Farmer Joe's Energy Solution

Prepared for Professor Pan

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ABSTRACT

The first energy crisis in the 70's has given an indication to alternative energy options. For Canada, a nation abundant in non renewable energy, signing and restricting emission levels according to Kyoto Protocol had administered the real push towards developing 'green' energy options.

The national and provincial branches of the government have installed measures to promote and support the growth of 'green' energy sector.

Farmer Joe, on a fictional corn farm in the province of Ontario, in support of the 'green' movement, is faced with a choice on one hand to lower his own emissions levels by installing a hybrid wind turbine-solar panel energy producing system on his farm and possibly sell the energy excess to the grid or invest in the 'green' company instead to support the 'green' energy in a location where its production is optimized.

Herein these two energy technologies are explored in further detail as well as the two valuable alternatives considered to select the one that could optimize Farmer Joe's utility. Administering NVP, utility, linear programming, single and multiple regressions against factors which influence Farmer Joe's decision making process and conducting further comparative and sensitivity analyses we conclude that Farmer Joe's optimal solution would be to directly invest in Canadian Hydro to be able to support and enjoy a profit from supporting clean 'green' energy source.

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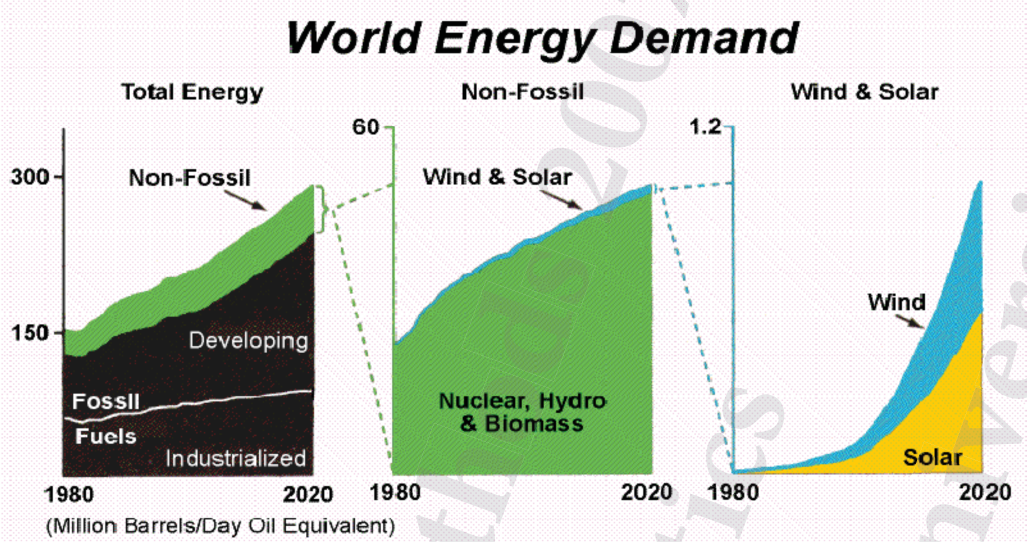
1 PROBLEM FORMULATION

1.1 Purpose of Research

The quality of our lives over the past century has become increasingly dependent on the fundamental necessity of access to energy. Ever since the industrial revolution we have seen a steady growth of the worldwide energy consumption, but it was in the 20th century the usage really began to skyrocket, with a twenty-fold increase in the use of fossil fuels. However, according to the RNCOS Energy Sector Research report posted Dec 10, 2007, the global oil output which is presently close to 81 Million barrels per day is anticipated to drop to 39 Million barrels per day by 2030. It is also forecasted that there will be a significant downfall in coal, gas and uranium production in the long run as these energy sources are getting exhausted with their increased use (RNCOS, 2007). Due to this overdependence on energy, along with predictions of the pending energy crisis, the world has been recently experiencing sharp energy price increases. There is also the exceedingly urgent issue of climate change due to the overwhelming amount of pollution caused by the burning of fuels.

While renewable sources today only produce approximately 2% of the world's energy demanded, depicted below, they account for about 18% of world investment in power generation, with wind generation at the investment forefront. Even though globally, wind power generation more than quadrupled between 2000 and 2006, solar and bio-fuel energy technologies have grown even faster than wind, but from a smaller base (see graph on next page) (Global Energy Network Institute, 2007).

For the world and society to survive, there requires some drastic changes to take place. However, it is not only the responsibility of governments and large, polluting corporations to turn this around, but also the responsibility of the individual to make changes in their own lives. We would therefore like to take a specific case of Farmer Joe, a fictitious farmer located in Ontario, Canada, who is a green thinker, and who would like to make a difference, either through operating his farm on 100% green electricity, or through investing in a renewable energy company. It is our purpose to help him determine which option is best for him.



1.2 Model description

We have chosen to use a decision tree with two options for Farmer Joe to choose between:

- Produce his own electricity through installed wind turbines or solar panels, or a combination of both, selling excess to the grid and buying from the grid when electricity production doesn't meet needs, aiming for a break-even year-by-year
- Invest in Canadian Hydro Developers Inc. (see appendix 5.1 for an overview of Canadian Hydro) (Canadian Hydro, 2007), a renewable energy company that would be most attractive to him because of it being the only company in Canada that produces Ecologo® certified low-impact renewable energy. We will determine how much he must invest to 'produce' his average yearly electricity consumption. He would have savings in the amount of the growth of his investment based on increase in stock price. He would continue to buy "regular" electricity off the grid

1.3 Facts on Wind and Solar Power

1.3.1 Wind Power

In 2000, rich in vast natural resources including natural gas and oil, Canada used only a small amount of renewable energy accounting for 1.3% of its primary energy supply. Compared with other industrialized countries, Canada has made little use of wind power. For example, by June 2004, Canada's installed capacity was only at 341 megawatts (MW), compared to 16,500MW installed by the same time in Germany. Interestingly, nearly 80% of total wind energy worldwide comes from the following top five countries: Germany, Spain 8000MW, The United States 6800MW, Denmark 3121MW and India 2800MW. A number of other countries, including Italy, the Netherlands, Japan and the UK, are above near the 1000MW mark. This further illustrates the opportunities for Canada's wind power production (Herberta, Iniyanb, Sreevalsanc, & Rajapandiand, 2005).

Wind Power consists of converting wind energy into electricity using wind turbines and is used in large scale wind farms for national electrical grids as well as in small individual turbines for providing electricity to rural residences or grid-isolated locations.

Wind differs from other energy resources in being both highly variable geographically and not directly transportable among regions (Menza & Vachona, 2005). The cost of generating wind power has declined consistently over the last several decades due to improved technology offering greater efficiency and lower production costs for wind turbines, resulting in a lower delivered cost for wind energy than any other new non-hydroelectric renewable resource. The extent of wind power development in a given region is subject to the availability of high quality wind resources and access to transmission lines ('the grid') (Energy, 2004a).

Where the economics of wind turbine systems are concerned, the wind generator costs are heavily linked to the characteristics of wind resources in a specific location. Therefore, the cost effectiveness of future wind turbines depend more on having dynamic and compliant design than on increased size. The most profitable wind farm is generated by minimizing costs involved in developing the site and by reducing the down time of the turbine machines (Herberta et al., 2005). Therefore, for Farmer Joe wind turbine to be economical his land needs to be located in an optimal, wind rich area.

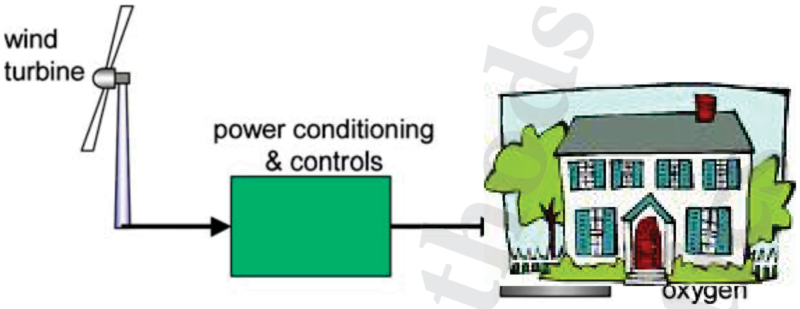


Fig. 1. Schematic diagram of grid independent wind electricity generation.

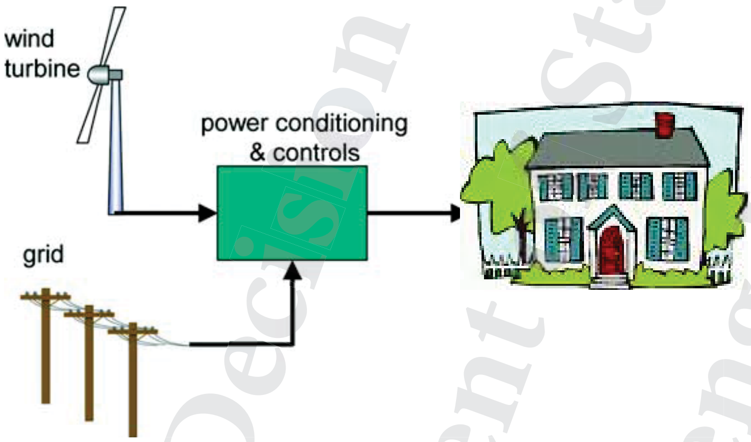


Fig. 2. Schematic diagram of grid-assisted wind electricity generation.

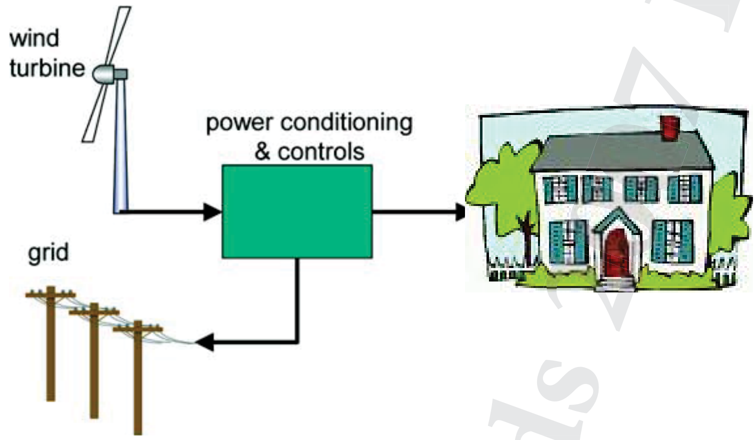


Fig. 3. Schematic diagram of wind power for grid-electricity generation (Sherif, Barbir, & Veziroglu, 2005).

For wind energy, it is crucial to know the wind speed of the site in order to determine the potential energy output. In general, wind maps may be used to roughly determine the seasonal wind speeds in your area, but this may not be relied on for accuracy. To obtain good information dataloggers must be used at the turbines height. It is important to take in consideration wind obstacles such as trees or buildings, a Turbine must always be placed in a premium location for maximum output. Advice from dealers and turbine users may also come in handy (Detronics, 2007).

Since wind turbines are mechanical they do require maintenance throughout their lifetime. Modern turbines are made to last and usually require very little maintenance. Usually a yearly inspection of the turbine is sufficient. The replacement of the blade leading edge may be required every few years. This is cheap and easy to do (Detronics, 2007).

1.3.2 Solar Power

Solar Power or Photovoltaic electricity has become a popular potential alternative energy source. The Sun radiates the earth with a tremendous amount of energy. Photovoltaic harness this energy in a renewable, clean form reducing the dependency on alternate energy sources with heavy CO^2 admissions.

"It is also worth noting that solar power is now finding niche applications in Canada, despite the fact that its cost remains relatively high (although falling)," (Whitmore & Bramley, 2004).

Solar power, especially in Canada is not suitable as a stand alone single energy source system, because it cannot provide a continuous source of energy due to the low availability during the no-sun period and the winter. It is therefore more practical to use a hybrid system where two or more renewable energy sources are utilized. Previous studies show that adding solar thermal electric generating capacity to a wind farm rather than expanding with additional wind capacity provides cost–benefit trade-offs that will continue to change as the two technologies evolve (Reichling & Kulacki, 2007).

There are some basic costs that are associated with this energy alternative. These include the high capital cost of implementing the system. The second is the need to store the energy because a systems output fluctuates because of factors including the weather, seasons and time of day. Finally is the maintenance cost for such a system is quite high. Some estimates place maintenance at being yearly 10% of the fixed cost (Standford, 2007).

For Farmer Joe, he has to manage the land requirements for any system that he implements. Corn is required for his income and it is important to understand how much land a photovoltaic would require. Some land for Farmer Joe's house can be utilized without compromising the output of the corn farm, but if farm production is compromised that would contribute to the cost of the unit.

There is also the cost of such a unit. Not even taking into account the enormous cost associated with maintenance photovoltaic energy is still an extremely expensive energy alternative. Some estimates put it at around $0.25 per kWh which when compared to the less the $0.05 per kWh of the electricity grid seems extremely expensive (Stanford, 2007).

If Farmer Joe does produce more energy than is required there is one incentive that could be taken into consideration. In March, 2006 Ontario implemented what is being heralded as one of the greatest energy incentives in North America in the last 20 years. The plan is to switch the reliance from larger energy producers to smaller individually owned power plants. The plan purchases photovoltaic energy at $0.42 per kWh (Broehl, 2006).

If he were to choose to implement a photovoltaic energy system depending on how much investment he makes will affect his energy output. If he was to produce periodically or continually greater than his energy needs photovoltaic energy could actually become an income stream.

1.4 Assumptions

Farm Location:	Ontario, Canada
Farm Type:	Producer of organically grown corn
Farm Size:	30 acres
Cost per kWh from the Grid:	5.3 cents (<250,000 kWh/year) 6.2 cents (>250,000 kWh/year) (www.ontariotenants.ca)
Length of Project:	It is assumed that the length of the project will be 30 years, as after that time new and more efficient technology will be available, and changes on the farm and energy use may have occurred

Average Electricity Use per Year:

Energy	Use/Acre*	Conversion Rate to kWh	kWh/Acre	Farm Acres	Yearly kWh Usage
Liquid Propane Gas (gallon)	6.36	37**	235.3	30	7,059.6
Electricity (kWh)	77.13	N/A	77.1	30	2,313.9
Natural Gas (feet3)	200	43.962***	8,792.4	30	263,773.0
Total			*9,104.9*	*30*	***273,145.5***
*Source: USDA, Economic Research Service and Office of Energy Policy and New Uses					
** http://wps.com/LPG/LPG-book-final.html					
*** http://www.citizensgas.com/pdf/EnergyConversion.pdf					
Note we just went with three categories of energy that is used on the farm as the others cannot readily be exchanged for electricity use.					

2 PROCEDURES

2.1 Solution Approaches

2.1.1 Alternative 1: Wind and Solar Power

For alterative 1 we will run a linear program, based on the data collected from the area where Farmer Joe lives. Taking into account total costs of these technologies and comparing them to their output in kWh we will determine the cost and the amount of wind turbines and/or solar panels necessary to replace Farmer Joe's energy usage of the LPV, electricity and natural gas.

Using a report from a nearby area, Farmer Joe calculates what would be required in terms of hardware and costs to determine if this is a feasible alternative for his consumption of energy.

2.1.2 Alternative 2: Investing in Canadian Hydro

For alternative 2, investing in Canadian Hydro, we have two steps:

- determine how much he needed to invest to cover the production of his energy consumption
- build a model that will predict the share price in order to know the growth rate based on expected growth rate of the variables; this will be built into the utility value for Farmer Joe for this alternative, as it will in effect decrease his cost

For the **investment amount**, we will:

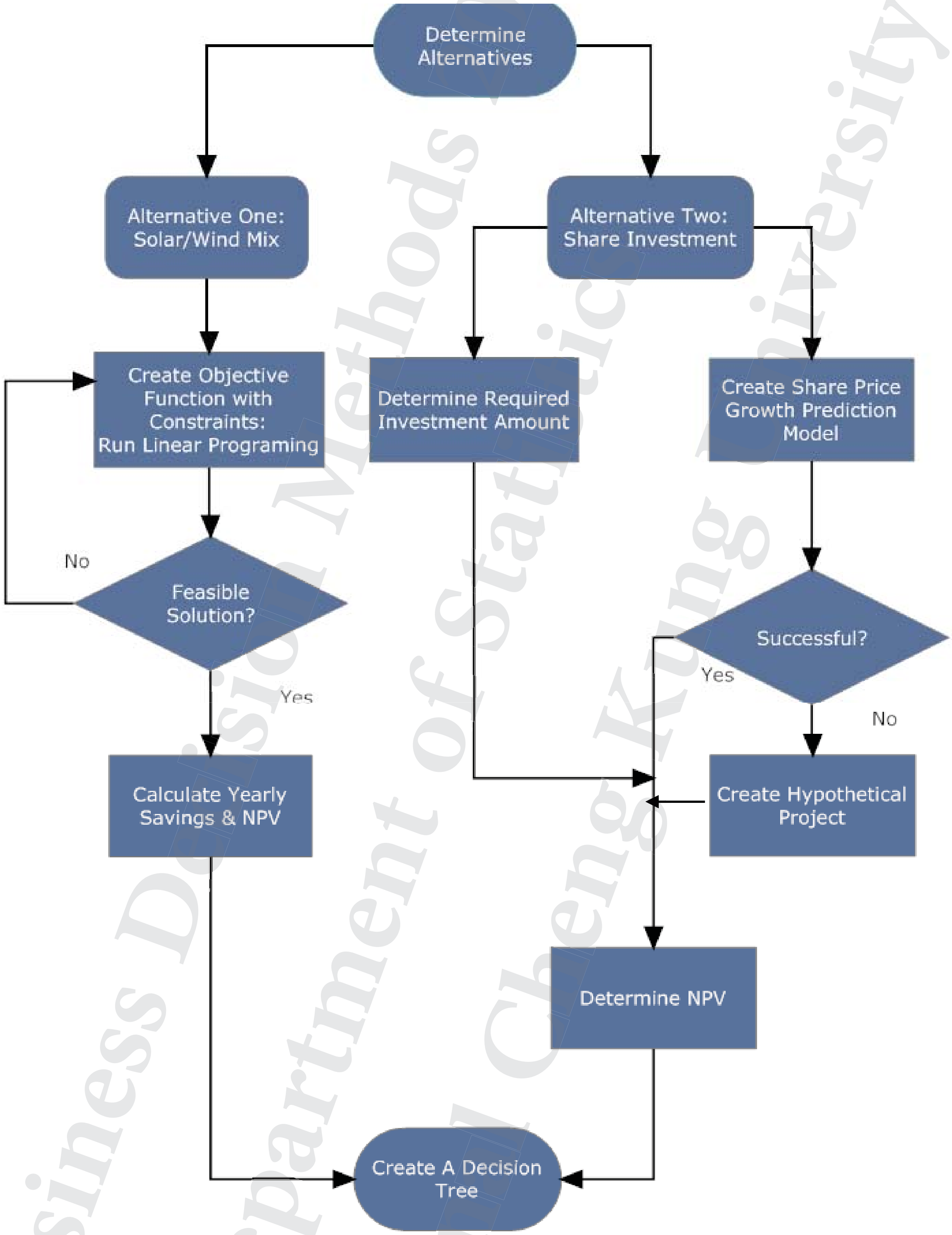
- determine how much it would cost Canadian Hydro to produce a hypothetical hydro plant with energy output in the amount of Farmer Joe's yearly usage

For the **growth rate**, we decided to run single and Multiple Regressions of the percent change in share price against the percent change in different variables, to attempt to find an acceptable model. The variables we have chosen are:

- company revenues
- company operating profits
- total capital employed
- the market (in this case the Toronto Stock Exchange/S&P 500 composite index)
- oil spot prices
- oil future prices

We will run yearly regression against company revenues, operating profits, and total capital employed from 1998 to 2006, as these years were the only years historical data was available to us, and will run weekly and monthly regressions against the outside variables, both long (beginning January 2002 to September 2007) and short (beginning mid January 2006 to September 2007, as there was a large stock offering in December 2005).

2.2 A Systematic Problem Solving Flowchart

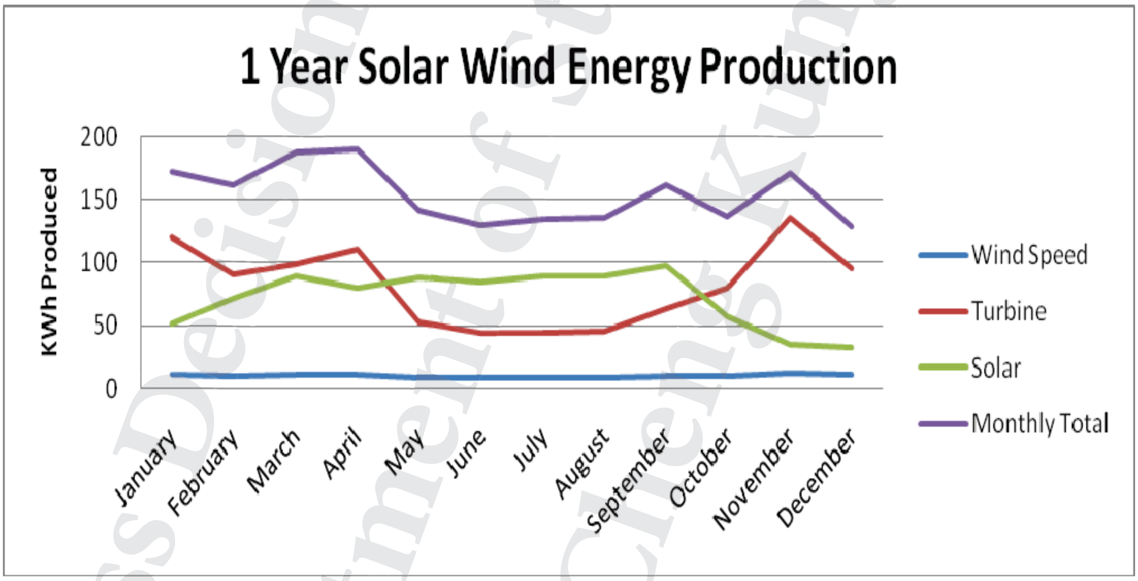


2.3 A Systematic Problem Solving Description

2.3.1 Alternative 1: Wind and Solar Power

Before suggesting that a dual energy system should be considered for farmer Joe, let's compare both technologies as to find out the differences in cost, maintenance and energy output. Since wind and solar energy depend on weather and daylight, we analyze how both technologies perform seasonally.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Totals
Wind Speed	10.8	10.2	10.5	11	8.7	8.4	8.2	8.2	9.5	10.1	12.3	10.7	
Turbine	121	90.1	98.6	110	52.6	44.3	44.2	44.8	63.6	79.2	136	95.7	**979.5**
Solar	51.8	71.8	89.1	80	88.4	85.3	89.3	90.1	98	57.7	35.2	32.3	**868.9**
Monthly Total	172	162	187.7	190	141	130	134	134.9	162	137	171	128	1848



We can see that between September and April, in farmer Joe's area the wind turbine produces more KW per hour. Inversly between May and August inclusively the solar system produces more KWh. These seasonal variations are to be taken seriously when choosing an energy system and is a strong factor for the recommendation of a hybrid system, if of coarse farmer Joe chooses to produce energy.

We can only assume the weather according to the historical data that has been collected. We cannot expect every year to have the same weather conditions. Every year is always unique in it's own way. The results gathered can only be used as a guide since we never know what mother nature will bring.

Based on the above we believe that the hybrid solution is the optimal solution when off the grid. Based on price per kWh produced, the wind turbine has an advantage over the solar system, if the system was on the grid, without a doubt going with an only wind solution would be the better choice. For off grid systems the seasonal variations are enough to consider the hybrid wind and solar system to fill the energy needs all year round.

We have utilized linear programming for two reasons. To keep it simple by implementing homogenous units who have the same potential production. We have decided to create a constraint of at least one unit for solar panels because we will have to bump up any partial entities to an integer number, causing us to produce a little more energy than we strictly need. As photovoltaic energy can be sold at a premium of $0.42/kWh, versus the $0.11 each kWh from wind energy, we assume that over 30 years the excess energy sold back to the grid will outweigh the increased cost. We will investigate to confirm that the assumption holds true in our final model.

2.3.1.1 Linear Programming Model

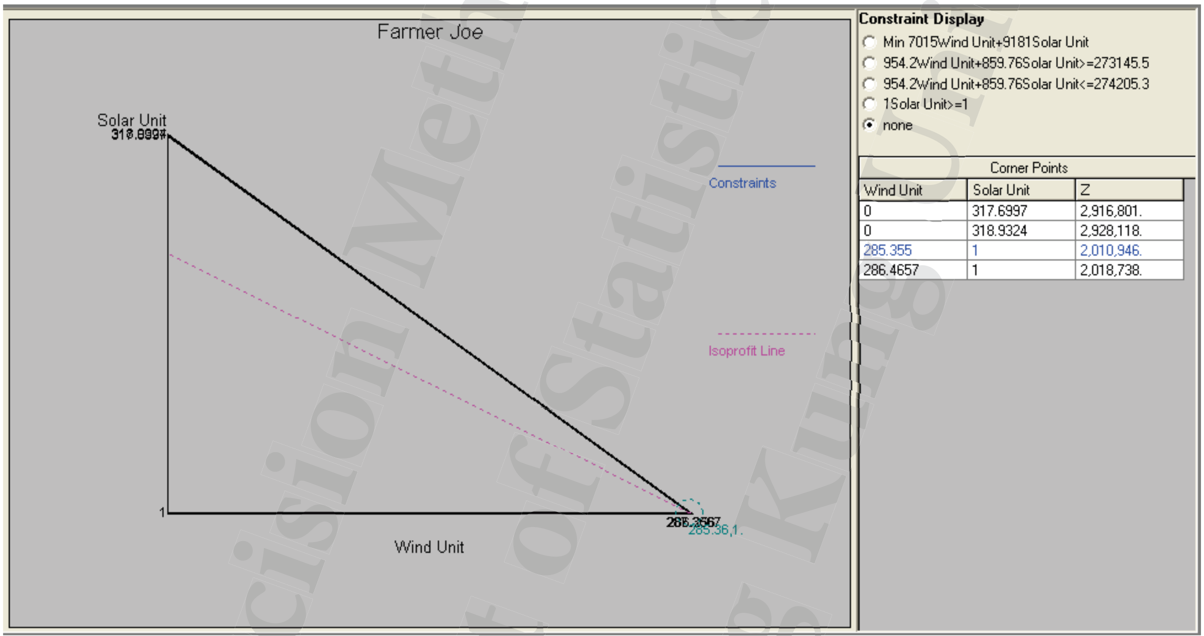
System	Cost per Unit	Energy Production per Year (2005)
Wind System	$7,015	954.2 kWh
Solar System	$9,181	859.76 kWh

Objective Function: Minimize cost: 7,015W + 9,181S
Where W equals number of wind turbines;
S equals number of solar panels

Subject to:

	$954.2W + 859.76S \geq 273{,}145.5$	(minimum kWh)
	$S \geq 1$	(minimum solar panel)
	$954.2W + 859.76S\ S \leq 274{,}005.26$	(extra kWh produced should not exceed the kWh produced by a solar panel, so that all extra kWh that is sold back to the grid if from the solar panel)

Graphical Solution:



Because the mathematical answer for the amount of Turbines is 285.355, and we cannot have 0.355 of a turbine, we rounded up to 286 turbines for the following solution:

Type of Energy	Units	Cost per Unit	Total Cost
Wind Turbines	286	$7,015	$2,006,290
Solar Panels	1	$9,181	$9,181
Total			$2,015,471

We then have to calculate in the earnings per year from sale of excess solar power over the life of the project (estimated at 30 year), discounted at the same discount rate as we will later use in the discounting of cash flows in alternative two's 'programming issues curtailed' section:

Total Energy Produced:	286* 954.2kWh+859.76kWh = 273,760.96kWh
Excess Energy Produced:	273,760.96kWh - 273,145.5kWh = 615.46kWh
Income When Sold as Excess Solar Energy:	615.46*$0.42 = $258.49
NPV of $258.49 over 30 years discounted at 10.79%:	$2,285
NPV of Expected Energy Savings of $0.062 per kWh:	$149,694
Government Subsidies* through Tax Savings due to Accelerated Amortization**:	$511,805
NPV:	**($1,351,687)**
**See Appendix 5.1 on Government Subsidies*	
***See table below for 30% accelerated amortization schedule*	

Year	30% Accelerated Amortization	Straight Line Amortization	Chosen Amortization Amount	Balance	Tax Savings	NPV of Tax Savings (10.79%)	Total NPV of Tax Savings
0				$2,015,471			$511,805
1	$604,641	$67,182	$604,641	1,410,830	$207,634	$187,412	
2	423,249	67,182	423,249	987,581	145,344	118,412	
3	296,274	67,182	296,274	691,307	101,741	74,816	
4	207,392	67,182	207,392	483,915	71,218	47,270	
5	145,174	67,182	145,174	338,740	49,853	29,867	
6	101,622	67,182	101,622	237,118	34,897	18,871	
7	71,135	67,182	71,135	165,983	24,428	11,923	
8	49,795	67,182	67,182	98,800	23,070	10,164	
9	29,640	67,182	67,182	31,618	23,070	9,174	
10	9,485	67,182	31,618	-	10,858	3,897	

To prove that the savings of having the solar panel exceeds the excess cost, we will look at the following:

Solar Panel Cost above Wind Turbine Cost:	$9,181 - $7,015 = $2,166
NPV of $258.49 solar energy sales over 30 years discounted at 10.79% (from above):	$2,285
Savings of solar panel purchase before considering income on potential sale of excess wind energy	$2,285 - $2,166 = $119
If turbine was purchased instead: kWh produced increase (1 wind – 1 solar)	954.2kWh - 859.76kWh = 94.44kWh
kWh sales based on wind energy sale price of $0.11 (original excess kWh + new excess kWh)	(615.46kWh + 94.44kWh)*$0.11 = 709.9*$0.11 = $78.089
NPV of sales of excess wind energy	$690.25
Savings on purchasing wind turbine instead of solar panel + NVP of sales excess wind energy:	$2,856.25
Conclusion	$2,856.25 > $2,285 therefore **do not purchase the solar panel**
Impact on NPV of Alternative is negligible and will therefore not be calculated at this time.	

2.3.1.2 Programming Difficulties

The farm is not big enough to viably host 286 turbines. We therefore adjusted Farmer Joe's energy consumption to be replaced by green energy to just include LPG and electricity, and he would have to continue to use natural gas. This reduction in energy replacement will be reflected in his utility values in the decision tree.

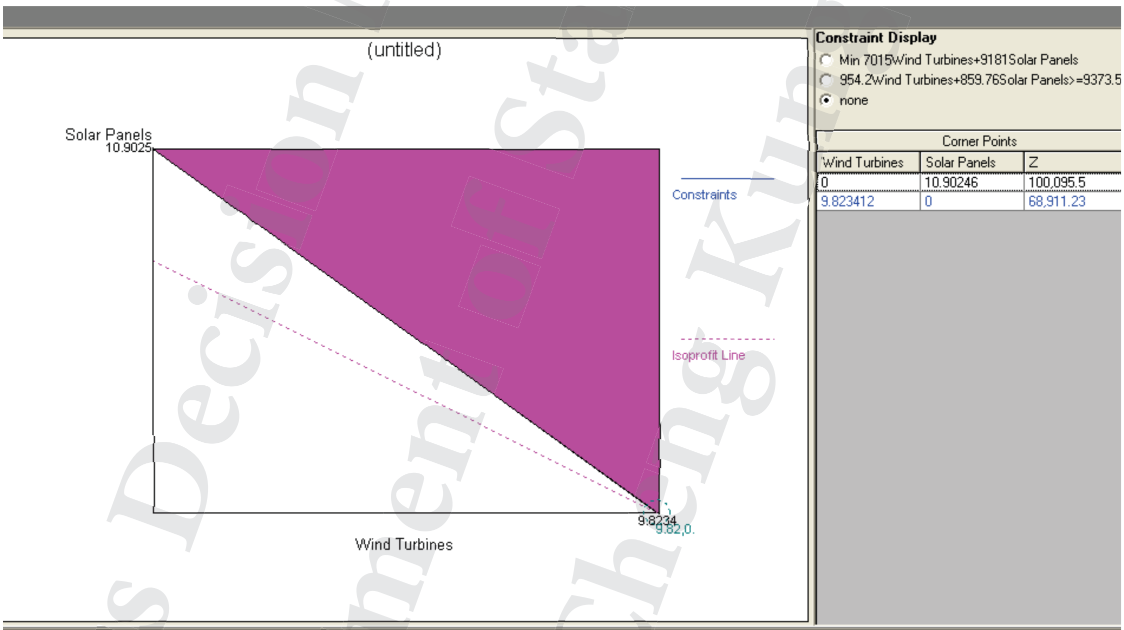
2.3.1.3 Programming Difficulties Curtailed: Linear Programming Model excluding Natural Gas Replacement

As proven above, the constraint of one solar panel will not be considered this time, decreasing the constraints to just the one: kWh produced must exceed the expected kWh used per year, and we know by just looking at it that it will require 10 wind turbines, but we still complete the linear programming to confirm the solution:

Objective Function: Minimize: 7,015W + 9,181S
Where W equals number of wind turbines;
S equals number of solar panels

Subject to: $954.2W + 859.76S \geq 9{,}373.5$ (minimum kWh)

Graphical Solution:



Rounding up to the nearest full turbine from 9.8 to 10 we get the following solution:

Type of Energy	Units	Cost per Unit	Total Cost
Wind Turbines	10	$7,015	$70,150
Solar Panels	0	$9,181	-
Total			$70,150

As before, we then have to calculate in the earnings per year from sale of excess power over the life of the project, which is still estimated at 30 years, and discounted at the same discount rate as we will later use in the discounting of cash flows in alternative two's 'programming issues curtailed' section:

Total Energy Produced:	10* 954.2kWh = 9,542.0kWh
Excess Energy Produced:	9,542.0kWh - 9,373.5kWh = 169.5kWh
Income When Sold as Excess Wind Energy:	169.5kWh*$0.11 = $18.65
NPV of $18.65 over 30 years discounted at 10.79%:	$164.81
NPV of Expected Energy Cost Savings of $0.053 per kWh:	$4,391
Government Subsidies* through Tax Savings due to Accelerated Amortization**:	$17,814
NPV:	**($47,180)**
**See Appendix 5.1 on Government Subsidies*	
***See table below for 30% accelerated amortization schedule*	

Year	30% Accelerated Amortization	Straight Line Amortization	Chosen Amortization Amount	Balance	Tax Savings	NPV of Tax Savings (10.79%)	Total NPV of Tax Savings
0				$70,150			$17,814
1	$21,045	$2,338	$21,045	49,105	$7,227	$6,523	
2	14,732	2,338	14,732	34,374	5,059	4,121	
3	10,312	2,338	10,312	24,061	3,541	2,604	
4	7,218	2,338	7,218	16,843	2,479	1,645	
5	5,053	2,338	5,053	11,790	1,735	1,040	
6	3,537	2,338	3,537	8,253	1,215	657	

7	2,476	2,338	2,476	5,777	850	415	
8	1,733	2,338	2,338	3,439	803	354	
9	1,032	2,338	2,338	1,100	803	319	
10	330	2,338	1,100	-	378	136	

2.3.2 Alternative 2: Investing in Canadian Hydro

2.3.2.1 Required Investment Amount

To calculate the required investment amount we need to look at Canadian Hydro's current construction projects:

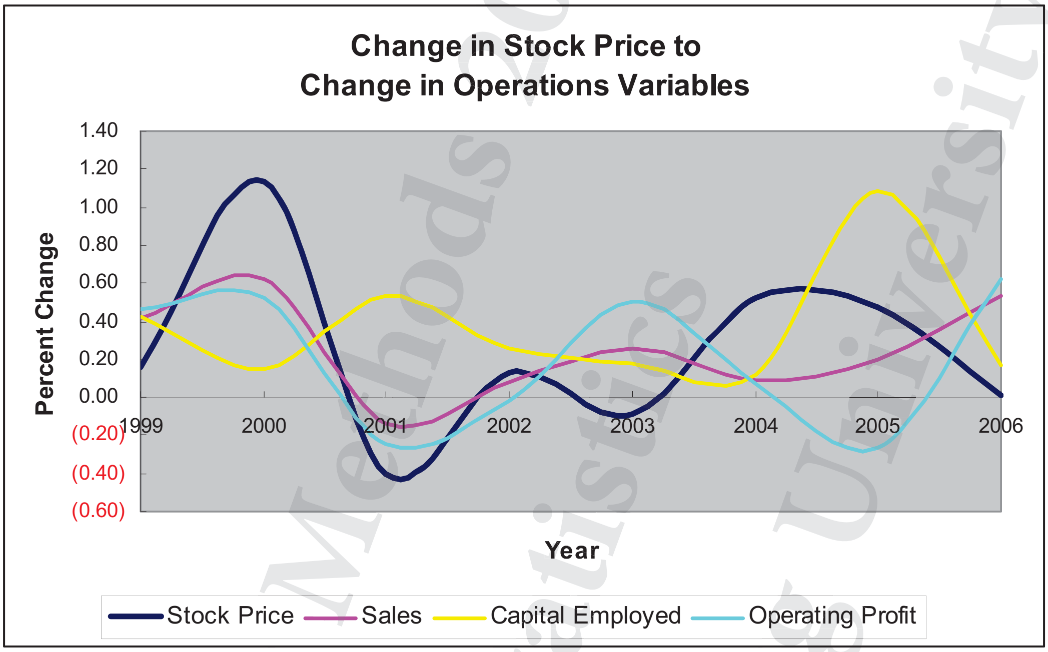
MW Capacity	Yearly kWh	Cost (in millions)	Fixed Price Contract	Expected Yearly kWh/Capacity	Cost/ Capacity
20	84,000,000	46	20 years BC hydro	4,200,000	$2,300,000
9.9	30,000,000	22	40 years BC hydro	3,030,300	2,200,000
9.6	34,000,000	22	40 years BC hydro	3,541,667	2,300,000
5	20,000,000	10	40 years BC hydro	4,000,000	2,000,000
			Average:	**3,692,992**	**$2,200,000**

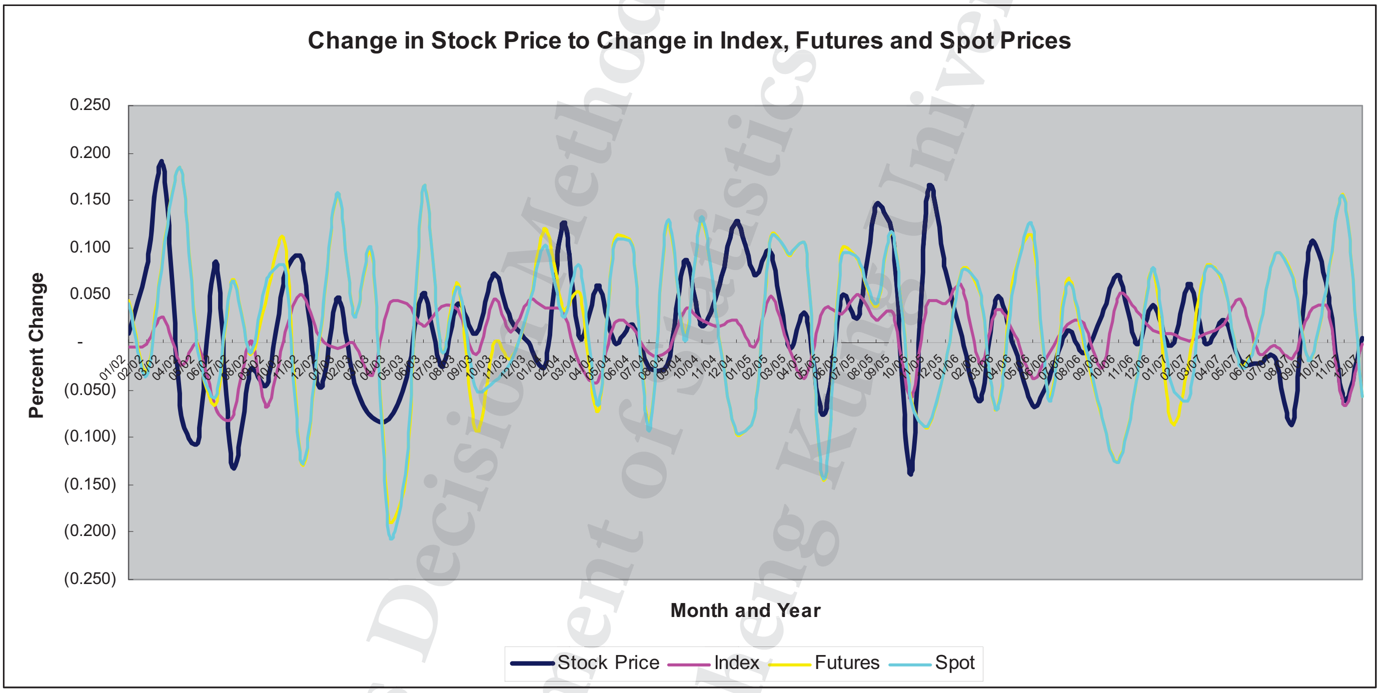
We can now calculate the required investment amount based on the estimated required capacity to produce Farmer Joe's energy requirement. In order to match the decision to the above wind and solar solution, we will work with the two scenarios of replacing versus not replacing the natural gas in our solution:

Acres	Yearly kWh Requirement	Required Capacity	Required Cost
30	273,145.5	0.07	$162,976
30	9,373.5	0.00254	$5,593

2.3.2.2 Regressions

For us to have an acceptable model, we determined the adjusted R^2 needed to be at least 0.8. Before running the regressions we look at a graph of the change in stock price to the change in operations variables, as well as to the change in the index, and oil spot and future prices, as seen the two graphs below:




Change in Stock Price to Change in Index, Futures and Spot Prices
Percent Change
0.250
0.200
0.150
0.100
0.050
-
(0.050)
(0.100)
(0.150)
(0.200)
(0.250)
Month and Year
Stock Price
Index
Futures
Spot

From the above graphs we can see that the likelihood of finding a model that fits through regression is low, but we wanted to be certain, so we then ran the regressions. The results are as follow:

Table 1: Single Regression against Operating Variables Results

Run Against	Time period	# of Data Points	R^2	Adj R^2
Revenue	1998 – 2006	8	0.310	0.195
Operating Profit	1998 – 2006	8	0.039	(0.121)
Capital Employed	1998 – 2006	8	0.007	(0.159)

These do not have R^2 that reach our minimum of 0.8, and so we ran regressions against the outside variables:

Table 2: Single Regression Results Summary

Run Against	Time period	# of Data Points	R^2	Adj R^2	Max
Index	Weekly Long	299	0.011	0.007	
	Weekly Short	91	0.119	0.110	
	Monthly Long	70	0.195	0.183	
	Monthly Short	21	0.386	0.354	
	Quarterly Long	23	0.127	0.086	
	Quarterly Short	7	0.526	0.432	**MAX**
Oil Spot Prices	Weekly Long	299	0.001	(0.003)	
	Weekly Short	91	0.001	(0.011)	
	Monthly Long	69	0.002	(0.013)	
	Monthly Short	21	0.193	0.151	**MAX**
	Quarterly Long	23	0.000	(0.048)	
	Quarterly Short	7	0.214	0.057	
Oil Futures Prices	Weekly Long	299	0.001	(0.002)	
	Weekly Short	91	0.005	(0.006)	
	Monthly Long	69	0.001	(0.014)	
	Monthly Short	21	0.151	0.107	**MAX**
	Quarterly Long	23	0.001	(0.047)	
	Quarterly Short	7	0.164	(0.003)	

None of the above regressions give us an adjusted R^2 of at least 0.8, so we know doing a Multiple Regression is not necessary. However, as we were curious as to the effect on R^2 we ran them anyhow:

Table 3: Multiple Regression Results Summary

Run Against	Adj R^2	Max
Index, Spot & Future	0.404	**MAX**
Index & Spot	0.380	
Index & Future	0.356	
Spot & Future	0.157	

These also did not have R^2's that were acceptable.

2.3.2.3 Programming Difficulties

We were not able to find a strong enough regression model. In some cases perhaps it was due to lack of data points, but without contacting the firm to get their financial statements from when they had their IPO in 1989, it is hard to determine. For the other categories, perhaps there is just not a strong enough correlation for a regression model to be able to be made, as we know the renewable energy sector is seeing much growth because the pressures from global warming, pollution, and eminent shortages of non-renewable energies. Therefore, in order to determine Farmer Joe's investment return we decided to determine the net present value of a hypothetical plant built with his investment money, discounted at the firm's cost of equity (as he would be an equity holder).

2.3.2.4 Programming Difficulties Curtailed: NPV of Hypothetical Investment

In order to complete an analysis of a hypothetical investment, we must make some assumptions based on the firm's usual investment policies. Through researching the annual reports we can create the following hypothetical environment:

Year	2008
Project	Construct hydro plant in BC
Cost	Required investment amount ($162,975 and $5,593)
Expected Yearly kWh Produced	Required energy production for Farmer Joe (273,145.5 kWh and 9,373.5 kWh)
Fixed price contract	40 years with BC Hydro
Fixed price/kWh	$0.080
Funding	Assumed 100% through credit facility which is closed shortly before or after operations start; repayment of credit facility is assumed to be with new 10-year debenture at then effective current pre-tax interest rate of 6.21%
Debt repayment	Interest paid semi-annually with principle repaid at maturity
Amortization	Straight-line over 40 years
Fixed costs	10% of projected revenues
Variable costs	Negligible
Marginal tax rate	34.34%
Cost of Equity	10.79%

From the above we can calculate the cash flows to equity holders, and net present value, based on the estimated first year earnings and the cash-flows, as the fixed price contract and average yearly kWh's produced allows for a stable earnings year-by-year:

Estimated Earnings		
Year	**Scenario 1**	**Scenario 2**
Production mWh	273,145.5	9,373.5

Price	$0.080	$0.080
Revenue	21,852	750
Fixed Cost	(2,185)	(75)
Depreciation	(4,074)	(140)
Operating Income	15,592	535
Interest Expense	(10,121)	(347)
EBT	5,471	188
Tax	(1,879)	(64)
Net Income	3,592	123

We are assuming the same project length as can be expected from the solar and wind solution Farmer Joe could invest in for himself on his own farm, 30 years:

Scenario 1: Cash Flow			
Year	**0**	**1 to 30**	**Debt Repayment at Maturity (yr 10)**
Net income		$3,592	
+ depreciation		4,074	
- cap exp	($162,976)		
+new debt	162,976		($162,976)
CF to equity	-	7,667	
Cost of Equity	10.79%		
PV(CFs)	-	67,770	(58,495)
NPV to equity	**$9,275**		

Scenario 2: Cash Flow			
Year	**0**	**1 to 30**	**Debt Repayment at Maturity (yr 10)**
Net income		$123	
+ depreciation		140	
- cap exp	($5,593)		
+new debt	5,593		($5,593)
CF to equity	-	263	
Cost of Equity	10.79%		
PV(CFs)	-	2,326	(2,007)
NPV to equity	**$318**		

3 RESULTS AND OPTIMAL CHOICE

Based on the above calculations, we can summarize the results into the following table:

Table 4: Summary Results of the Alternatives and Scenarios

	Alternative 1		Alternative 2	
	3 Energy Types Replaced	2 Energy Types Replaced	3 Energy Types Replaced	2 Energy Types Replaced
Total Cost	$2,008,456	$72,316	$162,976	$5,593
NPV	(1,351,687)	(47,780)	9,275	318

It is clear from the above table that if we do not consider Farmer Joe's utility values, the alternative solutions would be:

- Based on lowest cost:
  Invest in Canadian Hydro for the amount it would cost him to cover his average yearly use of liquid propane gas and electricity
- Based on highest net present value:
  Invest in Canadian Hydro for the amount it would cost him to cover his average yearly use of liquid propane gas, electricity, and natural gas

However, we must take into consideration Farmer Joe's utility values for the alternatives, scenarios, costs and net present values, to determine the optimal solution for him personally. Once these are determined, we can then conduct the decision trees and determine which action will give him the greatest utility value.

3.1 Farmer Joe's Utility Functions

By taking our previous assumptions of Farmer Joe into consideration, we can determine the following utility truths for his person:

- Utilities for Alternatives

His utility for investing in Canadian Hydro is higher than for developing the energy on his farm himself, as he believes the global impact per dollar spent would be higher for the company, due to their economies of scale

Alternative 1: utility of 0.3

Alternative 2: utility of 0.7

- Utilities for Scenarios

He values the greater impact he would have on the environment by replacing three energy sources more than the much smaller impact he would make by just replacing the LPG and electricity

Scenario 1: utility of 0.8

Scenario 2: utility of 0.2

- Utilities for Cost

He values the "green" impact of his actions higher than the money it would cost him, so anything up to about $200,000 he is pretty indifferent, while above that amount, his utility drops drastically as he has limited funds

- Utilities for NPV

His utility for NPV losses is at almost indifferent between how much he would lose, because he deems a loss as a bad business decision and unnecessary

His decisions should have him breaking even at his hurdle rate at the bare minimum for him to determine the action would be acceptable

Above a break even, he is pretty indifferent between how much he earns, up until about $50,000, after which his utility would rise sharply

For his utilities for the cost and NPV values of the alternatives and scenarios please see the summary below:

Table 5: Utility Values for the Alternatives, Scenarios and Results

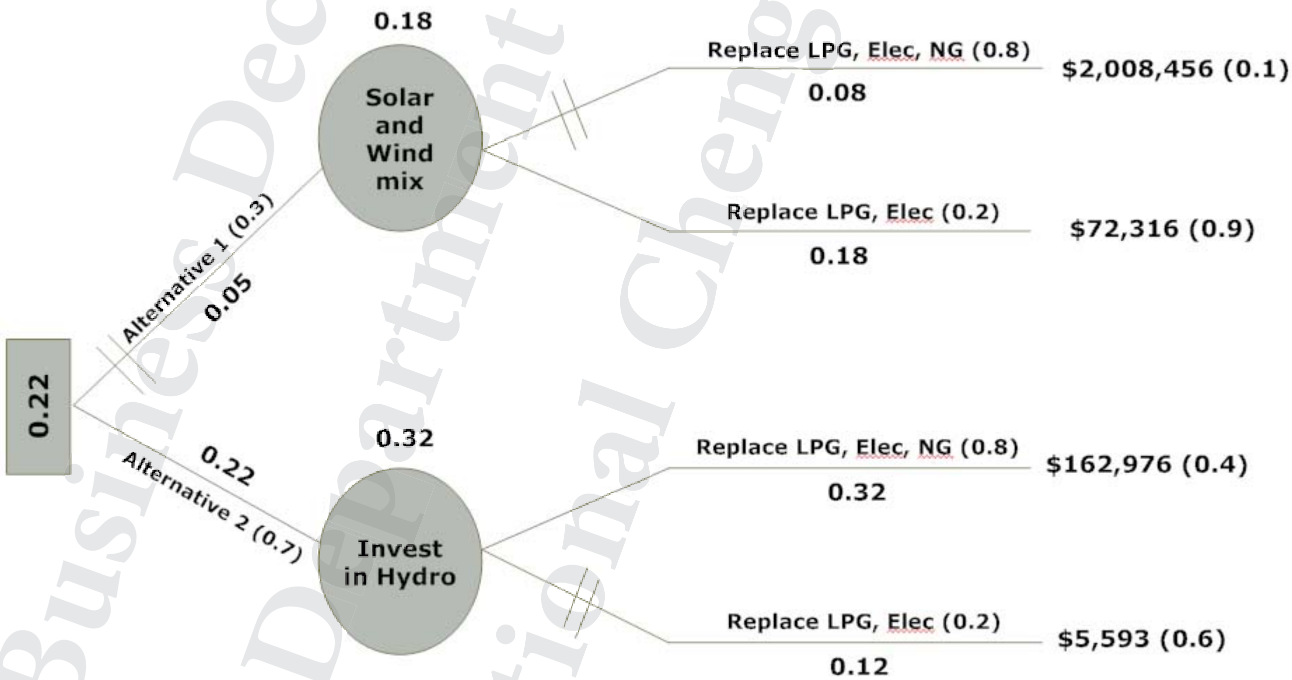
	Alternative 1 (Utility 0.3)		Alternative 2 (Utility 0.7)	
	3 Energy Types Replaced (Utility 0.8)	2 Energy Types Replaced (Utility 0.2)	3 Energy Types Replaced (Utility 0.8)	2 Energy Types Replaced (Utility 0.2)
Total Cost	$2,008,456	$72,316	$162,976	$5,593
Utility	0.1	0.9	0.4	0.6
NPV	(1,351,687)	(47,780)	9,275	318
Utility	0.4	0.6	0.6	0.4

We are now ready to determine Farmer Joe's optimal solution, by inputting his utility values into two decision trees, as he can base his choice on his cost, or on his net present value:

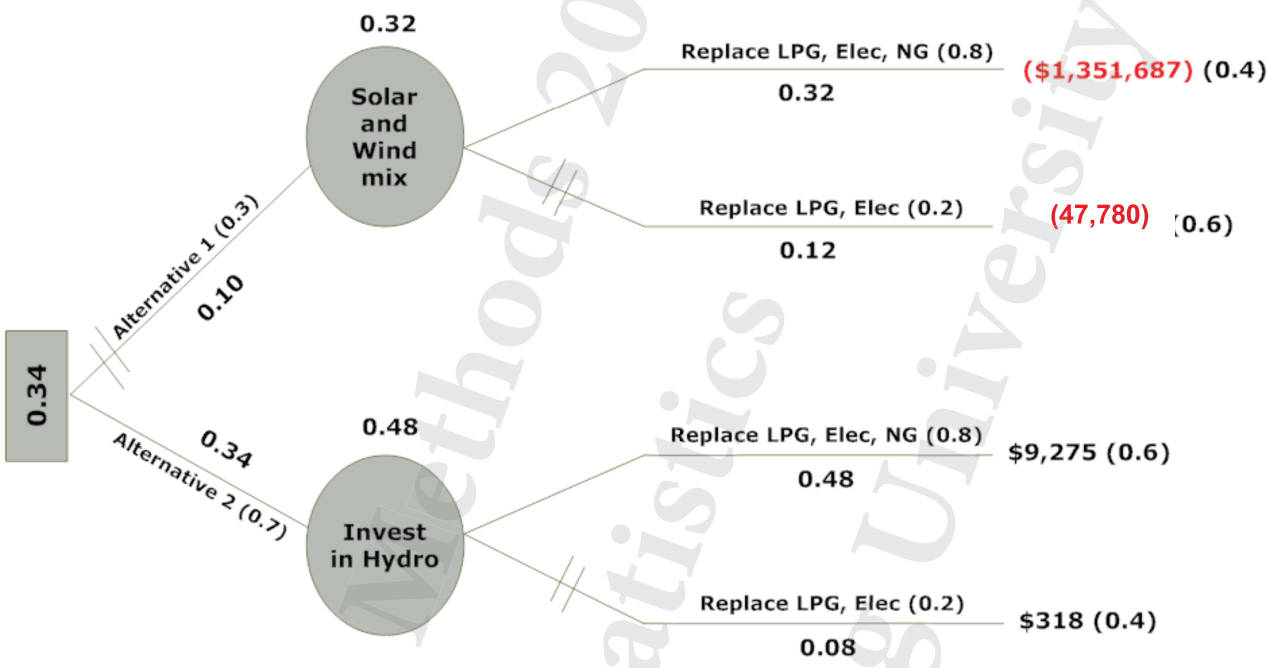
- Decision Tree based on Utility for Alternative, Scenario, and Cost
- Decision Tree based on Utility for Alternative, Scenario, and NPV

3.2 Decision Trees

Utility Decision Tree (Cost)



Utility Decision Tree (NPV)



3.3 Optimal Choice

We can summarize the decision tree results into the following table:

Table 6: Summary of Decision Tree Results

Decision Tree	Optimal Choice
Cost	Investment in Canadian Hydro, covering three energy types (alternative 2, scenario 1)
NPV	Investment in Canadian Hydro, covering three energy types (alternative 2, scenario 1)

Based on the above decision tree results, we can determine that the optimal solution for Farmer Joe is to invest in Canadian Hydro in the amount of $162,976.

4 ANALYSIS OF RESULTS

4.1 Comparative analysis

Canadian electricity costs are low: 5.3 cents/kWh when yearly consumption is less than 250,000 kWh (Ontario Tenants Rights, 2007), which has been shown to be a disincentive for the adoption of renewable energy technology on smaller scales (Dyer, 2005).

In terms of comparative cases, there was a similar case done south of Ontario, in the state of Minnesota. This case presents data analysis that can be used as a tool for evaluating the overall economic feasibility and generating characteristics for a hybrid wind–solar thermal electric power plant for any location with available wind, solar, electric load, and price data (Reichling & Kulacki, 2007).

The economic viability of the hybrid power plant project in Minnesota was cast in some doubt, as the energy it produced was only between 5% and 6% more valuable but costs almost twice as much to produce. Therefore, the results did not present an optimistic picture for a hybrid wind–solar thermal electric power plant in southwestern Minnesota, however, capital costs of the solar thermal system are currently greater than twice those of wind, and the added energy value is not large enough to overcome the additional capital costs. It is also considered that this outcome may change with time; as wind and solar thermal electric technologies are further developed.

Correspondingly, the value of electricity generated by the hybrid power plant in Minnesota was higher than that for the wind-only plant. Despite these advantages, the high capital cost of the solar component is significantly higher than that of the wind-only plant, making the hybrid plant economically unfeasible at that time for that location (Reichling & Kulacki, 2007).

Alternative Investment Opportunities Presented

The comparative study points out that Nevada is a much more suitable site for the hybrid power plant described because several Nevada wind sites are of equal quality to those modeled for Minnesota and the solar resource is comparable to that of El Paso, Mexico. And that at present, there is a 64MW solar thermal electric power plant under construction only 25 miles from Las Vegas in Nevada where wind conditions in this area are also favorable and another 80MW wind farm has been proposed for the same county.

Application of the methods described here may also be suitable for locations outside of the US. Several international studies have recently explored the potential of utility scale hybrid wind–solar electric power plants, with one study conducted for Turkey and another for the northeastern part of the Arabian Peninsula (Reichling & Kulacki, 2007). Other international on-shore projects where studies could be conducted include the GE Energy who supplied wind turbines worth $730 million to Energias de Portugal for its wind farm projects in Europe and the US (Contracts Blow In, 2007).

4.2 Sensitivity Analysis

When looking at a sensitivity analysis it is important to consider the following variables:

- Affecting the mix of solar and wind energy Farmer Joe could use to produce his required kWh amount
  - Change in the cost of the wind turbines and solar panels
  - Change in natural forces in Farmer Joe's area due to for example global warming
- Affecting his choice between alternatives
  - Technological advances significantly improving the amount of kWh produced by each wind turbine and solar panel
  - Significant decrease in cost per wind turbine and solar panel
  - Significant Increase in subsidies from the government (price per kWh purchased from Farmer Joe)

- Increase in hurdle rate (affecting NPV of the projects)
- Decrease in operational efficiencies in Canadian Hydro (affecting the kWh produced per capacity MW, and hence the cost, net income, and NPV of the cash flow)
- Change in Farmer Joe's utility values

From the above issues, it is not currently necessary to look a sensitivity analysis for the change in mix of wind turbines and solar panels for alternative 1, as the alternative is not currently being considered due to the losses being as big as they are, making this sensitivity analysis irrelevant at this time. As for a sensitivity analysis between alternatives, it is obvious that the changes would have to be so great, that when taking the current factors into consideration it is unreasonable to assume it would be possible to affect the outcome enough for Farmer Joe's optimal solution to change any time in the near future.

In the future, as significant changes occur, it would then be necessary to conduct the same analysis as we have done in this report, taking into consideration all other changes that have occurred as well.

5 CONCLUSION

Based on our findings we believe that Farmer Joe's optimal solution is to invest in Canadian Hydro. Considering that investing in Canadian Hydro will alleviate the costs of installation, maintenance and maintenance time it is in that respect more cost and time effective. Also, since Farmer Joe is very conscience of the environment and the future, his investment will not be in vain because it will contribute to the growth of this industry in the hope that it takes over polluting energies and in the end contributes to his earnings as his investment grows with the industry. Also, since Farmer Joe values his land very much, he will save the land that would be lost to the installation of the turbines and the solar panels.

There is a debate in the community on whether energy should be produced by individuals. It is Farmer Joe's belief that having larger scale energy production facilities that are regulated is the better way to go. This way, Farmer Joe believes everybody can profit from clean energy without having the hassle of purchasing and maintaining equipment individually. There is much to be said to economies of scale.

6 APPENDICES

6.1 Appendix A: Background on Canadian Hydro

Canadian Hydro Developers, Inc. (Canadian Hydro) is Canada's premier independent developer of EcoLogo®[1] certified low-impact renewable energy. Publicly listed since 1990, the company owns and operates eighteen green power facilities. Wind-generated electricity accounts for five sites and hydroelectric power twelve sites. Canadian Hydro's first biomass plant is located in Grande Prairie.

The environmental focus of Canadian Hydro is the foundation of its success. "In the future, the majority of the energy we consume will come from sustainable sources," says Canadian Hydro's Chief Executive John Keating. "That may be 50 or 100 years from now, but it's coming."

Canadian Hydro's 10 year Vision is to:

> *"Be the premier independent developer, builder and operator of renewable energy projects focusing on operational excellence, environmental stewardship and growth, empowering employees, and providing attractive returns to investors."*

The company's key competency is operational excellence as it relates to its strategy of design, building and operating their plants; this is also Canadian Hydro's competitive advantage.

By having an appropriate mix of low-impact, renewable power plants, located in different parts of the country, Canadian Hydro reduces its exposure to large overall

[1] (EcoLogo® is North America's most widely recognized and respected multi-attribute environmental certification mark)

variations in power generation through its technological and geographical diversification (www.canhydro.com/).

6.2 Appendix B: Regression Results

6.2.1 Share price to S&P/TSX Composite Index

Weekly Long	
MULTIPLE R	0.103563
R SQUARE	0.010725
Adjusted R SQUARE	0.007394
STANDARD ERROR	0.03948
OBSERVATIONS	299

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.005019	0.005019	3.219935	0.073763
RESIDUAL	297	0.462914	0.001559		
TOTAL	298	0.467933			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.002837	0.002299	1.234144	0.218125	-0.00169	0.007361	-0.00169	0.007361
X VARIABLE 1	0.241363	0.134507	1.794418	0.073763	-0.02335	0.506071	-0.02335	0.506071

Weekly Short

MULTIPLE R	0.3455932
R SQUARE	0.1194347
Adjusted R SQUARE	0.1095407
STANDARD ERROR	0.0280669
OBSERVATIONS	91

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0095093	0.0095093	12.071434	0.0007931
RESIDUAL	89	0.0701101	0.0007878		
TOTAL	90	0.0796194			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	-0.0002211	0.0029657	-0.0745424	0.9407461	-0.0061139	0.0056717	-0.0061139	0.0056717
X VARIABLE 1	0.5807934	0.1671638	3.4743969	0.0007931	0.2486425	0.9129443	0.2486425	0.9129443

Monthly Long	
MULTIPLE R	0.4412025
R SQUARE	0.1946597
Adjusted R SQUARE	0.1828164
STANDARD ERROR	0.060971
OBSERVATIONS	70

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0611016	0.0611016	16.436352	0.0001318
RESIDUAL	68	0.2527877	0.0037175		
TOTAL	69	0.3138892			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0078292	0.0075999	1.030169	0.306581	-0.0073362	0.0229945	-0.0073362	0.0229945
X VARIABLE 1	0.9518495	0.2347824	4.0541771	0.0001318	0.4833485	1.4203506	0.4833485	1.4203506

Monthly Short	
MULTIPLE R	0.6215479
R SQUARE	0.3863218
Adjusted R SQUARE	0.354023
STANDARD ERROR	0.0380606
OBSERVATIONS	21

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0173266	0.0173266	11.960854	0.0026321
RESIDUAL	19	0.0275236	0.0014486		
TOTAL	20	0.0448503			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	-0.0065118	0.0089636	-0.7264709	0.4764055	-0.0252727	0.0122492	-0.0252727	0.0122492
X VARIABLE 1	1.2098356	0.3498205	3.4584467	0.0026321	0.4776529	1.9420184	0.4776529	1.9420184

Quarterly Long	
MULTIPLE R	0.3567153
R SQUARE	0.1272458
Adjusted R SQUARE	0.0856861
STANDARD ERROR	0.1109039
OBSERVATIONS	23

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0376587	0.0376587	3.0617583	0.094755
RESIDUAL	21	0.2582934	0.0122997		
TOTAL	22	0.2959521			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0308752	0.025582	1.2069112	0.2408861	-0.0223255	0.084076	-0.0223255	0.084076
X VARIABLE 1	0.679176	0.3881476	1.7497881	0.094755	-0.1280211	1.4863731	-0.1280211	1.4863731

Quarterly Short	
MULTIPLE R	0.7254389
R SQUARE	0.5262616
Adjusted R SQUARE	0.4315139
STANDARD ERROR	0.0544667
OBSERVATIONS	7

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0164777	0.0164777	5.5543482	0.0650115
RESIDUAL	5	0.0148331	0.0029666		
TOTAL	6	0.0313108			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	-0.0365876	0.0301853	-1.2121004	0.2796206	-0.1141815	0.0410062	-0.1141815	0.0410062
X VARIABLE 1	1.7996891	0.7636264	2.3567665	0.0650115	-0.1632751	3.7626533	-0.1632751	3.7626533

6.2.2 Share price to Oil Spot Prices

Weekly Long	
MULTIPLE R	0.0239535
R SQUARE	0.0005738
Adjusted R SQUARE	-0.0027913
STANDARD ERROR	0.0396816
OBSERVATIONS	299

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0002685	0.0002685	0.1705074	0.6799592
RESIDUAL	297	0.4676642	0.0015746		
TOTAL	298	0.4679327			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0032276	0.0023056	1.3999309	0.1625777	-0.0013097	0.0077649	-0.0013097	0.0077649
X VARIABLE 1	0.0207374	0.0502207	0.4129254	0.6799592	-0.078096	0.1195708	-0.078096	0.1195708

Weekly Short	
MULTIPLE R	0.0260241
R SQUARE	0.0006773
Adjusted R SQUARE	-0.0105511
STANDARD ERROR	0.0298997
OBSERVATIONS	91

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	5.392E-05	5.392E-05	0.0603164	0.806562
RESIDUAL	89	0.0795654	0.000894		
TOTAL	90	0.0796194			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0011282	0.0031423	0.3590518	0.7204068	-0.0051154	0.0073719	-0.0051154	0.0073719
X VARIABLE 1	-0.0207098	0.0843253	-0.245594	0.806562	-0.1882623	0.1468428	-0.1882623	0.1468428

Monthly Long	
MULTIPLE R	0.0429538
R SQUARE	0.001845
Adjusted R SQUARE	-0.0130528
STANDARD ERROR	0.0683781
OBSERVATIONS	69

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.000579	0.000579	0.1238454	0.7260052
RESIDUAL	67	0.3132624	0.0046756		
TOTAL	68	0.3138415			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0173437	0.0084499	2.0525233	0.0440281	0.0004775	0.0342098	0.0004775	0.0342098
X VARIABLE 1	-0.0346948	0.098588	-0.3519167	0.7260052	-0.2314771	0.1620876	-0.2314771	0.1620876

Monthly Short	
MULTIPLE R	0.4397783
R SQUARE	0.193405
Adjusted R SQUARE	0.1509526
STANDARD ERROR	0.0436349
OBSERVATIONS	21

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0086743	0.0086743	4.5558116	0.0460534
RESIDUAL	19	0.036176	0.001904		
TOTAL	20	0.0448503			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0085952	0.009658	0.8899592	0.3846181	-0.0116192	0.0288096	-0.0116192	0.0288096
X VARIABLE 1	-0.3004676	0.1407715	-2.1344347	0.0460534	-0.5951058	-0.0058294	-0.5951058	-0.0058294

Quarterly Long	
MULTIPLE R	0.0096141
R SQUARE	9.243E-05
Adjusted R SQUARE	-0.0475222
STANDARD ERROR	0.1187083
OBSERVATIONS	23

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	2.735E-05	2.735E-05	0.0019412	0.9652735
RESIDUAL	21	0.2959247	0.0140917		
TOTAL	22	0.2959521			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0505493	0.0275442	1.8352037	0.0806803	-0.0067321	0.1078306	-0.0067321	0.1078306
X VARIABLE 1	-0.0091707	0.2081439	-0.0440592	0.9652735	-0.4420296	0.4236883	-0.4420296	0.4236883

Quarterly Short	
MULTIPLE R	0.4628608
R SQUARE	0.2142401
Adjusted R SQUARE	0.0570881
STANDARD ERROR	0.0701466
OBSERVATIONS	7

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.006708	0.006708	1.3632669	0.2956169
RESIDUAL	5	0.0246027	0.0049205		
TOTAL	6	0.0313108			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0256767	0.0279248	0.9194934	0.4000239	-0.0461064	0.0974598	-0.0461064	0.0974598
X VARIABLE 1	-0.297303	0.2546296	-1.1675902	0.2956169	-0.9518491	0.3572431	-0.9518491	0.3572431

6.2.3 Share price to Oil Future Prices

Weekly Long	
MULTIPLE R	0.0347982
R SQUARE	0.0012109
Adjusted R SQUARE	-0.002152
STANDARD ERROR	0.0396689
OBSERVATIONS	299

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0005666	0.0005666	0.3600773	0.5489209
RESIDUAL	297	0.467366	0.0015736		
TOTAL	298	0.4679327			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0031885	0.0023044	1.383609	0.1675172	-0.0013467	0.0077236	-0.0013467	0.0077236
X VARIABLE 1	0.02968	0.0494614	0.6000644	0.5489209	-0.0676592	0.1270192	-0.0676592	0.1270192

Weekly Short	
MULTIPLE R	0.0686299
R SQUARE	0.0047101
Adjusted R SQUARE	-0.006473
STANDARD ERROR	0.0298393
OBSERVATIONS	91

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.000375	0.000375	0.4211798	0.5180201
RESIDUAL	89	0.0792444	0.0008904		
TOTAL	90	0.0796194			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0009218	0.0031367	0.2938715	0.7695403	-0.0053108	0.0071544	-0.0053108	0.0071544
X VARIABLE 1	0.0575618	0.0886953	0.6489837	0.5180201	-0.1186739	0.2337975	-0.1186739	0.2337975

Monthly Long	
MULTIPLE R	0.0246129
R SQUARE	0.0006058
Adjusted R SQUARE	-0.0143105
STANDARD ERROR	0.0684205
OBSERVATIONS	69

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0001901	0.0001901	0.0406127	0.8408979
RESIDUAL	67	0.3136513	0.0046814		
TOTAL	68	0.3138415			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0170559	0.008454	2.0175055	0.0476512	0.0001817	0.0339301	0.0001817	0.0339301
X VARIABLE 1	-0.0197535	0.0980196	-0.201526	0.8408979	-0.2154015	0.1758945	-0.2154015	0.1758945

Monthly Short	
MULTIPLE R	0.3891116
R SQUARE	0.1514078
Adjusted R SQUARE	0.1067451
STANDARD ERROR	0.0447564
OBSERVATIONS	21

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0067907	0.0067907	3.3900251	0.0812612
RESIDUAL	19	0.0380596	0.0020031		
TOTAL	20	0.0448503			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0081698	0.0099037	0.8249208	0.4196533	-0.0125589	0.0288984	-0.0125589	0.0288984
X VARIABLE 1	-0.2648771	0.1438609	-1.8412021	0.0812612	-0.5659815	0.0362273	-0.5659815	0.0362273

Quarterly Long	
MULTIPLE R	0.0304049
R SQUARE	0.0009245
Adjusted R SQUARE	-0.0466506
STANDARD ERROR	0.1186589
OBSERVATIONS	23

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0002736	0.0002736	0.0194316	0.8904644
RESIDUAL	21	0.2956785	0.0140799		
TOTAL	22	0.2959521			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0516587	0.0274023	1.8851975	0.0733163	-0.0053274	0.1086448	-0.0053274	0.1086448
X VARIABLE 1	-0.0281792	0.20215	-0.1393973	0.8904644	-0.4485731	0.3922148	-0.4485731	0.3922148

Quarterly Short	
MULTIPLE R	0.4046932
R SQUARE	0.1637766
Adjusted R SQUARE	-0.0034681
STANDARD ERROR	0.0723641
OBSERVATIONS	7

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.005128	0.005128	0.9792631	0.3678207
RESIDUAL	5	0.0261828	0.0052366		
TOTAL	6	0.0313108			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0236266	0.0285747	0.8268351	0.4459812	-0.049827	0.0970801	-0.049827	0.0970801
X VARIABLE 1	-0.239095	0.2416133	-0.9895773	0.3678207	-0.8601817	0.3819917	-0.8601817	0.3819917

6.2.4 Share Price – Multiple Regressions

Index, Spot and Future Prices – Monthly Short	
MULTIPLE R	0.702296
R SQUARE	0.49322
Adjusted R SQUARE	0.403788
STANDARD ERROR	0.036565
OBSERVATIONS	21

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	3	0.022121	0.007374	5.515045	0.007852
RESIDUAL	17	0.022729	0.001337		
TOTAL	20	0.04485			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	-0.00304	0.009016	-0.33764	0.739768	-0.02207	0.015978	-0.02207	0.015978
Index Log	1.044613	0.359188	2.908266	0.00979	0.286794	1.802433	0.286794	1.802433
Spot Log	-0.95455	0.609547	-1.56599	0.135774	-2.24058	0.331484	-2.24058	0.331484
Futures Log	0.79558	0.60641	1.311951	0.206977	-0.48383	2.074992	-0.48383	2.074992

Index and Spot Prices – Monthly Short	
MULTIPLE R	0.6647629
R SQUARE	0.4419097
Adjusted R SQUARE	0.3798996
STANDARD ERROR	0.0372905
OBSERVATIONS	21

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	2	0.0198198	0.0099099	7.126422	0.0052522
RESIDUAL	18	0.0250305	0.0013906		
TOTAL	20	0.0448503			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	-0.0028698	0.0091937	-0.3121523	0.7585118	-0.0221852	0.0164455	-0.0221852	0.0164455
Index Log	1.0369206	0.366264	2.8310745	0.0110733	0.2674285	1.8064126	0.2674285	1.8064126
Spot Log	-0.1721394	0.1285601	-1.3389795	0.1972427	-0.4422342	0.0979554	-0.4422342	0.0979554

Index and Future Prices – Monthly Short	
MULTIPLE R	0.6481624
R SQUARE	0.4201145
Adjusted R SQUARE	0.3556828
STANDARD ERROR	0.0380117
OBSERVATIONS	21

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	2	0.0188423	0.0094211	6.5203054	0.0074145
RESIDUAL	18	0.026008	0.0014449		
TOTAL	20	0.0448503			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	-0.0037043	0.0093623	-0.3956654	0.6970022	-0.0233738	0.0159651	-0.0233738	0.0159651
Index Log	1.0766392	0.3727914	2.8880477	0.0097949	0.2934336	1.8598448	0.2934336	1.8598448
Futures Log	-0.1335244	0.130372	-1.0241802	0.3193183	-0.4074258	0.140377	-0.4074258	0.140377

Spot and Future Prices – Monthly Short	
MULTIPLE R	0.4910009
R SQUARE	0.2410818
Adjusted R SQUARE	0.1567576
STANDARD ERROR	0.0434854
OBSERVATIONS	21

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	2	0.0108126	0.0054063	2.8589862	0.0835131
RESIDUAL	18	0.0340377	0.001891		
TOTAL	20	0.0448503			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.0085092	0.0096253	0.8840523	0.388324	-0.0117127	0.0287312	-0.0117127	0.0287312
Spot Log	-1.0554796	0.723732	-1.4583846	0.1619634	-2.575984	0.4650248	-2.575984	0.4650248
Futures Log	0.7667904	0.7210811	1.0633899	0.3016638	-0.7481448	2.2817256	-0.7481448	2.2817256

6.2.5 Share Price to Operating Figures

Sales	
MULTIPLE R	0.5568663
R SQUARE	0.3101001
Adjusted R SQUARE	0.1951168
STANDARD ERROR	0.4191025
OBSERVATIONS	8

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.4737047	0.4737047	2.696914	0.15165
RESIDUAL	6	1.0538817	0.1756469		
TOTAL	7	1.5275864			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	-0.0229895	0.2194397	-0.1047644	0.9199772	-0.5599392	0.5139602	-0.5599392	0.5139602
X VARIABLE 1	1.0308132	0.6276918	1.6422284	0.15165	-0.5050932	2.5667196	-0.5050932	2.5667196

Operating Profit	
MULTIPLE R	0.1981778
R SQUARE	0.0392744
Adjusted R SQUARE	-0.1208465
STANDARD ERROR	0.4945691
OBSERVATIONS	8

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.0599951	0.0599951	0.2452798	0.6380312
RESIDUAL	6	1.4675913	0.2445986		
TOTAL	7	1.5275864			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.1903878	0.2044067	0.9314169	0.3875809	-0.3097773	0.6905529	-0.3097773	0.6905529
X VARIABLE 1	0.254213	0.5132949	0.4952573	0.6380312	-1.0017744	1.5102005	-1.0017744	1.5102005

Capital Employed	
MULTIPLE R	0.0832185
R SQUARE	0.0069253
Adjusted R SQUARE	-0.1585871
STANDARD ERROR	0.5028266
OBSERVATIONS	8

ANOVA

	DF	SS	MS	F	SIGNIFICANCE F
REGRESSION	1	0.010579	0.010579	0.0418417	0.8446841
RESIDUAL	6	1.5170073	0.2528346		
TOTAL	7	1.5275864			

	COEFFICIENTS	STANDARD ERROR	T STAT	P-VALUE	LOWER 95%	UPPER 95%	LOWER 95.0%	UPPER 95.0%
Intercept	0.286179	0.2766587	1.0344118	0.3408236	-0.3907804	0.9631385	-0.3907804	0.9631385
X VARIABLE 1	-0.1191591	0.5825354	-0.2045525	0.8446841	-1.5445718	1.3062537	-1.5445718	1.3062537

6.3 Appendix C: Government Policy Regarding Green Energy

The Canadian government, largely pressured to meeting the Kyoto emission level is implementing policies which are a driving force behind renewable energy development. Meeting the Kyoto target will challenge all Canadian governments and the energy industry to develop new and more effective strategies for speeding the development of sustainable energy to limit greenhouse gases (GHG) emissions. Some provinces are starting to set targets or consider renewable portfolio standards and are engaged in their implementation (Liminga, Haqueb, & Barg, 2006).

Fortunately for farmer Joe, the Canadian government and all major federal political parties have made explicit plans to move toward and promote cleaner, more renewable and efficient energy sources. The government of the province of Ontario, for example, has set its short-term and medium-term targets to generate 5% of total energy capacity from renewable sources by 2007, and 10% by 2010. The province has even ‘‘set aside’’ tradable emissions allowances for renewable energy projects and provides per project ‘allowances’ and tax regulations package with tax benefits (Ontario, 28 April 2004).

Moreover, the federal Income Tax Act allows taxpayers an accelerated write-off at up to 30% per year of equipment generating electricity from wind, hydro, biomass, solar PV (over 3 kW), geothermal and certain cogeneration systems. If Farmer Joe was to create a wind farm, the Income Tax Act would also allow him to fully deduct his first exploratory wind turbine in the year of its installation (Liminga et al., 2006).

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