Q. With reference to the Project **C-6, Installation of Variable Frequency Drives on Forced Draft Fans - Holyrood**, at pages 7-8 of the report filed in support of this Project (Volume I, Tab 2), Hydro provides the formula for determining the net present value of this Project, which includes as one of its factors the cost of a barrel of oil. The cost used in the formula is stated as being based on the Nalcor Energy Corporate Planning Forecast from January 2012 (the "Nalcor forecast cost").

(a) What is the Nalcor forecast cost of a barrel of oil, as applicable to the fuel required for the operation of the Holyrood in the years 2015 and 2016?

(b) Is the answer to (a) the forecast cost used in the net present value analysis, as summarized in Table 2, at page 8 of the report filed in support of this Project (Volume I, Tab 2), or was Nalcor forecast cost adjusted in any way before being inputed into the formula?

(c) Provide Hydro's detailed calculations for the net present value analysis, as summarized in Table 2.

(d) Is Hydro aware of any forecasts of the cost of a barrel of oil that are more recent than the Nalcor Energy Corporate Planning Forecast from January 2012? If yes, provide the range of costs of a barrel of oil, as applicable to the fuel required for the operation of the Holyrood in the years 2015 and 2016, indicated by those other forecasts.

(e) Provide the alternate calculations for the net present value analysis, as summarized in Table 2, if the range of costs of a barrel of oil identified in response to (d) were to be utilized instead of the Nalcor Energy Corporate Planning Forecast from January 2012.

(f) Apart from variability in the forecast cost of a barrel of oil, are there any other factors that could experience variability that would affect the net present value analysis for this Project, including any potential limitations/qualifications

outlined by Siemens regarding anticipated energy consumption of both systems?

A. (a) The forecast cost per barrel of oil is based on the corporate planning forecast from January, 2012 (includes prices from the PIRA Energy Group long term forecast, November, 2011), as follows:

2015: $133.10
2016: $137.50

(b) The fuel prices listed in the response to part (a) above, unadjusted, were used in the net present value analysis.

(c) As described in the report, the net present value analysis involves the following calculation:

Fuel Cost per year = MW * hours * barrels of oil/MWh * cost per barrel of oil

The components of this equation are as follows:

1. Cost per barrel of oil as provided in the response to part (a) above.

2. MW Consumption of Forced Draft Fan System, as provided by Siemens:
The table below illustrates the power consumption of the existing Inlet Vane Control (IVC) system and the proposed VFD system. As indicated, the fuel efficiency factor is dependent on the output of the unit.

Percent Unit Output at Holyrood	Forced Draft Fan Motor Load (MW)	
	IVC System	VFD System
20%	1.43	0.12
30%	1.61	0.15
40%	1.61	0.24
50%	1.71	0.32
60%	1.82	0.48
70%	1.93	0.69
80%	2.29	0.99
90%	2.38	1.40
100%	2.57	1.91

3. Holyrood Production Hours:

As described in the report, Hydro's forecast for the production at Holyrood includes the monthly average production at Holyrood for 2015 and 2016, the period during which the VFD system would be in operation.

For the purposes of this investigation, the forecast indicates that Unit 1 will be in operation for the full two-year period and Units 2 and 3 would be brought online as required. It should be noted that Unit 1 and Unit 2 are nearly identical units and, in reality, both machines would be dispatched such that their operating hours would be approximately equal. This discrepancy will not impact the CPW analysis because the total forecasted energy for Unit 1 and Unit 2 is accurately represented.

Month	# days unit on			Energy per Unit, GWh			Average Power per Unit, MW		
	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3
31-Jan-15	31	31	31	78.2	78.2	78.2	105.1	105.1	105.1
28-Feb-15	28	28	28	73.6	73.6	73.6	109.6	109.6	109.6
31-Mar-15	31	31	31	77.5	77.5	77.5	104.2	104.2	104.2
30-Apr-15	30	30	0	74.9	74.9	0.0	104.1	104.1	0.0
31-May-15	31	0	0	85.3	0.0	0.0	114.6	0.0	0.0
30-Jun-15	30	0	0	67.9	0.0	0.0	94.3	0.0	0.0
31-Jul-15	31	0	0	75.9	0.0	0.0	102.0	0.0	0.0
31-Aug-15	31	0	0	73.7	0.0	0.0	99.0	0.0	0.0
30-Sep-15	30	0	0	85.8	0.0	0.0	119.1	0.0	0.0
31-Oct-15	31	10	0	86.4	27.9	0.0	116.1	116.1	0.0
30-Nov-15	30	30	12	85.7	85.7	34.3	119.0	119.0	119.0
31-Dec-15	31	31	31	83.5	83.5	83.5	112.2	112.2	112.2
31-Jan-16	31	31	31	89.8	89.8	89.8	120.7	120.7	120.7
29-Feb-16	29	29	29	87.3	87.3	87.3	125.4	125.4	125.4
31-Mar-16	31	31	31	91.6	91.6	91.6	123.2	123.2	123.2
30-Apr-16	30	30	0	107.3	107.3	0.0	149.0	149.0	0.0
31-May-16	31	8	0	100.9	26.0	0.0	135.6	135.6	0.0
30-Jun-16	30	0	0	103.1	0.0	0.0	143.2	0.0	0.0
31-Jul-16	31	0	0	107.6	0.0	0.0	144.7	0.0	0.0
31-Aug-16	31	0	0	102.4	0.0	0.0	137.6	0.0	0.0
30-Sep-16	30	0	0	126.0	0.0	0.0	175.0	0.0	0.0
31-Oct-16	31	24	0	89.5	69.3	0.0	120.3	120.3	0.0
30-Nov-16	30	30	19	100.2	100.2	63.4	139.1	139.1	139.1
31-Dec-16	31	31	31	97.9	97.9	97.9	131.6	131.6	131.6

4. Holyrood Plant Conversion Rate (kWh/BBL):

   For the purposes of this analysis, Holyrood conversion rates are based on a regression analysis using actual plant production data from 2001-2010. As indicated, the conversion rate is dependent on unit output.

Percent Unit Output at Holyrood	Conversion Rate (kWh/Bbl)
20%	562
30%	593
40%	612
50%	624
60%	633
70%	640
80%	645
90%	650
100%	651

Hydro would typically use the approved Test Year conversion rate of 630 kWh/bbl, regardless of plant output. However, as the analysis of VFD system efficiency requires a breakdown of plant operation at discrete load levels, it was appropriate to use the figures listed in the table above.

5. Maintenance Costs

In addition to fuel saving, the installation of the VFD system would impact maintenance costs. Based on information provided by Siemens, maintenance costs for the new VFD system are estimated to be in the order of $30,000 during the operating period. This compares to an estimate of $40,000 for the existing IVC system. These figures were included as part of the CPW.

The results of the base case net present value analysis as provided in the report are summarized in the following table. The results are in 2012 dollars, based on a discount rate of 7.0 percent.

Install Variable Frequency Drives on 6 FD Fans

Alternative Comparison
Cumulative Net Present Value
To The Year
2016

Alternatives	Cumulative Net Present Value (CPW)	CPW Difference between Alternative and the Least Cost Alternative
Status Quo	10,278,019	4,343,355
VFD	5,934,664	0

(d) Updated prices for the cost of a barrel of oil according to PIRA are listed below:

November, 2011 Forecast:	2015: $133.10	2016: $137.50
March, 2012 Forecast:	2015: $135.30	2016: $138.90
May, 2012 Forecast:	2015: $107.60	2016: $111.80

(e) A sensitivity analysis was performed based on the minimum fuel prices from the PIRA forecast of May, 2012 as provided in response to part (d) above. All other parameters are the same as the base case. The results are summarized in the following table.

Install Variable Frequency Drives on 6 FD Fans		
Alternative Comparison ***Cumulative Net Present Value*** ***To The Year*** **2016**		
Alternatives	**Cumulative Net Present Value (CPW)**	**CPW Difference between Alternative and the Least Cost Alternative**
Status Quo	8,340,378	2,858,307
VFD	5,482,071	0

(f) The net present value analysis is sensitive to:

1) Fuel price;
2) The efficiency improvement of the VFD system over the original IVC system;
3) Production at Holyrood; and
4) Holyrood conversion rate.

The fuel price was addressed in the response to part (e) above. The efficiency improvement, Holyrood production, and Holyrood conversion rate are presented in Sensitivity #1, Sensitivity #2, and Sensitivity #3 respectively.

Sensitivity #1 – Reduction in VFD Efficiency

This sensitivity case was presented in the original report. It examines the case where the efficiency improvement of the VFD system over the original IVC system is reduced to 40 percent of the specified value. As indicated, there is still a CPW preference for the VFD system.

Sensitivity Values (Efficiency Improvement reduced to 40 percent of that specified by Siemens):

Percent Unit Output at Holyrood	Forced Draft Fan Motor Load (MW)	
	IVC System	VFD System
20%	1.43	0.91
30%	1.61	1.03
40%	1.61	1.06
50%	1.71	1.15
60%	1.82	1.28
70%	1.93	1.43
80%	2.29	1.77
90%	2.38	1.99
100%	2.57	2.31

All other parameters are the same as the base case.

Install Variable Frequency Drives on 6 FD Fans **Alternative Comparison** ***Cumulative Net Present Value*** ***To The Year*** **2016**		
Alternatives	**Cumulative Net Present Value (CPW)**	**CPW Difference between Alternative and the Least Cost Alternative**
Status Quo	10,278,019	205,248
VFD	10,072,771	0

Sensitivity #2 – Reduction in Production Hours

This sensitivity analysis examines the case where the production at Holyrood is reduced to approximately 30 percent of the specified value. As indicated, there is still a CPW preference for the VFD system.

1 Modified Holyrood Production Values for Sensitivity Analysis:

Month	# days unit on			Energy per Unit, GWh			Average Power per Unit, MW		
	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3
31-Jan-15	31	0	0	70.4	0.0	0.0	94.6	0.0	0.0
28-Feb-15	28	0	0	66.3	0.0	0.0	98.6	0.0	0.0
31-Mar-15	31	0	0	69.8	0.0	0.0	93.8	0.0	0.0
30-Apr-15	30	0	0	50.4	0.0	0.0	70.0	0.0	0.0
31-May-15	31	0	0	0.0	0.0	0.0	0.0	0.0	0.0
30-Jun-15	30	0	0	0.0	0.0	0.0	0.0	0.0	0.0
31-Jul-15	31	0	0	0.0	0.0	0.0	0.0	0.0	0.0
31-Aug-15	31	0	0	0.0	0.0	0.0	0.0	0.0	0.0
30-Sep-15	30	0	0	50.4	0.0	0.0	70.0	0.0	0.0
31-Oct-15	31	0	0	52.1	0.0	0.0	70.0	0.0	0.0
30-Nov-15	30	0	0	61.7	0.0	0.0	85.7	0.0	0.0
31-Dec-15	31	0	0	75.1	0.0	0.0	101.0	0.0	0.0
31-Jan-16	31	0	0	80.8	0.0	0.0	108.6	0.0	0.0
29-Feb-16	29	0	0	78.6	0.0	0.0	112.9	0.0	0.0
31-Mar-16	31	0	0	82.5	0.0	0.0	110.9	0.0	0.0
30-Apr-16	30	0	0	64.4	0.0	0.0	89.4	0.0	0.0
31-May-16	31	0	0	52.1	0.0	0.0	70.0	0.0	0.0
30-Jun-16	30	0	0	50.4	0.0	0.0	70.0	0.0	0.0
31-Jul-16	31	0	0	52.1	0.0	0.0	70.0	0.0	0.0
31-Aug-16	31	0	0	52.1	0.0	0.0	70.0	0.0	0.0
30-Sep-16	30	0	0	50.4	0.0	0.0	70.0	0.0	0.0
31-Oct-16	31	0	0	52.1	0.0	0.0	70.0	0.0	0.0
30-Nov-16	30	0	0	79.1	0.0	0.0	109.9	0.0	0.0
31-Dec-16	31	0	0	88.1	0.0	0.0	118.5	0.0	0.0

2 All other parameters are the same as the base case.

Install Variable Frequency Drives on 6 FD Fans		
Alternative Comparison ***Cumulative Net Present Value*** ***To The Year*** **2016**		
Alternatives	**Cumulative Net Present Value (CPW)**	**CPW Difference between Alternative and the Least Cost Alternative**
Status Quo	3,975,659	467,795
VFD	3,507,863	0

Sensitivity #3 – Conversion Rate as per RSP Application

This sensitivity examines the case where a flat Holyrood Conversion rate of 630kWh/bbl is used for the analysis (as per the 2012 RSP Application). All other parameters are the same as the base case.

Install Variable Frequency Drives on 6 FD Fans		
Alternative Comparison ***Cumulative Net Present Value*** ***To The Year*** **2016**		
Alternatives	**Cumulative Net Present Value (CPW)**	**CPW Difference between Alternative and the Least Cost Alternative**
Status Quo	10,392,082	4,230,078
VFD	6,162,004	0