

FUEL COST COMPARISON STUDY

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1.0 Introduction

Building owners today have many choices when considering heating system options. There has been much debate on which heating fuel is the most cost effective. Some options, such as condensing oil furnaces, a relatively new technology, offer high operating efficiency, however are accompanied by a high initial cost. Other options, such as electric heating, has a relatively low first cost, however a high energy cost. Other factors, such as the need for a chimney for a natural draft appliance, the ability to power vent condensing appliances through a relatively small plastic pipe, and the total lack of a chimney for an electric furnace, will influence the initial system cost. This has resulted in some confusion regarding which system will have the least cost when considering all costs, including material and labour for installation, operation and maintenance. The purpose of this study is to determine the total cost of five system options over a five year period.

The approach which is taken in the study is to assume that an individual is planning to build a house during the summer of 1993. In order to facilitate ventilation of the house, he is planning to install a forced air heating system. He has decided that he wishes to have an automated heating system ie. wood heat is not an option being considered. This decision was made for the purpose of this study since there are too many variables when considering wood heat. The efficiency of the wood burning appliance is very dependent on the appliance, as well as the manner in which the wood is burned (smoldering fires versus hot fires). The energy content of wood depends somewhat on the species, and to a large degree on the moisture content of the wood. The true cost of wood is debatable, depending if one wishes to consider the time spent bucking, splitting, and carrying wood, as well as cleaning ashes and chimneys. It is felt that including wood heat in this analysis would not be comparing "apples with apples". The five automated systems that are to be considered are an electric furnace, condensing and natural draft fuel oil furnaces, and condensing and natural draft propane furnaces.

The study will consider the total energy consumption required to heat a typical bungalow in Whitehorse, including the cost of the fuel and the electricity to operate the appliance. The heating energy consumption data will be obtained by computer simulation of the house. The total incremental cost of each system will be calculated...incremental cost referring to the fact that there are many costs which are common to all systems, such as ductwork and registers, a thermostat, and a basic electrical connection, and that these costs will not be considered when comparing systems. The total cost of each installation, including maintenance, amortization of capital costs, operating, and other

costs will be ascertained over a five year period, and compared.

2.0 Energy Use

In order to determine the energy use for the future dwelling, a sample residence was required. A sample Yukon Housing bungalow was selected, 109 square metres on one floor with a full basement, RSI 7.0 attic insulation, RSI 4.9 wall insulation (2x6 outer wall with a 2x3 inner strapped wall), RSI 4.9 basement walls (2x8 preserved wood foundation wall), double glazed low emissivity windows, 0.1 air changes per hour natural ventilation, 0.3 air changes per hour mechanical ventilation, with no heat exchange. While changing any of these components will somewhat change the analysis, including simply rotating the house 90 degrees (the computer simulation assumed that the front and back windows faced south and north respectively), this house is felt to be typical.

Based on the data given above, the HOT-2000 computer program (version 5.07) produced by the National Research Council of Canada predicts a total annual energy use for space heating of 16614 kilowatt-hours (kWh) per annum. The following table outlines the breakdown by month of this energy consumption.

Month	Consumption (kWh)
January	3243
February	2231
March	1839
April	1102
May	691
June	253
July	139
August	243
September	648
October	1236
November	2072
December	2917
Total	16614

Table 2.1 - Predicted Monthly Space Heating Energy Consumption

In addition to the energy consumed for space heating, electricity will be consumed for operating the furnaces. This will include electricity for operating burners, blowers, and induced draft fans. According to information from another report, which was provided by the Yukon Electrical Company Limited, the electricity consumed by a blower motor (1/2 hp) will be 250 watts, and by an

oil burner 155 watts. It was further assumed that an induced draft fan would consume 155 watts, and that a 1/3 hp blower motor would consume 170 watts. In order to determine the number of hours that each appliance will operate, the output of each appliance was compared to the energy requirement given in the previous table. The output for each device was based on Olsen appliances, with the exception of the condensing oil furnace (Olsen does not make one), which is manufactured by Dornback. The following summarizes the output for each appliance, as well as the seasonal efficiency used for the purposes of the analysis. The furnaces which are given below are the smallest output available which satisfied the design heat loss of the house of 11.5 kilowatts (kW). The design heat loss can be defined as the quantity of heat required to heat the house to 21°C at an outdoor air temperature of -43°C. A furnace having an output of 11.5 kW would operate continuously at this condition to maintain comfort levels in the house. A furnace will not likely, however, be available which exactly matches the actual calculated requirement for the house. Rather, the next available output would be selected, and the furnace would run less than full time, even at design condition. For example, the 15.0 kW electric furnace in the following table would run a calculated 11.5/15, or 77 percent of the time, even at design conditions.

Energy Source	Nominal Output (kW)	Seasonal Efficiency
Electric	15.0	100.0 %
Natural Draft Oil	26.7	77.5 %
Condensing Oil	20.5	93.0 %
Natural Draft Propane	17.6	65.0 %
Condensing Propane	15.8	90.0 %

Table 2.2 - Furnace Output Data

The annual energy use, nominal furnace outputs, seasonal efficiencies, and individual furnace energy requirements can be combined to calculate the electrical consumption of each system to operate blowers, burners, and/or induced draft fan. This is given in the table which is given on the following page.

Month	Electric	Nat. Draft Oil	Cond. Oil	Nat. Draft Propane	Cond. Propane
January	54	64	82	71	92
February	37	44	56	49	64
March	31	36	46	40	52
April	19	21	28	24	31
May	12	13	17	15	20
June	4	5	6	6	7
July	2	3	3	3	4
August	4	5	6	5	7
September	11	13	16	14	18
October	21	24	31	27	35
November	35	41	52	45	59
December	49	57	73	64	83
Total	279	326	416	363	472

Table 2.3 - Electrical Consumption by Furnace Type, kWh

The final table which can be constructed will outline the energy consumption by system type. This table is based on the monthly space heating energy requirement given in Table 2.1, the seasonal efficiency information given in Table 2.2, and the basic energy content of fuel. For the purpose of this analysis, the energy content of fuel oil is assumed to be 10.57 kWh per litre, and for propane 7.04 kWh per litre. This information is combined to produce the following table.

Month	Electric (kWh)	Nat. Draft Oil (litres)	Cond. Oil (litres)	Nat. Draft Propane (litres)	Cond. Propane (litres)
January	3243	396	330	709	512
February	2231	272	227	488	352
March	1839	224	187	402	290
April	1102	135	112	241	174
May	691	84	70	151	109
June	253	31	26	55	40
July	138	17	14	30	22
August	243	30	25	53	38
September	648	79	66	142	102
October	1236	151	126	270	195
November	2072	253	211	453	327
December	2917	356	297	637	460
Total	16614	2028	1691	3631	2621

Table 2.4 - Space Heating Fuel Consumption by Furnace Type

It is, of course, not typical for fuel oil or propane to be purchased by the month. Rather, purchase dates of February 1, April 1, October 1, and December 1 each year are more typical. The preceding table can be modified to represent this schedule as per the table given below.

Month	Electric (kWh)	Nat. Draft Oil (litres)	Cond. Oil (litres)	Nat. Draft Propane (litres)	Cond. Propane (litres)
January 1	2917	---	---	---	---
February 1	3243	752	627	1346	972
March 1	2231	---	---	---	---
April 1	1839	496	414	890	642
May 1	1102	---	---	---	---
June 1	691	---	---	---	---
July 1	253	---	---	---	---
August 1	138	---	---	---	---
September 1	243	---	---	---	---
October 1	648	376	313	672	485
November 1	1236	---	---	---	---
December 1	2072	404	337	723	522
Total	16614	2028	1691	3631	2621

Table 2.5 - Purchased Energy Amounts by Furnace Type

3.0 Installed Costs of Heating Systems

As previously mentioned, only the incremental cost of each furnace system is to be included in this analysis. The basic cost of each unit assumes that the cost of setting each furnace in place, including the ductwork and basic electrical connections, are the same for each furnace. Those items which are different, however, including the cost of the furnace itself, are summarized as follows. All costs include all labour and materials.

3.1 Electric Furnace System

The incremental costs for an electric forced air heating system include the cost of the furnace, 200 amp service versus a 125 amp service, larger breaker, and larger electrical connection between the panel and the furnace, including the disconnect. The total incremental cost of these items is estimated at \$1400.

3.2 Natural Draft Oil-Fired Furnace System

The incremental costs for a natural draft oil-fired forced air heating system include the cost of the furnace, a 1360 litre buried fuel oil tank complete with fill and vent line, 9.5 mm

fuel oil supply and return lines complete with filter and isolating valve, 6.7 metres of 150 mm class A chimney complete with rain cap, flashing, firestop spacer, and base tee, 150 mm breeching complete with a barometric damper, and the framing and dry-wall costs of running a shaft for the chimney through the main floor to the attic. The total incremental cost of these items is estimated at \$4100.

3.3 Condensing Oil-Fired Furnace System

The incremental costs for a condensing oil-fired forced air heating system include the cost of the furnace, a 1360 litre buried fuel tank complete with fill and vent line, 9.5 mm fuel oil supply and return lines complete with filter and isolating valve, and through-wall venting complete with drain line. The total incremental cost of these items is estimated at \$4600.

3.4 Natural Draft Propane-Fired Furnace System

The incremental costs for a natural draft propane-fired forced air heating system include the cost of the furnace, trenching from the storage tank to the house, 12 mm buried copper supply line to the house (estimated length 4.6 metres), piping from the second stage regulator to the appliance, second stage regulator, 6.7 metres of 100 mm class B chimney complete with rain cap, flashing, firestop spacer and base tee, 100 mm breeching complete with thimble, and the framing and drywall costs of running a shaft for the chimney through the main floor to the attic. The total incremental cost of these items is estimated at \$2600.

3.5 Condensing Propane-Fired Furnace System

The incremental costs for a condensing propane-fired forced air heating system include the cost of the furnace complete with an outdoor air kit, trenching from the storage tank to the house, 12 mm buried copper supply line to the house (estimated length 4.6 metres), piping from the second stage regulator to the appliance, second stage regulator, and through-wall venting complete with drain line. The total incremental cost of these items is estimated at \$3700.

The estimated incremental costs of the various systems are summarized in the table which is given on the following page.

Fuel Type	Incremental Cost
Electric	\$1400
Natural Draft Oil	\$4100
Condensing Oil	\$4600
Natural Draft Propane	\$2600
Condensing Propane	\$3700

Table 3.1 - Incremental Costs by Furnace Type

4.0 Other Costs

There are other costs which are incurred in addition to those previously covered costs (space heating fuel and electricity costs, electricity costs associated with burner, blower, and induced draft fans, and initial incremental costs). These include propane tank rental costs, and scheduled and emergency maintenance costs.

The propane tank rental costs apply, obviously, only to the propane systems, and are currently \$120 per annum. Since these costs are likely to rise over time, they will be assumed to be \$125 per year for the five year period of the analysis. Currently, the first year tank rental is free. The total tank rental cost will therefore be assumed to be \$500 for the five years.

It is assumed that each fuel-fired system will be serviced every other year. While this is recommended as an annual event, it is felt that the general public more realistically purchases this service at half this rate. The average cost for this service is expected to be \$120 per visit. In addition, it is expected that one emergency service visit, at \$150, will occur in the five years. In general, when an emergency call-out is made, there is inadequate time to perform a general tune-up. The emergency call-out, therefore, is not expected to replace the cost of a general service call. The total cost of service calls over the five years should be budgeted at 2-1/2 at \$120, plus one at \$150, or \$450.

It was noted that the initial material and labour costs of installing each system would be reduced to an annual cost by amortizing the first cost at current mortgage rates. According to the Toronto Dominion Bank, the five year closed mortgage rate as of February 22, 1993, is 9.5 percent per year. This results in the following annual costs of each system, based on the initial incremental costs given in Table 3.1 and a 25 year amortization period.

Fuel Type	Incremental Cost
Electric	\$147
Natural Draft Oil	\$430
Condensing Oil	\$482
Natural Draft Propane	\$273
Condensing Propane	\$388

Table 4.1 - Amortized Annual Costs by Furnace Type

5.0 Energy Costs

As mentioned, this analysis is intended to compare the total costs of the five systems for a five year period. While establishing the current cost of electricity, propane, and fuel oil, it is impossible to predict with any accuracy the costs of these fuels over the next five years. As a first look at the possible energy costs for the next five years, the past five years will be considered. This may provide some clues to what one might expect over the next five years. The second approach will be to simply inflate the current energy costs by the current rate of inflation in Canada (2.0 percent per annum). Since electricity is less subject to the vagaries of world prices, and is more controlled by local supply and demand conditions, a third approach will be to use the predicted rates as provided by the Yukon Energy Corporation for the next five years. Since these rates will be largely contingent on the re-opening of the Curragh Resources lead-zinc mine in Faro, two sets of predicted electricity rates were obtained, for the mine open and closed.

5.1 Energy Cost Performance, Past Five Years

The energy costs for the past five years were gathered for electricity, propane, and oil. While electricity rates are equal for anyone in Whitehorse, the same is not true for oil and propane. The actual price may vary with location within the city and the quantity purchased. It should further be noted that there have been a number of riders and rebates attached to electrical rates over the last five years, relating to changes in income tax, accounting procedures, and the transfer of the utility from the Northern Canada Power Commission to the local utility. Also, the Goods and Services Tax was applied to electrical rates in January of 1991.

Electricity is billed using a structure resulting in one rate for an initial block of consumption, with a second rate for any additional consumption. The rates given in the table are average rates taken from actual bills, and consequently represent a

blended cost of the two rates.

The information given for propane costs was provided by ICG, a local propane supplier. While there is a cash and a credit rate, it is felt that the typical consumer would use the credit rate. The information for electricity and oil costs was taken from the records of two separate residences. In the case of electricity, this was felt to represent an average electricity cost, inclusive of all riders, rebates, and declining rate scales. The oil costs were taken from a typical residence simply because they were not available from oil suppliers.

The oil and propane costs for the past five years are given based on fill dates of February 1, April 1, October 1, and December 1, as previously outlines. The electricity rates are annual averages. All charges include the Goods and Services Tax as of 1991.

	1988	1989	1990	1991	1992
February 1	\$0.330	\$0.320	\$0.381	\$0.442	\$0.399
April 1	\$0.330	\$0.320	\$0.381	\$0.410	\$0.388
October 1	\$0.330	\$0.320	\$0.403	\$0.410	\$0.410
December 1	\$0.330	\$0.330	\$0.403	\$0.421	\$0.410

Table 5.1 - Historical Propane Cost, per Litre

	1988	1989	1990	1991	1992
February 1	\$0.393	\$0.393	\$0.385	\$0.517	\$0.427
April 1	\$0.393	\$0.369	\$0.385	\$0.421	\$0.427
October 1	\$0.393	\$0.388	\$0.391	\$0.427	\$0.427
December 1	\$0.393	\$0.388	\$0.503	\$0.427	\$0.427

Table 5.2 - Historical Fuel Oil Cost, per Litre

	1988	1989	1990	1991	1992
All Year	\$0.0721	\$0.0649	\$0.0619	\$0.0801	\$0.0869

Table 5.3 - Historical Electricity Cost, per kWh

6.0 Total Cost, All System Options

In order to obtain the total cost over five years for each system, the electricity, propane, and fuel oil costs must be extrapolated. As outlined, this was to be done for all energy types

using the historical performance over the last five years. However, as can be seen from Table 5.3, this resulted in electricity rates which exhibited a very unusual performance. Due to the transfer of the Northern Canada Power Commission, and the resulting forgiving of the debt carried by the previous owner, the rate fell by 10 percent from 1988 to 1989, and by a further 5 percent from 1989 to 1990. While the rate climbed by 40 percent over the next two years, resulting in a total increase from 1988 to 1992 of 21 percent, the pattern of a rate decrease followed by a large rate increase is felt to be a one time anomaly, and will be abandoned as an approach to predict the electricity costs over the next five years.

The propane and oil rates continue to be subject to the world events which have influenced the rates over the last five years. As a result, the approach of using historical rates to predict future rates is considered to remain valid. Therefore, the first approach taken in the report will be modified to use the predicted rates as provided by the Yukon Energy Corporation (YEC) with the historical rates used to extrapolate predicted rates for oil and propane, while the second approach will be to simply inflate all rates by the general rate of inflation in Canada (currently 2.0 percent per year). The predicted electricity rates provided by the Yukon Energy Corporation include scenarios with and without the operation of the Curragh Resources mine in Faro, since this will have a major impact on the resulting rates. Table 6.1 which follows indicates the expected propane, fuel oil, and electricity rates (with and without Curragh Resources, Faro) based on historical performance for propane and fuel oil, and rates provided by the Yukon Energy Corporation for electricity. Table 6.2 indicates the expected propane, fuel oil, and electricity rates based on an inflation rate of 2 percent. This second table makes no differentiation between rates with Curragh Resources operating and without.

A final comment on Table 6.1 is that two electricity rates are given, one for base rate, and one for run-out rate. The base rate is based on a blend of the initial block rate for residential electricity consumption and the fixed monthly charge, while the run-out rate is the second block rate for residential electricity consumption (the cost for the last kWh of electricity purchased per month). When extrapolating annual total energy costs later in this report, the base rate will be used for base loads (furnace fan, burner, and draft fan), while the run-out rate will be used for electric heat electricity consumption.

It should be noted that the initial rate for consumption is based on the actual rate as of February 1, 1993 for propane and fuel oil, and the average of the February base and run-out rates and predicted July 1, 1993 to December 31, 1993 base and run-out

rates for electricity.

Propane \$/litre	1993	1994	1995	1996	1997
February 1	\$0.438	\$0.425	\$0.506	\$0.587	\$0.530
April 1	\$0.438	\$0.425	\$0.506	\$0.544	\$0.515
October 1	\$0.438	\$0.425	\$0.535	\$0.544	\$0.544
December 1	\$0.438	\$0.438	\$0.535	\$0.559	\$0.544

Fuel Oil \$/litre

February 1	\$0.427	\$0.427	\$0.418	\$0.562	\$0.464
April 1	\$0.427	\$0.401	\$0.418	\$0.457	\$0.464
October 1	\$0.427	\$0.422	\$0.425	\$0.464	\$0.464
December 1	\$0.427	\$0.422	\$0.547	\$0.464	\$0.464

Electricity, \$/kWh, Curragh Operating

Base Rates	\$0.0906	\$0.0975	\$0.1024	\$0.1075	\$0.1129
Runout Rates	\$0.0955	\$0.1025	\$0.1076	\$0.1130	\$0.1187

Electricity, \$/kWh, Curragh Not Operating

Base Rates	\$0.1081	\$0.1300	\$0.1326	\$0.1353	\$0.1380
Runout Rates	\$0.0980	\$0.1050	\$0.1071	\$0.1092	\$0.1114

**Table 6.1 - Future Energy Costs Based On Past History
For Propane and Fuel Oil Rates, Yukon
Energy Corporation Data for Electricity Rates**

Table 6.2, given on the following page, outlines the predicted future energy costs based on the average annual inflation rate of two percent per annum. The base and runout rates for electricity are based on the actual rates for February 1, 1993.

Propane \$/litre	1993	1994	1995	1996	1997
February 1	\$0.438	\$0.447	\$0.456	\$0.465	\$0.474
April 1	\$0.438	\$0.447	\$0.456	\$0.465	\$0.474
October 1	\$0.438	\$0.447	\$0.456	\$0.465	\$0.474
December 1	\$0.438	\$0.447	\$0.456	\$0.465	\$0.474

Fuel Oil \$/litre

February 1	\$0.427	\$0.436	\$0.444	\$0.453	\$0.462
April 1	\$0.427	\$0.436	\$0.444	\$0.453	\$0.462
October 1	\$0.427	\$0.436	\$0.444	\$0.453	\$0.462
December 1	\$0.427	\$0.436	\$0.444	\$0.453	\$0.462

Electricity, \$/kWh

Base Rates	\$0.0862	\$0.0879	\$0.0897	\$0.0915	\$0.0933
Runout Rates	\$0.0900	\$0.0918	\$0.0936	\$0.0955	\$0.0974

Table 6.2 - Future Energy Costs Based On 2% Annual Inflation

Based on Tables 6.1 and 6.2, tables can be constructed which outline the total energy cost for each of the five system types for a five year period. Due to the number of tables involved, they are presented in Appendix A and Appendix B. However, the totals which can be extracted from these tables contained in the appendices are summarized in Tables 6.3, 6.4, and 6.5, which begin on the following page.

5 Year Historical
and YEC Projected 2% Annual
Energy Costs Inflation Rate

Electric, With Curragh	Heating	\$8927	\$7452 ← 500/yr
	Basic Elec.	142	126
	Maintenance	---	---
	Mortgage	735	735
Electric, Without Curragh	Heating	\$8816	\$7452
	Basic Elec.	180	126
	Maintenance	---	---
	Mortgage	735	735
Natural Draft Oil	Heating	\$4577	\$4507 900/yr
	Basic Elec. (w/ Curragh)	167	146
	Basic Elec. (w/o Curragh)	209	n/a
	Maintenance	450	450
	Mortgage	2150	2150
Condensing Oil	Heating	\$3809	\$3760
	Basic Elec. (w/ Curragh)	214	186
	Basic Elec. (w/o Curragh)	267	n/a
	Maintenance	450	450
	Mortgage	2410	2410
Natural Draft Propane	Heating	\$8996	\$8280
	Basic Elec. (w/ Curragh)	185	163
	Basic Elec. (w/o Curragh)	233	n/a
	Maintenance	450	450
	Mortgage	1365	1365
	Tank Rental	500	500
Condensing Propane	Heating	\$6494	\$5976 ← 1700/yr
	Basic Elec. (w/ Curragh)	241	211
	Basic Elec. (w/o Curragh)	304	n/a
	Maintenance	450	450
	Mortgage	1940	1940
	Tank Rental	500	500

Table 6.3 - Summary of Individual Five Year Costs

The totals of the costs given in the preceding table are given in Table 6.4 which is given on the following page.

	5 Year Historical and YEC Projected Energy Costs (w/ Curragh)	5 Year Historical and YEC Projected Energy Costs (w/o Curragh)	2% Annual Inflation Rate
Electric	\$ 9804	\$ 9731	\$ 8313
Oil, Nat. Draft	\$ 7344	\$ 7386	\$ 7253
Oil, Condensing	\$ 6883	\$ 6936	\$ 6806
Propane, Nat. Draft	\$11496	\$11544	\$10858
Propane, Condensing	\$ 9625	\$ 9688	\$ 9177

Table 6.4 - Summary of Total Five Year Costs

It may be more useful to present the information contained in Table 6.4 as an average annual cost, a total more familiar to many homeowners. This is given in Table 6.5 which follows.

	5 Year Historical and YEC Projected Energy Costs (w/ Curragh)	5 Year Historical and YEC Projected Energy Costs (w/o Curragh)	2% Annual Inflation Rate
Electric	\$ 1961	\$ 1946	\$ 1663
Oil, Nat. Draft	\$ 1469	\$ 1477	\$ 1451
Oil, Condensing	\$ 1377	\$ 1387	\$ 1361
Propane, Nat. Draft	\$ 2299	\$ 2309	\$ 2172
Propane, Condensing	\$ 1925	\$ 1938	\$ 1835

Table 6.5 - Summary of Average Annual Costs

7.0 Comments and Conclusions

From Tables 6.4 and 6.5, one can see that the result of this analysis indicates that condensing fuel oil is the least expensive option within the parameters of this analysis, followed in all cases by natural draft oil. The third place energy source is nearly a dead heat between condensing propane and electricity given the figures on future electricity prices provided by YEC combined with the predicted future propane and fuel oil rates

based on the past five year performance. This changes little either with or without Curragh Resources in operation. If one assumes a uniform 2% per annum inflation rate for all energy types, the third place finisher is electricity. In all inflation scenarios, natural draft propane finishes fifth of the five energy types.

It is important to note that the initial costs were amortized over a 25 year period, while the analysis covered a five year period. This leaves a residual amount in each mortgage which is not dealt with in the analysis. This would be equivalent, however, to the individual living in the residence for five years, and then moving. Amortizing the heating system over five years rather than 25 years would remove this residual, however would present the unrealistic situation of a heating system financed separately from the remainder of the house.

This would most properly be dealt with by calculating the total costs over the 25 year life of the mortgage rather than a 5 year period. This would necessitate investigation into the actual life of each furnace, which is likely less than 25 years in most cases. This investigation is not within the scope of this study.

It is interesting to note the simple cost per delivered unit of heat at current energy rates. This is outlined in the following table, and is based on the rates as of February 1, 1993, including the Goods and Services Tax.

	Current Cost Per Unit	Energy Content	Seasonal Efficiency	Cost Per Unit of Energy
Electricity	\$0.0862/kWh	1 kWh/kWh	100.0%	\$0.0862/kWh
Propane	\$0.438/litre	7.04 kWh/L	65.0%	\$0.0957/kWh
			90.0%	\$0.0691/kWh
Fuel Oil	\$0.427/litre	10.57 kWh/L	77.5%	\$0.0521/kWh
			93.0%	\$0.0434/kWh

Table 7.1 - Feb. 1, 1993 Costs per Unit of Delivered Energy

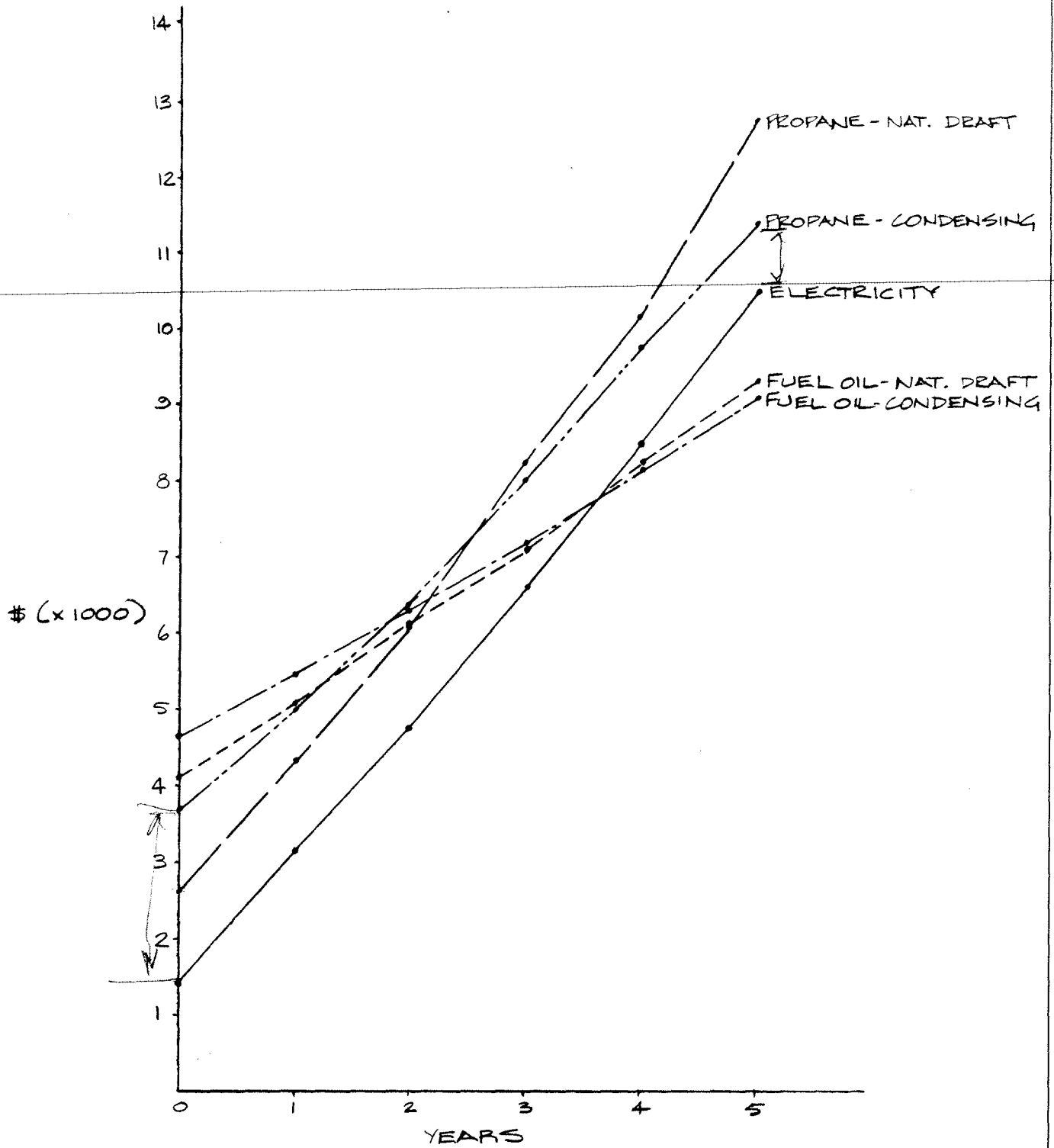
It can be seen from the above table that, if electricity is assigned a base value of 1, then natural draft propane has a base value of 1.11, condensing propane 0.80, natural draft oil 0.60, and condensing oil 0.50.

It is recognized that this analysis represents a bit of a snapshot in time. The future energy cost data given in the report is based on two scenarios (one of which is a combination of two separate approaches). A drastic change in the cost of any form of energy, however, could vastly change the results. For example, in 1973 when OPEC first formed, oil and propane prices

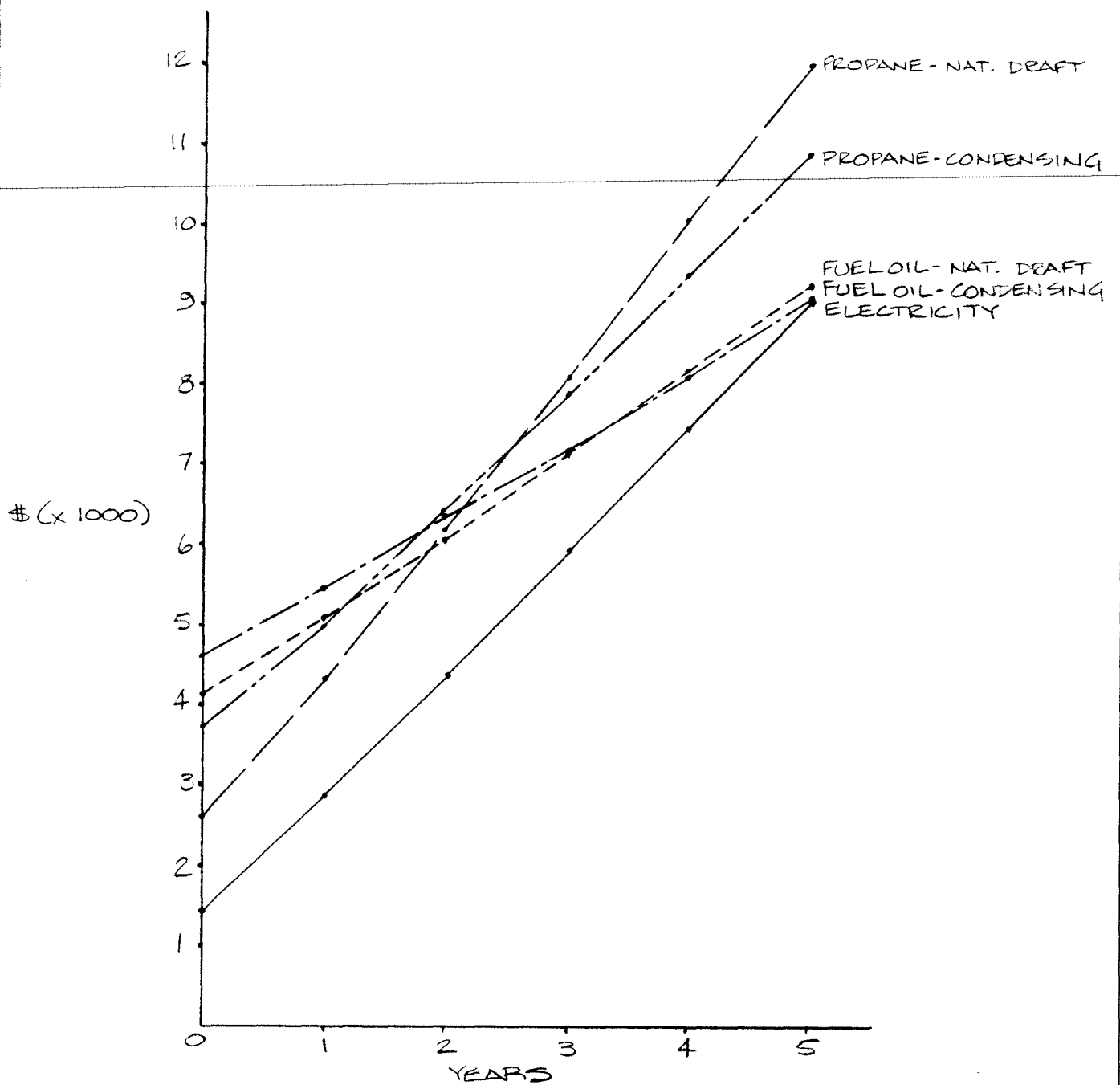
became very volatile. It was mentioned that riders and rebates have been the order of the day for electricity rates over the last five years, and that the transfer from the Northern Canada Power Commission to the local utility had the effect of reducing rates for a two year period. It is possible that other jumps may occur in the future, and that all logical attempts to predict future rates may prove to be fruitless. The report is structured, however, such that any reader could manipulate all costs in order to determine the impact on the results.

The graphs which are given on the following pages outline the total cost of each system over a five year period, under two inflation scenarios. Since the annual costs varied little with or without Curragh Resources operating, only one graph is produced for inflation based on a combination of historical performance and YEC predictions (with Curragh operating). The second graph indicates a simple 2 percent inflation. Extrapolating the graph beyond the five year period must be done with caution. This is because the analysis was only based on a five year period, and does not consider all costs which may be incurred after this time frame. It should also be noted that the graph for each energy type originates at the first cost for each system as outlined in Table 3.1, and the amortized capital cost as given in Table 4.1 are not included in the annual cost added each year to obtain the cumulative cost.

It is interesting to note that both propane systems result in the largest cumulative five year costs under either inflation scenario. Under the two percent inflation scenario, the cumulative electricity cost nearly catches the fuel oil system costs, although not quite. Under the other inflation scenario, the electricity system cumulative costs surpass the fuel oil system costs between years three and four.



Graph Indicating Total Cost (First Cost and Operating And Maintenance Costs) For Each System Using Energy Data Inflated By Historical Patterns for Propane and Fuel Oil and Yukon Energy Corporation Data for Electricity



Graph Indicating Total Cost (First Cost and Operating And Maintenance Costs) For Each System Using Energy Data Inflated By Two Percent Per Annum, All Energy Types

APPENDIX A

TOTAL ENERGY COSTS, EACH OF FIVE SYSTEM TYPES

**INFLATION BASED ON HISTORICAL PRICE CHANGES
FOR PROPANE AND FUEL OIL**

**INFLATION BASED ON YUKON ENERGY CORPORATION PROJECTIONS
FOR ELECTRICITY**

Electricity, \$/year, Curragh Operating

	1993	1994	1995	1996	1997
Space Heating	\$1587	\$1703	\$1788	\$1877	\$1972
Basic Functions	\$ 25	\$ 27	\$ 29	\$ 30	\$ 31

Table A.1.A - Electric Heating System

Electricity, \$/year, Curragh Not Operating

	1993	1994	1995	1996	1997
Space Heating	\$1628	\$1744	\$1779	\$1814	\$1851
Basic Functions	\$ 30	\$ 36	\$ 37	\$ 38	\$ 39.

Table A.1.B - Electric Heating System

Fuel Oil, \$/fill

	1993	1994	1995	1996	1997
February 1	\$ 321	\$ 329	\$ 314	\$ 423	\$ 349
April 1	\$ 212	\$ 199	\$ 207	\$ 227	\$ 230
October 1	\$ 161	\$ 159	\$ 160	\$ 174	\$ 174
December 1	\$ 173	\$ 170	\$ 221	\$ 187	\$ 187

Electricity, \$/year, Curragh Operating

Basic Functions	\$ 30	\$ 32	\$ 33	\$ 35	\$ 37
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Electricity, \$/year, Curragh Not Operating

Basic Functions	\$ 35	\$ 42	\$ 43	\$ 44	\$ 45
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Table A.2 - Natural Draft Fuel Oil Heating System

Fuel Oil \$/fill

February 1	\$ 268	\$ 268	\$ 262	\$ 352	\$ 291
April 1	\$ 177	\$ 166	\$ 173	\$ 189	\$ 192
October 1	\$ 134	\$ 132	\$ 133	\$ 145	\$ 145
December 1	\$ 144	\$ 142	\$ 184	\$ 156	\$ 156

Electricity, \$/year, Curragh Operating

Basic Functions	\$ 38	\$ 41	\$ 43	\$ 45	\$ 47
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Electricity, \$/year, Curragh Not Operating

Basic Functions	\$ 45	\$ 54	\$ 55	\$ 56	\$ 57
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Table A.3 - Condensing Fuel Oil Heating System**Propane, \$/fill**

	1993	1994	1995	1996	1997
February 1	\$ 590	\$ 572	\$ 681	\$ 790	\$ 713
April 1	\$ 390	\$ 378	\$ 450	\$ 484	\$ 458
October 1	\$ 294	\$ 286	\$ 360	\$ 366	\$ 366
December 1	\$ 317	\$ 317	\$ 387	\$ 404	\$ 393

Electricity, \$/year, Curragh Operating

Basic Functions	\$ 33	\$ 35	\$ 37	\$ 39	\$ 41
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Electricity, \$/year, Curragh Not Operating

Basic Functions	\$ 39	\$ 47	\$ 48	\$ 49	\$ 50
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Table A.4 - Natural Draft Propane Heating System

Propane, \$/fill

	1993	1994	1995	1996	1997
February 1	\$ 426	\$ 413	\$ 492	\$ 571	\$ 515
April 1	\$ 281	\$ 273	\$ 325	\$ 349	\$ 331
October 1	\$ 212	\$ 206	\$ 259	\$ 264	\$ 264
December 1	\$ 229	\$ 229	\$ 279	\$ 292	\$ 284

Electricity, \$/year, Curragh Operating

Basic Functions	\$ 43	\$ 46	\$ 48	\$ 51	\$ 53
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Electricity, \$/year, Curragh Not Operating

Basic Functions	\$ 51	\$ 61	\$ 63	\$ 64	\$ 65
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Table A.5 - Condensing Propane Heating System

APPENDIX B
TOTAL ENERGY COSTS, EACH OF FIVE SYSTEM TYPES
INFLATION BASED ON 2 PERCENT PER YEAR INCREASE IN PRICES

Electricity, \$/year

	1993	1994	1995	1996	1997
Space Heating	\$1432	\$1460	\$1490	\$1520	\$1550
Basic Functions	\$ 24	\$ 25	\$ 25	\$ 26	\$ 26

Table B.1 - Electric Heating System**Fuel Oil, \$/fill**

	1993	1994	1995	1996	1997
February 1	\$ 321	\$ 328	\$ 334	\$ 341	\$ 347
April 1	\$ 212	\$ 216	\$ 220	\$ 225	\$ 229
October 1	\$ 161	\$ 164	\$ 167	\$ 170	\$ 174
December 1	\$ 173	\$ 176	\$ 179	\$ 183	\$ 187

Electricity, \$/year

Basic Functions	\$ 28	\$ 29	\$ 29	\$ 30	\$ 30
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Table B.2 - Natural Draft Fuel Oil Heating System**Fuel Oil \$/fill**

February 1	\$ 268	\$ 273	\$ 278	\$ 284	\$ 290
April 1	\$ 177	\$ 181	\$ 184	\$ 188	\$ 191
October 1	\$ 134	\$ 136	\$ 139	\$ 142	\$ 145
December 1	\$ 144	\$ 147	\$ 150	\$ 153	\$ 156

Electricity, \$/year

Basic Functions	\$ 36	\$ 37	\$ 37	\$ 38	\$ 38
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Table B.3 - Condensing Fuel Oil Heating System

Propane, \$/fill

	1993	1994	1995	1996	1997
February 1	\$ 590	\$ 602	\$ 614	\$ 626	\$ 638
April 1	\$ 390	\$ 398	\$ 406	\$ 414	\$ 422
October 1	\$ 294	\$ 300	\$ 306	\$ 312	\$ 319
December 1	\$ 317	\$ 323	\$ 330	\$ 336	\$ 343

Electricity, \$/year

Basic Functions	\$ 31	\$ 32	\$ 33	\$ 33	\$ 34
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Table B.4 - Natural Draft Propane Heating System**Propane, \$/fill**

	1993	1994	1995	1996	1997
February 1	\$ 426	\$ 434	\$ 443	\$ 452	\$ 461
April 1	\$ 281	\$ 287	\$ 293	\$ 299	\$ 304
October 1	\$ 212	\$ 217	\$ 221	\$ 226	\$ 230
December 1	\$ 229	\$ 233	\$ 238	\$ 243	\$ 247

Electricity, \$/year

Basic Functions	\$ 41	\$ 41	\$ 42	\$ 43	\$ 44
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Table B.5 - Condensing Propane Heating System