in reducing the costs of living in subsidized housing to affordable levels. The grant was used to fund a tenant energy specialist to help the residents of Northgate's 336-unit apartment complex understand their converted heat systems, along with other installed energy-efficient measures. The tenant energy specialist also was responsible for monitoring energy cost savings for Northgate.[R#9]

FULL-SCALE RESIDENTIAL CONVERSION PROGRAM

Using the results of the pilot program, BED initiated the full-scale Heat Exchange program: a full-scale residential, electric heat conversion program. The full-scale program began in April 1991, with a goal of reaching 1,500 residential customers over 5 years. The design of this program component differs from the pilot program primarily because the pilot program was designed to achieve immediate capacity savings through rapid customer penetration. BED is not attempting to implement the program rapidly, but instead is hoping to reach high penetration levels over a longer period of time with a smaller customer subsidy. The Heat Exchange program places a unique emphasis on rental housing because 68% of BED's electric space heating customers are renters. The program provides water, as well as space, heating conversions, along with weatherization measures where needed. It is interesting to note that BED only markets electricity, and gas service for BED customers is provided by Vermont Gas Systems, an investor-owned company.[R#8]

The Heat Exchange program received the Special Recognition Energy Innovations Award in September of 1992 from the U.S. Department of Energy as one of the top 25 energy conservation programs in the country.

Implementation

MARKETING

Funding for the program was financed by a bond issue that provided for investments in energy efficiency by BED. Much of the Heat Exchange marketing took place before the program was implemented. Since Burlington is a small, close-knit community, the local media's coverage of the bond issue and resulting positive vote led to a great deal of program awareness. As a result of the publicity surrounding the bond issue, over 1,000 housing units were signed up to participate in the Heat Exchange program even before it had begun. Similarly, word of mouth has helped spread program awareness. In addition, BED announced the program in its customer newsletter and public meetings were held to discuss the program.

DELIVERY

The Heat Exchange program begins with a free energy audit conducted by a contractor and a BED energy services specialist. After the audit, for which all house sizes are eligible, a report is sent to the customer. The report contains details of the contractor-designed heating system that is the most cost-effective for the given home, including the price and projected annual savings. A summary of weatherization work, if necessary, required to meet BED minimum standards is provided. The report also recommends other energy-efficient measures. Finally, a summary of the program's financial options is included. There are two forms of financing available: a loan or a cash rebate. Rebates can be up to $1,000, and represent 50% of the project cost. Customers can only select one of the financing options.[R#5,7,10]

Once the customer receives BED's report, they can proceed with the proposal or they can contract the work on their own. When the customer settles upon an installation arrangement, an agreement is signed between the customer and BED. The customer's new heating system must be cost effective (using a societal definition of cost effectiveness) in order to be eligible for the program. If the customer finances the work with a loan from BED, BED oversees the work. BED ensures that the contractor is paid, and the loan repayment begins after the work is completed. If the customer finances the project independently to receive the rebate, after signing a contract with BED, the customer is responsible for work arrangements and payment of the contractors. BED issues the rebate after the heating system installation and any necessary weatherization has been completed.[R#7,10]

With the loan, the contractor-proposed heating system and needed weatherization improvements are paid for up front. The loans, arranged and guaranteed by BED are made available through a local bank. BED compares the customer's current heating costs with projected heating costs after the conversion, including new fuel costs. (This is done using standard heating design load calculations.) The customer pays 60% of the first year's estimated savings every year for five years. The other 40% of the first-year savings estimate is kept by the customer. Any balance remaining after five years is paid by BED.[R#7,10]

The rebate is available when the customer assumes responsibility for the work or installs a more expensive heating system than suggested in the audit. The rebate amount is equal to the net present value of subsidies that BED would have provided under the loan mechanism. If a customer chooses a more expensive system, the rebate is based on the original design.[R#5,7,10]

MEASURES INSTALLED

Space heaters comprise 54% of the heating units installed with the Heat Exchange program, while central heating systems make up the other 46%. A strong majority (66%) of the domestic hot water units installed are integrated systems, with stand alone tanks representing 24% of the hot water units installed, and rental tanks responsible for 10%. Most of the weatherization measures are in the form of air sealing holes in customers' homes. This is because most electrically-heated homes in Burlington have been weatherized many times over the years.[R#5]

Almost all of the conversions have been to natural gas, which is unique to BED as it is one of only a few service territories in Vermont with significant availability of natural gas.[R#7]

STAFFING REQUIREMENTS

The Heat Exchange program is administered by Program Manager Chris Burns, who spends approximately 75% of his time on the program. In addition to the program manager, the program is administered by an administrative assistant (50% time), two and a half full time auditors, and an intern (25% time). Thus the program is run by a total, in terms of full-time equivalents, of 4 utility personnel. Additionally, Three contractors are currently responsible for installation of the heating systems though BED has worked on this program to some degree with all of the heating contractors (approximately 20) in the Burlington service area.[R#5]

Monitoring and Evaluation

MONITORING

BED is able to monitor participation in the Heat Exchange program relatively easily since it is directly involved with all Heat Exchange projects. Loans and rebates are monitored by computer, using a customized Paradox database. From this BED produces a monthly Heat Exchange Program Report, listing cumulative activity, including residential project status, along with a cost savings analysis for all completed projects. Loans are administered directly by the bank with the customer. The productivity of the energy auditors is not difficult to track because BED must sign off on every Heat Exchange project.[R#5,11]

BED monitors the prices charged by the heating contractors but does not monitor the customer/contractor relationship. BED acts as an agent, bringing the customer and contractor together, but once the customer signs the Heat Exchange agreement, a traditional customer/contractor relationship ensues. BED provides a final inspection and arranges for a required safety inspection by the building inspector prior to making payments. To date, this arrangement has not led to any major problems.[R#5,12]

EVALUATION

So far BED has placed more emphasis on implementing the Heat Exchange program than evaluating the program, though a plan for a formal evaluation has been prepared. An executive summary of the DOE pilot program was published in October 1991. This report covers program planning, implementation, energy savings, and lessons learned. A summary report of the Northgate project was published in March 1992, which explains all the steps of the energy education program, along with research and energy savings.[R#5,11]

DATA QUALITY

• As mentioned previously, three discrete BED projects are treated as one program for the purposes of this profile. Cost, savings, and participation numbers from the DOE pilot program, the Northgate project, and the full-scale residential Heat Exchange program have all been combined. BED chooses to combine these numbers in part to simplify program evaluation, but also because the 336 Northgate units and 44 DOE pilot program units are all part of BED's residential fuel conversion program efforts.

• All of the numbers in the cost and participation sections of this profile represent total impact from the program's inception through November 20, 1992 and reflect only completed projects. The numbers in the savings section reflect total annual energy savings for completed projects.[R#9,11]

• Dollar values in the Utility Overview and the Utility DSM Overview sections have been levelized to 1990 U.S dollars. All dollar values in the other sections are unlevelized.

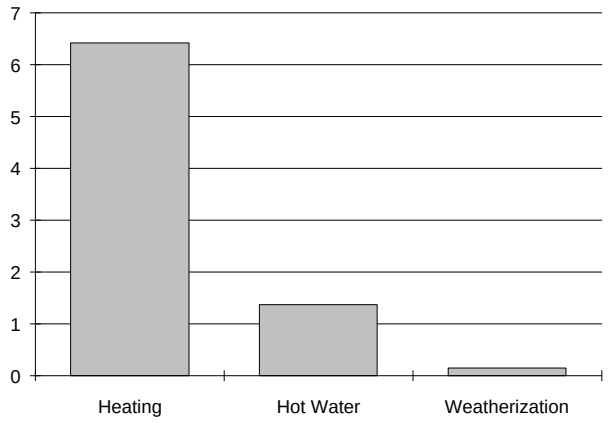
• Hot water units and weatherization measures were not installed with the DOE pilot program. Therefore, energy savings from the pilot program are only reflected in the heating component of program savings. Similarly, energy savings from the Northgate project appear in the heating and hot water component of program savings, but not in the weatherization component.[R#11,13]

• Demand reduction estimates for the pilot program were calculated assuming an average peak kW savings per residence of 2.01 kW; the value for single family residences was 3.5 kW.[R#5]

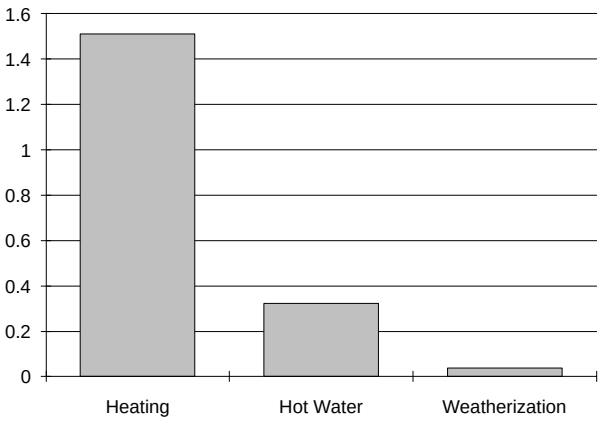
Program Savings

Savings Overview Table	Annual Energy Savings (MWh)	Lifecycle Energy Savings (MWh)	Annual Capacity Savings (MW)
Heating	6,426	96,392	1.510
Hot Water	1,370	20,546	0.322
Weatherization	156	2,343	0.037
Total	7,952	119,282	1.869

ANNUAL ENERGY SAVINGS (GWH)



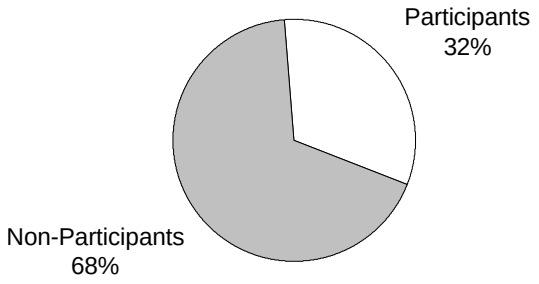
ANNUAL CAPACITY SAVINGS (MW)



To date, BED's Heat Exchange program has accounted for total annual energy savings of 7,952 MWh and total annual capacity savings of 1.9 MW. Lifecycle energy savings are 119,282 MWh.[R#11]

PARTICIPATION RATES

To date, 753 housing units have completed Heat Exchange conversions. BED has 14,600 residential customers but before the Heat Exchange program began, 16% of residential customers had electric space heating (2,336 customers) and 47% had electric water heaters (6,862). Thus based on the eligible population of electric space heating customers the program has had a participation rate to date of 32%.[R#7]



The utility projects that 61% of customers with primary electric space heat and 50% of customers with electric water heaters will fuel switch over the life of the program (5 to 8 years). BED's participation goal is 1,500 customers over the first 5 years of the program.[R#7]

Savings Per Participant Table	Completed Projects	Annual Electricity Savings per Completed Project (kWh)
Program Total	753	10,561

MEASURE LIFETIME

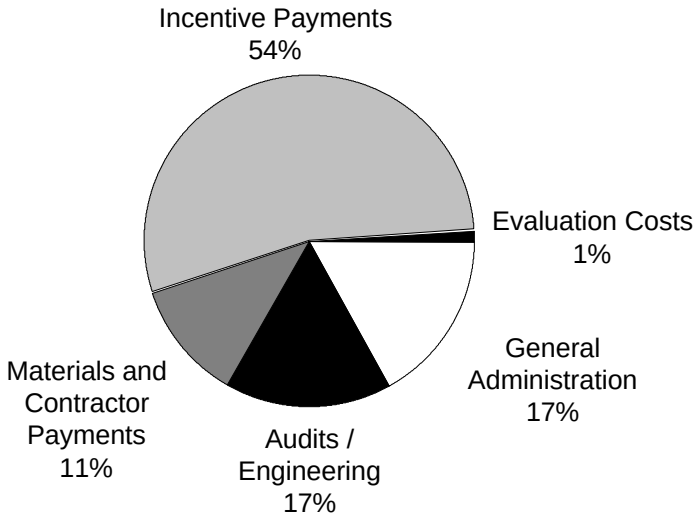
All heating and hot water units installed by BED are assigned 15-year lifetimes. Weatherization measures are not assigned an average lifetime but are included in the program savings. (For the purposes of this profile we have conservatively used a 15-year measure life for weatherization measures in order to calculate lifecycle energy savings and the cost of saved energy.)

PROJECTED SAVINGS

If BED achieves its Heat Exchange participation goals for all three components discussed in this profile, an annual reduction of 5 MW and energy savings of 12 million kWh are predicted.[R#8]

Cost of the Program

Costs Overview Table	Administration, Marketing, Legal, and Finance Costs (x1000)	Audits / Engineering	Materials and Contractor Payments (x1000)	Incentive Payments (x1000)	Evaluation Costs (x1000)	Total Program Cost (x1000)	Cost per Participant
Program Total	$140.1	$137.1	$94.6	$446.0	$8.0	$825.8	$1,096.74



Cost of Saved Energy Table (¢/kWh)	Discount Rates						
	3%	4%	5%	6%	7%	8%	9%
Program Total	1.08	1.16	1.24	1.32	1.41	1.50	1.59

BED has spent a total of $825,799 on the Heat Exchange program. BED customers have spent a cumulative total of more than $2,570,000 on installation costs. Thus BED has paid 24% of the cost of the program to date.[R#5]

COST EFFECTIVENESS

The Results Center calculates the cost of saved energy using a range of discount rates, and BED's conservative estimated 15-year lifetimes for the measures. The cost of saved energy for the Heat Exchange program, calculated at 5% is 1.24 ¢/kWh saved.

COST PER PARTICIPANT

BED's cost per participant is $1,096.74, while the end-user's average cost has been $3,413. Interestingly, landlords have been attracted to the program as they have had a hard time renting electrically-heated apartments. The program has been an effective means for them to increase the value of their properties and make their rental units more attractive.

FREE RIDERSHIP

BED plans to estimate free ridership as part of the planned evaluation. Part of the analysis will consider the rate of fuel conversions prior to Heat Exchange. For the purposes of calculating the program's savings, free ridership was not factored into the equation.[R#5]

COST COMPONENTS

To date BED has spent $825,799 on Heat Exchange, with the lion's share, 54%, spent directly on incentive payments. Incentive expenditures (primarily rebates) by BED total $446,000. BED has spent $106,023 on general administration costs, and $94,602 on materials and contractor payments. More than $137,138 has been spent on auditing/engineering. A total of $8,000 has been spent on evaluation. BED expenditures in other areas (marketing, legal, and finance) total $34,076.[R#5]

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%	17,145,000	407,000	82,000	8,000
B	10,000	1.20%	18,282,000	157,000	53,000	39,000
	Controlled Emissions					
A	9,400	2.50%	17,145,000	41,000	82,000	1,000
B	10,000	1.20%	18,282,000	16,000	53,000	3,000
C	10,000		18,282,000	105,000	52,000	3,000
	Atmospheric Fluidized Bed Combustion					
A	10,000	1.10%	18,282,000	48,000	26,000	13,000
B	9,400	2.50%	17,145,000	41,000	33,000	2,000
	Integrated Gasification Combined Cycle					
A	10,000	0.45%	18,282,000	32,000	5,000	13,000
B	9,010		16,445,000	12,000	4,000	1,000
Gas	**Steam**					
A	10,400		9,972,000	0	23,000	0
B	9,224		8,660,000	0	54,000	3,000
	Combined Cycle					
1. Existing	9,000		8,660,000	0	33,000	0
2. NSPS*	9,000		8,660,000	0	16,000	0
3. BACT*	9,000		8,660,000	0	2,000	0
Oil	**Steam--#6 Oil**					
A	9,840	2.00%	14,433,000	219,000	26,000	24,000
B	10,400	2.20%	15,308,000	217,000	32,000	16,000
C	10,400	1.00%	15,308,000	31,000	26,000	8,000
D	10,400	0.50%	15,308,000	91,000	32,000	5,000
	Combustion Turbine					
#2 Diesel	13,600	0.30%	19,157,000	38,000	59,000	3,000
Refuse Derived Fuel						
Conventional	15,000	0.20%	22,743,000	59,000	77,000	17,000

Avoided Emissions Based on 7,952,125 kWh Saved (First Year Only)

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 BED's level of avoided emissions saved through its Heat Exchange 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.

*** Acronyms used in the table**

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

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.

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 Heat Exchange 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 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 potentially 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 resource options 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 Heat Exchange. BED specifies the maximum sulfur content for the #2 fuel oil (1.3%) while the #2 Diesel row in the accompanying table is based on 0.3% sulfur content – thus applying a conservatism to the environmental benefit as it relates to SO_x.[R#11]

LESSONS LEARNED

BED feels that the flexibility afforded the customer by offering the option of either a loan or rebate has been one of the keys to the success of the Heat Exchange program. Customers who prefer a hands off approach from the utility have chosen the rebate option, while customers preferring hands on assistance from the utility have chosen the loan option.[R#5]

The utility has learned the importance of employing top notch energy auditors. Auditors must be able to envision energy efficiency from the standpoint of the entire building and have a broad knowledge of all energy efficiency technologies available. The people skills of the auditors are very important as they are the ones who explain the proposed installations to the customers and communicate with installation contractors. BED realizes that for the success of the program, it is worthwhile to pay more to maintain quality auditors.

BED learned quickly with the Heat Exchange program that very few customers were interested in learning the technical ins and outs of the program's installations or the calculations for the program loan or rebate. Customers wanted to keep things simple. "What are my costs and savings going to be if I participate in the program?"

Because Vermont state codes governing heating contractors are not very strict, BED has realized that it cannot assume that all contractors are experts. There is a wide range of abilities among contractors. BED makes it clear to contractors that the utility knows the technological aspects of energy-efficient installations. By communicating this knowledge to the contractors, the utility hopes to ensure top-notch work.

Some program participation problems have occurred because BED requires that new heating systems be societally cost effective. This means that BED does not allow participation in the Heat Exchange program unless a cost effective heating system plan can be designed. Some customers want to participate in the program, but they want to buy a fancy heating unit that is much more expensive than the least-cost option recommended by BED. This problem has only been encountered with about 10% of the interested customers and usually occurs with single family homes. BED has found in several instances that homeowners have already met with independent heating contractors who have recommended an expensive heating unit. Owners of rental apartment buildings have been almost universally accepting of all BED installation suggestions. Luckily for BED, 68% of their customers are renters.

BED learned the hard way the importance of clearly outlining program details in order to manage initial customer expectations of BED energy-efficiency programs. Customers voted to finance a bond issue which funded many of BED's DSM programs. In order to gain support for the funds, BED outlined the programs it planned to implement. As a result, over 1,000 units were signed up to participate in the Heat Exchange program even before it had begun. Naturally there was a backlog initially, and some customers became upset about having to wait for their new heating system installations. The actual Heat Exchange program also differed somewhat from the program design described for the bond issue vote. For example, some customers might have expected larger rebates, especially in light of the full-cost pilot program.

Many people were confused by the rebate and loan calculations. Customers would talk to each other and compare the differences in rebate and loan amounts. Many did not understand why, for example, they received a $100 rebate while their neighbor got $500. BED also realized the importance of making customers very aware of the intrusive nature of the installation process. The utility highlights this message in the customer proposal report presented after the audit.

The weatherization aspect of the program caused some problems. If BED deems it necessary, customers are required to weatherize their residences in order to participate in the program. Many air leaks in customer residences are large but

easily remedied by simple weatherization techniques. Often customers do not consider weatherization necessary and just want new heating units. BED requires weatherization because it does not want to simply turn a residence that is a large and inefficient electric user into an equally large and inefficient gas user. Their goal is energy efficiency and users must upgrade their homes to a set of criteria specific to Heat Exchange which is quite similar to code. (BED will finance the weatherization measures if some electric heat remains.)

TRANSFERABILITY

Fuel switching remains quite controversial as there has historically been a competitive tension between electric and gas providers. (Naturally this is not an issue for dual fuel utilities that sell both gas and electricity.) Especially when both gas and electric utilities are investor-owned, the competitive nature of the utility business has all but ruled out fuel switching programs.

More recently there has been a new awakening in the utility industry that fuel switching may be the first and most effective step to achieving thermodynamic efficiency. Thus we are beginning to see a new awareness, even among investor owned utilities, that fuel switching (in both directions) is an important component of garnering maximum levels of energy efficiency.

Burlington, like other municipal utilities that are not driven by shareholder profitability, is in an ideal position to promote thermodynamic efficiency. Thus BED has been a leader in providing the most efficient energy services for Burlington's residents, even when it may mean a decrease in total revenues for the utility. Since BED's "shareholders" are its customers, BED's primary interest is supporting maximum energy and economic efficiency.

The most cost effective space heating and water heating conversions are from electricity to natural gas. In areas where gas service is not available, like much of Vermont and in many rural areas, fuel switching is far less attractive. For instance, switching from electricity to fuel oil, may not be at all prudent given the price volatility of fuel oil. Thus effective fuel switching must be determined by carefully looking at the short and long term economic horizon of the fuel in question.

BED believes that its Heat Exchange program is transferable to other utilities. In fact, as part of their grant application for the pilot program, BED listed the development of a program that can be replicated by other small utilities as one of their primary goals. But BED thinks they have a decided advantage over other utilities, especially larger ones, that might try to implement a similar program. BED has such a small service area that any customer can be reached by car within 15 minutes. Because of such easy customer access BED is able to provide superior customer service.

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