British Columbia Hydro
Power Smart Refrigerator Buy-Back Pilot
Profile #10, 1992

Executive Summary

British Columbia Hydro's Power Smart Refrigerator Buy-Back Program provides utility customers with an environmentally-sound means of disposing of "second" refrigerators, alleviating restricted landfill capacity, the uncontrolled release of chlorofluorcarbons into the atmosphere, and inefficient electricity use. Each year in British Columbia over 30,000 refrigerators are landfilled, and their CFCs, embedded in refrigerants and in the insulation of the refrigerators, are released harming the ozone layer.

Many consumers keep old, second refrigerators in their garages and basements – often stocked with little more than a six of beer! A market research study found that 60% of these second refrigerators are full-sized, and that 55% of them are more than 12-years old. To pull these "hulks" out of service, B.C. Hydro implemented a pilot buy-back program during fiscal years 1990 and 1991 and offered a $50 bounty for customers who would allow the utility to come and take the refrigerator away. The pilot has been B.C. Hydro's most successful residential program and has received more press coverage than any other program including those offered province wide.

The Refrigerator Buy-Back pilot program is a logical complement to B.C. Hydro's New Refrigerator Rebate Program. The latter was effectively influencing consumers' buying behavior in favor of efficient new refrigerators, but often the customers did not how to properly dispose of their old units. The pilot program operated for two years, picking-up more than 16,000 refrigerators saving an estimated 119 GWh over the calculated remaining life of the second refrigerators. For a total cost of $2.8 million (1990 U.S.$) the pilot has also resulted in peak capacity savings of 1.36 MW. Now B.C. Hydro is in the process of expanding the Buy-Back Program to offer service to its customers province-wide.

Of the most profound results of the pilot is the existence of a state of the art dismantling facility for refrigerators just outside the City of Vancouver. There, old refrigerators are sorted by refrigerant and the refrigerants are carefully removed and recovered. The remains are then dismantled and their components recycled. As a result of the success of this facility, and the marketing and delivery mechanisms developed by Power Smart for the program, Power Smart Inc. is making the program guidelines available to its members around the world and several Power Smart member utilities in Canada plan to implement the program this year.

Refrigerator Buy-Back Pilot Program

Utility:	British Columbia Hydro and Power Authority
Sectors:	Residential/Commercial
Measure:	Removal of second refrigerators
Mechanisms:	Free refrigerator pick-up, $50 rebate to the owners, education
History:	The pilot program began in March of 1990 and ended in March of 1992. A province-wide program began in March of 1992.

Fiscal 1991/92 Program Data

Annual energy savings:	7,933,280 kWh
Lifecycle energy savings:	79,332,800 kWh
Capacity savings:	0.91 MW
Cost:	$1,908,779

Fiscal 1990/91 - 1991/92 Data:

Energy savings:	11,948,608 kWh
Lifecycle energy savings:	119,486,080 kWh
Capacity savings:	1.36 MWf
Cost:	$2,821,094

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

B.C. Hydro provides electric service to 1.3 million customers in the province of British Columbia in Canada. Its service area includes 92% of British Columbia's population. Although the vast majority of B.C. Hydro's customers are residential customers, sales to this sector represented only 26% of the electricity B.C. Hydro sold in 1991. The largest consumer was the "transmission" sector (or large industrial) which accounted for 34% of electricity sold in 1991. The "general" (or commercial and light industrial) sector received 30%. The remainder went to electricity trade and other destinations.

Electricity sales volume increased in 1991 to 43,991 GWh. Average annual kWh use for residential customers and small commercial customers increased in 1991, while average consumption for large industrial customers decreased from 1990 to 1991. B.C. Hydro attributes the decline to the successful delivery of its DSM programs.

Hydroelectric plants generate most of B.C. Hydro's electricity. Only 5% is generated by other sources. B.C. Hydro predicted, in its 1991 Electricity Plan, that no new generation facilities would be required until 2005. In that plan, B.C. Hydro committed to make full use of its existing facilities and to fully develop other resource options prior to developing new hydro generation projects. These other resource options include: Power Smart, B.C. Hydro's DSM initiative; coordination and purchases; a capacity enhancement program called "Resource Smart;" and private sector generation.

B.C. HYDRO 1991 STATISTICS

Number of Customers	1,289,590	
Energy Sales	43,991	GWh
Energy Sales Revenue	$1.636	billion
Winter Peak Demand	8,122	MW
Generating Capacity	10,466	MW
Reserve Margin	28.86	%
Average Electric Rates		
Residential	4.62	¢/kWh
General	4.05	¢/kWh
Transmission	2.48	¢/kWh

[R#1]

Utility DSM Overview

B.C. Hydro launched its Power Smart initiative in March of 1989 with the objective of obtaining a 2,400 GWh load reduction over ten years through the implementation of residential, commercial, and industrial DSM programs. The initiative received much initial success, and B.C. Hydro expanded Power Smart's goal to a 5,600 GWh reduction by the year 2010.

The initiative was launched with a handful of programs and has included as many as 27 Power Smart programs operating concurrently. As of March 1992, these programs had generated 724 million kWh in savings [R#12]. One of the major reasons for B.C. Hydro's success is the high level of customer awareness of the Power Smart programs. One of B.C. Hydro's most successful programs aimed at increasing customer awareness was "Power Smart Month." The program, first conducted in 1990, consisted of a month of energy awareness promotion culminating on "Power Smart Night" when customers were encouraged to turn off all unnecessary lights. When the program was repeated in October of 1991, B.C. Hydro estimates that its customers saved 244,000 kWh on Power Smart Night alone.

Utility DSM Overview Table	Annual DSM Expenditure (x1000)	Annual DSM Energy Savings (GWh)
1989	$8,457	52
1990	$30,082	195
1991	$48,714	452

B.C. HYDRO DSM PROGRAMS 1991

Residential Programs
- Quality Plus Homes
- Home Improvement
- Refrigerator Efficiency
- **Refrigerator Buy-Back Pilot**
- Electric to Gas Hot Water
- Power Smart Water Heaters
- Hot Water Saver Pilot
- Residential Lighting
- Energy Education
- Non Integrated Areas

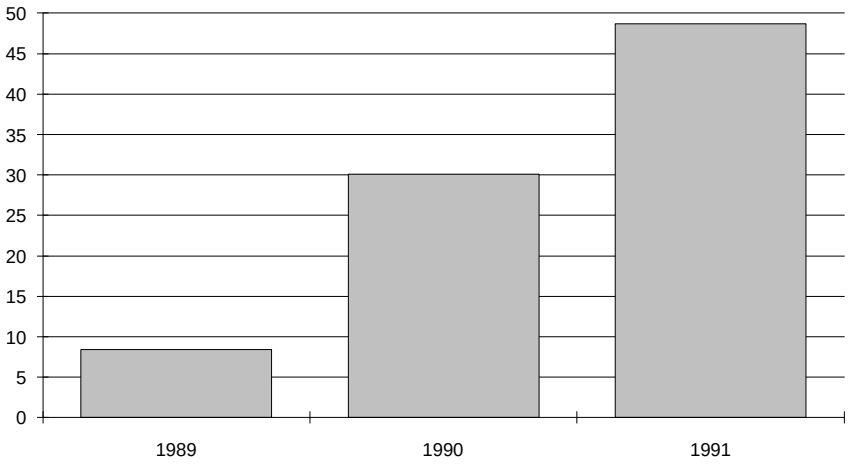
Commercial Programs
- Energy-Efficient Lighting
- New Building Design
- Water Heating Conversion
- In House Energy Efficiency
- Commercial Cogeneration
- Commercial Building Improvements
- Municipal Energy Efficiency
- Energy Management Control Systems
- Economizers
- Commercial Natural Gas: Fuel of Choice

Industrial Programs
- High Efficiency Motors
- Efficient Compressed Air
- New Plant Energy Assessment
- Efficient Roadway Lighting
- Bonus Partners
- Efficient Fans
- Pumping Profits

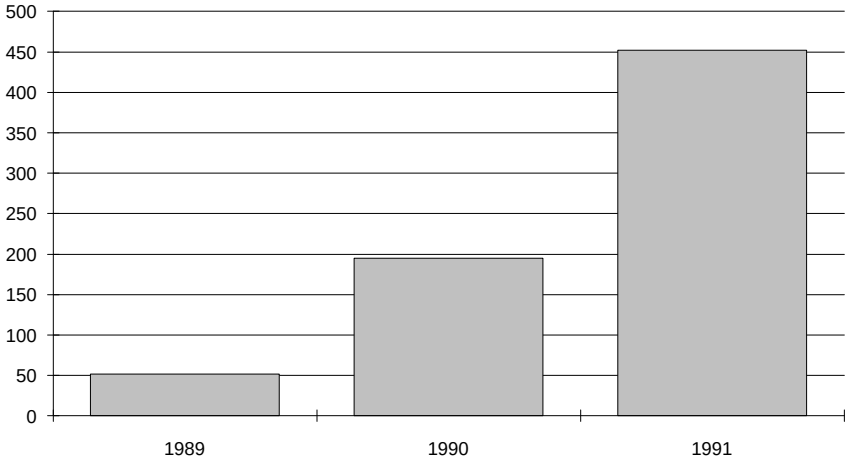
B.C. Hydro operated nine DSM programs aimed at residential customers in 1991. These programs included two programs pertaining to refrigerators, three programs pertaining to hot water use, an energy audit program, a new home construction program, an education-oriented program, and a program aimed specifically at reducing load in those areas not served by main electric transmission lines.

Commercial sector DSM programs offered in 1991 included a lighting rebate program, building improvement and new construction programs, and several other rebate programs. For industrial customers, B.C. Hydro offered a number of rebates, education, and incentive-based programs, including a very successful high efficiency motors program, an efficient roadway lighting project, and new plant design assistance.

ANNUAL DSM EXPENDITURE ($1,000,000)



ANNUAL DSM ENERGY SAVINGS (GWH)



Program Overview

The Refrigerator Buy-Back Pilot Program was implemented by B.C. Hydro during fiscal years 1990/91 and 1991/92. The program offered customers, in a limited area, $50 to give up their second refrigerators. B.C. Hydro provided free pick-up and disposal of the refrigerators. Disposal was conducted in an environmentally-sound manner and included dismantling of the refrigerators and recycling of chlorofluorocarbon (CFC) based refrigerants, preventing their accidental release.

The Buy-Back Program was originally implemented as a complement to B.C. Hydro's existing New Refrigerator Rebate Program. The New Refrigerator Rebate Program, launched in 1989, offers customers purchasing a new refrigerator a rebate if they purchase an energy-efficient model. Soon after the implementation of this program, it became evident that simply encouraging the purchase of energy-efficient refrigerators was not enough. Without an easy means to dispose of their old refrigerators, many customers simply put them in their basements or garages to use as second refrigerators. Although B.C. Hydro was influencing its customers' buying behavior in favor of energy-efficient new refrigerators, the old, inefficient refrigerators were still in use. The Refrigerator Buy-Back Program was begun to provide a convenient, socially responsible, and environmentally conscientiously means for customers to dispose of these unwanted refrigerators.

Market research, conducted in two communities prior to the start of the Refrigerator Buy-Back Pilot Program, suggested that second refrigerators are generally under-utilized and often inefficient. The research also indicated that a significant stock of second refrigerators exists. Other findings include [R#10]:

1. 25% of all respondents in the test area owned two or more refrigerators. This saturation is significantly higher than the provincial average of 16.4% and the Canadian national average of 18.7%. (It should be noted that the test area for this study consisted mainly of single family housing. Apartment housing has been found to have much lower second refrigerator saturation, approximately 1% [R#11].)

2. The main uses of second refrigerators were to store beverages (especially beer) and seasonal items and as additional storage space for special occasions.

3. 60% of second refrigerators were full-sized, and 55% were more than 12 years old.

The number of second refrigerators currently in use in British Columbia has been estimated at 180,000 units, with an additional 7,000 added each year. The average annual energy consumption of a refrigerator is estimated to be 1,446 kWh [R#10]. The main goals of the Refrigerator Buy-Back Pilot Program were to show that the load contribution of unwanted, second refrigerators could be cost-effectively reduced, to stop the growth in the saturation of second refrigerators, and to educate customers about the higher costs of operating secondary refrigerators.

The pilot program was conducted in two phases. Phase I began in March 1990 and served two small communities located approximately 40 miles outside of Vancouver. Its goal was to collect 1,000 refrigerators in one year. Within six months, 80% of this goal had been met. Phase II was therefore begun early, in October 1990. This phase served another five communities, dispersed geographically throughout the province, and boosted the goal to 6,189 refrigerators for fiscal 1990/91. Both Phase I and Phase II offered customers free pick-up of their old, "operational refrigerators" and a $50 rebate. Operational refrigerator was defined as any refrigerator that had a door and a compressor at the time of pick-up. During Phase I only residential customers could participate in the program. Phase II allowed new and used appliance dealers, landfill operators, recycling organizations and commercial customers such as apartment complexes to participate, as well. [R#10]

Implementation

MARKETING

The marketing effort for the Refrigerator Buy-Back Pilot Program centered on advertisements in community newspapers. Preliminary market research suggested that readership of these newspapers is extremely high. In addition to the advertisements a significant number of stories appeared in these newspapers, covering the program's initial launch and other milestones such as the 1,000th refrigerator picked up. Other marketing methods included direct mail to customers through bill stuffers, presentations to municipal governments, distribution of promotional materials to, and education of, new and used appliance retailers, and participation in special environmental events. Television and radio were not utilized in order to avoid spill over into communities that were not being served by the pilot program.

DELIVERY

Phase I utilized a single community-based contractor, the Ridge Meadows Recycling Society, to pick-up and to dismantle refrigerators. Ridge Meadows subcontracted the dismantling process, which consisted mainly of CFC recovery and capacitor removal, to an appliance service company. After dismantling, the refrigerator hulks were recycled by a local steel handling company.

For Phase II, B.C. Hydro selected a number of local contractors through a competitive bidding process. These contractors, mainly household moving companies, were responsible for picking-up and storing the refrigerators. They were not responsible for dismantling, as in Phase I. The dismantling process was conducted by an experienced contractor who was also selected through a competitive bidding process. The dismantling facility was completed during June of 1991, at which time refrigerators were either taken directly to the facility or, in the more distant program areas, stored until enough units were accumulated for transportation to the facility to be cost-effective.

Prior to the launch of Phase II, contractors attended a one-day training session where they were instructed on the safe removal of refrigerators, program marketing, customer service, complaint management and administrative details. Coordination between regional B.C. Hydro marketing personnel and the local contractors was an important aspect of the program and was crucial to resolving customer service problems.

Phase II employed a toll-free telephone line as the entrance point into the program. Marketing materials instructed customers in the pilot areas to call the line to register for the program. The personnel processing the registrations sent the registrants' information, via fax, to the appropriate local contractors. Within two days, the contractors contacted the customers to arrange a convenient time for pick-up.

A marketing promotions company maintained the toll free telephone line, processed the rebates, and generated reports. Reports included summaries of pick-ups by region and by contractor and weekly logs of telephone inquiries and rebates paid.

When the contractor picked-up the refrigerator, the customer completed an application form. The form included the customer's name, address, telephone number, and account number; identifying information about the refrigerator; and the signatures of both the customer and the contractor verifying the transfer of the refrigerator. Within four to six weeks after refrigerator pick-up, customers received their rebate check in the mail.

The contractors transported the refrigerators to the dismantling facility or to a storage facility and then submitted the application forms to B.C. Hydro for payment. Compensation for pick-up contractors depended upon the distance traveled.

Phase II was designed to be delivered by a network of community-based, non-profit organizations. However, the short time frame in which program staff had to develop Phase II prohibited them from identifying local recycling organizations and developing relationships with them as was done in Phase I. In addition, the availability of these organizations within each of the communities serviced by the program was inconsistent. Some communities had sophisticated, mature recycling societies that had access to CFC recovery facilities, while others had little infrastructure or no recycling society at all.

STAFFING REQUIREMENTS

Full-time program staff included a program manager and a co-op student. (B.C. Hydro often employs students in their final year of business school.) Several part-time, regional field representatives were responsible for maintaining communication between retailers, the community, and the utility. After the first full year of operation, a third full-time staff person was hired to provide assistance in the design and administration of the province-wide program. Several consultants with technical, managerial, or environmental expertise were employed for varying lengths of time to contribute to program development. The evaluation tasks involved in setting up and assessing the impacts of both phases of the pilot were performed by an independent consulting firm and B.C. Hydro's DSM evaluation department.

MONITORING

Because the savings generated by the Refrigerator Buy-Back Pilot Program did not rely upon customers' independent actions, such as proper installation of energy saving equipment, little monitoring of the program was necessary. The only monitoring effort centered around ensuring proper customer participation at the point of entry to the program. A software program employed by the personnel operating the toll-free telephone line compared the account number of a customer who was requesting service to the account numbers of customers previously serviced. A "flag" was raised when a previously serviced account number was found. When this happened, the operator informed the customer that only two refrigerators per residence were eligible for rebates. (However, there was no limit to the number of refrigerators a commercial customer could submit for buy-back.)

EVALUATION

The Pilot Program Manager commissioned independent consulting firms to conduct market research studies prior to the launch of the Refrigerator Buy-Back Pilot Program and after completion of Phase I. The study conducted after completion of Phase I surveyed 603 program participants and reported the following general results [R#9]:

- 95% of respondents indicated that the contractors provided good or excellent service;
- 89% said it was easy to arrange pick-up;
- most respondents heard of the program through community newspapers, word of mouth, B.C. Hydro bill stuffers, or retailers;
- 81% of the refrigerators were operating at the time of pick-up;
- the average age of the refrigerators that were picked-up was 20 years.

In mid-1991 B.C. Hydro's DSM Program Evaluation Department performed a comprehensive evaluation of Phases I and II. The evaluation included estimates of program benefits and costs, free ridership, persistence of savings, market potential, etc. The results of the evaluation are located throughout this profile, especially within the program costs and savings sections.

Formal evaluations of the cost effectiveness of and the energy savings generated by the province-wide program are scheduled to be performed on an annual basis.

DATA QUALITY

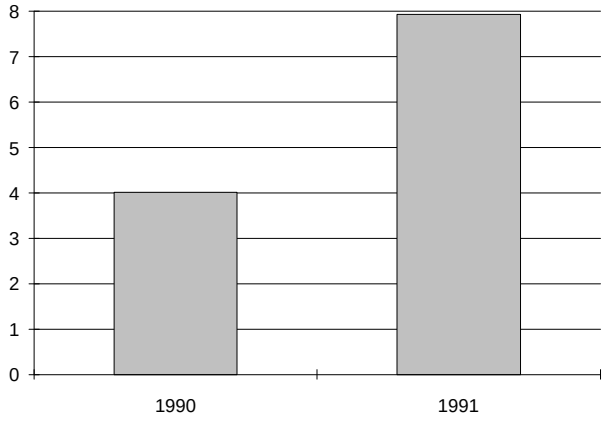
Energy savings were determined by multiplying the number of refrigerators by the energy consumption of an average refrigerator and then correcting for free riders. The July 1991 program evaluation suggested that this methodology should be investigated because the energy consumption of second refrigerators may be different than the energy consumption of average refrigerators. The value used for the energy consumption of an average refrigerator was determined through load research studies conducted by B.C. Hydro. The analysis focused on 3,000 end-use study households which were analyzed to determine appliance energy use through linear regression techniques. Many types, ages, and operating conditions were included. Second refrigerators will likely operate differently than those considered in the conditional demand analysis. Generally second refrigerators are older, operate in a cooler ambient temperature, and are used less frequently than average refrigerators. Being older, these refrigerators are probably less efficient and use more energy than an average refrigerator. However, cooler ambient temperatures and less frequent use might cause them to use less energy than the average. The evaluators suggested employing long term metering to determine an accurate average energy consumption level.

Capacity savings were not determined by any evaluations of the pilot program but will be included in evaluations of the province-wide program. The Results Center has calculated these figures, for the pilot program, with the assistance of B.C. Hydro. We assumed that the aggregate load of second refrigerators operates at approximately the same level all of the time (the load shape may increase during the day but is essentially flat). Therefore, the capacity savings is evenly distributed among every hour of the year and is calculated by dividing the annual energy savings by the number of hours in a year (8,760). [R#11]

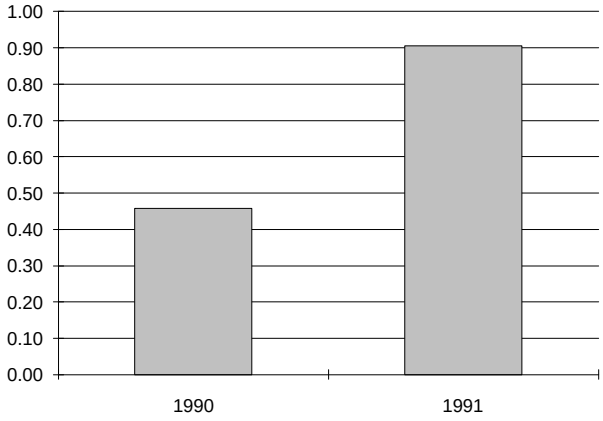
Program Savings

Savings Overview Table	Annual Energy Savings (kWh)	Cumulative Energy Savings (kWh)	Lifecycle Energy Savings (kWh)	Average Annual Capacity Savings (MW)	Cumulative Capacity Savings (MW)
1990	4,015,328	4,015,328	40,153,280	0.46	0.46
1991	7,933,280	11,948,608	79,332,800	0.91	1.36
Total	11,948,608	15,963,936	119,486,080	1.36	

ANNUAL ENERGY SAVINGS (GWH)

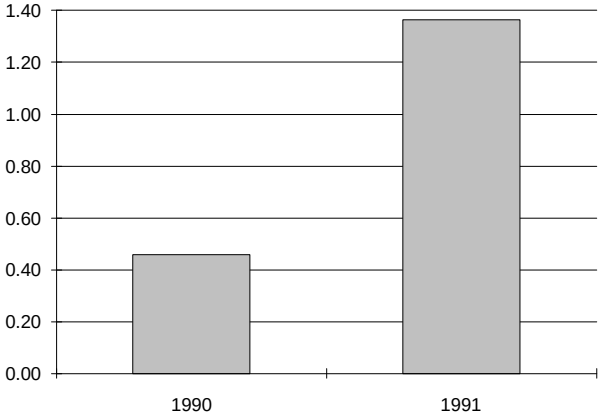


ANNUAL PEAK CAPACITY SAVINGS (MW)



CUMULATIVE ENERGY SAVINGS (GWH)

CUMULATIVE PEAK CAPACITY SAVINGS (MW)



During its two years of operation, the Refrigerator Buy-Back Pilot Program saved a total of 15,963,936 kWh of energy and 1.36 MW of capacity.

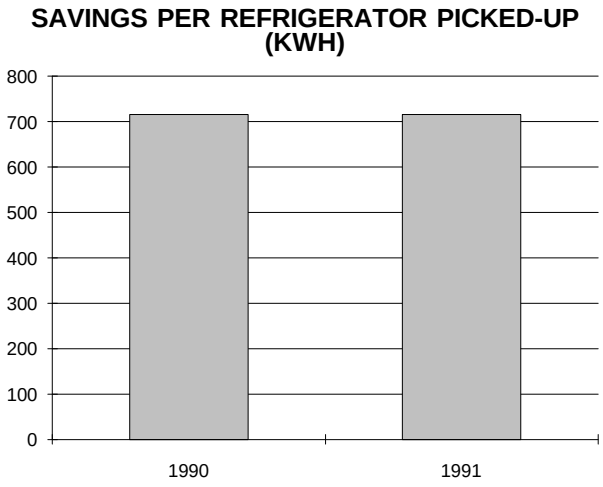
MEASURE LIFETIME

In the July 1991 program evaluation, B.C. Hydro's DSM evaluators indicated that determining the upper bound for the expected lifetime of an average second refrigerator is very difficult. They determined the lifetime effect of removing a second refrigerator by determining that the average age of the operational refrigerators that the program picked-up was 20 years. Of the refrigerators older than 20 years, the average age was 30 years. The evaluators concluded that the future operational life of the average operational refrigerator picked-up would be at least 10 years beyond the date of pick-up. Therefore, B.C. Hydro estimated that the savings effects of the Refrigerator Buy-Back Pilot program would persist for 10 years beyond the time of pick-up. [R#8]

PARTICIPATION

The pilot program had a goal of picking-up 13,072 refrigerators in Phases I and II. It exceeded this goal by 29% and picked-up 16,688 refrigerators.

Fiscal Year	Refrigerators Picked-up	Annual Energy Savings per Refrigerator (kWh)
1990	5,608	716
1991	11,320	716
Total	16,928	



Cost of the Program

A total of 16,688 refrigerators were picked up by B.C. Hydro's Refrigerator Buy-Back Pilot Program. The entire cost for the pilot was $2,821,094.

COST PER REFRIGERATOR

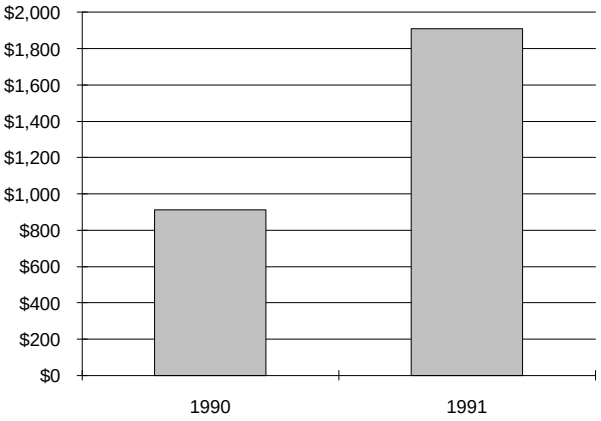
The average cost per refrigerator picked-up during the pilot (both years) was $157 per refrigerator. The cost per refrigerator picked-up decreased $9 from fiscal 1990/91 to fiscal 1991/92. During that period total program costs increased 89%, but the total number of refrigerators picked-up increased by 102%.[R#5,6,12]

FREE RIDERSHIP

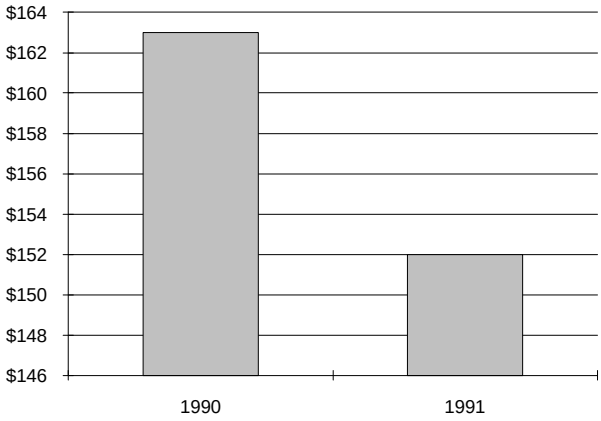
The July 1991 program evaluation suggested that the

Cost Overview Table	Advertising and Start-up Costs	Admin. Costs	Refrigerator Processing	Rebates Paid	Total Program Cost	Cost per Refrigerator Picked-Up
1990	$263,113	$155,643	$252,607	$240,315	$911,678	$163
1991	$167,198	$326,309	$762,004	$467,328	$1,722,839	$152
Total	$430,311	$481,951	$1,014,612	$707,643	$2,634,517	$157

TOTAL PROGRAM COST (x1,000)



COST PER REFRIGERATOR PICKED-UP



Cost of Saved Energy (¢/kWh)	Discount Rates						
	3%	4%	5%	6%	7%	8%	9%
1990	2.66	2.80	2.94	3.09	3.23	3.39	3.54
1991	2.82	2.97	3.12	3.27	3.43	3.59	3.75

question of what would have happened to a refrigerator in the absence of the program must be continually assessed in order to maintain the reliability of impact estimates. If a refrigerator would have remained in the house unplugged or otherwise non-operating or would have been transported to a dump in the absence of the program, then that refrigerator would not have been an operating second refrigerator and is considered a free rider.

When the Refrigerator Buy-Back Pilot Program began no assumption existed for estimating free-ridership. A savings model based on the data obtained in the February 1991 market research study and run by the B.C. Hydro DSM program evaluators suggested that only 50% of the refrigerators picked-up in Phase I would have become second refrigerators. Thus free-ridership equaled 50%. A significant factor in this determination was the number of inoperable, or "dead," refrigerators picked-up, 19% of the total. [R#8]

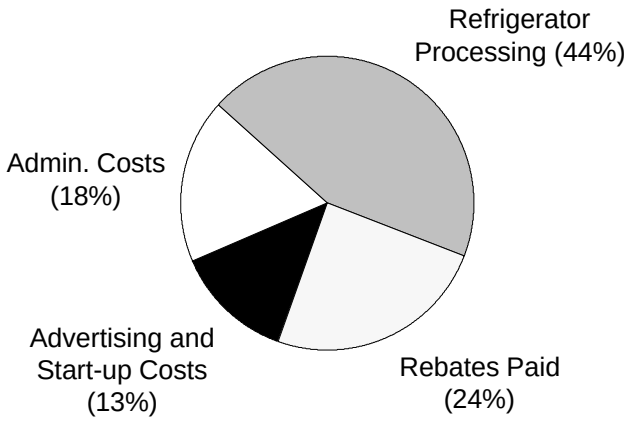
COST EFFECTIVENESS

The cost of saved energy of the Refrigerator Buy-Back Pilot Program for fiscal year 1991, calculated at 5%, is 3.12 ¢/kWh saved. This value is 20% less than B.C. Hydro's cost of generating energy which is 3.88 ¢/kWh [R#1]. It should be noted that the pilot program included significant start-up costs that will not be incurred by the province-wide program. Also included in the pilot program costs were the costs to dismantle the refrigerators and to recycle or properly dispose of their various components. These costs do not contribute to saved energy and therefore cause the program to appear more expensive than it would otherwise be.

COST COMPONENTS

When analyzing the costs of the Refrigerator Buy-Back Pilot Program, it is important to recognize that some costs are start-up costs and will not be repeated when expanding the program province-wide. Some costs are fixed and do not vary with program size, while other costs vary with the size of the program. Start-up costs include research and development of dismantling technologies, most outside consulting, and some cross charges from other departments. Fixed costs include most administrative costs, most of the cost of the dismantling facility, and some advertising. Variable costs include some administrative costs, rebates, pick-up, transportation of refrigerators, most advertising, some cross charges from other departments, and some of the cost of the dismantling facility. [R#8]

Most of the program costs were for refrigerator processing, 44% of the two year pilot total. Customer rebates accounted for 24%. Administrative costs were 18%. While advertising and start-up costs consumed 13%. [R#5,6,12]



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%	34,418,000	817,000	165,000	17,000
B	10,000	1.20%	36,701,000	316,000	107,000	79,000
	Controlled Emissions					
A	9,400	2.50%	34,418,000	82,000	165,000	1,000
B	10,000	1.20%	36,701,000	32,000	107,000	5,000
C	10,000		36,701,000	211,000	105,000	5,000
	Atmospheric Fluidized Bed Combustion					
A	10,000	1.10%	36,701,000	97,000	53,000	26,000
B	9,400	2.50%	34,418,000	82,000	66,000	5,000
	Integrated Gasification Combined Cycle					
A	10,000	0.45%	36,701,000	65,000	11,000	26,000
B	9,010		33,013,000	24,000	8,000	2,000
Gas	**Steam**					
A	10,400		20,019,000	0	46,000	0
B	9,224		17,385,000	0	109,000	5,000
	Combined Cycle					
1. Existing	9,000		17,385,000	0	67,000	0
2. NSPS*	9,000		17,385,000	0	32,000	0
3. BACT*	9,000		17,385,000	0	4,000	0
Oil	**Steam--#6 Oil**					
A	9,840	2.00%	28,975,000	439,000	52,000	49,000
B	10,400	2.20%	30,731,000	435,000	65,000	32,000
C	10,400	1.00%	30,731,000	62,000	52,000	17,000
D	10,400	0.50%	30,731,000	183,000	65,000	10,000
	Combustion Turbine					
#2 Diesel	13,600	0.30%	38,457,000	77,000	119,000	6,000
Refuse Derived Fuel						
Conventional	15,000	0.20%	45,657,000	118,000	155,000	34,000

Avoided Emissions Based on 15,963,936 kWh Saved (1990 - 1992)

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 B.C. Hydro's level of avoided emissions saved through its Refrigerator Buy-Back Pilot 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 include a 10% credit for DSM savings to reflect the avoided transmission and distribution losses associated with supply-side resources.

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

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

*** Acronyms used in the table**

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

LESSONS LEARNED

The July 1991 program evaluation stated several lessons that were learned through the implementation of the Refrigerator Buy-Back Pilot program. They are the following:

- It is important to minimize the number of non-operable refrigerators collected as this factor dramatically increases the cost of saved energy.
- The software system employed by the program intake contractor must include rejection flags that can be raised when an address, cheque name, or account number that has previously been serviced appears again.
- When a customer requests pick-up of a refrigerator and information about the customer is entered into the database, information about the refrigerator to be picked-up should also be entered into the database.

Program Manager Sophia Sorensen presented a paper entitled "The Great Fridge Pick-Up" before the Northwest Regional Solid Waste Symposium, on September 24, 1991. In this presentation, Ms. Sorensen presented the history of the Refrigerator Buy-Back Pilot Program, as well as some issues or events that have presented difficulty to its administration, have not been fully resolved, or that have not been fully utilized for their positive public relations potential. These are the following:

1. Used appliance dealers are concerned with the potential for adverse effects on their businesses. They are concerned that B.C. Hydro's efforts will reduce the market for used refrigerators, reduce the number of used refrigerators available for resale, and reduce the supply of used refrigerators that can be salvaged for spare parts.
2. Some not-for-profit organizations, such as the Salvation Army, rely upon selling donated appliances for a portion of their operating revenues. These organizations are concerned that the program will reduce the number of refrigerators that people donate to them and thus reduce their revenues.
3. The agreement with DuPont Canada to recycle the CFCs recovered in the refrigerator dismantling process has not been capitalized upon for its positive public relations effect. [See "The Dismantling Facility" section]
4. B.C. Hydro sent a proposal to the B.C. Ministry of Environment concerning a possible joint program through which the ministry would fund the pick-up and dismantling of non-operating refrigerators and thus prevent their CFCs from being released to the atmosphere.
5. There is not yet a cost-effective system to recover ammonia from refrigerators. This, however, is not a critical problem because only 21 refrigerators that utilize amonia as a coolant are now in storage at the dismantling facility [R#13].
6. The effect of the program on municipal solid waste management plans has not been adequately addressed. Many municipalities are in the process of developing comprehensive waste management plans that will accommodate B.C. Ministry of Environment guidelines that suggest that "large metallic objects suitable for recycling" will be prohibited from landfills in the future.

Another lesson learned involved program abuse. A case of program abuse was found in which an appliance repair concern removed all operable parts from refrigerators, rendering them inoperable, and then called B.C. Hydro to pick-up the hulks. The individual used a number of different names on the rebate claims. The software used to process customer requests for refrigerator pick-up was designed to check applicants' account numbers and to prevent such an occurrence. The problem is being corrected for the province-wide program. In the future, an address search prior to pick-up will indicate if a customer has previously participated in the program and how often. Further defining the refrigerator eligibility requirements for the program will also address this problem.

Defining eligibility requirements for refrigerators is important to the program's sucess. The pilot accepted any refrigerator that had a door and a compressor. This resulted in many non-working refrigerators being picked-up. Thus free ridership and the cost of saved energy for the pilot are unnecessarily high. When the program is offered province-

wide, customers will be asked if the refrigerator is operational when they call to request pick-up. They will be asked again, by the pick-up crew, if the refrigerator cools and will be required to sign a statement stating that the refrigerator is operational and will cool. In addition, the pick-up crew will plug the refrigerator in to verify that it works.

TRANSFERABILITY

The Refrigerator Buy-Back Program is highly transferrable to other areas. Program Manager Sophia Sorensen identified many lessons that may be applicable in transferring the program to another area or in implementing any white goods recycling program. They are the following:

- make it easy for customers to participate
- estimate the size of the target market and all possible responses to that market
- determine which white goods disposal options are currently available to the customers
- if the implementing organization cannot financially support a program, it should consider a joint effort with government or private organizations
- regional staff must support the program – personnel "on the front lines" must fully understand how and why the program works
- control must be maintained over resources and the quality of program delivery
- determine all methods of communication prior to program implementation
- avoid media spillover, if the program is being offered in only limited areas
- utilize existing lines of communication with customers, such as newsletters, bill inserts, telephone queries, etc.
- promote program successes
- learn from existing programs, avoid mistakes encountered in the past
- have a contingency plan for overwhelming program success
- brainstorm all program delivery options for the region before implementation, this will allow more flexibility later

POWER SMART INC. (PSI)

The Refrigerator Buy-Back Program is available to other utilities through membership in Power Smart Inc. (PSI). In addition to B.C. Hydro, four other Canadian Power Smart utilities have already adopted or are in the process of adopting the program for delivery in their service territories.

PSI is a demand-side management organization which was incorporated as a wholly owned subsidiary of B.C. Hydro. Its membership currently includes utilities and government energy agencies in Canada, the Caribbean, Mexico, and Czechoslovakia. A variety of services and products are offered to members. These include DSM program and marketing materials; assistance to design, market, and implement DSM programs; marketing and retail promotions services; and sales and marketing training; etc.

The Dismantling Facility

B.C. Hydro implemented a pilot of Power Smart's Refrigerator Buy-Back Program not only to reduce electricity consumption but also to provide a means to safely remove CFCs from old refrigerators. Prior to the program, approximately 30,000 refrigerators per year were going to metals recycling facilities or to the landfill. Of these refrigerators, only a small percentage had their CFCs removed. The rest released their CFCs into the environment.

A significant emphasis was placed on research and development of an environmentally-sound refrigerator dismantling facility. This effort led to the opening of Canada's first such facility on June 7, 1991, fourteen months after the launch of Pilot Phase I. The facility is operated by an independent contractor, with experience in appliance recycling, and is located in a 17,000 ft2 warehouse just outside the City of Vancouver.

At the facility, capacitors are removed from the refrigerators and the refrigerants are recovered. The refrigerator hulks are then sent to a local steel company where the remaining components are either recycled or disposed of properly. By recycling as many components as possible, B.C. Hydro recovers some costs, while eliminating additional burdens to existing refuse disposal systems. In addition, B.C. Hydro has pledged to incorporate new recycling technologies into this process as they become available.

Long-haul trailers transport refrigerators to the facility from the regional storage centers. Upon arrival, the refrigerators are sorted by type of refrigerant: chlorofluorocarbon (CFC), sulfur dioxide (SO_2), or ammonia (NH_3). Most of the refrigerators brought to the facility contain CFC-based refrigerants.

The dismantling process can remove CFCs from up to 20 refrigerators at once, utilizing a recovery system developed by the contractor. The system uses a number of filters to extract CFCs with a minimum of contamination. Recovered CFCs are then transferred to a DuPont facility in Maitland, Ontario, for reclamation.

Approximately 1% of the refrigerators received by B.C. Hydro use SO_2 as a refrigerant. This material is recovered via a low temperature distillation method, and stored for semi-annual shipment to a Greater Vancouver Regional District wastewater treatment plant where it is consumed in a dechlorination process.

Approximately 0.1% of the refrigerators use NH_3 as a refrigerant. Currently, there is no practical means of recovering NH_3. B.C. Hydro is storing these refrigerators at the dismantli]ng facility until such time as a good recovery method is developed. Currently, B.C. Hydro has only 20 of these refrigerators.

Many of the other components of refrigerators are recovered for other uses. All steel, which forms the hulk of most refrigerators as well as the compressor, is shredded at the local steel company and sold on the international market. Aluminum and copper piping is likewise shredded, sorted, and sold.

Some refrigerator parts cannot currently be recovered for reuse. These parts are disposed of in accordance with all applicable regulations. Compressor oil is transported to a hazardous waste disposal unit. Capacitors are inspected for possible inclusion of PCBs, with PCB-containing capacitors to be stored at a B.C. Hydro storage facility. (No suspect capacitors have yet been found.) Plastics and insulation are shredded at the local steel company, sorted as fluff, and sent to the local landfill. B.C. Hydro intends to incorporate plastics and insulation recycling into the dismantling process as soon as cost-effective methods are found.

B.C. Hydro staff interact with the dismantling facility's manager on a weekly basis. The B.C. Hydro Refrigerator Buy-Back Program manager, the dismantling facility plant manager, and the dismantling facility administrative manager periodically attend program status update meetings. These meetings address problem resolution and administrative procedure adjustments.

Tours of the dismantling facility are occasionally given to government officials, recycling societies or others who express serious interest in developing a similar facility.

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Special thanks to Carol Nelson for her patience and help throughout the development of this profile.