18. Reference: KM Report Summary of Findings Page xxxvii

a) Please provide KM's estimates of the potential hydraulic generation shortfalls under current energy resources (from an average output of 29,000 GWh) for the following drought periods;

- Fiscal 2002/02 to 2004
- Fiscal 1987/88 to 1991/92 (Basis for 5-year drought)
- Fiscal 1936/37 to 1942/43 (Basis for 7-year drought)

Answers:

1) Fiscal 2002/02 to 2004

First, the average generation over the entire period 1912-2005 is 30067 GWh and this is the average that we will use in the calculations. Second, we will not make a distinction between calendar and fiscal year and no real distinction between Hydro generation and other generation given the small share of the other sources in total generation. The short fall is defined by the sum of generation for 2001/02 of 28990 GWH and 2002/03 of 20182 GWH deducted from the average of 2 times 30067 is 10962 GWh.

2)For Fiscal 1987/88 and 1991/92 the total generation is 117,233 GWH the average over these five years is 150,335, the shortfall is 33,102 GWh.

3) For Fiscal years 1936/37 to 1942/43 the total generation was 168,712 GWh and average generation for the 7 year period is 210,469 for a shortfall of 41,757 GWh.

b) On an order of magnitude basis would KM agree that the other significant historical droughts could have seen potential hydraulic generation shortfalls as follows:

- 1980/81 to 1984/85 – Similar but less than 1987/88 To 1991/92
- 1976/77 to 1977/78 – Somewhat greater than 2002/03 to 2004/05
- 1960/61 to 1962/63 – Similar to 1980/81 to 1984/85
- 1929/30 to 1933/34 – Similar to 1987/88 to 1991/92

Answers:

The fiscal year designations are not used. Calendar years are used instead and comparability in terms of time is also assumed. This is not the way the questions were specified, but the way we designated the comparisons appear to me more reflective of the intentions of the questions.

1) 1980-1984 generation totaled 135,426 GWh is larger than the 1987-1991 generation of 117,233 GWh.
2) 1976-78 generation was 52,565 GWh while 2002-2004 generation was 49,172 GWH.
3) 1960-1963 generation was 111,535 GWH while in 1980-1983 generation was 108,692
4) 1929-1933 generation was 123,028 GWh while in 1987-91 it was 117,233.

c) Would KM agree that the financial impact of the hydraulic generation shortfall in 2002/03 to 2004/05 fiscal years would have been exceeded by at least six other drought periods?

Answer: This depends on a number of factors other than shortfall in generation. The costs of non-hydro generation, the cost of imports and the prevailing electricity rates will be key determinants of the financial losses during droughts.

d) Would KM agree that MH's worst drought on record would currently have an aggregate hydraulic generation shortfall almost 4x greater than the 2002/03 to 2004/05 drought period?

Yes we can confirm that the shortfall from average generation over the years 1937-41 was four times the shortfall from average generation between 2001-2004.

e) Would KM agree that MH's designated 5-year drought (reflective of 1987/88 to 1991/92) would currently have an aggregate hydraulic generation shortfall about 2x greater than 2002/03 to 2004/05?

Answer: KM cannot confirm this proposition. The total shortfall between 1987-92 from average generation is only 2500 GWH. This is a third of the shortfall between 2002-2005.

19. Reference: KM Report Summary of Findings (p. xxxvii), Table 6.2 p. 229, PUB/MH I-206 (a)

"low water flows have the largest impacts on net revenue of MH. A total of $788 million can be lost on account of the worst drought on record".

a) Please confirm that a $788 million revenue loss in one year (excluding finance expenses) is substantially greater than the net income loss of $424 million recorded in 2003/04.

Answer: During the Hearing KM found a few mistakes in its reported calculations that we have since corrected. The correction involved a minor impact from a typographical mistake involving the royalties but more seriously was the mistake involving generation level. As things stand after the corrections, we calculate a total loss of $758 million in net revenues excluding interest but using low generation corresponding to 1940 water flows and generation and including high import prices. This loss is for one year from the base year revenue of $445 million. When interest expenses are included, but low flows of 1940 are assumed and high import prices are used, the net loss is $811 million from a base case loss of $23.4 million.

b) Please confirm that MH's 5 year drought analysis included a one year net revenue shortfall of $742 million under current demand conditions and 1988/89 (flows) indicating a hydraulic generation shortfall of 10,700kwh.

The new calculations are not consistent with these numbers.

c) Please confirm that the hydraulic generation shortfall with 1941/42 flow conditions and current generation facilities should have much greater net revenue losses than 1988/89. Explain.

Answer: Yes we can confirm this, all other things being equal. This is so because the generation losses corresponding to 1940/41 water flows are lower than those in 1988/89.

20. Reference: MH Annual Report – 2010 (p. 100/101)

a) Please confirm that in 2003/04 MH suffered a net income loss (including finance expenses) of $436 million resulting from a net revenue reduction of about $500 to $600 million.

Answer: The $436 million loss was the estimate given by MH of its net revenue losses in 2003/04.

b) Please confirm that MH's 2003/04 hydraulic generation shortfall was about 10,000 GWH which with IFF09-1 export price forecasts beyond 2011/12 would potentially result in much higher revenue reductions.

Answer: The loss of about 10,000 GWh in generation in 2003 will impact net revenues in proportion to export and import prices. The higher both of these prices are the larger the losses.

21. Reference: PUB/MH I-206(a)

a) Can KM confirm that that MH in PUB/MH I-206(a) as attached indicated that a 5 year drought would see a total hydraulic generation shortfall of 33,246 GWH (compared to IFF09-1 output assumptions)?

b) Did KM arrive at a similar total hydraulic generation in their 5-year drought analysis?

Answer: Using the historical record, the worst five years drought involved a shortfall of 35,000 GWh. This is the benchmark number used.

c) What total hydraulic generation did KM arrive at in their 7-year drought analysis?

Answer: KM adjusted the 35000 GWh by a factor of 7/5.

22. Reference: PUB/MH BOD 9, p. 42 SEP Sales prices, PUB/MH BOD 34, Q.2 & Q.3 of 2004/05 Q.1 of 2006/07

a) Was KM aware that MH offers a "Surplus Energy Program " (SEP) to industrial customers at market prices for peak, shoulder and off-peak energy as determined from MISO real time and day-ahead sales

KM have reviewed Order No. 20/10 February 10, 2010 which detailed the approval of PUB of MH's February 9, 2010 application for ex-parte approval of the revised SEP prices and the extension of this practice to March 31, 2013.

The offer is for interruptible supplies offered by MH to the Utility's "opportunity exports" or import costs with a surcharge (10%). The expectation is that SEP will break even on weekly basis.

b) Was KM aware that MH in June to October of 2009/10 was offering surplus energy to SEP industrial customers and also was making off-peak summer (night time) sales into the MISO market at <1.0 ¢/kwh; in effect covering only water rental and transmission charges?

KM examined Appendices A-D of Order 20/10 that show that for a limited period in Mid October 2010 this price fell to around $12.5 per MWH for average Spot Market prices. In Nov and December this average spot price increased to a range between $40 and $60 a MWh. But indeed in 2009 this price for Off Peak energy was below 1 cent per KWh for 20 weeks (Appendix D).

c) Would KM agree in Pub/MH BOD 34 (p.72), it can be shown that MH was also offering off-peak surplus energy to MH's SEP industrial customers (and by inference to MISO market) at less than 1 cent/kwh for:

- 16 weeks in 2005

- 12 weeks in 2006

Answer: We do not have these prices in 2005 and 2006 but KM confirms that in 2009 it went below 1 cent for 20 weeks.

23. Reference: PUB/MH Appendix 56 Market Planning Conditions J. Flynn May 31/2010

a) In Appendix 56, MH has provided (p. 7 & 8 of the J. Flynn presentation on "MH market considerations for planning"), typical variable production costs from existing generation which suggest these variable costs could range from:

- Coal generation 1.7 to 2.2 ¢/kwh
- CCCT generation 3.0 to 6.0¢ /kwh (Natural Gas cost $3-7/GJ)
- GT (peaker generation) 4.0 to 7.5 ¢/kwh (Natural Gas cost $3-7/GJ)

Can KM explain what MISO market circumstances would require MH to offer off-peak energy at less than the variable production costs (fuel and operating) in order to sell its off-peak hydraulic energy?

Answer: KM cannot justify selling electricity at below variable cost. It is possible to supply in the short run electricity at below average total cost as long as average variable cost and some average fixed cost is covered.

b) Did KM determine what percentage of the off- peak (7x8 overnight) MISO market trading was being supplied by MH?

Answer: KM did not go into this kind of detailed analysis.

c) What in KM"s view would be the impact on MH"s off-peak sales if MH offered energy in the MISO market at a minimum price of 1.5 ¢/kwh or at a minimum price of 2.0 ¢/kwh?

Answer: The real applicable consideration here is that average variable costs should not exceed price.

d) In KM's view is MH the lowest price provider of off-peak (7x8 overnight) energy in the MISO market?

Answer: There is a downward pressure on price offerings in the MISO market. Suppliers target prices that would allow them to qualify for merit prices. Of course this is conditional on prices that would cover average variable costs.

24. Reference: PUB/MH BOD 35 P. 78, BOD 3 P. 10, BOD 35 P. 76,

a) When KM speaks of Risk Misalignment –Could this have been the case in 2003/04 when the Board understands that MH sold 6917 GWh as exports including about 1000 GWh in excess of dependable contract commitments?

Answer: Dependable energy is a constraint that should not be violated to be consistent with acceptable risk management best practice.

b) Was KM aware that after incurring a $436 million net loss, MH sought rate increases from PUB which led to rate increases of:

• 5.0% as of Apr. 1, 2004	$33M/yr
• 2.25% as of Oct. 1, 2004	$22M/yr
• 2.25% as of Apr. 15, 2005	$23M/yr
	$80M/yr

Answer: KM are aware of these rate increases' targets for the stipulated years above.

c) Was KM aware that MH achieved ongoing future revenue gains of $80M/yr totaling over $500M since F 2004?

Answer: KM were aware of this.

d) Was KM aware that in 2003/04 MH undertook to buy-back about 2500 GWh and import about 7000 GWh of energy in order to satisfy firm commitments?

Yes KM are aware of these buy backs.

e) Would KM agree that if MH had started 2003/04 with an additional 5000 GWh (9200 GWh instead of 4200 GWh) of energy in storage as of April 1st the drought costs might have been reduced by about 50% and that lower rate increases could have resulted?

Answer: KM has argued for prudent and more conservative management of water resources even when this may entail some potential losses in good years in order to be covered in bad ones.

f) Was KM aware that the 2003/04 shortfall came about in part because in 2002/03 MH sold:

- 3,900 GWh (dependable)
- 3,300 GWh (opportunity time)
- 3,000 GWh (day ahead and real-time opportunity)
- 10,200 GWh TOTAL

Answer: KM would not go that far. With hindsight it makes sense to have MH refrain from selling in the opportunity market when it had the choice not to do so. MH must balance a number of divergent factors. It makes sense to refrain from selling in the opportunity market when indicators are tipping in the direction of a shortage.

g) Was KM aware that about half of this energy was sold in the last 8 months of 2002/03 when MH reduced energy storage by 10,200 GWh from 14,400 GWh down to 4,200 GWh?

Answer: KM is not aware of the particular time profile of the sales. The losses at the end of the year are persuasive enough that a different sale strategy would have been preferred.

h) Please confirm that if MH had a policy of minimum April 1st energy in storage of 9,200 GWh the 2002/03 sales would have been down by 5,000 GWh or by about $100-$200M (with a 2-4 ¢/ KWh value). Confirm on this basis there would have been an additional 5,000 GWh in 2003/04 which would have been worth about $250-300M (based on a 5-6 ¢/KWh value)

Answer: The answer depends on two propositions being correct. First, that MH has indeed a policy of maintaining a minimum of 9,200 GWh in storage and second, if the price level ranges sketched in sub-question (h) were to hold. If both of these propositions are true, KM see no difficulty in confirming the calculations.

LIST OF UNDERTAKINGS from pp. 6642-6644 of transcripts

Intro

Many of the following answers have been taken from the KM supplemental document "Manitoba Public Utilities Board. Manitoba Hydro's Application for Approval of New Electricity Rates for 2010/11 and 2011/12" dated June 10, 2011, which contains a more thorough and comprehensive description of some extra calculations that KM did with its Chapter 6 model in order to address some of the concerns raised during our testimony at the hearing.

The supplemental documents is attached as appendix "A".

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Doctors Kubursi and Magee to produce a spreadsheet including information from Exhibit KM-10 and Statistics Canada

The following 6 tables present information in a similar format to KM-10, and are drawn from some subsequent simulations that KM have done.

Table 1 - Overall Benchmark, All Random, No Interest Costs

Component	Value	Distribution
Hydro Generation	33,404	Extreme Value
Wind	350	
Coal	717	
Total Generation	34471.07	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	5,215	Weibull
Provincial Exports Non-Firm	607	Triangular
Imports US	1,718	Extreme Value
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	0.00%	
Gross Revenue	1,528,236,620	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	183,537,970	
Import Costs		
US	81,696,674	
CDN	12,712,848	
Revenue Net of Imports	1,446,539,945	
Revenue Net of All Costs	434,318,968	

Table 2 - Overall Benchmark, All Random, Including Interest Costs

Component	Value	Distribution
Hydro Generation	33,404	Extreme Value
Wind	350	
Coal	717	
Total Generation	34471.07	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	5,215	Weibull
Provincial Exports Non-Firm	607	Triangular
Imports US	1,718	Extreme Value
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	6.47%	
Gross Revenue	1,528,236,620	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	183,537,970	
Import Costs		
US	81,696,674	
CDN	12,712,848	
Revenue Net of Imports	1,446,539,945	
Revenue Net of All Costs	- 22,775,603	

Table 3 - 1940 Minimum Flows (Using the Intercept), No Interest Costs

Component	Value	Distribution
Hydro Generation	18,770.2	
Wind	350	
Coal	717	
Total Generation	19837.20	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	5,247	
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	0.00%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	249,455,450	
CDN	12,712,848	
Revenue Net of Imports	1,248,418,413	
Revenue Net of All Costs	236,197,436	

Table 4 - 1940 Minimum Flows (Using the Intercept), With Interest Costs

Component	Value	Distribution
Hydro Generation	18,770.2	
Wind	350	
Coal	717	
Total Generation	19837.20	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	5,247	
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	6.47%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	249,455,450	
CDN	12,712,848	
Revenue Net of Imports	1,248,418,413	
Revenue Net of All Costs	- 220,897,135	

Table 5 - 2.5% Quantile (Using the Intercept), No Interest Costs

Component	Value	Distribution
Hydro Generation	15,836.6	
Wind	350	
Coal	717	
Total Generation	16903.60	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	8,181	
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	0.00%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	388,917,542	
CDN	12,712,848	
Revenue Net of Imports	1,108,956,321	
Revenue Net of All Costs	96,735,344	

Table 6 - 2.5% Quantile (Using the Intercept), Including Interest Costs

Component	Value	Distribution
Hydro Generation	15,836.6	
Wind	350	
Coal	717	
Total Generation	16903.60	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	8,181	
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	6.47%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	388,917,542	
CDN	12,712,848	
Revenue Net of Imports	1,108,956,321	
Revenue Net of All Costs	- 360,359,227	

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Doctors Kubursi and Magee to provide the calculations of the relationship between flow and generation assumed in the model

KM took the water flow (Annual System Inflow, Kcfs) and generation (MH Hydraulic Energy, GWh/yr) data measured annually from flow years 1912 to 2005, contained on p.312 in Tab 75 of MIPUG 2010/11 & 2011/12 GRA/RISK BOOK OF DOCUMENTS and estimated two linear regression lines, one without an intercept (the steeper line in the plot on the next page) and one with an intercept, using the econometric software package *Stata*. The numerical results are given below. The *Stata* output is provided in Table 9.

Ordinary Least Squares Regressions

Without Intercept: *energy = 262.42 water_flow*
(2.35)

With Intercept: *energy = 8499.43 + 190.20 water_flow*
(1024.32) (8.69)

(Standard errors in parentheses. They are Newey-West st. errs. with lag=3. lag is set at three in accordance with the recommendation that it be set equal to the nearest integer to the sample size raised to the power 0.25.)

The standard errors are computed using the Newey-West technique, which accounts for autocorrelation and heteroskedasticity of unknown form in the error terms. (The 'regular' standard errors are slightly smaller than these reported ones.) The *t*-ratio on the intercept term is 8.30, which is highly statistically significant, which favours using the regression line with intercept to impute the generation numbers for the drought scenarios. The with-intercept line lies above the no-intercept line at low water flow levels, reflecting extra generation from prudent use of water storage. The with-intercept line lies below the no-intercept line at high water flow levels, reflecting lost generation from spillage. Since both statistical and practical considerations favour the use of the with-intercept regression line, KM has adopted it for this round of calculations.

Table 9 - STATA Output from Regressions

```
 tsset year
        time variable:  year, 1912 to 2005

 newey energy water, noconstant lag(3)

Regression with Newey-West standard errors          Number of obs  =        94
maximum lag: 3                                      F(  1,     93) =  12428.33
                                                    Prob > F       =    0.0000

------------------------------------------------------------------------------
             |             Newey-West
      energy |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       water |   262.4177   2.353894   111.48   0.000     257.7434    267.0921
------------------------------------------------------------------------------

. newey energy water, lag(3)

Regression with Newey-West standard errors          Number of obs  =        94
maximum lag: 3                                      F(  1,     92) =    478.83
                                                    Prob > F       =    0.0000

------------------------------------------------------------------------------
             |             Newey-West
      energy |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       water |   190.1997   8.691983    21.88   0.000     172.9367    207.4628
       _cons |   8499.427   1024.317     8.30   0.000     6465.044    10533.81
```

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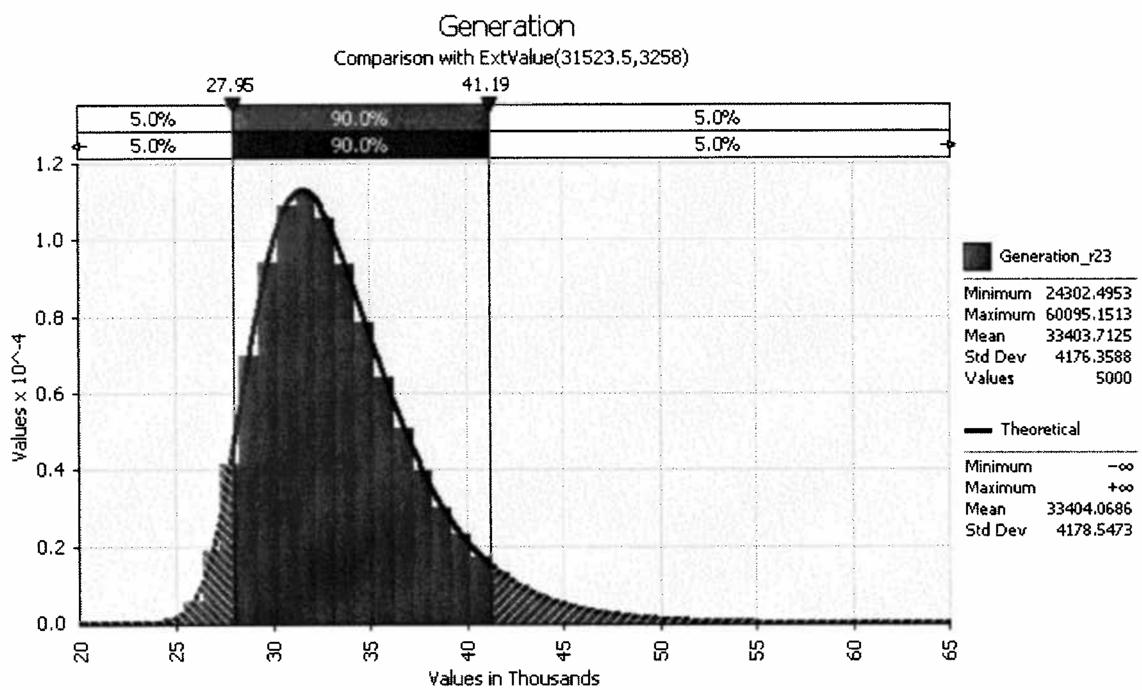
Doctors Kubursi and Magee to provide, in the event that six point four four (6.44) on page 260 is not the probability distribution used in the base case, what in fact is that probability distribution

Figure 9 – Generation Probability Distribution (GWh)



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Doctors Kubursi and Magee to indicate where they got the data, with respect to average water flows

From Manitoba Hydro: "MH System Uncontrolled Inflow (Kcfs)". Data is reproduced on page 311 of KM report.

155
Doctors Kubursi and Magee to provide the formula which is shown on KM-13 applied to the two (2) scenarios identified, the first one is the 54 kcfs flow, and the second one is thirty-eight point five seven six (38.576) flow, and what the computer then assumed was the generation resulting from that flow

Original report used equation without intercept:
energy = 262.42 water_flow

If water flow = 54 *then energy = 14170.68 GWh/yr*
If water flow = 38.58 *then energy = 10123.11 GWh/yr*

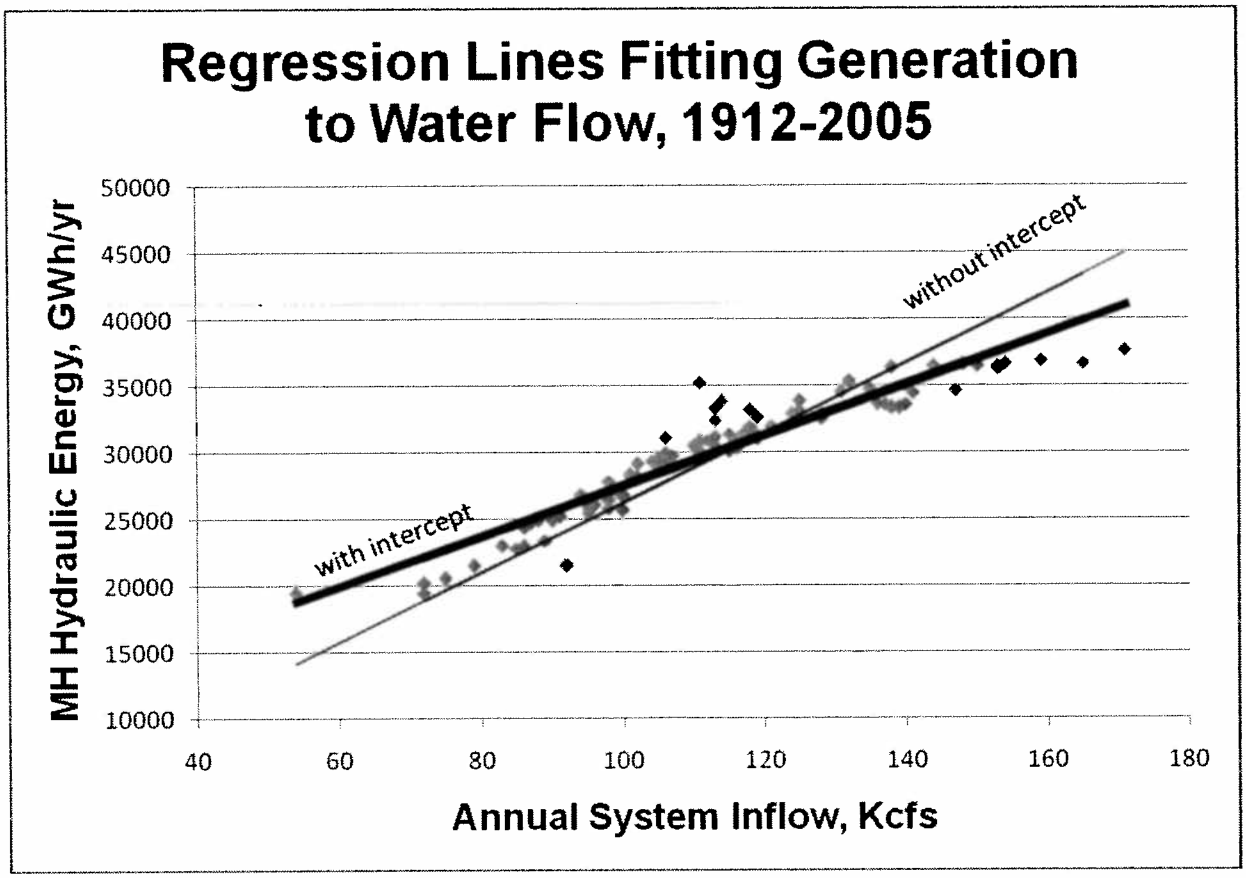
Our revised calculations included here used equation with intercept:
energy = 8499.43 + 190.20 water_flow

If water flow = 54 *then energy = 18770.23 GWh/yr*
If water flow = 38.58 *then energy = 15836.59 GWh/yr*

156
Doctors Kubursi and Magee to provide numbers, in regards to Table 6.1 on page 227, for wind and thermal generation

Wind: 350 GWh/yr
Coal: 717 GWh/yr

157
Doctors Kubursi and Magee to plot the formula set out in KM-13 against data relating to Manitoba Hydro hydraulic energy and annual system inflows for the period 1912-2005, as set out in Manitoba Hydro's response to PUB-1-81



158
Doctors Kubursi and Magee to provide any data that was provided by any party that is not included on the record

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MEMO TO:	**L.A.B. Notes to File**	**February 6, 2010**
FROM:	**Larry Buhr**	**Energy in Storage after 2003/04**

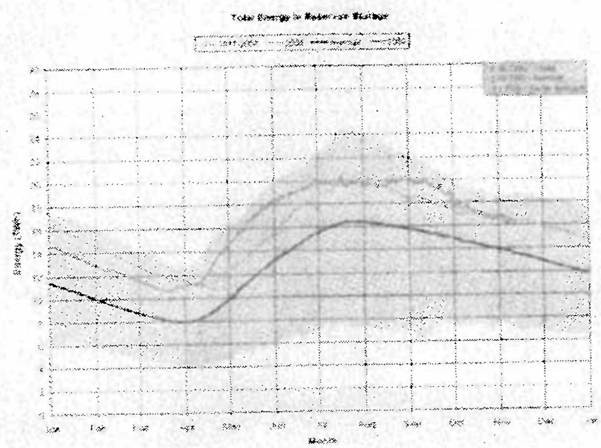


Figure 8.6.3. Total Energy in Reservoir Storage

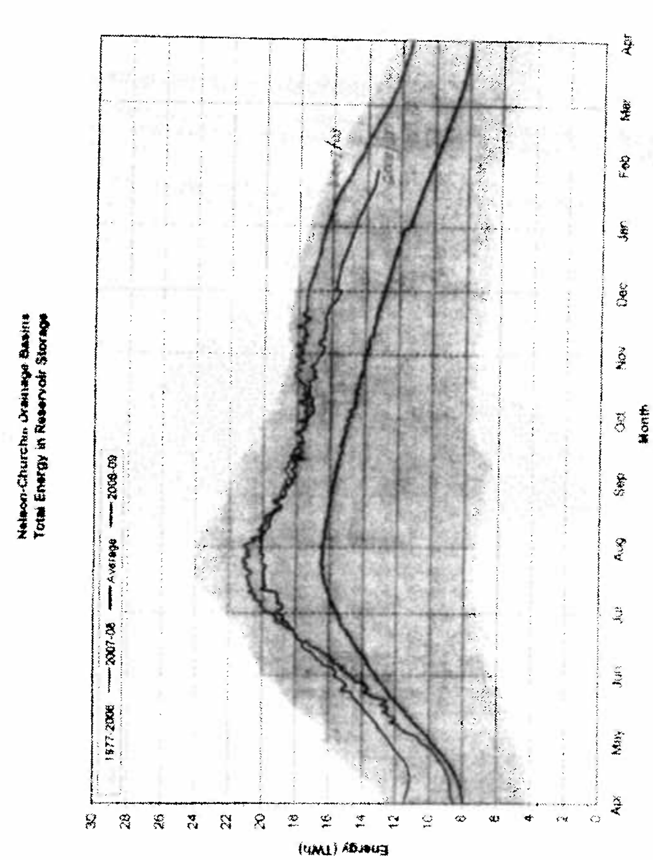
Total Hydraulic Generation

The history of Total Hydraulic Generation since the in-service of Limestone GS is shown in Figure 8.6.4. Total hydraulic generation is forecast to exceed 34 TW.h for fiscal year 2009/10 potentially making it the third highest hydraulic generation year on record

C:\Documents and Settings\Owner\Local Settings\Temporary Internet Files\Content.IE5\23AY93TT\February 6-10 LAB Memo to File Energy in Storage in 2003-04.doc

PRIVILEGED & CONFIDENTIAL

MEMO TO:	**L.A.B. Notes to File**	**February 6, 2010**
FROM:	**Larry Buhr**	**Energy in Storage after 2003/04**



159
Doctors Kubursi and Magee to produce names of engineers involved in developing models at BC Hydro and Quebec Hydro 6800

Quebec

Tom Halliburton (Stochastic and Dynamic Programming) - Quebec
Mario Periera (Stochastic Dual Dynamic Programming)- Quebec
Michael Gendreau (Stochastic and Non-linear programming) - Quebec.

BC

Daniel Frances - Stochastic Programming
T.K.Sui and (Dynamic Programming)

160
Doctors Kubursi and Magee to use the data from PUB 1-81, in terms of annual system inflow and Manitoba hydraulic energy tested using a simple regression, and by simple regression, ordinary least-square regression of water flow on generation with zero intercept, and as to how that would fit the data

This is addressed above.

161
Doctors Kubursi and Magee to examine Table 3 and comment on its contents

KM contacted Stat Can and got referred to this statement SC made about the quality of data of their publication Electric Power Generation, Transmission and Distribution.
Please see the following information provided by Statistics Canada regarding this table:

> Electric Power Generation, Transmission and Distribution: Data quality, concepts and methodology:
> Methodology and data quality
>
> Statistics Canada
> www.statcan.gc.caSkip to content | Skip to institutional links Common menu bar
> linksFrançais HomeContact UsHelpSearchcanada.gc.caHome > Publications > 57-202-X
> Electric Power Generation, Transmission and Distribution > Data quality,

concepts and methodology > Site navigation menu
(primary)Publications

2007

Highlights
Analysis
Tables
Data quality
Appendices
User information
PDF version

Page content follows Data quality, concepts and methodology: Methodology and data quality This publication presents annual commodity and operating statistics on the electric utility industry in Canada (code 2211 of the North American Industrial Classification System, catalogue number 12-501-XPE). For completeness, the report also provides data on industrial establishments with generating facilities.

Statistics on the supply and disposition of electric energy are compiled from an annual survey of all power producers in Canada (approximately 340 producers). The response rate for this survey is very high. As a consequence, minimal imputation is required and minimal bias resulting from non-response is introduced in these data. Exports and imports information are obtained from the National Energy Board.

Financial and operating statistics are compiled from an annual survey of major electric utilities in Canada. The response rate for this survey is very high. As a consequence, minimal imputation is required and minimal bias resulting from non-response is introduced in these data. Installed generating capacity data are obtained from an annual survey of electric utilities and industrial establishments which have at least one plant with total generating capacity of over 500 KW. The survey covers some 1100 generating stations.

Data published in this report are subject to a certain degree of error, be it in
differences in the interpretation of the questions, or mistakes introduced
during processing. Reasonable efforts are made to ensure these errors are kept
within acceptable limits through careful questionnaire design, liaison with
major respondents, editing of data for inconsistencies and subsequent follow-up
and quality control of manual processing operations.Date Modified: 2009-04-20

162
Doctors Kubursi and Magee to check Figure 6.38 to determine where the negative number comes from

It was not possible to recover the values of the random variables for the particular replication that produced that negative number.

163
Doctors Kubursi and Magee to advise if they have seen any of the following documentation: master purchase and sale agreements, the electricity transaction confirmations, the natural gas transaction confirmations, the storage injection and withdrawal schedules, the option transaction confirmations, the corporate import/export policies and procedures, and any export strategy documentation

No, KM has not seen any of these documents directly. KM saw references to it and uses made from some of these documents by KPMG and The NYC.

Manitoba Public Utilities Board

Manitoba Hydro's Application for Approval of New Electricity Rates for 2010/11 and 2011/12

Submitted By

Dr. Atif Kubursi

and

Dr. Lonnie Magee

June 10, 2011

Introduction

A number of questions were raised about KM's quantification of Manitoba Hydro's risks. The questions focused on the translation of water flows into generation, whether KM used a ratio method and a shorter time series than the entire water flow data and the assumptions made about the particular probability distributions associated with the various variables. There were also questions about the data particularly the number for 2007 on royalties paid and the change that would make when the correct number is used. There were also issues not raised at the hearing about the consistency of the data and results across the board of the simulations that KM reconsidered by reviewing thoroughly and directly each scenario.

The results of this re-assessment, corrections and filling in the gaps are presented in this document. Our intent in this note addressing the undertakings is to present a consistent, verifiable, replicable and accurate set of results that address the questions raised during the hearing and even go beyond the questions to represent corrected and defensible results.

For each scenario presented below we have a Table and a Figure that represent the input data and the output results. Each Table could be used to regenerate and check and validate our results. The logic of the scenarios is simple. We begin with treating all but two variables (Wind and Thermal energy) as random variables. We use Statistics Canada data for the period 2001-2007 on all the variables that enter into the determination of the key result (Net Income). Different probability distributions are fitted to the seven year data and the ones with lowest Chi-Square scores are chosen as these suggest that the distribution chosen represents the best fit from where this data could have been picked.

Two benchmark cases are identified. The first calculates not income exclusive on interest costs and the other inclusive of these costs. Effective interest rates are used (total interest payment divided by total long term debt. There are issues about this use as interest payments on borrowing for capital formation are capitalized. We opted to use the strongest stress test by assuming that interest payments are expensed annually.

Once the benchmarks are defined, a number of stress tests are performed by changing a variable or a combination of variables at a time and highlighted the impact of these stresses on Net Income. The key variables that are dealt with here include flows and generation during the worst drought recorded over the period 1912 and 2005, those that resulted from our simulations for the average minima that are worse that the 1940 flows and the combination of the worst historical drought conditions with high import prices. Several other variables were allowed to change one at a time including, the exchange rate, interest rates, different cost elements, etc. but these changes showed results that are no different from those in the Report (Chapter Six) and are therefore left out of this note.

One of the critical assumptions that we made in the Report is the use of the ratio method (technically, this means that we used an estimate of the direct coefficient that links generation to water flows and we used it for a short period 2001-2007). In this note we estimated this coefficient (translating water flows Kcfs into generation GWh) using an intercept. The latter suggests that there is no one-to-one correspondence between water flows and generation as other variables (water management, storage capacities, drawbacks, etc) can influence this relationship.

We report on the results of both fits in Table 9 and Figure 13. The intercept specification is chosen as the statistical significance of the intercept is high. This choice changed the translation of water flows in any given period into a given generation output. Specifically it raised the generation level we used for the scenarios defining low flows and reduced the estimates of actual and opportunity cost of droughts.

The full results of the various stress scenarios are in Table 10. The discussion of the actual results, their significance and the way they relate to earlier results in the KM Report are the last section of this note.

At this point, we would like to highlight the following correspondences to the undertakings:

First, we corrected the data in Table 6.1 in regard to royalty expenses in 2007 and this correction is reflected in all of the results in this note.

Second, we refitted the distribution of royalty expenses and these are in Figure 11. There is no longer a ludicrous negative tail.

Third, we refitted generation and its probability distribution is displayed in Figure 9. In the KM Report what was referred to as the probability distribution was in fact that for load. We have displayed in Figure 10 the probability distribution of Load. All of these corrections will be made to the Report and a corrected copy would be filed with the Board.

Fourth, also included in this note is the missing probability distribution from the KM Report of the price of foreign imports. This is now presented in Figure 12.

Fifth, we have avoided the use of Curtailable Generation that was used in some of the scenarios in the KM Report. Since we opted to put all of our data in a transparent and replicable way, we were concerned that Curtailable levels would expose terms of contracts that are subject to the Confidentiality Agreement we signed with MH.

The full ~~of~~ display of the distributions and results are in the sections to follow. First, we display the graphs of the Monte Carlo results on Net Revenues associated with the various scenarios beginning with the two critical benchmarks and then the various stress cases. This followed by the corrected or missing probability distribution functions. A separate section is devoted to the regression estimation of generation as a function of water flows. Finally, the results are summarized and discussed.

Figure 1 – Overall Benchmark, All Random, No Interest Costs

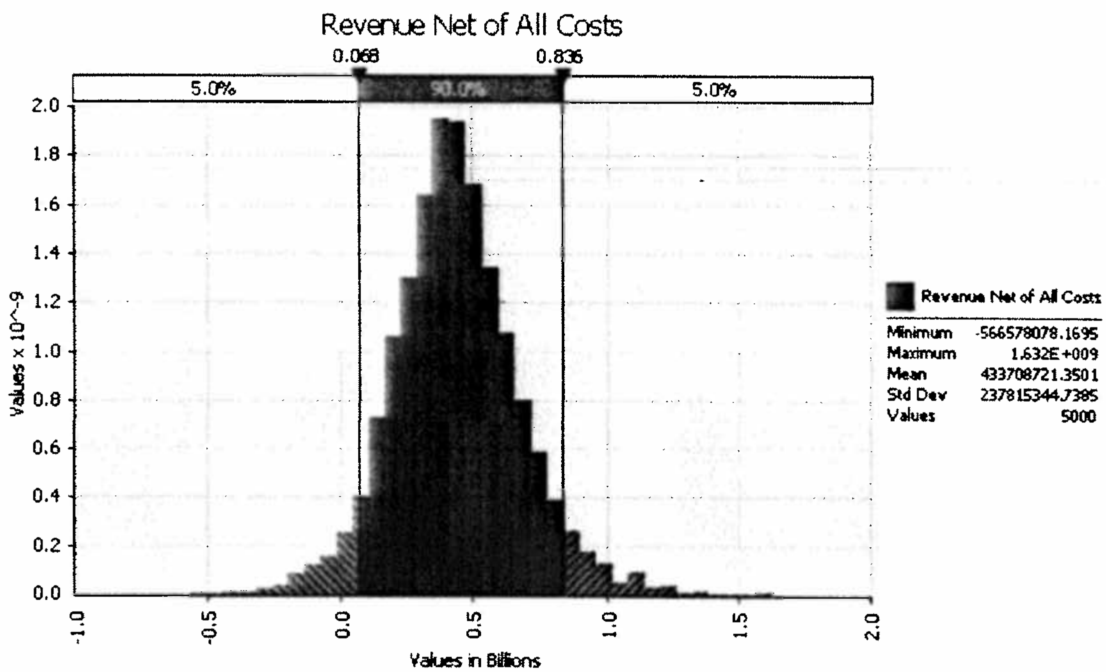


Figure 2 – Overall Benchmark, All Random, Including Interest Costs

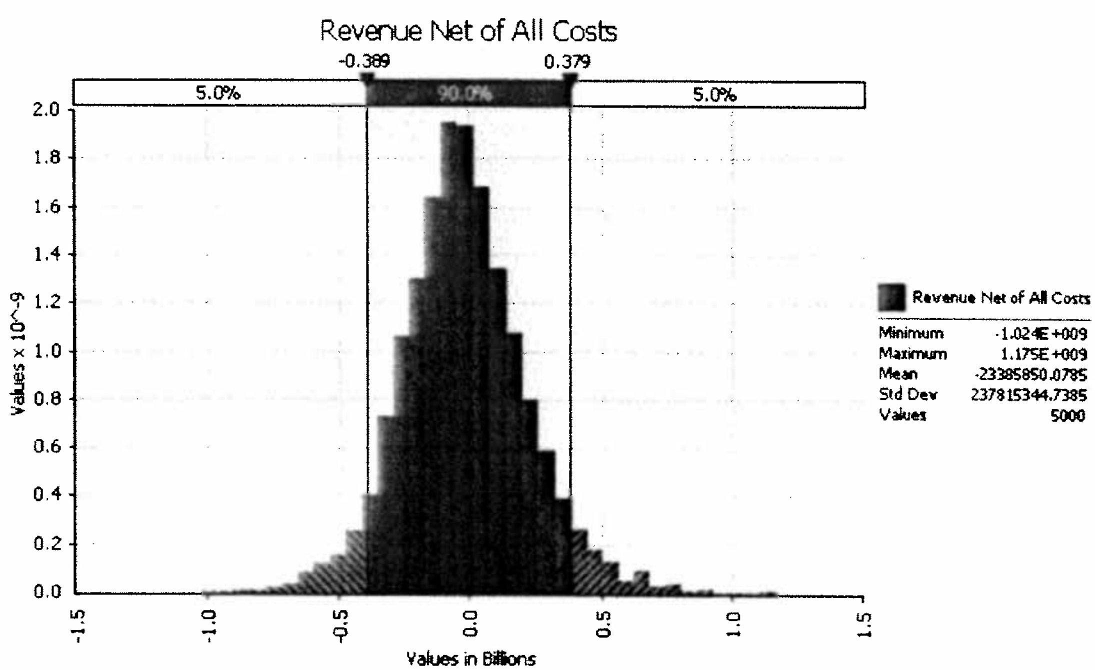


Table 1 - Overall Benchmark, All Random, No Interest Costs

Component	Value	Distribution
Hydro Generation	33,404	Extreme Value
Wind	350	
Coal	717	
Total Generation	34471.07	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	5,215	Weibull
Provincial Exports Non-Firm	607	Triangular
Imports US	1,718	Extreme Value
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	0.00%	
Gross Revenue	1,528,236,620	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	183,537,970	
Import Costs		
US	81,696,674	
CDN	12,712,848	
Revenue Net of Imports	1,446,539,945	
Revenue Net of All Costs	**434,318,968**	

Table 2 - Overall Benchmark, All Random, Including Interest Costs

Component	Value	Distribution
Hydro Generation	33,404	Extreme Value
Wind	350	
Coal	717	
Total Generation	34471.07	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	5,215	Weibull
Provincial Exports Non-Firm	607	Triangular
Imports US	1,718	Extreme Value
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	6.47%	
Gross Revenue	1,528,236,620	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	183,537,970	
Import Costs		
US	81,696,674	
CDN	12,712,848	
Revenue Net of Imports	1,446,539,945	
Revenue Net of All Costs	**- 22,775,603**	

Figure 3 – 1940 Minimum Flows (Using the Intercept), No Interest Costs

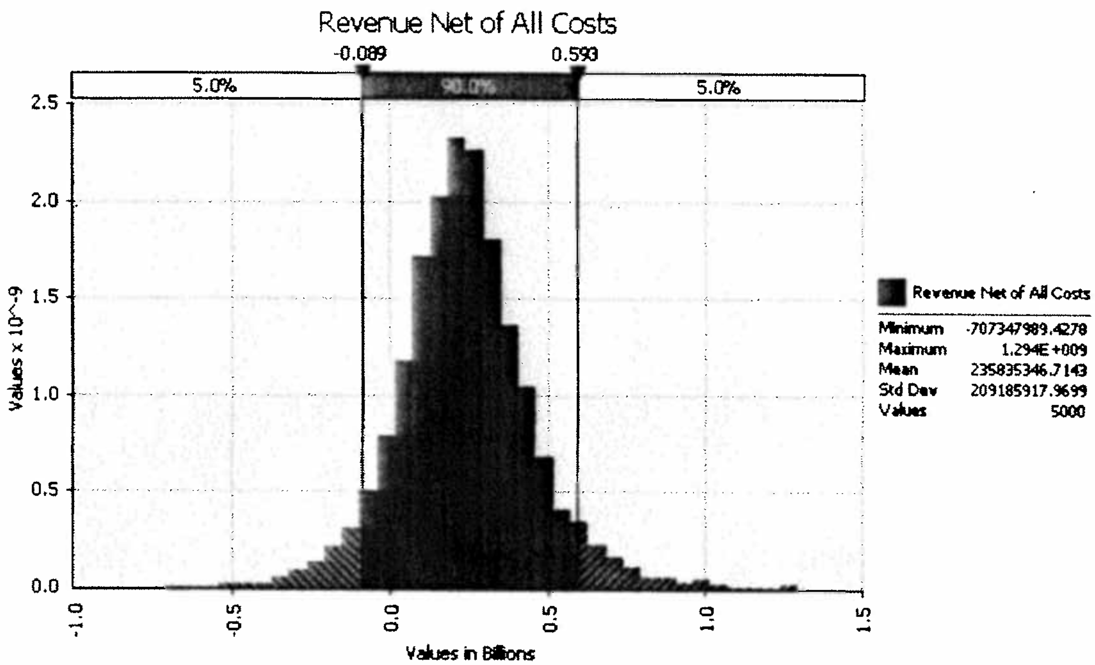


Figure 4 – 1940 Minimum Flows (Using the Intercept), Including Interest Costs

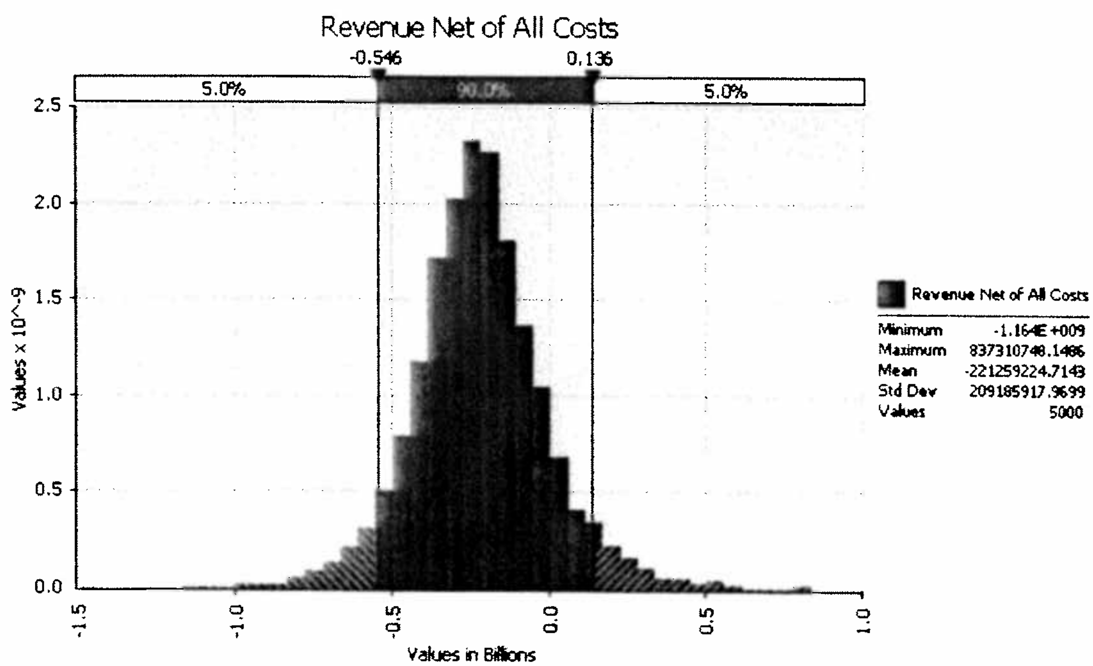


Table 3 - 1940 Minimum Flows (Using the Intercept), No Interest Costs

Component	Value	Distribution
Hydro Generation	18,770.2	
Wind	350	
Coal	717	
Total Generation	19837.20	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	5,247	
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	0.00%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	249,455,450	
CDN	12,712,848	
Revenue Net of Imports	1,248,418,413	
Revenue Net of All Costs	**236,197,436**	

Table 4 - 1940 Minimum Flows (Using the Intercept), With Interest Costs

Component	Value	Distribution
Hydro Generation	18,770.2	
Wind	350	
Coal	717	
Total Generation	19837.20	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	5,247	
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	6.47%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	249,455,450	
CDN	12,712,848	
Revenue Net of Imports	1,248,418,413	
Revenue Net of All Costs	**- 220,897,135**	

Figure 5 – 2.5% Quantile (Using the Intercept), No Interest Costs Included

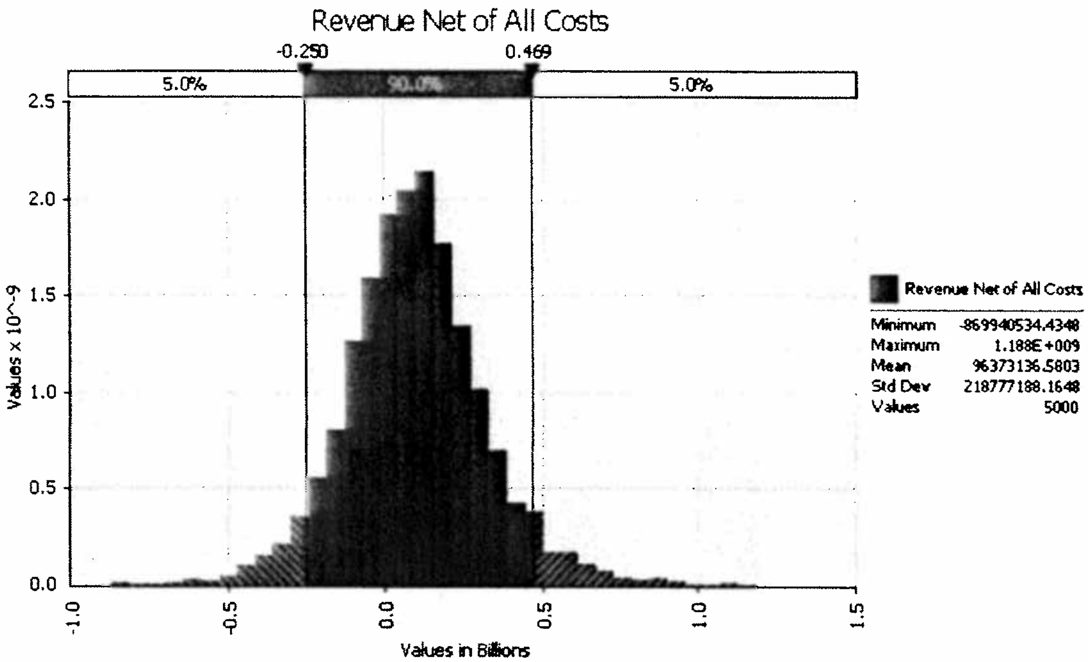


Figure 6 – 2.5% Quantile (Using the Intercept), Interest Costs Included

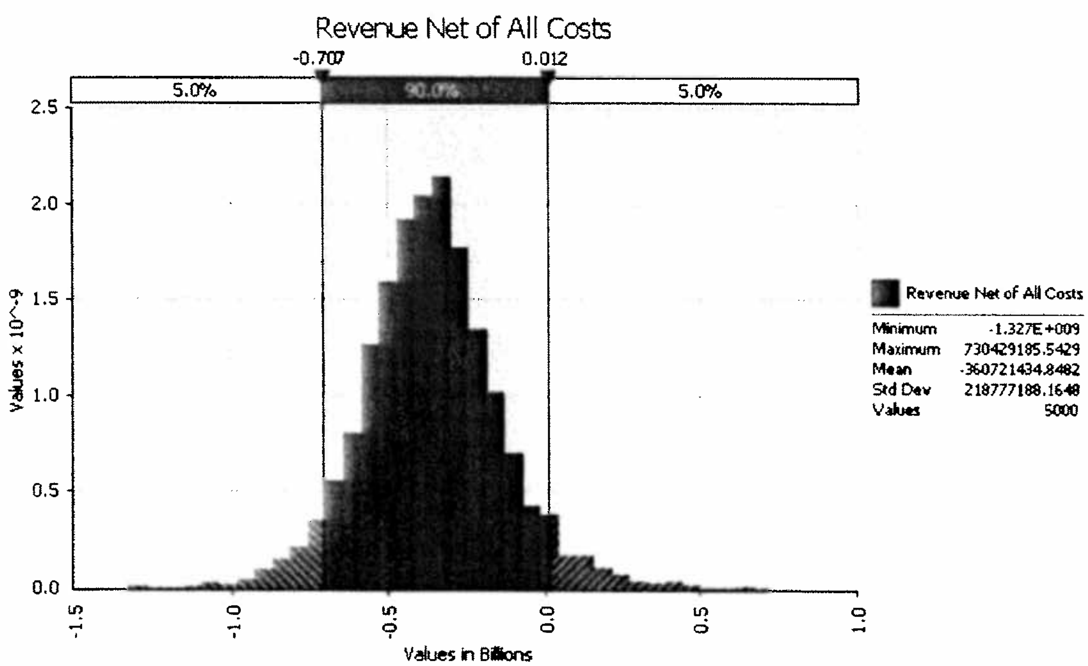


Table 5 - 2.5% Quantile (Using the Intercept), No Interest Costs

Component	Value	Distribution
Hydro Generation	15,836.6	
Wind	350	
Coal	717	
Total Generation	16903.60	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	8,181	
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	0.00%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	388,917,542	
CDN	12,712,848	
Revenue Net of Imports	1,108,956,321	
Revenue Net of All Costs	**96,735,344**	

Table 6 - 2.5% Quantile (Using the Intercept), Including Interest Costs

Component	Value	Distribution
Hydro Generation	15,836.6	
Wind	350	
Coal	717	
Total Generation	16903.60	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	8,181	
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	3.70	Weibull
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	6.47%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	388,917,542	
CDN	12,712,848	
Revenue Net of Imports	1,108,956,321	
Revenue Net of All Costs	**- 360,359,227**	

Figure 7 – 1940 Minimum Flows (Using the Intercept), High Import Prices, No Interest Costs

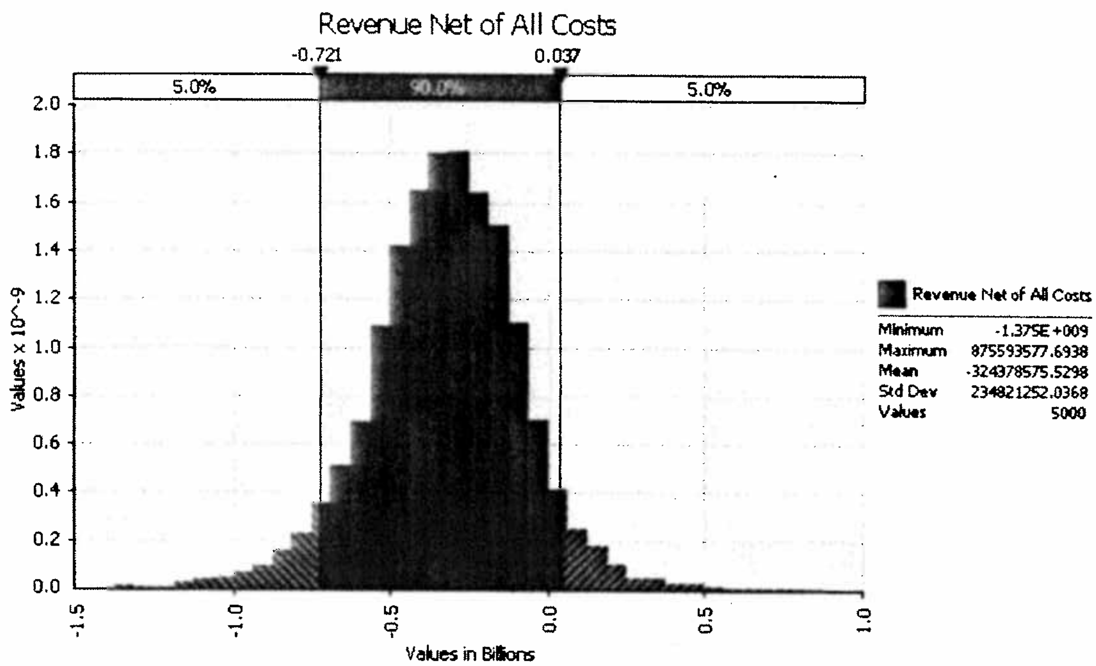


Figure 8 - 1940 Minimum Flows (Using the Intercept), High Import Prices, Including Interest Costs

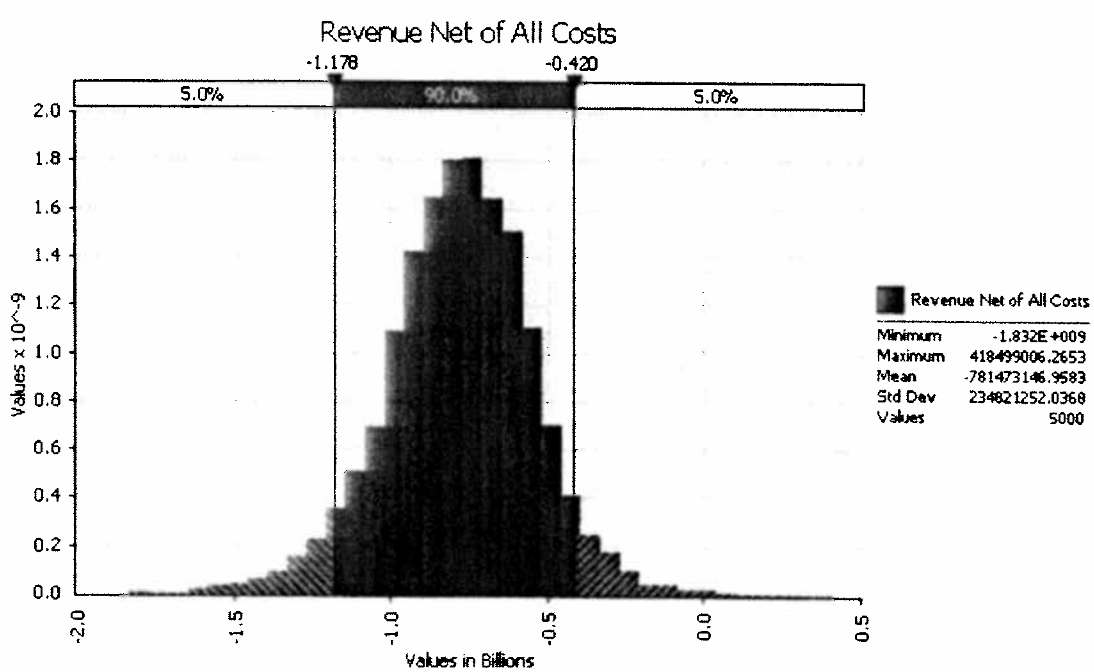


Table 7 - 1940 Minimum Flows (Using the Intercept), With Interest Costs and High Import Prices

Component	Value	Distribution
Hydro Generation	18,770.2	
Wind	350	
Coal	717	
Total Generation	19837.2	
Net Load	18,755	Logistic
Firm Exports	6597.261294	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	5,247	
Imports Provincial	267	Weibull
Operating Expenses	723,150	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	12.00	
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.284853333	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	0.00%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	809,044,702	
CDN	12,712,848	
Revenue Net of Imports	688,829,161	
Revenue Net of All Costs	**- 34,320,816**	

Table 8 - 1940 Minimum Flows (Using the Intercept), Including Interest Costs and High Import Prices

Component	Value	Distribution
Hydro Generation	18,770.2	
Wind	350	
Coal	717	
Total Generation	19837.20	
Net Load	18,755	Logistic
Firm Exports	6597.26	
US Exports Firm	4,383	Extreme Value
Provincial Exports Firm	2,214	Triangular
US Exports Non-Firm	0	Weibull
Provincial Exports Non-Firm	0	Triangular
Imports US	5,247	
Imports Provincial	267	Weibull
Operating Expenses	1,012,221	
Wages and Salaries	290,030	Weibull
Cost of Fuel Used	22,736	Inverted Gauss
Cost of Material Used	22,445	Logistic
Cost of Purchased Services	13,655	Triangular
Cost of Repair and Maintenance	10,704	Triangular
Royalty Expenses	91,277	Weibull
Indirect Taxes	51,734	Weibull
Other Expenses	26,155	Log Normal
Electricity Purchased	194,414	Weibull
Depreciation	289,071	Logistic
Domestic Price	4.90	Inverted Gauss
Export Firm (US)	5.55	Exponential
Export Non-Firm (US)	3.97	Logistic
Export Firm (CDN)	6.92	Pareto
Export Non-Firm (CDN)	5.00	Inverted Gauss
Impots Price (US)	12.00	
Impots Price (CDN)	4.75	Weibull
Exchange Rate	1.285	Triangular
Long Term Debt (CDN)	7,063,933	
Interest on L.T. Debt (CDN)	457,095	
Effective Interest Rate	6.47%	
Gross Revenue	1,497,873,863	
Domestic Revenue	919,515,704	
US Revenue	425,182,946	
Provincial Revenue	153,175,214	
Import Costs		
US	809,044,702	
CDN	12,712,848	
Revenue Net of Imports	688,829,161	
Revenue Net of All Costs	- **780,486,387**	

Figure 9 – Generation Probability Distribution (GWh)

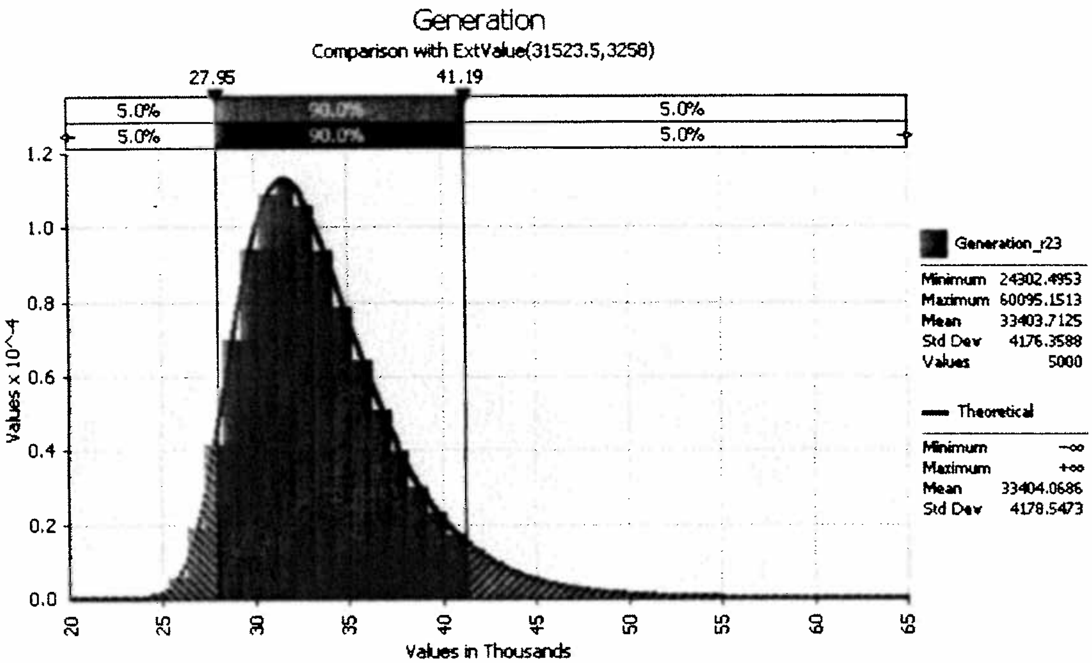


Figure 10 – Load Probability Distribution

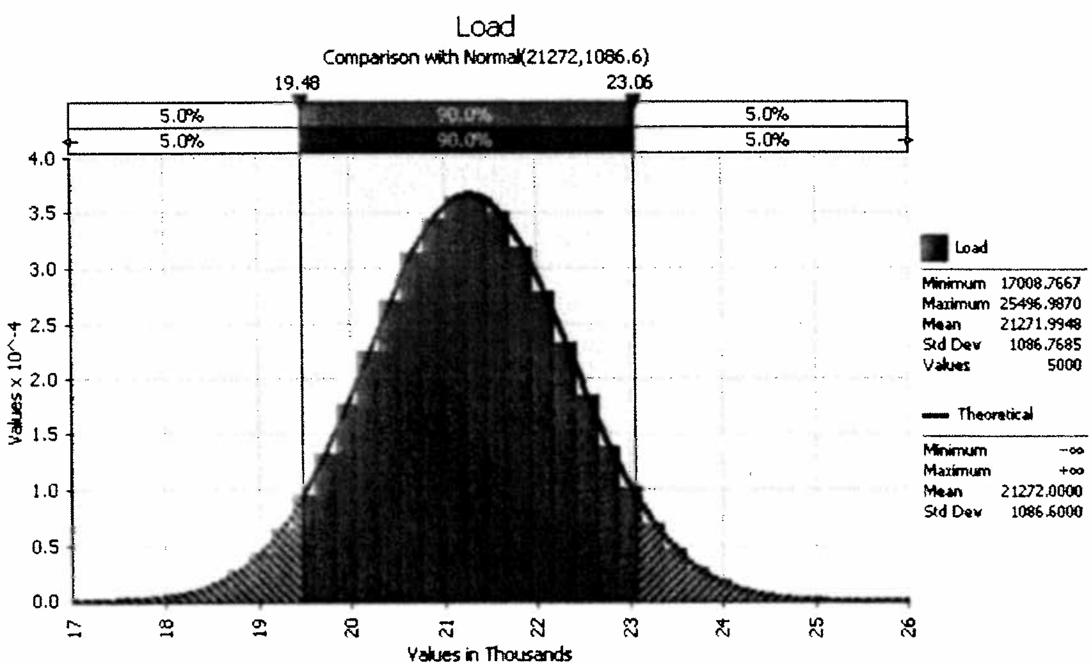


Figure 11 – Royalty Expense Probability Distribution

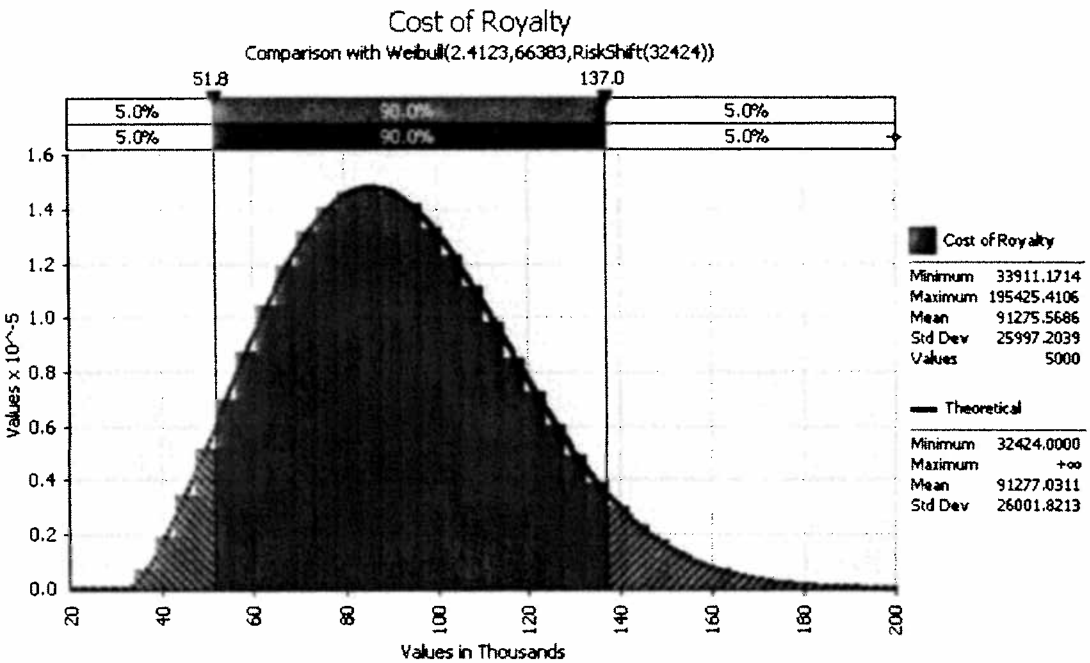
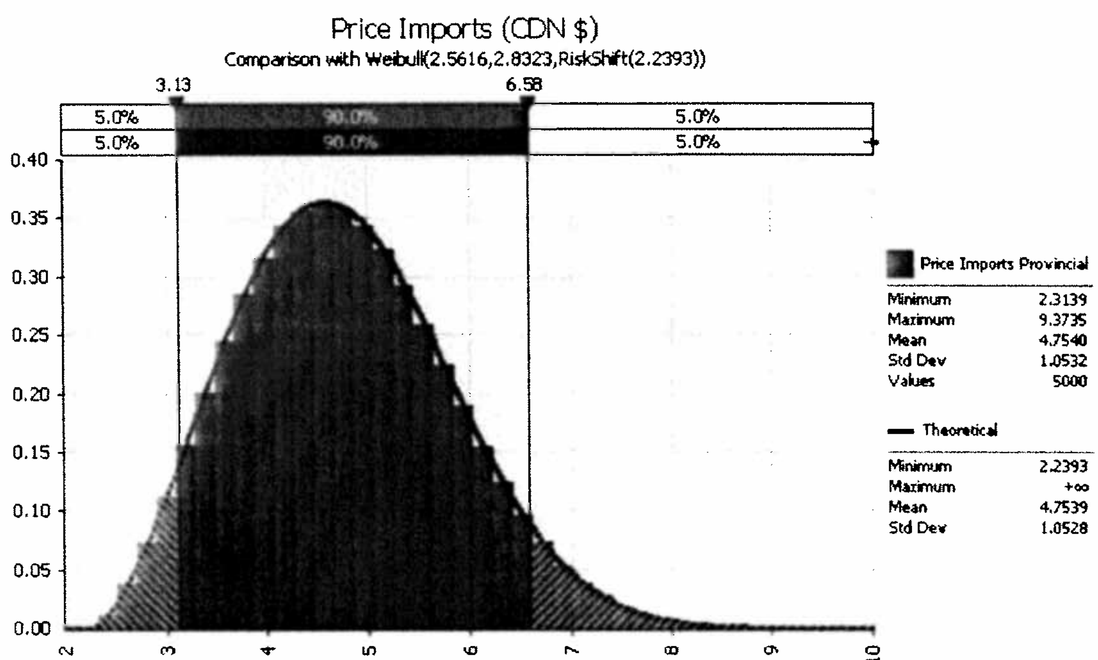


Figure 12 – Import Price Probability Distribution



Generation and Water Flows' Linkages

In the drought scenario calculations in chapter 6 of our report, we computed the generation input using a ratio method described in a hand-written document KM-13. In response to some of the suggestions received during our appearance at the hearings, we have used a different method in this time. Generation is read off a regression line (which expresses generation as a function of water flow) with intercept, as opposed to our previous ratio method. (The ratio method is essentially the same as reading generation off a regression line without an intercept.)

We took the water flow (Annual System Inflow, Kcfs) and generation (MH Hydraulic Energy, GWh/yr) data measured annually from flow years 1912 to 2005, contained on p.312 in Tab 75 of MIPUG 2010/11 & 2011/12 GRA/RISK BOOK OF DOCUMENTS and estimated two linear regression lines, one without an intercept (the steeper line in the plot on the next page) and one with an intercept, using the econometric software package *Stata*. The numerical results are given below. The *Stata* output is provided in Table 9.

Ordinary Least Squares Regressions

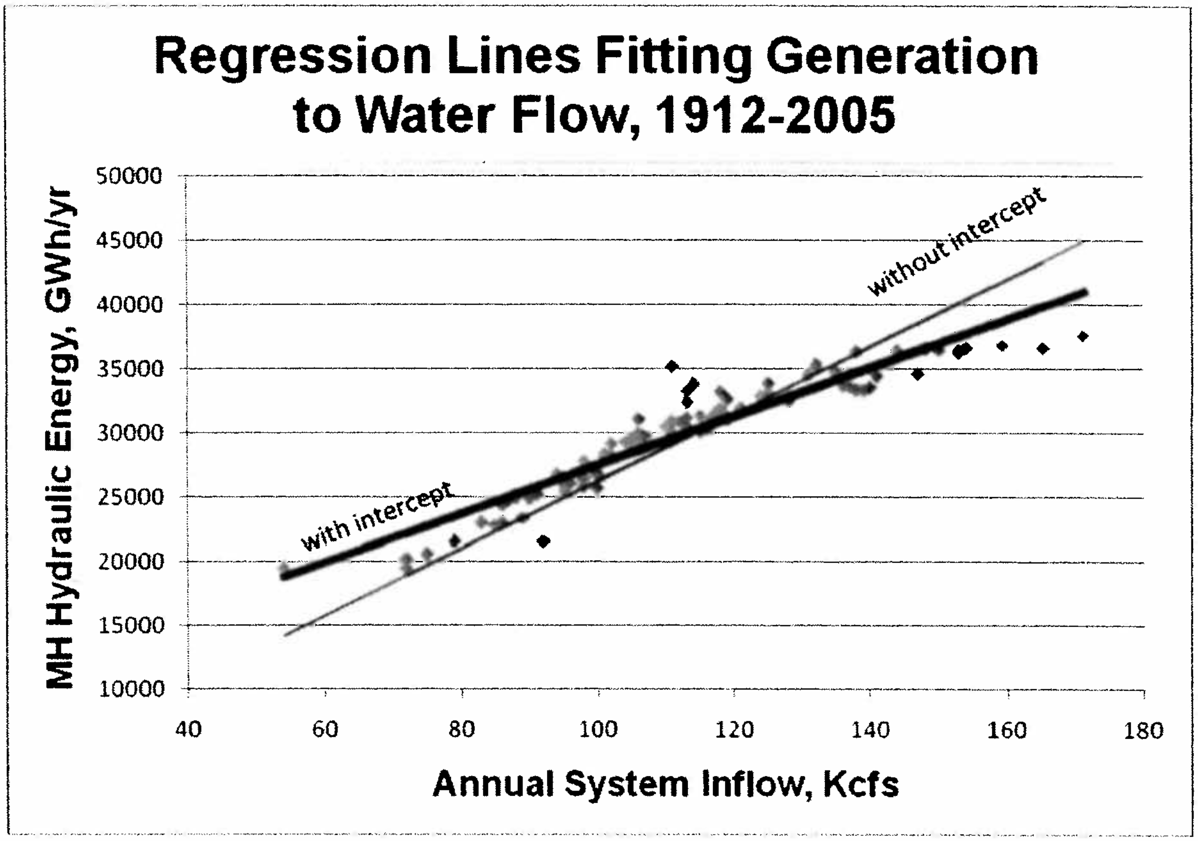
Without Intercept: *energy = 262.42 water_flow*
(2.35)

With Intercept: *energy = 8499.43 + 190.20 water_flow*
(1024.32) (8.69)

(Standard errors in parentheses. They are Newey-West st. errs. with lag=3. lag is set at three in accordance with the recommendation that it be set equal to the nearest integer to the sample size raised to the power 0.25.)

The standard errors are computed using the Newey-West technique, which accounts for autocorrelation and heteroskedasticity of unknown form in the error terms. (The 'regular' standard errors are slightly smaller than these reported ones.) The *t*-ratio on the intercept term is 8.30, which is highly statistically significant, which favours using the regression line with intercept to impute the generation numbers for the drought scenarios. The with-intercept line lies above the no-intercept line at low water flow levels, reflecting extra generation from prudent use of water storage. The with-intercept line lies below the no-intercept line at high water flow levels, reflecting lost generation from spillage. Since both statistical and practical considerations favour the use of the with-intercept regression line, we have adopted it for this round of calculations.

Figure 13



Regression Lines Fitting Generation to Water Flow, 1912-2005
MH Hydraulic Energy, GWh/yr
50000
45000
40000
35000
30000
25000
20000
15000
10000
40
60
80
100
120
140
160
180
Annual System Inflow, Kcfs
without intercept
with intercept

Table 9 - STATA Output from Regressions

```
 tsset year
       time variable:  year, 1912 to 2005

 newey energy water, noconstant lag(3)

Regression with Newey-West standard errors          Number of obs  =        94
maximum lag: 3                                      F(  1,     93)  =  12428.33
                                                    Prob > F       =    0.0000

------------------------------------------------------------------------------
             |             Newey-West
      energy |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       water |   262.4177   2.353894   111.48   0.000     257.7434    267.0921
------------------------------------------------------------------------------

. newey energy water, lag(3)

Regression with Newey-West standard errors          Number of obs  =        94
maximum lag: 3                                      F(  1,     92)  =    478.83
                                                    Prob > F       =    0.0000

------------------------------------------------------------------------------
             |             Newey-West
      energy |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       water |   190.1997   8.691983    21.88   0.000     172.9367    207.4628
       _cons |   8499.427   1024.317     8.30   0.000     6465.044    10533.81
```

Quantification of Manitoba Hydro Risks: Selective Stress Tests

Three major changes are reflected into Table 10 below. First, generation associated with droughts was higher as the intercept added around 8500 GWh to any direct relationship between water flows and generation. Using the ratio method would underestimate this value of generation. This automatically raises the generation revenues. While the base case is $433.7 million excluding interest payments (this is lower than the reported value in KM of $445 (KM p. 229) because of the correction of the royalty expenses that added to cost), the loss in net revenue due to the lowest flow on record (54 Kcfs) is not proportional to this major deviation from average flows (113 Kcfs), as the intercept shores the generation up. Therefore, the loss in net revenue due a single year drought at the lowest water flow level in 1940 is only $197.9 million. This rises to $337.3 million when the 2.5% quantile minimum is used and climbs to $758.1 million when high import prices are added to the low flows. The corresponding values in the KM Report are not much different but they were not consistent because of transcription errors and wrong probability distributions.

The direct loss when interest payments were included was $23.4 million in the benchmark case, $236.2 when the low flows of 1940 are factored and climb to $834.3 million when import prices are combined.

Table 10 - Quantification of Manitoba Hydro Risks (Millions of $)

Scenario	Excluding Interest Costs: Impact on Net Revenue	Excluding Interest Costs: Net Impact	Including Interest Costs: Impact on Net Revenue	Including Interest Costs: Net Impact
Base Case	433.7		-23.4	
Drought, 1940 Flows	235.8	-197.9	-236.2	-212.8
Drought More Severe Than 1940 (2.5% Quantile)	96.4	-337.3	-385.0	-361.6
Drought, 1940 Flows and High Import Prices	-324.4	-758.1	-834.3	-810.9