W.C.R.I. Energy Efficiency Project

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1.0 Introduction

The Waterloo Co-Operative Residences Incorporated (W.C.R.I.) are preparing to undergo major renovations (Spano, 2002), which offers the residence many opportunities to create a "greener" living space for its residents. To these ends, this project seeks to make recommendations on energy efficient appliances and how they might be used in the new apartments to both save W.C.R.I. money and help them become less detrimental to the environment in the process.

1.1 Purpose

Since the Green the Campus (and now Community) course started in 1990, it has provided the impetus for the creation of over 190 projects that have set out to "green" the University of Waterloo campus and many parts of the Kitchener/Waterloo and Cambridge communities as a whole (WATgreen, 2002).

The purpose of this project is to aid W.C.R.I. in the decision making process involved in choosing appliances for the new apartments. This will help achieve the goals of WATgreen by aiding a student community have less negative environmental impacts through their electricity use, as well as raise awareness of energy efficiency among the residents and staff of W.C.R.I.

This project also seeks to create an educational component that will be used by W.C.R.I. to help students become informed about energy efficiency and conservation.

Education is an important part of establishing any environmental ethics, and will help promote energy conservation within the residences.

1.2 Research Question and Objective

What are the most energy efficient and cost-effective appliances from the following list that could be purchased for the W.C.R.I. renovations?

- Refrigerators
- Stoves
- Washing Machine
- Dryer
- Lighting

Additional Objective: To produce an educational item to help encourage energy conservation in W.C.R.I.

1.3 Definitions

Energy efficiency: Is usually understood in terms of technological efficiency. As explained by the World Energy Council, "it encompasses all changes that result in decreasing the amount of energy used to produce one unit of economic activity (e.g. the energy used per unit of GDP or value added) or to meet the energy requirements for a given level of comfort" (2002). Energy efficiency is associated with economic efficiency and improvements in efficient involve behavioural, technological and economic changes (World Energy Council, 2002).

Improvements in energy efficiency imply a reduction in the amount energy used for a given energy service, for instance heating, lighting or level of activity (World Energy Council, 2002). Reduction of energy consumption is not necessarily associated to technical changes, since it can also be an outcome of better organization and management, or improved economic efficiency in the sector (World Energy Council, 2002).

Kilowatt Hours (kWh): Energy is measured in kilowatt hours (kWh) (Wind Power, 2002). I kWh is equal to 1000 watts (Electric Power, 1999). One kilowatt hour is equivalent to burning a 100-watt light bulb for 10 hours, or running the hot water in the shower for three minutes (OEE, 2002a).

2.0 Background Information

The W.C.R.I. renovations that are being planned include a renovation of "Hammar", at a cost of 3 million dollars, the creation of a new set of apartments at 280 Phillip St. at a cost of up to 25 million dollars, or a combination of the two or a "do nothing" approach. The architects that have been hired for the project are Quadrangle, from Toronto (Demko, 2002). In total, there is a need to purchase 630 appliances:

268 Phillip Street

- 96 Refrigerators (20 ft capacity)
- 96 Stoves (4 burner with oven)
- 96 Air Conditioners (8 000 btu)
- 10 Washing Machines

- 10 Dryers

280 Phillip Street

- 128 Refrigerators
- 128 Stoves
- 15 Washers
- 15 Dryers

139 University Avenue:

- 15 Refrigerators
- 15 Stoves
- 3 Microwaves
- 3 Dishwashers

Prior to November, 2002, increased prices in electricity in Ontario following government regulation lead to a surge of concerns with regards to energy cost, use and efficiency. In November, 2002 the Ontario government declared that after months of varying prices for electricity, a cap would be placed on it at 4.3 cents per kilowatt hour.

2.1 Literature Review

Much of the most valuable literature on energy efficiency comes from government sources, (in particular Natural Resources Canada), and consumer based sites, such as

MySimon.com. The most valuable resource, by far, was the Office of Energy Efficiency within Natural Resources Canada which sets out the guidelines for (and implements) the EnerGuide program.

3.0 Methodology

To rate different appliances, Natural Resources Canada's "EnerGuide" system was used. Data on the cost of some potential models were gathered from the Office of Energy Efficiency within Natural Resources Canada.

Overall, this study primarily represents exploratory research (Palys, 1997), primarily due to time constraints. A wide body of resources have been used to describe the ways in which energy efficiency can be achieved by careful selection of appliances during the purchasing process. As with an exploratory project, it serves to help future studies be worked out more exactly (Festinger, 1953). This will allow this project to serve as a starting point for future WATgreen projects, supplying a base of information for new projects, and allowing this area of study to grow in the ERS 250 course.

3.1 Assumptions Made

For the purpose of examining the long-term financial costs and benefits of the appliances, it was assumed that the price of electricity would remain at its cap of 4.3 cents per kilowatt hour for the next ten years (Frame, 2002). With distribution and other charges, the

price to the consumer for electricity was estimated to be approximately 8 cents per kilowatt hour for energy savings calculations.

4.0 Systems Analysis

There are two primary systems of importance with regards to energy efficiency at W.C.R.I. the actor system and the decision making system.

4.1 Actor Systems

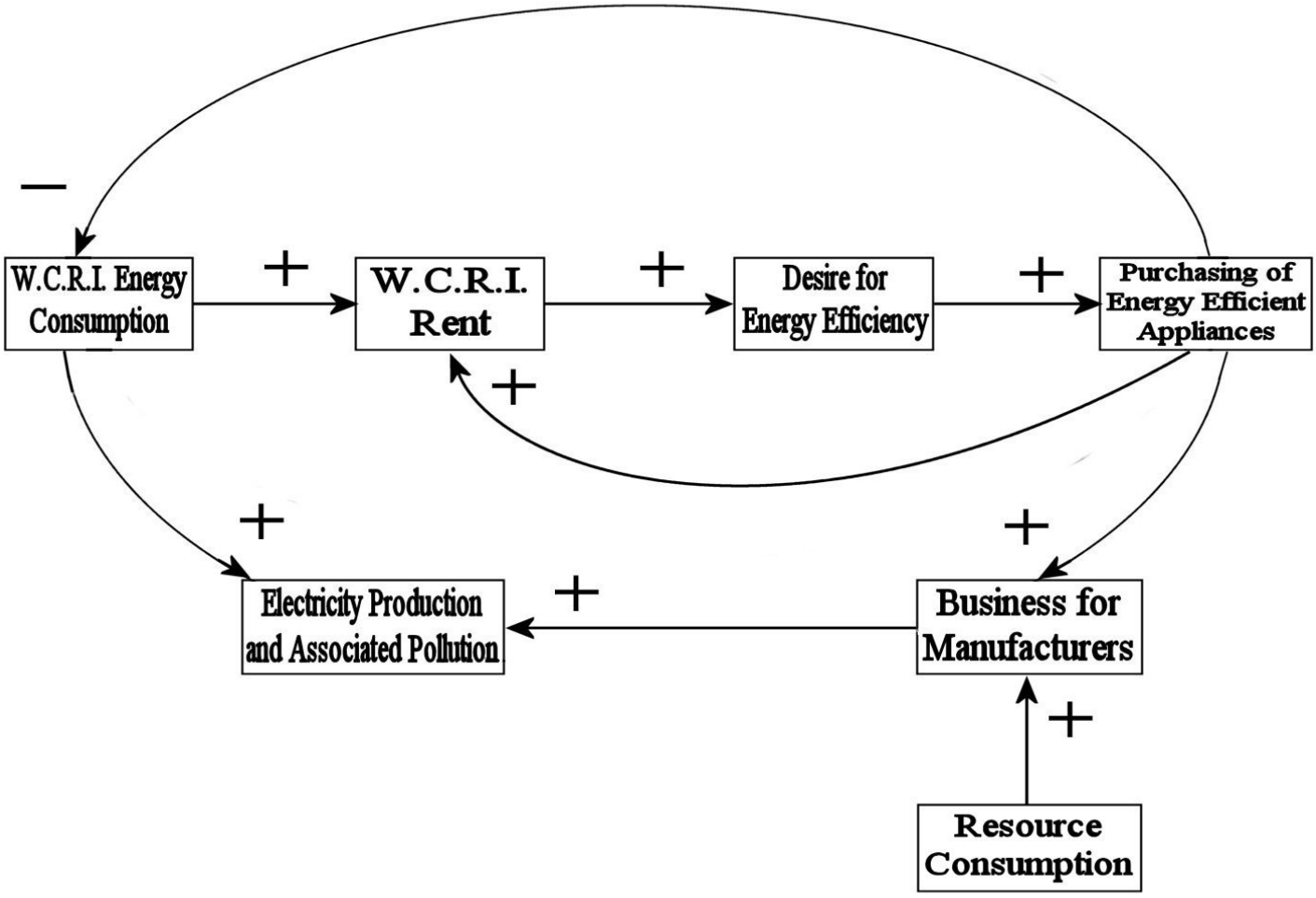
Table 1 – Energy Efficiency Actor System

Actor	Influence	Interest
W.C.R.I. Board	• Final decisions given to architects and planners	• Wishes to see W.C.R.I. reflect interests of residents • Staying within budget
W.C.R.I. Residents	• W.C.R.I. board	• Improved quality of life within W.C.R.I. • Buildings built with environmental impact in mind (extent of this to be seen through studies) • Cost is kept within

		what is acceptable to students
Architectural Firm	• Research team (via access to information) • W.C.R.I. board (via professional opinions)	
Government	• Affecting electricity price to consumers via policy and caps	• Being re-elected • Ensuring affordable access to electricity for Canadians
Appliance Suppliers	• Cost of products • (Potentially) architecture firm (by "selling" idea.)	• Making a profit • Becoming more well known

4.2 W.C.R.I. System Diagram

Fig. 1 – W.C.R.I. Decision Making and Energy System



What the preceding systems diagram shows is how cost of electricity can influence rent at W.C.R.I., which in turn affects the resident's desire for energy efficiency and the purchasing of energy efficient appliances. One important aspect of this system is that rent is affected both by the purchasing of appliances as well as the cost of electricity. Although it is beyond the scope of this project, it would be useful to include a weighting on both of these arrows, to show how much each affects the cost of rent. (Because as it stands, it does not show any difference between the costs of energy efficient appliances and cost of electricity, thus failing to suggest any net savings over time).

5.0 Results

The results of this study represent data gathered from various resources on the differences in energy efficiency among the following types of appliances (life expectancies in brackets – source: OEE, 2002d):

- Refrigerators (17 years)
- Stoves (18 years)
- Washers (14 years)
- Dryers (18 years)
- Lighting (n/a)

Data was also collected on the average prices of appliances, and how much energy efficiency would change money spent on energy over time.

5.1 Appliances

The energy efficiency of appliances varies by model and brand. Efficiency can vary because of size, insulation, and other factors.

The EnerGuide Appliance Directory 2002 (OEE, 2002a) was a major source for the following information on appliances. The data from this directory was used and re-arranged in way to help compare sizes and energy-efficiency rating. The prices are calculated based an electricity cost of 8 cents per kWh. The model name and number will accompany the most appropriate recommendations for this particular study. It should be noted that the EnerGuide Appliance Directory 2002 shows the model name and number in a certain manner. Sometimes the symbols * and # are used in the model numbers (OEE, 2002a). These symbols indicate a brand name series of models that have the same energy rating and features (OEE, 2002a). The asterisk stands for a series of letters showing the relation between a series of models (OEE, 2002a). The number sign stands for a series of model numbers (OEE, 2002a). Also, some models have additional prefix or suffix number or letters, which mean that the appliance has additional features or is of a certain color (OEE, 2002a). The differences reflected by variations in model numbers do not affect the energy consumption rating (OEE, 2002a).

It is uncertain whether all the model suggested by the Appliance Directory may still be available on the market. It must be noted that there are new and even more energy-efficient models that can be currently found on the market. However, due to the new technology involved in these appliances, they are usually much more expensive.

The Second Price Tag is used in order to help determine the cost of the approximate amount of electricity used by and appliance during its lifetime (OEE, 2002b).

Calculating the Second Price Tag

EnerGuide rating (kWh/year)

x

the appliance life in years

x

local electricity costs

(dollars/kWh)

=

The Second Price Tag

Source: OEE, 2002b.

When the time comes to choose a new appliance, one can calculate the second price tag and add it to the first in order to gain a better idea of what the appliance will actually cost in the long run (OEE, 2002b).

5.21 Refrigerators

The most efficient refrigerator according to Energy Guide has a rating of 559 kWh per year (OEE, 2002b).The least efficient refrigerator has a rating of 767 kWh per year (OEE,

2002b). This information has been determined based on ratings for frost free, two-door refrigerators with top-mounted freezer in the 20.5-22.4 ft^3 size range (OEE, 2002b).

Generally, side-by-side door refrigerators consume more energy than refrigerators with top-mounted freezers (OEE, 2002b). A side-by-side refrigerator uses about 7 to 13% more energy than a top-freezer model of similar size (Hassol, 1994).

There are ways of selecting energy-efficient refrigerators other than checking the EnerGuide rating. A refrigerator with a switch to turn down heating coils can help save energy (OEE, 2002b). It is better to choose a refrigerator without an ice-maker because the purchase cost will be lower, you will not have to pay extra money for the energy it uses and will not have to pay for the frequent repairs ice-makers require (Hassol, 1994). Typically an ice-maker increases energy consumption by 14 to 20% (Hassol, 1994). Also consumption can be increased by 5 to 10% due to anti-sweat heaters (Hassol, 1994).

When choosing a refrigerator, it is important to consider how many people will be using the refrigerator and the amount of space they will require. The following guidelines help determine the size of refrigerator for general needs (as opposed to the needs of a chef, for example):

- For one or two people, consider a refrigerator of about 340 L (12 cu. ft.);
- For three or four people, consider a unit of about 395 to 480 L (14 to 17 cu.ft.);
- And for each additional person, add 55 L (2 cu. ft.). (OEE, 2002b)

For the purpose of this project, research was done on refrigerators with top-mounted freezers and without ice-makers or water dispensers. The refrigerators considered have Energy Star labels. Only refrigerators that feature automatic defrosting can qualify for the

Energy Star mark (OEE, 2002a). All the Energy Star qualified refrigerators must achieve energy efficiency levels of at least 10 percent higher than the minimum regulated standard in Canada (OEE, 2002a).

Table 2 – Refridgerator Costs and Efficiencies

Refrigerators

Total Volume (cu.ft.)	**Annual Energy Consumption (kWh)**	**Annual Electricity Cost**	**Electricity Costs for 17 years**	**Model**	**Number**	**Difference in:**
18.8	416	17.89	304.13	Kenmore	6199*10*	Annual Energy Consumption = 34 kWh Annual Electricity Cost = 1.46$ cubic feet = 1.2 electricity costs for life time of appliance = 24.82$
	417	17.93	304.81	Kenmore Kenmore	6198*10* 7198*10*	
20	450	19.35	328.95	LG Goldstar	GR-729RN GR-729RN	
20.5	458	19.7	334.9			
20.6	458	19.69	334.73			Annual Energy Consumption = 7 kWh Annual Electricity Cost = 0.30$
20.7	463	19.91	338.47			

20.8	463	19.91	338.47			cubic feet = 1.6 electricity costs for life time of appliance = 5.10$
20.9	467	20.09	341.53			
21.6	457	19.65	334.05	Kenmore	6128*10*	
				Kenmore	7120*10*	
				Kenmore	7128*10*	
				Kenmore	7129*10*	
	472	20.3	345.1			

Table 2 contains data partly from the EnerGuide Appliance Directory for 2002 (OEE, 2002a). The data used was that of Type 3 refrigerators, which are defined as refrigerator-freezers with automatic defrost, with top-mounted freezer, without through-the-door ice service, and all refrigerators without freezers but with automatic defrost (OEE, 2002a). The data was rearranged and some information was added.

Information on 20 cubic feet refrigerators was requested, however, according to the EnerGuide Consumer's Guide to Buying and Using Energy-Efficient Appliances, the most efficient size for a refrigerator for 3 to 4 people is between 14 to 17 cubic feet. For the apartment style buildings for 4 people, it is probably more efficient to purchase refrigerators between 17 and 20 cubic feet, just to make sure there is enough space for the students to store their food.

According to the above chart, choosing an 18.8 cubic foot fridge instead of a 20 cubic foot fridge, one can save about $24.82 over the fridge's lifetime, which is determined to be

on average 17 years. This is assuming that the price of electricity will remain to be 4.3 cents per kWh. There is about a 33 kWh and 1.2 cubic feet difference between the two types of fridges. A refrigerator with a low EnerGuide rating can help save money in the future, especially if the price of electricity may rise and fluctuate greatly.

For buildings that are not apartment style, a refrigerator with a larger capacity is probably better suited. It depends in the quantities required to be refrigerated, such as the food needed by the cafeteria.

If a larger refrigerator is required, it is best to move up to a 21.6 cubic feet refrigerator rather than the sizes in between. As seen in the chart, it costs less to upgrade from a 20 cubic feet fridge to a 21.6 cubic foot fridge than any of the sizes in between. The difference in energy consumption and electricity costs is not very large in comparison to the additional amount of cubic feet. As seen in table 2, a refrigerator with a capacity of 21.6 cubic feet will cost about 0.30 cents more in electricity to operate in a year than a 20.0 cubic foot capacity refrigerator.

The model numbers are noted in the following specific way as outlined in the EnerGuide Appliance Directory for 2002. Sometimes the symbols * and # are used in the model numbers. These symbols indicate a brand name series of models that have the same energy rating and features. For example, if model numbers 1234 AG, 1234 BG, 1234 CG and 1234 DG all have the same features and EnerGuide rating, the appliance will be listed as 1234* with the asterisk standing for a series of letters. If you see the number sign, it stands for a series of model numbers. Certain models also have additional prefix or suffix number or letters. These numbers or letters simply mean that the appliance has additional features or

is of a certain color. These differences reflected by variations in model numbers do not affect the energy consumption rating.

Even more energy efficient refrigerators can be currently found in the market. However, they are likely to be the most expensive. Whirlpool offers a selection of top-mounted refrigerators with very low EnerGuide ratings.

Overall, efficiency based on electricity per cubic foot decreases with size. Large refridgerators, with a 20 cubic foot capacity can have efficiencies around 450 kwH/year, while small, compact refridgerators with capacities of only 3.4 feet can have electricity ratings as high as 330 kwH/year (FutureShop, 2002).

5.22 Stoves (Ranges)

There are many different features to pick from when choosing a new range. The first thing to consider is the EnerGuide rating. For a self-cleaning electric range with 30-inch conventional tops, the most efficient has an EnerGuide rating of 639 kWh per year (OEE, 2002a). The least efficient has a rating of 858 kWh per year (OEE, 2002a).

A range with a **self-cleaning** oven can actually help save energy and therefore costs. Even though such ranges use intense heat to clean the oven, the self-cleaning function requires the ranges to be better insulated than the other types (OEE, 2002b). A well insulated oven will require less energy when cooking and baking food (OEE, 2002b). Although the intense heat needed in the self-cleaning process requires much energy, in the long run energy,

can be saved due to the extra insulation if the self cleaning mechanism is only used a few times a year (OEE, 2002b).

Also, different cooking tops for ranges have different energy requirements. Conventional burners require more energy than the recently developed induction and halogen cooktops (OEE, 2002b). However, these types of cooking tops can be very expensive. A **quartz-halogen lamp** is used by halogen elements to radiate heat to the ceramic glass surface (Cureton, 1995a). **Magnetic induction elements** can only be used with iron or steel pots and pans since it heats metal cookware by exciting the molecules magnetically (Cureton, 1995a). **Radiant elements** are like electric coil elements but placed under heat-resistant ceramic glass and take longer to heat up (Cureton, 1995a).

If the range has a built in exhaust fan, additional energy will be required for its operation (OEE, 2002b). Also, during the winter time, the fan will also take the warm air out from the room thus having to make the furnace work harder and use more energy (OEE, 2002b). Exhaust fans that are less powerful but still get the job done will require less energy to operate and less energy to reheat the home.

There are electric and gas ranges to choose from with each their own advantages and disadvantages. Cooking with gas is very efficient because gas stove-tops and ovens use much less energy since the fuel is used directly for cooking (Cureton, 1995a). It doesn't go to a power generation plant to be converted into electricity and then used for cooking (Cureton, 1995a). A gas range will have about half the energy costs of an electric range if it has an electric ignition and not a pilot light (Cureton, 1995a). Even though a pilot light burns

small amounts of gas, it will burn the gas 24 hours, 7 days a week (Cureton, 1995a). Although pilot lights can be shut off, it is not considered safe to do so (Cureton, 1995a). Precise control over cooking can be achieved because the flames can be set at any intensity with accuracy (OEE, 2002b). Waiting for an element to heat up and cool down is unnecessary because heat can be turned on and off instantly (OEE, 2002b). However, cooking with gas can be hazardous since the gas is very combustible (Cureton, 1995a). The fumes produced by the combustion can pose health risks and requires extensive ventilation that brings in air from outside (Cureton, 1995a). Gas ranges currently do not have EnerGuide labels (OEE, 2002c). Gas ranges must be certified by the Canadian Gas Association (CGA) or Underwriters Laboratories of Canada (ULC) (OEE, 2002c). Natural gas ranges generally cost more than electric ranges and there are also installation charges which can vary in cost (OEE, 2002b).

For residence purposes, an **electric range** is probably the best buy. Considering that students with a wide range of cooking experiences will be using the ranges, a natural gas model may be too hazardous even though gas ranges are more energy-efficient. A **well insulated self-cleaning** electric range will help reduce energy consumption and related costs. A **smaller oven space** is recommended since students will most likely be cooking or baking in small amounts. Otherwise, energy will be wasted if a large oven is used to cook small meals. A range with a **conventional cooking top** is recommended. A range with a smooth cooking top can also be considered since there are many ranges that are as equally energy-efficient as ranges with conventional cooking tops, even though the coil must first heat up the ceramic glass plate before it heats the cookware. However, smooth cooking tops may be less energy-efficient if the cookware used is not perfectly flat. No special recommendations in

cookware are required for conventional elements. Also, conventional elements can be easily taken apart for **cleaning** or for **repairs**.

The following is a list of conventional element, self-cleaning electric ranges. They are put in order of increasing usable oven space (L), annual energy consumption (kWh), annual electricity costs, lifetime electricity costs and model.

Table 3 – Costs and Efficiencies of Ranges

Ranges with Conventional Cooking Tops

Nominal Width: 30 in						
Usable Oven Space (L)	**Annual Energy Consumption (kWh)**	**Annual Electricity Cost**	**Electricity Costs for 18 years**	**Model**	**Number**	**Difference in:**
50.9	690	$55.20	$993.60	Frigid.	CFEF216*	
52.0	748	$59.84	$1,077.12	Maytag	MER6550+*#	
				Maytag	MER6770+*#	usable oven space = 14.3 L
				Maytag	MER6771+*#	A. Energy Consumption=22 kWh
				Maytag	MER6772+*#	A. Electricity Cost = 1.76$
				Maytag	MER6870+*#	electricity costs for life time of
				Maytag	MER6871+*#	appliance = 31.68$
				Maytag	MER6872+*#	
61.1	725	$58.00	$1,044.00	Inglis	I**898**	
	732	$58.56	$1,054.08	Kit.Aid	YKERS507****	
65.2	712	$56.96	$1,025.28	Frigid.	CFES359*	
	729	$58.32	$1,049.76	Crosley	CE1340	
				Frigid.	CCEF355*	
67.1	744	$59.52	$1,071.36	Gen.El	GRSL3640Z**1	
	749	$59.92	$1,078.56	Beaumrk	10581-1	
				Hotpnt	HRSL3600A**-1	usable oven space = 4.7 L
	765	$61.20	$1,101.60	Gen.El	GRSF3201Z**1	A. Energy Consumption=13kWh
				Moffat	MRSF3180Z**1	A. Electricity Cost = 1.04$

	768	$61.44	$1,105.92	Conc II Gen.El Hotpnt Moffat	CRSL3400Z**1 GRSF3301Z**1 HRSF3180A**-1 MRSL3400Z**1	electricity costs for life time of appliance = 18.72$
	769	$61.52	$1,107.36	Beaumrk Beaumrk	10561-1 10571-1	
68.6	732	$58.56	$1,054.08	Gen.El	JCSP31*	
69.9	725	$58.00	$1,044.00	Whirlpl Whirlpl	W**548** W**838**	
	730	$58.40	$1,051.20	Whirlpl Whirlpl	G**852** G**858**	
	735	$58.80	$1,058.40	Whirlpl	G**842**	
	739	$59.12	$1,064.16	Inglis	I**338**	
	740	$59.20	$1,065.60	Inglis	I**878**	usable oven space = 3.1 L
	742	$59.36	$1,068.48			A. Energy Consumption=86 kWh
	744	$59.52	$1,071.36			A. Electricity Cost = 6.88$
	745	$59.60	$1,072.80			electricity costs for life time of
	753	$60.24	$1,084.32			appliance = 123.84$
	758	$60.64	$1,091.52			
73.0	639	$51.12	$920.16	Amana	ZRRS6550*	
	684	$54.72	$984.96	Amana	ZRRSC8050*	
	743	$59.44	$1,069.92	Amana	ZRR6400*	

Table 3 contains data from the EnerGuide Appliance Directory 2002 (OEE, 2002a). Data has been rearranged and presented in a slightly different format. Some additional calculations have been added. It is uncertain whether all the model suggested by the Appliance Directory may still be available on the market. Some of the models were left out due to the fact that their energy efficiencies were not comparable to others.

A type of range with an average or small oven will be the most energy-efficient. When deciding on a range using size as a criteria, it is important to consider the increments of

size and the EnerGuide rating. It turns out to be most cost efficient to increase usable oven space increment from 50.9 L to 65.2 L to 69.9 L to 73.0 L, if a larger oven is required. The yellow fill demonstrates the differences between the best size increments.

In general, the smaller the usable oven space, the lower the EnerGuide rating and the less money spent on electricity. A range with a smaller usable oven space such as 50.9 L or 65.2 L is recommended.

5.23 Washers

According to MySimon.com, a websource for purchasing information, top loading washers are cheaper upfront but front-loading washers cost less to operate. Front loaders are more energy efficient due to the fact that they use less water, including hot water. Another benefit to front loaders is that, because of their design, they have larger capacities for the same sized machine than top loaders do. They are also louder than front loaders, which is an important consideration for students whose rooms are next the laundry areas. Front loaders are also easier on clothes. An important feature is a washer, which sets the water level automatically, thus conserving more water than a machine without the feature.

Although front-loading washing machines use fewer resources, they only make back the difference in price in areas with high water and energy bills.

In consumer reports tests all washers clean clothes on a comparable level, so this was not a big concern when selecting the best models. Front loaders are ideal as they use less water and energy, and they are quieter.

According to MySimon.com, if six loads of laundry are washed per week a front-loading machine can save almost 6,000 gallons (22 712 litres) of water per year.

It is better to recommend phosphate free detergents to residents, as phosphates are very harmful to the aquatic systems that the wastewater winds up in.

Table 4 – Cost and Efficiencies of Clothes Washers

(L)	(kWh)	Cost	14 years
45.4	227	18.16	254.24
46.0	256	20.48	286.72
48.0	246	19.68	275.52
	252	20.16	282.24
	267	21.36	299.04
48.3	303	24.24	339.36
	322	25.76	360.64
48.5	201	16.08	225.12
50.0	189	15.12	211.68
	209	16.72	234.08
	252	20.16	282.24
57.0	316	25.28	353.92
59.0	252	20.16	282.24
75.0	259	20.72	290.08
	275	22.00	308.00
	351	28.08	393.12
80.4	293	23.44	328.16
	318	25.44	356.16
82.0	282	22.56	315.84
	302	24.16	338.24
	362	28.96	405.44

Source: OEE, 2002a

The United States Environmental Protection Agency offers a "money savings" tool based on the efficiency of washing machines. It can be found online at: http://www.epa.gov/nrgystar/purchasing/calculators/cw-main.html

5.24 Dryers

According to MySimon.com, while most dryers function on more or less that same principles, there are a few key aspects that can affect energy efficiency. Sensors (either moisture or thermostat) allow the machines to turn off on their own once the clothes are dry, while different sources of fuel (natural gas, electric) effect. Machines with moisture sensors tend to detect dry laundry faster than ones with thermostats, and thus use less electricity.

Dryers typically range in size from 27 to 29 inches (with drum capacities ranging from 5 to 7 ½ cubic feet) for average models, and around 24 inches (with a drum capacity of 3 ½ cubic feet) for "space-savers".

Table 5 –Costs and Efficiencies of Dryers

Dryers

Drum Capacity (L)	Annual Energy Consumption (kWh)	Annual Electricity Cost	Electricity Costs for 18 years
125	837	66.96	1205.28
	877	70.16	1262.88
170	900	72.00	1296.00
198	898	71.84	1293.12
204	906	72.48	1304.64

Source: OEE, 2002a (For specific models, please see the EnerGuide Appliance Directory, 2002)

Consumer reports have found that nearly all dryers dry clothes equally well. (MySimon.com, 2002).

5.25 Lighting

Fluorescent light bulbs come in a variety of shapes and wattages to fit the various needs of consumers'. Fluorescent light bulbs have been traditionally a linear light source, but also come in u-shape, circular and compact shapes (Speec Inc 2002). Some fluorescent light bulbs are compact sources that give lots of light in a small source at a low wattage. Compact florescent lights (CFL) have been used extensively in building applications where energy consumption is of high concern (Speec Inc 2002).

CFL bulbs are far more energy efficient that the standard incandescent light bulbs used in most residential applications (Speec Inc 2002). A biax or bent tube bulb is the traditional CFL and offer substantial energy savings (DOE 1996).

Compact fluorescent light bulbs will help save energy and money. Savings up to 80% in energy costs and not having to change bulbs as often are two of the many positive aspects of CFLs. With energy efficient CFLs light output is not sacrificed, they're brighter and come in a wide variety of sizes shapes and colours (Speec Inc 2002).

Alternative energy and conservation comes in many forms. A lot of people talk about alternative energy sources like solar and wind power, but an inexpensive alternative energy idea is energy saving light bulbs. Alternative energy conservation goals can be helped by simply converting conventional incandescent bulbs to CFLs (Speec Inc 2002).

A 20 watt energy saving triple biax CFL provides the light equivalent to that of a 75 watt incandescent bulb while only using 20 watts (NCS 2002). With a lifetime averaging over 9000 hours CFLs in some cases are guaranteed by the manufacturer to last over 7 years and 10 times longer than an incandescent bulb. CFLs help pay for themselves in not only energy savings but also the reduced cost of building maintenance by not having to change them as

often. Below a break down of the total costs associated with CFLs and incandescent bulbs (minus maintenance costs) clearly show that CFLs are significantly more energy and economically efficient.

Table 5 – Costs and Efficiencies of CFL vs. Incandescent Bulbs

	Initial Cost	Life Expectancy	Wattage for Comparable light output	Cost per kWh	Second Price Tag	Total Cost for 9000 hours of use
CFL	$22.00 (one bulb)	9000 hours (one bulb)	20 W	$0.08	$14.40	$36.40
Incandescent	$ 7.50 (10 bulbs)	9000 hours (10 bulbs)	75 W	$0.08	$54.00	$61.50

Source: DOE 1996

6.0 Educational Component

Education is essential in promoting energy efficiency and conservation. It is interesting to note that some websites such as The Brick (www.thebrick.com) do not actually list energy efficiency under "product information" for appliances such as refridgerators, clothes washers, clothes dryers, and microwaves, except for models specifically deemed "high-efficiency" models. Notably, Sears (www.sears.ca), US Appliance (www.us-appliance.com/), and FutureShop (www.futureshop.ca) all listed efficiency along with the

product information. If efficiency is to be used to help Canada reach its goals under the Kyoto accord, better information about EnerGuide efficiency ratings and conservation techniques will need to be made available in the future.

The following represents a set of facts that could be used in an educational piece produced by W.C.R.I. Currently, it is in "informational package" format, however there are many ways in which the information could be delivered to residents, including:

- Posters (in particular laminated ones to be kept on the refridgerators)
- Complimentary stationary or mugs with quick facts
- Information packages included in introductions to co-operative living
- Columns in Newsletters
- Notes in mailing lists

Conserving Energy in Your Home

The Refrigerator

☺ If your refrigerator has an "energy saver" switch, adjust it to the setting that provides maximum energy savings without causing condensation on the outside of the unit (EnerGuide, 2002).

☺ Organize the contents in your fridge to ensure good air circulation around the items and so you won't spend a lot of time looking for what you want (EnerGuide, 2002).

☺ Butter conditioners use small heaters to keep the butter soft. Always flick the switch to "hard" to save energy (EnerGuide, 2002)..

☺ Let food cool, at least partially, before putting it in the refrigerator. This way, the refrigerator won't have to work as hard to keep the food cold (EnerGuide, 2002).

☺ If the refrigerator is a manual-defrost model, defrost it when 7 millimetres (1/4") of frost builds up on the walls (EnerGuide, 2002).

When Cooking and Baking

☺ Preheating your oven is not usually necessary, except for baking. When preheating is necessary, 10 minutes is usually sufficient (EnerGuide, 2002).

☺ Turn off the oven a few minutes before cooking is complete; the heat already in the oven will finish the job (EnerGuide, 2002).

☺ If you have a self-cleaning oven, clean it only when necessary, and clean it right after cooking a meal to take advantage of the heat already in the unit (EnerGuide, 2002).

☺ Don't overcook your meal or open the oven door too often; both practices waste energy. Every time you open the oven door, as much

as 20 percent of the heat escapes, and the oven has to work that much harder to replace it (EnerGuide, 2002).

☺ Thaw frozen foods inside the refrigerator. This will help cool the interior and eliminate the use of energy for thawing in an oven or microwave (EnerGuide, 2002).

☺ Keep the drip pans under conventional burners clean. Don't line them with aluminum foil; this may reflect too much heat and damage the element (EnerGuide, 2002).

☺ Use the convection oven setting whenever possible; it will reduce baking times up to 30 percent by circulating heated air around the food (EnerGuide, 2002).

☺ Make sure all pots are right-sized for the elements. A small fry pan on a large element wastes energy (Home and Family Guide, 2000).

☺ Save energy, water and vitamins when cooking vegetables by using a steamer with a small amount of water and a tight-fitting pot lid (Home and Family Guide, 2000).

☺ For stews, roasts, vegetables and many other dishes, a pressure cooker cuts down greatly on cooking time (EnerGuide, 2002).

☺ A microwave uses less than half the energy of a conventional oven for most cooking jobs. Savings are greatest with small to medium quantities of food that would normally be heated in the oven. Follow the manufacturer's instructions to get maximum performance (EnerGuide, 2002).

☺ When using a conventional oven, cook a number of dishes at once (EnerGuide, 2002).

☺ Don't fill the kettle every time you boil water -- boil only as much as you will need (EnerGuide, 2002).

☺ Avoid using electrical gadgets -- can openers, knives and coffee grinders (even corkscrews!!) -- when manual appliances will do the trick. Often these gadgets are hard to repair and end up in the garbage after a limited time of use (Home and Family Guide, 2000).

Washing Dishes

☺ Don't run the tap to get a cold, cold glass of water. Keep a pitcher of water in the fridge for that purpose (EnerGuide, 2002).

☺ If you have a double sink, put a few inches of water in each -- one with soapy water for washing, the other for rinsing (EnerGuide, 2002).

☺ A dishwashing soap-wand is inexpensive and can help reduce water use. Check in hardware, department and grocery stores. You dilute liquid dishwashing detergent with water and pour into the handle of the wand. Soap is automatically dispensed through the sponge or scrubber end (these are replaceable) as you wash the dishes. Don't leave the hot water running as you scrub. Turn the water on to rinse the dishes (Home and Family Guide, 2000).

☺ Use phosphate-free and/or biodegradable cleaning products available in hardware and health food stores (Home and Family Guide, 2000).

In the Bathroom

☺ To reduce the amount of water used, you can spend less time in the shower and turn the water off between soaping and rinsing. If the room is cold - work fast! (Home and Family Guide, 2000).

☺ Water-saving or low-flow shower heads or shower head inserts effectively use less water to give a good spray action and can save

up to three-quarters of the water used by conventional shower heads. These shower heads use between 5 and 8 litres a minute (1.1 to 1.7 gallons per minute). Choose the type that allows you to turn the water on and off while showering without having to readjust the temperature. (Turn the water on to get wet and off to soap and shampoo, then on again to rinse) (Home and Family Guide, 2000).

Doing Laundry

The Clothes Dryer

☺ Shake out the wet clothes before placing them in the dryer (EnerGuide, 2002).

☺ Reduce the drying time for lighter loads (EnerGuide, 2002).

☺ Organize your washing and drying so that you are always doing full loads (EnerGuide, 2002).

☺ Clean the filter in the dryer before every load to ensure maximum operating efficiency (EnerGuide, 2002).

☺ "Perma-press" drying cycles offer a "cool-down" feature that finishes the job and prevents heat-set wrinkles by using residual heat from the dryer (EnerGuide, 2002).

The Washer

☺ Limit the use of hot water when washing your clothes (a large portion of the energy consumed by clothes washers goes towards heating the water). Use the cold wash option whenever possible (modern detergents are formulated to make it easier to wash clothes in cold water) (EnerGuide, 2002).

☺ Wash only full loads whenever possible. If a partial load is necessary, adjust the water level accordingly (EnerGuide, 2002).

☺ Level your clothes washer; an unleveled machine works harder, wearing out parts before their time (EnerGuide, 2002).

Lighting in the Home

Lighting accounts for as much as 25% of our home energy consumption! (EnerGuide, 2002).

☺ Turn off lights when not in use (EnerGuide, 2002).

☺ Reduce wattage on bulbs to the minimum required to do the job (EnerGuide, 2002).

☺ When buying new lighting -- buy fluorescent. Some studies suggest that artificial lighting inhibits vitamin D production and, during the winter, certain people experience depression (seasonally affected disorder) if they don't get enough natural light. You may want to choose full-spectrum fluorescent bulbs. Compact fluorescent bulbs come with an adaptor to screw into regular sockets and use 70 to 80% less energy than standard bulbs and may last as long as 10 years each. Since the initial cost is fairly high (starting at $15 for one bulb), you may want to spread the expense over a period of time. These bulbs are designed for continuous long hours of operation which enable their efficiency to offset the initial high cost (EnerGuide, 2002).

☺ Make the light shine on the task or work area -- on your desk or kitchen counter -- rather than lighting the whole room (EnerGuide, 2002).

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7.0 Conclusions

There is a wide range of energy efficient products available on today's market, although sometimes this is not made clear to the purchasing public.

Future areas of research related to this study could include:

- How use of educational components affects energy consumption in W.C.R.I.
- How purchasing decisions at W.C.R.I. could influence other similar residences undergoing purchasing of new appliances
- Tracking changes in energy efficiency technology
- Creating a system of standards for purchasing of energy efficient products by the University of Waterloo.

8.0 Recommendations

1) That energy efficient appliances be purchased for the W.C.R.I. renovations, with financial concerns taken into consideration, and that these decisions should be made in consultation with an electrical engineer working with the Quadrangle Architectural Firm.

2) That the findings of this study be made available to future groups interested in energy efficiency appliances through the WATgreen website.

2) That the text based educational material be incorporated into an educational item for W.C.R.I. residents, whether this takes the form of posters, papers in introductory material, newsletters, mailing lists, etc.

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