Refrigerator and Freezer Retirement Program

2011-2012 Year End Report

Yukon
Energy, Mines and Resources

YUKON ENERGY

Overview

The Refrigerator and Freezer Retirement program launched June 20, 2011 with the goal of retiring a total of 210 older, inefficient refrigerators and freezers in the first fiscal year of the program (2011-2012) and 320 appliances in the following year for a two year total of 530 retired appliances. The purpose of the program is to reduce the residential energy load of Yukon communities as part of a larger Demand Side Management Yukon initiative. The program is a joint partnership between Energy Solutions Centre and Yukon Energy Corporation.

The program targets refrigerators and freezers that are 5 years and older and in current use. Client participation is incentivized through a $50 rebate offered per appliance (up to 2 appliances per individual) and through the provision of free appliance pick-up, transportation to the landfill and the payment of the landfill tipping fee and recycling costs. The total incentive value to the client comes to $153 for a single appliance with $50 as rebate, $68 as transportation and pick-up fee and $35 as landfill tipping fee. There are two potential program client types:

1. Clients who own and operate a secondary fridge and/or freezer who wish to permanently **retire** the appliance.
2. Clients who own and operate a primary fridge and/or freezer who wish to **replace** the appliance with a new, more energy efficient appliance (likely in conjunction with ESC's Good Energy program which offers rebates for the purchase of Energy Star Appliances).

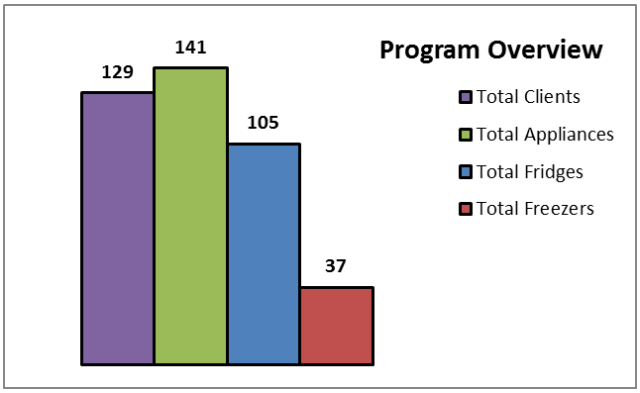
The estimated energy savings resulting in the retirement of a refrigerator is projected at 559 kWh and 393 kWh for the retirement of a freezer. The energy savings resulting in the retirement and concurrent replacement of an older, inefficient refrigerator and freezer with new, Energy Star-certified models are projected at 114 kWh and 70 kWh, respectively.[1]

The Refrigerator and Freezer Retirement program has collected 141 appliances from June, 2011, to March, 2012. Of those appliances, 104 are refrigerators and 37 are freezers. The number of participants in the program has dropped since the summer launch of the program. The program averaged 36 appliances retired per month in the summer, 15 appliances retired per month in the fall and 7 appliances retired per month in the winter. The decline in participation is likely due to a suspension of program advertising. The purpose of this report is to evaluate the program's progress to date and to determine if any changes or modifications to the program are required.

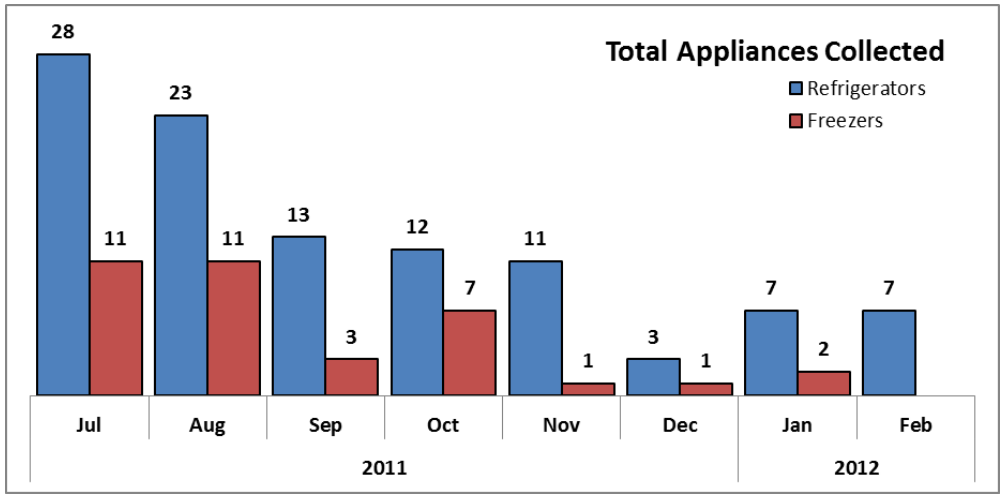
[1] Note that these estimated energy savings are based on NRCan's average annual unit of energy consumption (UEC) for refrigerators and freezers for 2001 (http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tableshandbook2/res_00_16_e_4.cfm?attr=0) rather than the Energy Star's Refrigerator Retirement Calculator used in the Refrigerator and Freezer Retirement Work Plan and the Interim Report (http://www.energystar.gov/index.cfm?fuseaction=refrig.calculator).

Results

To date the Refrigerator Retirement Program has collected a total of 141 appliances from 129 clients since the inception of the program in June 2011 to the beginning of March, 2012 (fiscal year end invoices were collected from A-1 and the City of Whitehorse Landfill on February 29, 2012). Refrigerators represented 74% of collected appliances.



The program enjoyed a strong initial launch with media support in the form of newspaper ads run concurrently in the Whitehorse Star and the Yukon News newspapers in July. A total of 89 appliances were collected within the first three months. Participation in the program has declined since, due in part to the suspension of Yukon government advertising during the fall Territorial election. The program was not actively promoted during the winter months and participation dropped off, with 51 appliances collected from October 2011 to February 2012.



The Refrigerator Retirement Program resulted in energy savings of over 37,000 kWh over the first 8 months of the program. The average age of appliances collected for the program was 14 years for the first appliance and 18 years for the second appliance (11% of clients retired/replaced the program's limit of 2 appliances). The Program Cost per kWh Saved provides a means to measure the cost effectiveness of the program against the conserved cost of electricity (CCE).[2] While the Annual Program Cost per kWh Saved is

Action/Appliance (Assumed 2001 Manufacture)	Units	Annual Energy Consumed per Appliance (kWh)	Total Annual Energy Consumed (kWh)	Annual Program Cost per kWh Saved ($)	Program Cost per kWh Saved - 10 Year Projection ($)
Retire Refrigerator	40	559	22,360		
Retire Freezer	15	393	5,895		
Replace Refrigerator	65	114	7,395		
Replace Freezer	22	70	1,533		
Total	**142**		**37,184**	**$ 0.69**	**$ 0.07**

[2] "The CCE is the annualized incremental capital and O&M cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs. The CCE represents the cost of conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity," from Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011) ICF Marbek.

greater than both the CCE of $0.35 per kWh for residential accounts on the Hydro Grid and the $0.30 per kWh for residential accounts on Large and Small Diesel systems[3], the Projected 10 Year Program Cost per kWh Saved of $0.07 per kWh demonstrates a very effective CCE.

Currently the criteria for the Refrigerator Retirement Program specifies eligible appliances for the program as being refrigerators and/or freezers that are 5 years or older and in current use. This table reveals that the retirement of refrigerators and freezers manufactured in 2001 results in a low CCE of $0.03 to $0.04 over a 10 year projection. This is expected – the removal of an electrical load results in energy savings. When the load is replaced by a newer and more efficient appliance, the energy savings are reduced and the CCE rises. In the 2001 replacement scenario, the replacement of a refrigerator and a freezer with their respective Energy Star counterparts results in a program cost savings of $0.13 and $0.22 over 10 years – both come in well below the CCE threshold. In the 2006 replacement scenario, the replaced refrigerator comes in above the CCE threshold at $0.43 while the replaced freezer comes in below the threshold at $0.27.[4]

Date of Appliance Manufacture	Action/Appliance	Annual Energy Consumption per Appliance (kWh)	Program Cost per Appliance ($)	Program Cost per kWh Saved - 10 Year Projection ($)
2001	Retire Refrigerator	559	153	0.03
	Retire Freezer	393	153	0.04
	Replace Refrigerator	114	153	0.13
	Replace Freezer	70	153	0.22
2006	Retire Refrigerator	481	153	0.03
	Retire Freezer	380	153	0.04
	Replace Refrigerator	**36**	**153**	**0.43**
	Replace Freezer	57	153	0.27

To eliminate the issue of incentivizing the retirement of refrigerators manufactured in 2006 that do not provide a CCE payback (as illustrated in the table above), the age criteria of appliances could be raised from 10 to 5 years. In this scenario, the program cost per kWh saved has been reduced from a 10 year projection to 5 years based on the average 15 year life expectancy of a refrigerator.[5] In this scenario the replacement of refrigerators and freezers manufactured in 2006 and the replacement of freezers manufactured in 2001 no longer are

Date of Appliance Manufacture	Action/Appliance	Annual Energy Consumption per Appliance (kWh)	Program Cost per Appliance ($)	Program Cost per kWh Saved - 5 Year Projection ($)
2001	Retire Refrigerator	559	153	0.05
	Retire Freezer	393	153	0.08
	Replace Refrigerator	114	153	0.27
	Replace Freezer	**70**	**153**	**0.44**
2006	Retire Refrigerator	481	153	0.06
	Retire Freezer	380	153	0.08
	Replace Refrigerator	**36**	**153**	**0.85**
	Replace Freezer	**57**	**153**	**0.54**

[3] "Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011)," ICF Marbek.

[4] The basis for the decline in energy savings and program cost per kWh saved is the increasing efficiency of appliances over time – improvements in insulation, compressor, door seals, controls and fans lead to appliances that consume less energy.

[5] Consumer Reports cites 13 years as the life expectancy of a refrigerator and 11 years for a freezer (http://news.consumerreports.org/home/2009/03/appliance-life-expectancy-national-association-of-home-buildersbank-of-america-home-equity-study-of-.html). NRCan cites 17 years for a refrigerator and 11 years for a freezer (http://oee.nrcan.gc.ca/equipment/appliance/8665).

viable with a $0.35 CCE. In order to maintain the viability of the freezer component of the program, the reduction of the cost of the program must be considered.

In a scenario where the program costs are lowered through the elimination of the $50 rebate per appliance, the replacement of refrigerators and freezers manufactured in 2001 (or earlier) remains viable while the replacement of appliances manufactured in 2006 comes in higher than the $0.35 CCE threshold. The elimination of the $50 rebate is a departure from ESC's flagship market transformation program, the Good Energy program, where rebates are offered for the purchase of energy efficient appliances. This reimagining of the Refrigerator and Freezer Retirement program may have the effect of positioning the program as more of a service program facilitating the retirement and recycling of energy intensive appliance rather than a buy-back program. This positioning may provide greater opportunities for education and engaging clients on energy efficiency topics and other programs that ESC offers as clients may be less motivated and/or distracted by financial incentives.

Date of Appliance Manufacture	Action/Appliance	Annual Energy Consumption per Appliance (kWh)	Program Cost per Appliance ($)	Program Cost per kWh Saved - 5 Year Projection ($)
2001	Retire Refrigerator	559	103	0.04
	Retire Freezer	393	103	0.05
	Replace Refrigerator	114	103	0.18
	Replace Freezer	70	103	0.30
2006	Retire Refrigerator	481	103	0.04
	Retire Freezer	380	103	0.05
	Replace Refrigerator	36	103	0.58
	Replace Freezer	57	103	0.36

To date the 2011-2012 Refrigerator and Freezer Retirement Program has resulted in a total annual savings of $3,800 for the 142 appliances collected. The total projected annual energy savings over 10 years for the first year of the program comes to $38,000. Note again that the energy cost savings for retiring an appliance is substantially higher than the savings for replacing an appliance. The decision of whether to replace an old appliance with a newer, more efficient appliance is complex and is discussed in the Additional Details section below under Life Cycle Costs.

Action/Appliance (Assumed 2001 Manufacture)	Units	Annual Individual Energy Cost Savings ($)	Total Annual Program Energy Cost Savings ($)	Total Energy Cost Savings Over 10 Years ($)
Retire Refrigerator	40	$ 57	$ 2,285	$ 22,852
Retire Freezer	15	$ 40	$ 602	$ 6,025
Replace Refrigerator	65	$ 12	$ 756	$ 7,558
Replace Freezer	22	$ 7	$ 157	$ 1,567
Total	**142**		**$ 3,800**	**$ 38,002**

2011-2012 BUDGET

ADVERTISING	Units	Unit Value	Total
Inkspirations			
Banner with stands	2	560	1,120
Graphic design	5	85	383
LEAF			
June 22 Design Newspaper	3	80	260
Yukon News			
Friday, July 8 & 15	3	192	576
Whitehorse Star			
July 8 & 15	3	275	825
			$ 3,164

OPERATING COSTS			
Rebates	128	50 or 100	7,155
A-1 Delivery	126*	67.50	10,046
City of Whitehorse Landfill	128	35 or 70	5,285
			$ 22,486

Cost of Program to Date (March 2012)	**$**	**25,650**
Initial Budget Projection	$	48,783
Difference	**$**	**23,133**

2012-2013 BUDGET

ADVERTISING	Units	Unit Value	Total
Promotion			3,000
			$ 3,000

OPERATING COSTS			
Rebates	230	50	11,500
A-1 Delivery			
Whitehorse	200	68	13,500
Communities	30	143	4,298
City of Whitehorse Landfill	230	35	8,050
			$ 37,348

Projected Program Cost (March 2013)	**$**	**40,348**

* Two clients transported their appliances to the landfill so no transportation fees were paid to A-1.

Budget

The Refrigerator Retirement Program is operated in partnership with Yukon Energy Corporation (YEC). The initial budget for the program was estimated at $50,000 with ESC and YEC each contributing up to $25,000**.** The project came in well under budget as the initial program target of replacing and/or retiring 210 appliances was not met nor was the full advertising budget for the program spent. The 2012-2013 projects the collection of 230 appliances (88 appliances more than the previous year) with 50 of those appliances coming from the communities. Due to the increased number of appliances projected to be collected and the transportation costs relating to servicing the communities, the budget for 2012-2013 is projected to be $40,348. Note that the total appliances projected for collection in the second year has been reduced from 320 refrigerators and freezers to 230 refrigerators.

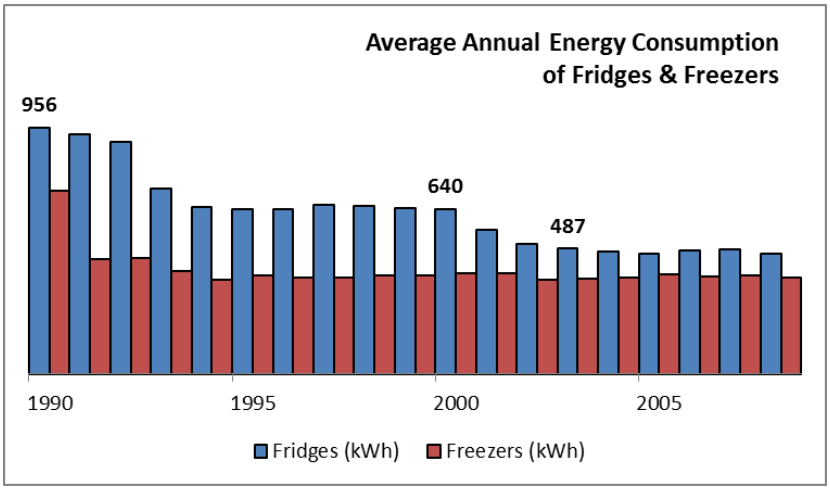
Additional Details

Evaluating the Refrigerator Retirement Program on the basis of CCE provides a very concise framework from which to measure performance. There are other additional factors to consider, however, such as efficiency trends, free riders and life-cycle cost analysis that provide valuable insight and alternative perspectives on the design and performance of the Refrigerator Retirement Program.

Efficiency Trends

Determining the age at which to retire or replace a refrigerator or freezer depends on two main trends affecting refrigerator and freezer energy performance. They are:

- Improved appliance designs resulting in annual energy efficiency gains industry-wide
- Decline in energy performance of appliances over time due to the gradual deterioration of insulative blowing agents.



According to an NRCan report,[6] the greatest gains in energy efficiency for refrigerators occurred between 1992 – 1994 and 2000 – 2001.[7] These gains were due to the federal government's introduction of the minimum energy performance standards (MEPS) and its later amendment. The report notes that since 2003, the energy performance of refrigerators has remained relatively stable.[8] The annual energy consumption of refrigerators and freezers does not remain constant, however. The energy performance of refrigerators and freezers declines over time due to the leakage of insulative blowing agents. According to Hyung Chul Kim et al,[9] losses can amount to 15 to 20% of annual energy consumption over 10 years depending on the type of blowing agent used. For the purpose of this report, the decline in energy performance of individual appliances has not been incorporated into the energy savings results as the performance is dependent on specific blowing agents used in each appliance and no large-scale

[6] "The Energy Consumption of Major Household Appliances Shipped in Canada, Trends for 1990-2008", http://oee.nrcan.gc.ca/publications/statistics/cama10/pdf/cama10.pdf

[7] Among the technology developments that have contributed to these advances are improved condensers, compressors, evaporators, fan motors and door seals, and the use of foam insulation, http://oee.nrcan.gc.ca/equipment/appliance/7718.

[8] ibid.

[9] "Optimal Household Refrigerator Replacement Policy For Life-Cycle Energy, Green House Gas Emissions and Cost," Hyung Chul Kim, Gregory A. Keoleian, Yuhta A. Horie, http://css.snre.umich.edu/publication/optimal-household-refrigerator-replacement-policy-life-cycle-energy-greenhouse-gas-emiss.

study has been conducted to determine an averaged appliance-based energy performance loss percentage.[10]

Free Riders

One of the challenges of developing and evaluating a client-based energy savings program is identifying not only the cost effectiveness of the program but also the potential for exploitation of the program – the dreaded free rider. In Diane Fielding's report for BC Hydro, "Estimating the Level of Free Riders in the Refrigerator Buy-Back Program," Fielding identifies free riders as "those individuals who would have adopted the program recommended actions in the absence of the program, but who received an incentive… for participating in the program." She defines incremental or partial free riders as "participants who, in the absence of the program, would have temporarily removed a refrigerator from service." [11] For example, someone unplugging a refrigerator or freezer for a portion of the year would be considered a partial free rider. To determine the level of free ridership in BC Hydro's 1993 Buy-Back Program, Fielding conducted and compared the results of two surveys. The participant survey determined the usage of refrigerators picked up by the program and what would have happened to the secondary appliance if the program did not exist. The second survey was conducted on a comparison group not associated with the program to determine what these individuals would do in the absence of an appliance buy-back program. The free ridership for BC Hydro's Refrigerator Buy-Back program was estimated to be 21% for all refrigerators collected.

Free ridership is a nebulous area and difficult to define. Fielding's definition identifies individuals who would have recycled or retired their refrigerators in the absence of the program. The problem with this approach in defining free ridership is that there is no way to reduce or limit free ridership aside from ending the program. For the purpose of the Refrigerator and Freezer Retirement Program, free ridership is defined by individuals who call for the collection of appliances that are no longer in working condition. The goal of the program is to remove older, inefficient appliances from secondary sale markets and decrease the load on the grid – not to de-clutter someone's backyard of old, abandoned, non-working appliances. To this end, the Refrigerator Retirement Program relies on honesty – the client must speak with a ESC staff person, verbally affirm their appliance meets the criteria for the program and sign off on release form again stating their relinquished appliance meets the criteria of the program. The program costs would be too high to require A-1 to test whether each appliance is in operable condition. An effective measure to deter free ridership would be to perform a plug-in test and age profile for each appliance collected. Unfortunately these are not cost-effective measures as they would involve additional steps and responsibilities for A-1 resulting in more tracking and greater costs.

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[10] Based on a 1 and 2% decrease in annual energy performance (as per the Kim et al. report) the cost over 15 years for a refrigerator manufactured in 2001 amounts to an additional $63 for the 1% scenario and an additional $131 for the 2% scenario.

[11] "Estimating the Level of Free Riders in the Refrigerator Buy-Back Program," Fielding, Diane M, 1993, http://www.aceee.org/proceedings-paper/ss94/panel08/paper07.

Life-Cycle Costs

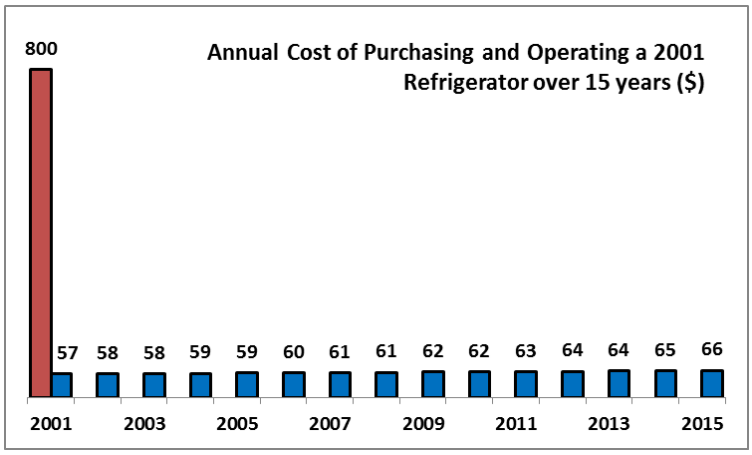
To this point, the evaluation of the Refrigerator and Freezer Retirement program has taken into account the cost effectiveness of the program based on the CCE – a measurement tool used by energy utilities to compare the conservation to the cost of developing new electricity generating capacity. Two alternate points of view are worth considering when evaluating an appliance for purchase and/or for the retirement of an appliance.

1. The second price tag.[12] NRCan encourages consumers to consider the total annual energy cost of operating an appliance over the course of its lifetime.
2. A life-cycle cost analysis (LCCA). There have been a number of studies that have analyzed the life-cycle cost of refrigerators and attempt to determine the ideal time to retire an appliance based on energy and cost savings.

The importance of the "second price tag" and LCCA in relation to purchasing and/or retiring a refrigerator or freezer is the economic and energy costs/savings they provide at the point-of-purchase for the consumer and in determining the optimal life time of the appliance based on cost, performance and energy use. The LCCA accounts for energy costs in the production of the appliances – costs that are externalized when evaluating the program based on CCE.

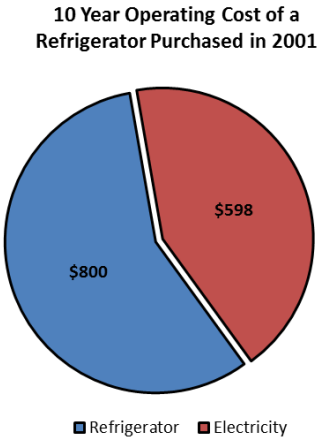
Second Price Tag

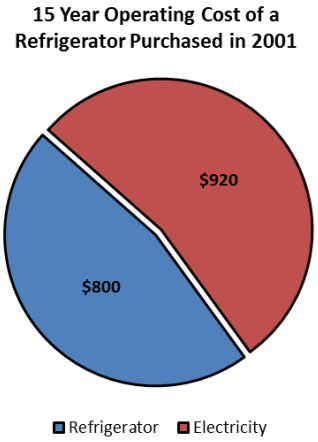
This table below reveals the high initial cost of purchasing a refrigerator followed by the incremental increase operating costs for the refrigerator over the course of a 15 year lifespan. Consumers tend to focus on the initial cost of the refrigerator rather than considering or optimizing what NRCan identifies as the second cost – the energy cost for the lifetime operation of the refrigerator. The secondary operating costs appear to be minimal when compared to the purchase cost. As the LCCA charts reveal below, however, after 10 years of use the operating cost of a refrigerator manufactured in 2001 approaches the purchase cost. By year fifteen, the operating cost of the appliance is greater than the purchase cost and at this point the appliance has reached the average rate at which consumers retire their refrigerators. The high initial cost of purchasing a refrigerator and the trend towards appliance efficiency suggests that consumers will be increasingly less likely to take into account the energy performance of their appliances. This highlights the importance of programs offering incentives for the purchase of energy efficient appliances and for the retirement of those appliances when they reach the point where the purchase of a newer, more efficient model makes sense.



[12] http://oee.nrcan.gc.ca/equipment/appliance/10776

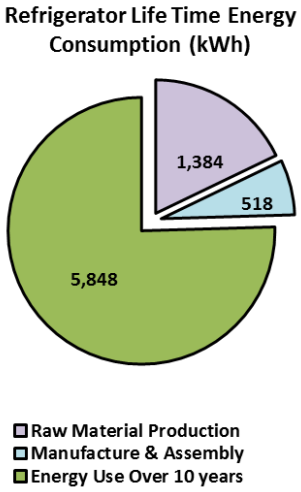
Over the course of 10 years, the operating cost of an average refrigerator purchased in 2001 is 43% of the total purchase and operating costs. In 15 years the operating cost has grown to 54% of total purchase and operating costs. The point at which the operating costs equal the purchase cost is just over 13 years.





Life-Cycle Cost Analysis

In the "Life Cycle Optimization of Household Refrigerator-Freezer Replacement," Yuhta Alan Horie states that the "optimal replacement intervals that minimize primary energy consumption are 2 to 12 years based on the energy efficiency trends from Consumer Reports" and that the "optimal replacement intervals that minimize life cycle cost are 18 and 18 years based on the energy efficiency trends from Consumer Reports" (between the years of 1985 and 2020).[13] He notes that the "optimal lifetimes are comparable to the average expected lifetime of refrigerators—20 years and slightly longer than the average observed lifetime – 14 years (AHAM 1990; NFO 1996; ARIC 2004)."[14] From the cost savings perspective of a consumer, maintaining a refrigerator over the course of its lifetime is the most cost effective strategy. Incentives are therefore needed to encourage consumers to retire/replace their appliances in order to achieve energy savings (and GHG reductions for diesel-powered grids) at the community level.



Another consideration is the Life-Cycle Cost Analysis, is the amount of energy consumed by a refrigerator not only in its operating life but also in its manufacture. If an appliance requires a great deal of energy to produce the raw material and to manufacture and assemble the appliance, there may be little gain in retiring an appliance early in its lifecycle. Refrigerators tend to have a relatively high energy use to energy consumed in production. The lifetime energy consumption of a refrigerator shown above reveals that for a 10 year old appliance, 75% of the energy consumed is during the operation phase of its lifecycle. Energy consumed in the disposal of a refrigerator is low due to the

[13] "Life Cycle Optimization of Household Refrigerator-Freezer Replacement," Yuhta Alan Horie, August 2004, (http://css.snre.umich.edu/css_doc/CSS04-13.pdf).

[14] Ibid.

recycling of refrigerants and white metal (although shipping materials south to be processed in British Columbia does require extra energy input).

Conclusion

The 2011-2012 Refrigerator and Freezer Retirement Program has been successful in providing 129 clients with the opportunity to retire a total of 142 appliances. The total energy savings realized by the program to date is over 37,000 kWh. The goal for the 2012-2013 Refrigerator Retirement Program is 200 refrigerators retired and 101,000 kWh in savings. Based on the interim results highlighted in the preceding paragraphs and tables, this report recommends the consideration of the following potential changes to the program at the conclusion of the pilot:

- Raising the age criteria for refrigerators and freezers to 10 years,
- Projecting the Program Cost per kWh saved on a 5 year basis to reflect appliance lifespan,
- Decreasing or eliminating the rebate incentive to generate a better CCE and
- Evaluating the program yearly for the point at which energy savings cancel out program costs (based on a CCE of 0.35). Once this point has been met, the program will require further modification to bring the program cost per kWh projection back below the CCE threshold.

A more comprehensive evaluation of these results will be conducted at the conclusion of this pilot in April 2013 in which the future of this program will be determined.