Judah Rose Direct Testimony

Before the Public Utilities Board of Manitoba Hydro

February 22, 2011

Outline

Outline (continued)

IV. ANALYSIS OF MH DROUGHT RISKS

Outline (continued)

V. MH MODELING, FORECASTING, AND PLANNING

- V.1 Review of Performance of MH's Models
- V.2 Conclusions on Use of Multiple Models
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VI. SELECTED RISK AND FINANCIAL ISSUES

- VI.1 Comment on Whether MH Should Have an Explicit Drought Fund / Rate Stabilization Fund That is Linked to Hydrology
- VI.2 Comment on MH and Standard Utility Practice Regarding Floating v. Fixed Rate Debt Portfolio

Outline (continued)

VII. GOVERNANCE, TRADING, AND RISK-RELATED COMMENTS

I. INTRODUCTION AND BACKGROUND

I.1 Experience in the Energy Industry

I.2 Purpose of Engagement With MH

Experience in the Energy Industry

- Education
- Professional Experience
- Previous Testimony Before Regulatory Boards
- Publications

Purpose of Engagement with MH

Manitoba Hydro requested that ICF provide an independent assessment of its export sales and associated risks. This assessment was carried out during the second and third quarters of 2009.

Specifically, MH requested that we provide comments and conclusions with respect to six items contained in the Terms of Reference for the assignment:

- **I.** The appropriateness, from a long-term business strategy and risk exposure perspective, of Manitoba Hydro entering into long-term firm contracts 20 or 30 years into the future;
- **II.** The adequacy of price that Manitoba Hydro derives (or will derive) from export sale transactions (both long-term firm and short-term opportunity sales);
- **III.** The risks assumed by Manitoba Hydro in selling long-term firm energy from dependable resources (in consideration of the requirements to meet firm sale commitments during periods of drought);
- **IV.** The extent to which Manitoba Hydro should be involved in pure merchant energy trading transactions;
- **V.** The reasonableness of Manitoba Hydro’s quantification of risk exposure related to an extended (5-year) drought; and
- **VI.** The adequacy of Manitoba Hydro’s drought risk mitigation measures.

II. THE U.S. POWER MARKET AND THE ROLE OF MH EXPORTS

MISO Wholesale Power Market Conditions

- MISO wholesale power markets are relevant to MH strategy for several reasons:

  (1) it is the only wholesale market large enough to absorb MH's surplus energy;

  (2) It is the only wholesale market large enough to supply significant energy in the event of a drought or system emergency;

  (3) spot prices affect the revenue available from short-term sales;

  (4) volatility in short term spot prices affects the desirability of and interest in long-term contracts with fixed pricing;

  (5) spot prices bear on the likely long-term prices, though the relationship is complex, and easily misunderstood;

  (6) in event there is a shortage of hydro power due to a drought, there is concern about the cost of replacement power (as discussed, much of this concern is related to previous rather than current contract terms); and

  (7) If the market is strong enough to support long-term sales it facilitates MH reliability via new transmission ties.

- MISO power markets are also important because they are complementary to MH's very heavy reliance on hydro power. MISO is a liquid market based primarily on thermal sources of supply and hence is an excellent backstop in event of a worse drought than the worst on record.

Annual 1997-2000 MISO Wholesale Spot Power Prices (U.S. Dollars)

Source: 1997-2000 MAPP Weekly Index; 2001–2005 Northern MAPP Weekly Index; and 2005-2010 MINN Hub Weekly Index, from Power Market Week

Historical MISO Wholesale Spot Power Prices (1997 -2010)

- Between 1997 and 2010, the average spot price for on-peak Midwest Independent System Operator (MISO) wholesale power was approximately $50/MWh (2010 real dollars).[1] This almost twice the domestic generation rate of MH. In the five years preceding our engagement, MISO prices averaged $66/MWh. In contrast, in 2009 and 2010, prices averaged $33/MWh (2010 real dollars). These prices, especially the prices in the 2003 to 2008 prices were much higher than MH domestic generation rates.

- Over the entire period, the standard deviation of the price was $15/MWh or 30 percent of the average price. Thus, MISO short term spot sales prices are uncertain. This uncertainty faces MH, and hence, MH has an interest in long term contracts to control price and revenue uncertainty from short term energy sales. This uncertainty also faces buyers of power which have relatively few long term alternatives that do not expose them to great cost and regulatory uncertainty, and hence, this contributes to their willingness to pay for long term hydro supply at relatively known prices that are well in excess of average spot prices.

- Current low spot prices reflect in large part the effects of the recent recession which depressed demand for power, natural gas, and coal.

- The recent recession was the worst in 70 years. Care should be taken to avoid making inferences from a rare once in 70 year event. Indeed, longer-term MISO regional electricity demand growth has been only modestly below the U.S. average and combined with retirements will cause prices to rise to levels needed to support new entry.

[1] All dollars are U.S. dollars unless otherwise noted.

MISO Historical On-peak Power Prices (Real and Nominal $/MWh)

Measure	1997 – 2010	2003 – 2008	2009 – 2010
On-Peak Spot (2010 $/MWh)	50	66	33
2025 Dollars On-Peak[1] (2025 $/MWh)	72	96	48

[1] 2.5% annual inflation (i.e., 2010$ * 1.45)

- Care should also be exercised regarding comparing historic spot market wholesale prices to future prices and costs. For example, if these price levels are maintained in real dollars, by 2025 they would be 45 percent higher in nominal dollars just from the effects of general inflation (e.g. 72 not 50 dollars per MWh).
- Also, long-term firm sales allow utilities to defer capacity additions. In such cases, a firmness premium is often warranted over spot prices (equal to premium needed to support entry). This would further increase the price willing to be paid (e.g., in 2025 long term firm prices may well be above the levels shown). There is also an additional premium for price certainty and for protection against environmental regulatory risks.
- Thus, as discussed later, available term sheet prices are well above MH domestic generation rates.

U.S. Henry Hub Natural Gas Spot Prices (2010$/MMBtu)

Year	Henry Hub Spot Prices (2010 $/MMBtu)
1991	2.2
1992	2.5
1993	3.0
1994	2.6
1995	2.3
1996	3.6
1997	3.2
1998	2.7
1999	2.9
2000	5.4
Average 1991 – 2000	3.1

Year	Henry Hub Spot Prices (2010 $/MMBtu)
2001	4.8
2002	4.0
2003	6.4
2004	6.7
2005	9.8
2006	7.2
2007	7.2
2008	9.0
2009	4.0
2010	4.4
Average 2001 – 2010	6.4

Source: Bloomberg Informational Services
Note: 2010 prices are through December 14, 2010

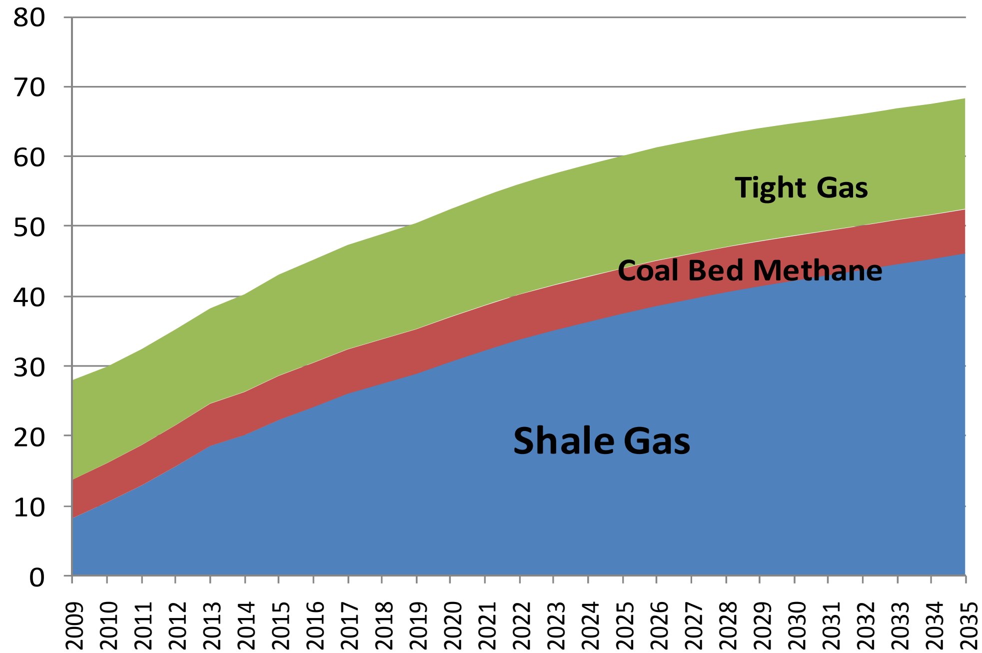
- MISO spot power prices are correlated with natural gas prices, especially over many years. Also, new natural gas plants are the main alternative available to US utilities in the absence of the MH hydro option.
- Natural gas prices are uncertain and cannot be readily hedged – mark to market collateral requirements cannot be easily managed. This creates buyer interest in alternatives not dependent on natural gas prices, especially for companies whose customers are used to relatively stable rates.
- At the same time, prices have recently been low; the 2009-2010 average is 35 percent below the 2000-2010 average. This creates risks to MH if there is excessive reliance on short term sales.

ICF Forecasts of Henry Hub Natural Gas Price are Lower (2010$/MMBtu)

Year	October 2010	February 2009	Percent Change
2011	4.1	7.6	-47%
2012	4.5	7.6	-41%
2013	4.6	7.8	-41%
2014	5.2	7.8	-34%
2015	4.6	7.9	-41%
2016	5.6	8.1	-31%
2017	5.9	8.3	-29%
Average	4.9	7.9	-38%

- ICF forecasts of Henry Hub natural gas spot prices in 2017 have decreased. ICF's October 2010 vintage forecast for 2017 is $5.9/MMBtu in 2010$, and $7.0/MMBtu in nominal dollars (i.e., those actually paid).
- ICF has recently lowered its gas price forecasts due to technological improvements in natural gas Exploration and Production (E&P).
- However, year-by-year price volatility is still expected. ICF does not typically forecast the volatility (even though it will be there) but rather focuses on the average expected price.
- ICF's updated long term forecast of average prices notwithstanding, there is also long term uncertainty about long term average gas prices.

U.S. and Canada Unconventional Natural Gas Production is Expected to Increase due to Technological Improvements



Source: ICF analysis

- The decrease in forecasted natural gas prices is mainly due to greater expectations for increased unconventional shale gas supply using the newly developed horizontal multi-fracking technology.
- As noted, however, future gas pricing is uncertain. Buyers are worried about both annual volatility and uncertainty about long term average pricing. At the same time, MH can benefit from protection from exposure to gas price uncertainty by entering into long-term contracts.

ICF Forecasts of U.S. CO_2 Emissions Allowance Prices (2010 $/ton)

Year	Previous	Current
2011	0	0
2012	0	0
2013	0	0
2014	0	0
2015	22	0
2016	24	0
2017	25	0
2018	26	10 - 15

- ICF has also lowered its forecasts of likely CO_2 emission allowance prices due to political developments. This lowers interest in hydro supply all else equal. However, much environmental regulatory uncertainty remains, creating continued interest in low CO_2 options. For example, US EPA regulations on greenhouse gas emissions are still moving forward and regional initiatives are continuing. Also, concern about CO_2 still blocks new coal power plant options; none broke ground in the U.S. during 2009 - 2010. This eliminates an option that has low volatility in costs.

Forecast of U.S. Power Plant Retirements Due to EPA Regulations (GW)

Organization	Coal	Coal & Oil/Gas	Date (As of)
ICF Q3	82	101	2020
ICF Q4	73	85	2020
EEI Scenario 1	56	86	2020
EEI Scenario 2	95	133	2020
NERC Low (Moderate)	10	40	2018
NERC High (Stringent)	37	70	2018
CRA	39	NA	2015
Black & Veatch	52	61 (CA Gas Only)	2015
Brattle Low	50	NA	2020
Brattle High	66	NA	2020
Credit Suisse Low	35	NA	2017
Credit Suisse Medium	60	NA	2017
Credit Suisse High	103	NA	2017
Bernstein	65	NA	2015
Simple Average	58	NA	NA
Range	10 – 103	NA	NA

Power Plant Retirements Due to EPA Regulations by Region (GW)

(Numbers Shown As Coal/Oil-Gas Retirements)

Study	MISO	PJM	SERC	Other	Total
ICF Q3[3]	26/1	19/2	26/4	11/12	82/19
ICF Q4[3]	22/0	17/1	23/4	11/7	73/12
EEI Scenario 1[3]	15/0	15/2	18/11	8/17	56/30
EEI Scenario 2[3]	26/1	18/2	32/11	19/24	95/38
NERC[2]	1-4/1	3-11/5	3-15/7	3-5/17-21	10-35/30-34
CRA	4	13	16	6	39
Brattle	16-20	12-19	10-11	12-16	50-66
Black & Veatch (B&V)	Unknown	Unknown	Unknown	Unknown	52
Bernstein[1]					
Credit Suisse (Medium)	18	13	19	10	60

[1] Regional generation impacts only.
[2] Range moderate stringent. MISO assumed by ICF to be equal to MRO and PJM to equal RFC; announced retirements not included.
[2] Kentucky is reported with MISO; firm retirements are included (totally approximately 6 GW of coal; 5 GW of O/G)

Stringent Non-CO_2 Environmental Regulations Increase Demand for New Capacity in MISO

- The US EPA, in part in response to court orders, is tightening non-CO_2 environmental regulations. These regulations address hazardous air pollutants (HAPS), SO_2, NO_x, coal ash and coal combustion residues, use of cooling water, etc. They are already authorized by existing legislation.
  - These trends not only may greatly increase coal power plant retirements, but NERC has also concluded that the regulations are a threat to reliability.
  - Aging U.S. coal fleet adds to the potential for retirements; this is a problem in MISO.
  - In recent forecasts of ICF and EEI, both performed using ICF models, 55 to 90 GW of coal power plants are projected to retire. The retirements are concentrated in MISO, PJM, and SERC. MISO (the area where MH power would be delivered) retirements might be as high as 26 GW. Announced U.S. coal power plant retirements already equal approximately 11 GW.
  - Even though the political landscape has changed as a result of the recent U.S. elections (negative for potential for legislative action for CO_2 control as discussed), possibility for administrative action under existing authority remains.
- The increasingly stringent environmental regulations create long-term demand for alternatives including emissions free hydroelectric power from a stable reliable counterparty like MH. Retirements will raise wholesale prices in order to support entry, reinforcing the attractiveness of MH supply.
- Hydroelectric power is also a good source for diversification for U.S. utilities.

MH's Role in the Export Power Business

MH should be in the hydro-electric based power export business. ***The question is not whether, but how.*** This conclusion is based on the following considerations:

- **Natural resource endowment of hydroelectric supply** – There exists hydro-surplus (in the short term) even without additional investments, and the only feasible market is the export market. MH current supply was built based on plans to export power, and takes advantage of long lives of hydro supply. The average age of U.S. power plants is approximately 32 years versus 55 years for U.S. hydroelectric plants (on a capacity weighted average basis).

- **Exports enable low domestic rates for electricity customers –** Manitoba electricity rates are the lowest in Canada, and also lower than rates in the U.S. This is in part due to export of surplus electricity to the U.S. Export prices on term sheets greatly exceed domestic generation rates. The proposed average export contract price is well above the domestic generation cost of approximately $27/MWh. In contrast, long-term term sheet prices exceed $87/MWh in 2010$ or $126/MWh in 2025$ at 2.5% per year inflation.

- **Exports are critical to the construction of new hydro plant** - The main alternative to export driven hydro development is not hydro development for service of domestic load but a sequence of natural gas power plant builds. Such an option represents a major departure for MH (see below).

Role of MH's Export Power Business (continued)

- **Future long-term exports to U.S. utilities will perpetuate low rates in the future** – The proposed new long-term firm contracts to export hydro power to the U.S. backed by construction of new hydro facilities is projected to result in significant savings relative to the alternatives.
- **Long-term contracts shield MH customers from even greater export price volatility -** Long-term export sales commitments are helpful in decreasing the volatility of revenues from export sales, in turn allowing MH to maintain the stability of domestic rates and/or to reduce pressure on the Corporation's balance sheet during episodes of low spot prices.
- **Exports will facilitate construction of transmission** – These lines are crucial for securing firm import and export capability and may be difficult or impossible to get sited and constructed in the absence of the long-term contracts. They are also expensive if MH must build and pay for them with export contracts.
- **Corporate Direction** – MH's corporate mandate supports the export of power. Moreover, stakeholders have benefited in past from export sales (in terms of low rates), and future export sales will perpetuate these benefits in the future.

MH has a Long History in the Export Power Business: 50 Years of Exports

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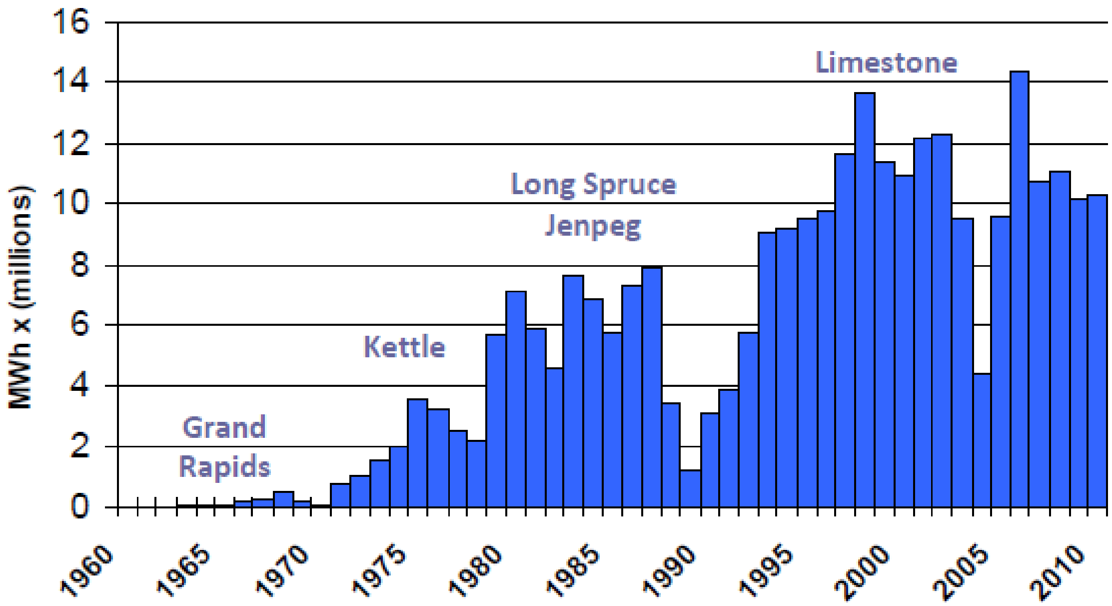
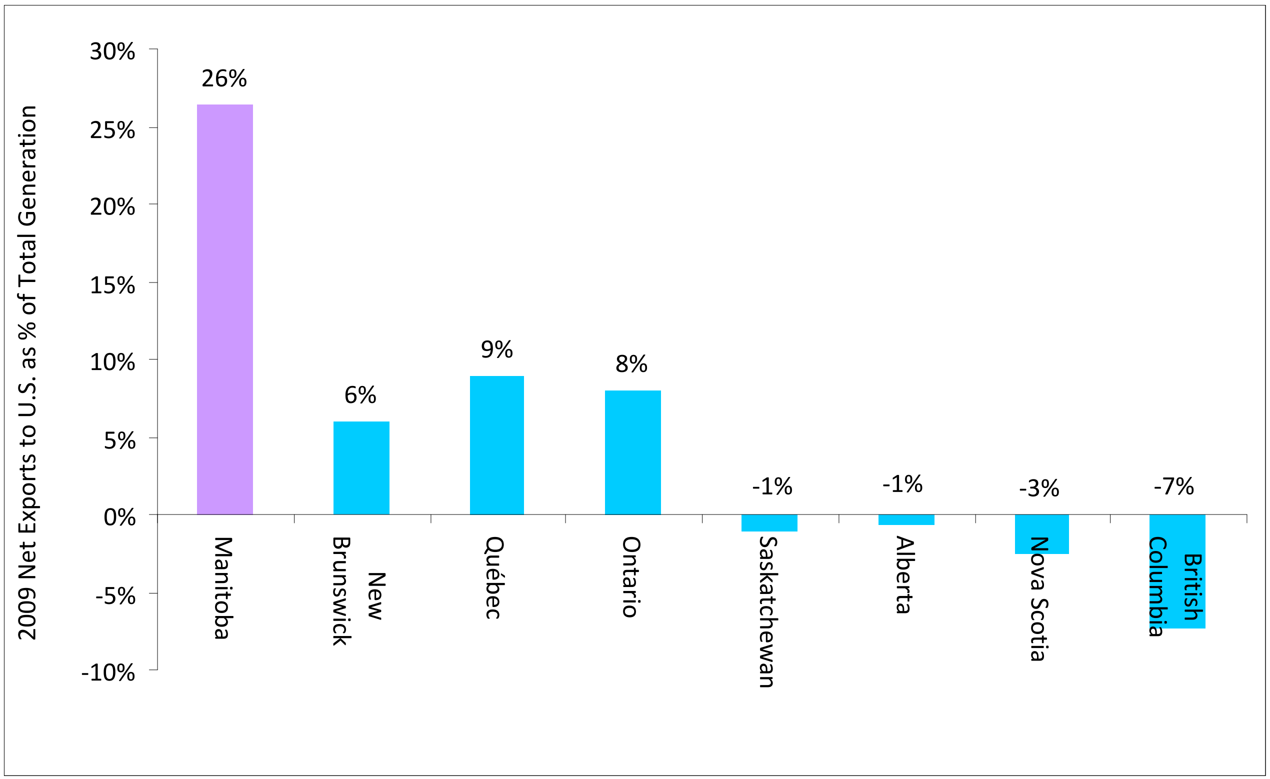


Source: Manitoba Hydro

- MH has a long history of exports; over the last few decades, exports and long term export contracts were key in financing new construction without rate shock.
- Hydro surpluses are also sold at short term prices. Thus, there is some revenue volatility from short term export sales due to volume and price uncertainty. However, this is a small part of a bigger picture – there are benefits from exports such as the low average annual rates MH customers enjoy.

Manitoba has Abundant Natural Resource Endowment of Hydroelectric Supply

2009 Net Electricity Exports to U.S. as a Percentage of Total Generation

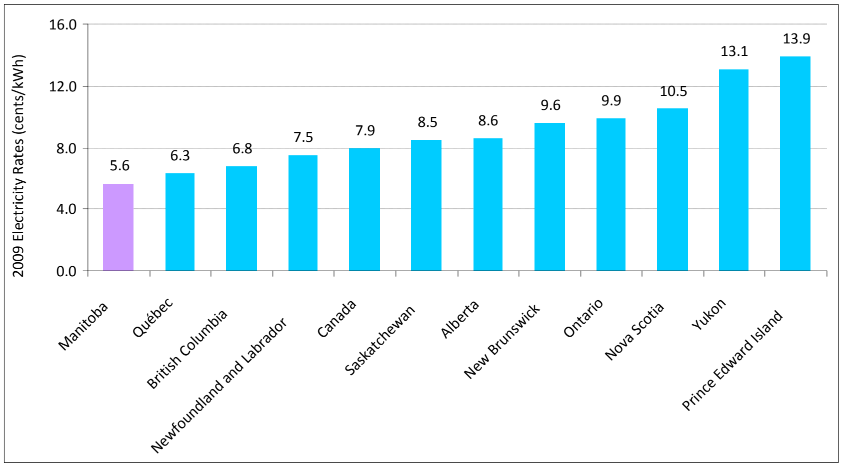


Source: Data from Statistics Canada via email communication (December 29, 2010)

- As shown above, exports are a far larger share of generation for MH compared to other Canadian utilities. It is not surprising MH has the lowest electric rates.

MH Electricity Rates: Lowest in Canada and Lower than Rates in the U.S.

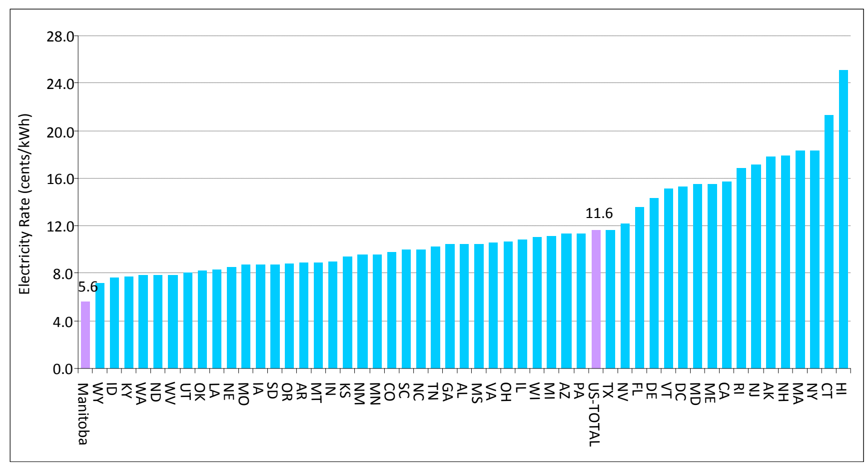
Manitoba Electricity Rates: Lowest in Canada



- MH has the lowest domestic electricity rates in Canada and North America in part because of exports (see figures); export prices greatly exceed MH's embedded generation costs, and the revenues are used to decrease domestic rates and/or to provide the financial wherewithal to withstand droughts without rate shocks or heavy use of additional Province backed financing.

- The correlation coefficient between hydro share of generation and electricity rates is -0.8 across the Canadian provinces. The more hydro the lower the rates.

Manitoba Electricity Rates: Lowest Compared to Rates in the U.S.



Sources: Canadian rates from Statistics Canada, email communication (December 29, 2010); U.S. retail rates from EIA; and exchange rate from Bank of Canada

Implication of Natural Gas Sequence of Builds as Alternative to Hydro Builds

- The alternative to export based hydro construction is very likely a reliance on a sequence of natural gas plant builds to meet domestic load growth. These plants have low $/kW capital costs, but high and volatile fuel costs. As a consequence of such a strategy:
  - Rates will rise and become increasingly volatile along with natural gas prices
  - Rates expectations will need to be adjusted as subsidies from exports end; there is little interest in gas power exports to the U.S.
  - Emissions will rise even if some renewables are added and there will be exposure to tightened regulations and new gas powerplant development and siting issues will emerge
  - If developments in the natural gas industry are unexpected, MH will become exposed to these developments (which could include new environmental regulations on gas drilling, gas export demand, unexpectedly higher gas production costs)
  - Financial structure and/or rate policy will need to change to accommodate new production approach – more frequent rate changes via an automatic fuel adjustment clause, greater equity share in MH capitalization
  - Hedging of fuel supply will be very difficult on a contractual basis due to mark-to-market collateral requirements
  - Competition from other gas sources may increase need for open access tariff and competition
- A sequence of natural gas builds is the alternative facing MH's potential long-term contract counterparties in the U.S. Their response to this is interest in purchases of MH hydro power.

III. REVIEW OF MH STRATEGY WITH REGARD TO MIX OF LONG- AND SHORT-TERM CONTRACTS

III.1 Assessment of MH's Export Strategy Involving a Mix of Long-term and Short-term Commitments
III.2 Reliability Benefits of Long-term Contracts
III.3 Role of and Maximum Potential of Short-term Contracts
III.4 Assessment of Risks of Low Export Prices
III.5 Role of Intermediate Term Contracts
III.6 Review of Industry Practice Related to Use of Long-term Power Sales
III.7 Assessment of the Adequacy of the Price of the Long-term Contracts
III.8 Use of Multiple Independent Long-term Price Forecasts

Contracting Approach to Exports

- It is standard practice in the utility industry to sell a large portion of power under very long-term contracts in light of the above considerations. This practice is reflected in: (1) past MH contracts, (2) recently proposed Hydro Quebec export sales contracts in ISO NE, (3) the implicit long-term contractual relationship MH has with its domestic customers, (4) the same implicit relationship characterizing most power sales in the US between utilities and ratepayers, and (5) long-term contracts between the great majority of new plants under construction and buyers. Additionally, the counter example is IPPs who sold largely short-term (including spot sales) and subsequently suffered financial distress.
- MH is also far from putting all of its eggs in one basket; it has a balanced combination of shorter term and longer term contracts.

A Mix of Long-term and Short-term Commitments is Crucial for a Good Export Strategy

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Diversification between long- and short-term commitments is very important. Each contract type has its pros and cons; not putting all eggs in one basket avoids pitfalls of any one approach.

Advantages of long-term contracts:

(1) pricing certainty facilitates financial planning and rate stability for both buyers and sellers

(2) buyers can more easily make long-term investment decisions (e.g., adding transmission and deferring new generation construction); deferring of generation by buyer is a key basis for higher contract prices

(3) transmission addition crucial for MH. Transmission achieves market access for both short-term economy purchases and sales above dependable. Even more importantly, transmission additions increases MH reliability in event of worse drought than worst on record. Passes transmission costs to buyers.

(4) Aligns contract term and asset lifetime to decrease MH risks

(5) The contracts that extend 20-30 years from today are consistent with the long lead time for adding hydro-electric generation and transmission facilities (five to ten years). They are also consistent with the long useful lives of electric utility equipment and systems (for example, forty year lifetimes) which allow for low amortization of costs each year, and hence, low rates.

Disadvantages of long-term contracts:

(1) Volume commitment can have financial impacts during droughts

(2) Potential for seller's regret (i.e., spot prices turn out to be higher)

Advantages of short-term contracts:

(1) More easily facilitates alignment of sales volumes within available supply to manage financial impacts

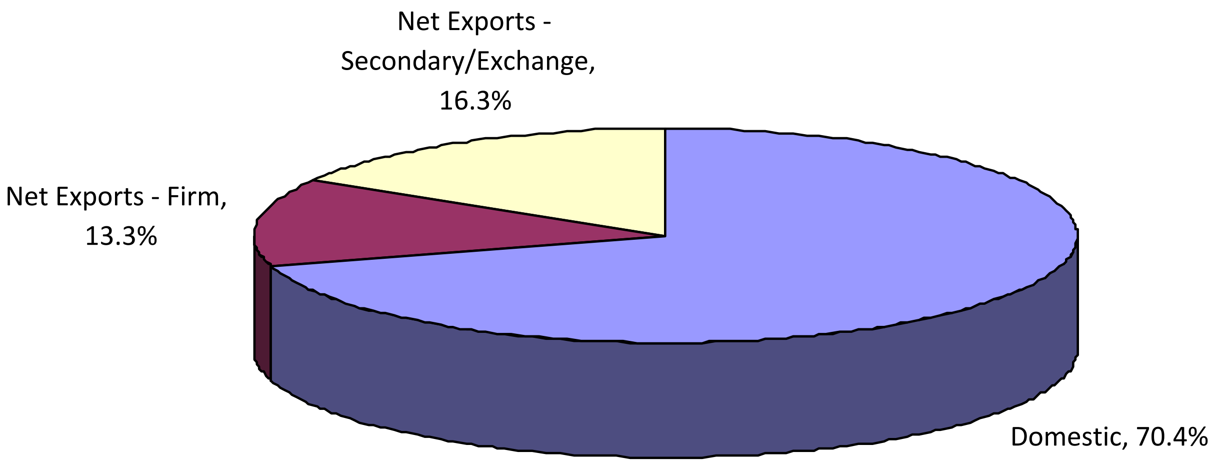
(2) Prices close to then market prices (no seller's regret)

Disadvantages of short-term contracts:

(1) pricing is volatile

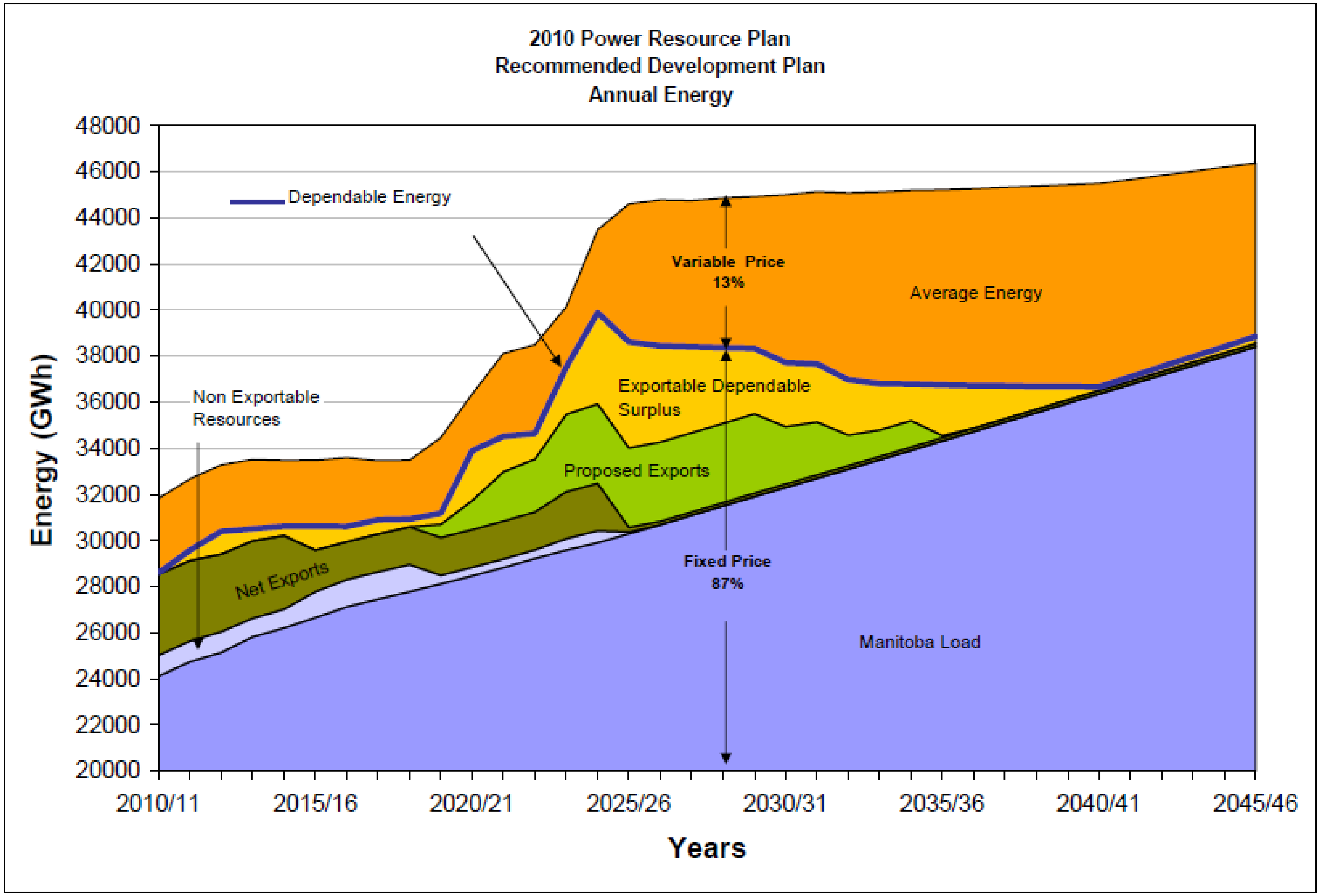
(2) not firm enough to support transmission investment and full pricing (flipside of advantages of long-term contracts)

Average MH Energy Disposition Involves a Mix of Long-Term and Short-Term, and Domestic and Export Commitments: 2000-2009



Source: 2000-2007 Annual Electric Power Generation, Transmission and Distribution Reports, Statistics Canada; 2008-2009 data from Statistics Canada via email communication (December 29, 2010)

MH's Dependable Exports, Proposed Exports, and Opportunity Sales Maintain Mix



Source: Manitoba Hydro

Key Reliability Benefits of MH's Strategy of Entering into Long-term Contracts

- Concerns exist about the impacts of droughts including the risks of having to meet long-term export obligations during droughts. Actually, d*rought planning and concerns can lead to counter intuitive conclusions regarding long term contracts. This is because: (1) new contracts are not system based but hydro system based transferring risk, and (2) the long-term export contracts are critical for protecting the Province against extreme droughts – i.e. worse than the worst on record.* Long-term export contracts facilitate reliability by increasing U.S. to MH transmission interties. This gives MH more power import options from a large and extremely thermal power reliant entity in the event of a worse drought than the worst on record. Because in such a condition, the lines are not being used for exports, they can be used for imports.

- Such extremes are referred to as "Black Swan" events in the risk management literature, i.e., planning for an event outside the historical record, and the company's risk management strategy explicitly and correctly incorporates Black Swan risks.

- In the absence of these lines, it may be necessary for MH to build greater import capability and/or more fossil generation. MH could have to pay up to $2 billion (nominal as expended Canadian $) for new transmission lines. [1]

[1] MISO facility's study 1.46 billion U.S. $ – does not include interest during construction. Does not include other facilities.

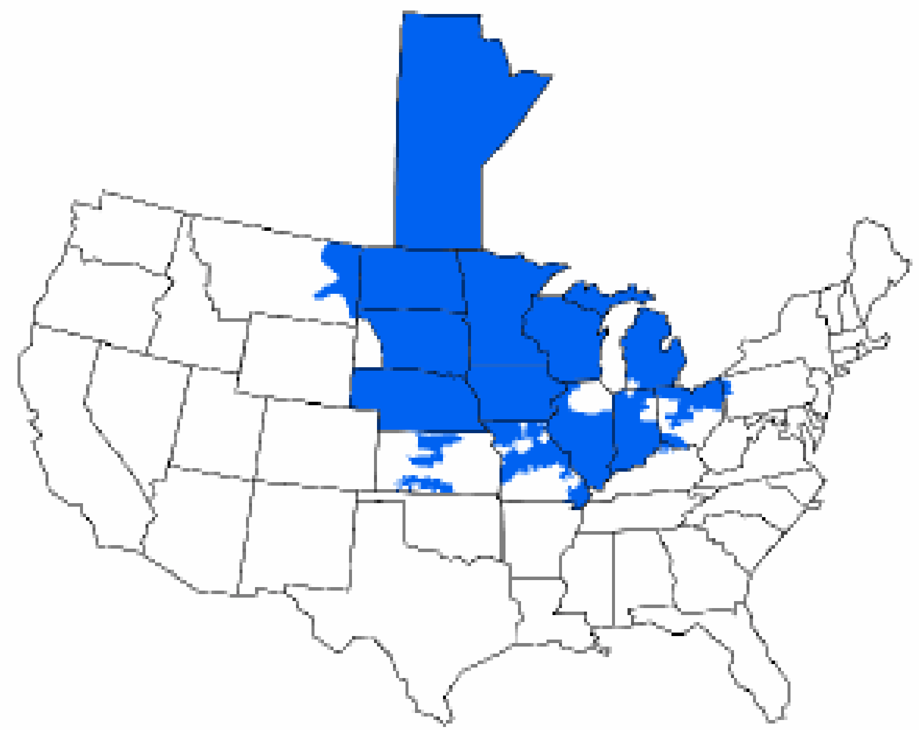
Key Reliability Benefits of MH's Strategy of Entering into Long-term Contracts (continued)

- Further, in the event MH does not pursue long-term export contracts, there would be less chance of the transmission expansion; without US utility support MH may not be able to site and permit the lines regardless of the cost because some portion of the needed interties will be on the U.S. side of the border.

- Since the passage of the US 2005 Energy Policy Act and subsequent regulations, U.S. transmission entities now face enforceable centralized standards for reliability. There is a risk that MISO or NERC, now the U.S. ERO, might conclude that the current transmission system's export capabilities are not robust enough to consider MH exports to be firm.

Better Interties Between MH and the U.S. MISO Area are an Important Risk Management Tool

MISO Area Footprint



- MH is on the periphery of the main North American grid areas.
- In the case of a more extreme drought than any on record, a critical risk management mechanism is stronger import ability.
- Long-term contracting is necessary to obtain U.S. transmission construction.
- *Concerns about extreme droughts support long-term contracting, not the opposite.*

Short-term Contracts Have Several Disadvantages

- Disadvantages of very heavy reliance on short-term export sales:
  - Pricing is extremely volatile, and hence, episodes of very low prices are possible. The best evidence is recent market conditions, e.g., the recession of 2009, and 2010, and the prior years of high prices. It should also be noted that while high spot market prices pose a risk to the Corporation's financial stability during periods of drought, falling spot market prices can have adverse financial consequences during non-drought years.
  - U.S. companies dependent on short-term contracting have had very difficult, even catastrophic financial experiences.
  - Volatility may increase as the relationship between power and natural gas pricing tightens and/or new environmental regulations such as CO_2 cap and trade are potentially implemented.
  - Volatile pricing would affect MH's financial planning, budgeting, and rates.

Short-term Contracts Have Several Disadvantages

- Short-term contracts are not firm and/or long enough term to support transmission investment which can be crucial for MH, especially during periods of critical import needs.
- Not firm and/or long enough term to support full long term avoided cost pricing.
- Not long enough to cover even infrastructure development lead times, much less the time period for recovery of investment – not aligning investment and contracting time frame creates risks of high costs and lower revenues.
- Heavy reliance on short-term contracts could require financial and/or rate restructuring of MH. For example, increasing the equity target, relying on a greater frequency of domestic changes in rates, increasing collateral and liquidity access for expanded third party hedging, and increasing hedging with non-utility long-term off-takers.
- Low prices also can coincide, as they did recently, with recessions and difficult financial and economic conditions.

The Extreme Risk of Excessive Reliance on Short-Term Power Sales: U.S. IPP Credit Rating Before and After Bankruptcy

Company Name	Date of Filing into Bankruptcy	S&P Rating before Bankruptcy	Date of Emerging from Bankruptcy	S&P Rating after Bankruptcy
NRG Energy Inc.	14-May-03	N.A.	23-Dec-03	N.A.
Mirant Corporation	14-Jul-03	D (WR)	20-Jan-05	B+
Calpine Corporation	21-Dec-05	D	1-Feb-08	B

Source: SNL Financial

Note: The ratings quoted in the table represent the ratings that were published closest to the event date.

- Three of the six major IPPs in U.S. that pursued the merchant model (i.e., emphasis on short- to medium-term sales) went into bankruptcy in the last six years and the remaining IPPs have experienced episodes of extreme financial distress. These companies built new units without always having long-term contracts with known or relatively known pricing.
- Thus, long-term and highly capital intensive commitments, such as building new plants, coupled with reliance on short-term pricing, can be very risky.
- The table shows the credit rating of the three IPPs that went bankrupt, before filing for and after emerging from bankruptcy. No major U.S. IPP has investment grade rating, except those with long-term contracts.

Assessment of Risks of Low Export Prices

Low spot export prices are a legitimate risk for MH.

- Evidenced during recent recession in 2009 and 2010: MISO spot prices were almost 50 percent lower than record high prices in the immediately preceding years (2005-2008). Prices remain low today.
- Diversification of term and pricing of export contracts guards against this risk; long term prices are more stable.
- At the same time, there are factors which can raise short term prices:
  - Retirements and/or load growth create need for new capacity and prices will rise to meet this need. U.S. load growth in 2010 was positive 4.1 percent due to stronger economy and hotter weather. MISO load growth during this period was even greater at 5.2 percent.[1]
  - Potential for higher fuel pries raises power prices
  - Greater hours in which marginal supply is natural gas also raises power prices; as demand grows and no new US baseload is added, gas is increasingly on the margin

[1] This estimate excludes the load impact of the new entrants to the MISO market in 2009.

Role of Intermediate-term Commitments

- Exclusive use of intermediate contracts is highly problematic. Intermediate-term commitments (i.e., 5 to 10 years) barely covers the lead time for planning, permitting, and construction of hydroelectric and transmission, and hence, does not align contract with investment horizon and optimal annual amortization levels. Exclusive use of intermediate contracts would not support required investment.

- Intermediate term contracting leaves a long uncontracted “tail” period of cost recovery for new projects creating large risks and high costs for MH ratepayers.

- Stretching financial hedging from short-term to intermediate-term could require significant market-to-market collateral exposure.

- However, some intermediate contracting can provide a bridge and be part of a diversified approach.

Long-term Power Sales: Standard Industry Practice

Type	Firm U.S. Capacity (GW)
Utility Ownership	23
IPP with Long-Term Contract > 50% of Capacity	4
IPP Merchant - < 50% of Capacity Long-Term Contract	12
Total Under Construction Capacity	38

Source: Ventyx database accessed on May 5, 2009

- MH is accelerating the construction of two new hydroelectric facilities, Conawapa and Keeyask, to provide the power under the proposed new contracts. Generally, three models exist for developing new power plants:
  - Long-term contracting with known or indexed prices
  - Implicit long-term contracting through a regulated utility franchise, and/or government status. This often involves utilities with integrated structures which provide power on a cost plus basis
  - Merchant structure with spot sales and primarily short-term contracts and hedges (one to five years)
- At this time, new power plant construction predominantly is associated with long-term explicit or implicit contracting. Of 38 GW in the U.S. that are under construction, 70 percent are under long-term contract for majority of their output, or are utility owned (see adjacent exhibit). The remainder is largely units that were insufficiently advanced to have contract information. The trend of long-term contracting is in part a reaction to the problems experienced in the U.S. during the merchant power boom in the U.S. in the 1999 to 2003 period.
- Hydro Quebec is also planning long-term contract sales and new hydro development and transmission construction.
- Entities heavily reliant on short-term transactions usually lack access to long-term contracting. MH long-term contracting opportunities should be embraced.

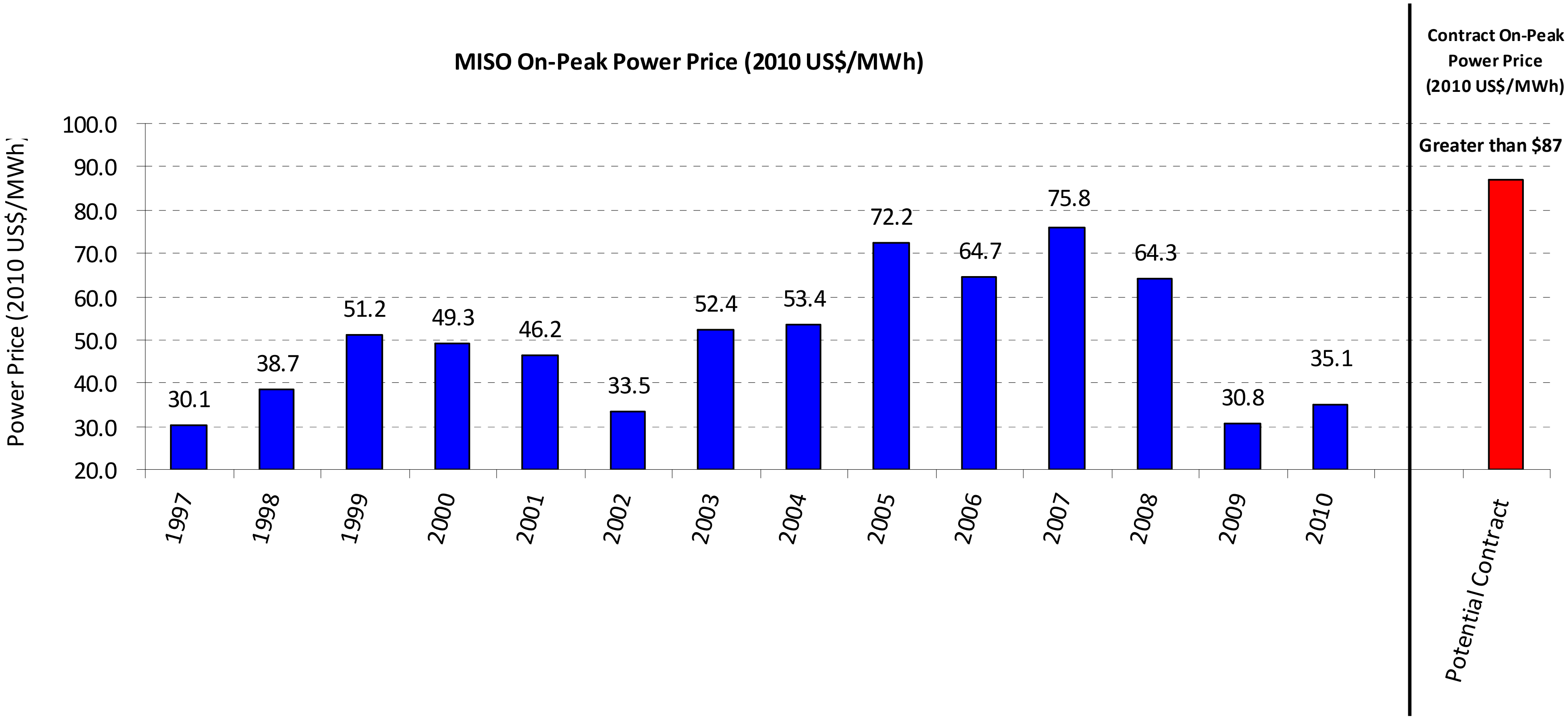
Adequacy of the Price of Long-term Contracts: Prices Exceed $87/MWh in 2010$ or $126/MWh in 2025$[1]

Based on the following considerations I conclude that MH derives adequate pricing for its long-term contracts:

- **Historical Spot Prices** – MH's proposed export contract prices are well above historical spot prices, even the 2008 record high spot prices experienced in the MISO market. Indexing will cause prices to maintain this premium in real terms.
- **Existing Contract Prices** – The proposed export contract prices are well above average existing contract prices, i.e., more than 50 percent higher.
- **Domestic Generation Service Prices** – The proposed export contract prices are well above domestic rates for generation services, i.e., nearly three times as high.
- **ICF Wholesale Price Forecasts Available at the Time of Negotiations** – The proposed contract prices are above ICF's forecast of prices available at the time contract negotiations were ongoing. Thus, MH appears to have properly accounted for the then current price forecasts in their negotiations. The contract prices are even higher than ICF's current forecast in light of the changes discussed above.
- **Consensus Price Forecasts** – MH prices are even higher than the consensus forecasts, i.e., the average of forecasts from five independent consultants.
- **Approach to Future Price Forecasting** – The approach of using consensus forecasts plus a premium over that as a minimum for pricing long-term contracts is reasonable. This helps guard against seller's regret, i.e., regret if spot prices turn out to be higher.
- **Market Timing and Trends** – ICF believes it has been a reasonable time to enter into long-term contracts. While trends had been for increasing prices before the Great Recession (which argued for waiting for even higher prices), the recession has highlighted that there are some counter trends and risks to waiting.

[1] 2.5 percent inflation. $126/MWh equals 12.6 cents per kWh.

Comparison of Contract Prices with Historical MISO On-Peak Spot Power Prices



Source: 1997-2000 MAPP Weekly Index; 2001-2005 Northern MAPP Weekly Index; 2005-2010 MINN Hub Weekly Index from Power Market Week

MH’s Practice of Utilizing Multiple Independent Long-term Price Forecasts is Reasonable

- Averaging forecasts has the following advantages:
  - Different forecasts draw on varying information and emphasize different issues – averaging captures these diverse views and evens out extreme positions
  - They may use different methods of forecasting – averaging likely to offset errors

- Professors Larrick and Armstrong recommend this approach to forecasting (excerpts from WSJ article on next page)

- In fact, MH prices are even higher than the consensus forecasts (i.e., the average of forecasts from five independent consultants). MH’s approach to use consensus forecasts plus a premium as a minimum for pricing long-term contracts is reasonable. This helps guard against seller’s regret, i.e., regret if spot prices turn out to be higher, and ensures Manitoba Hydro negotiators have access to up-to-date information.

Support for Averaging Forecasts

- "Perhaps the most powerful tool for improving the quality of predictions is simply to combine several forecasts from a variety of independent sources…Forecasts from different sources tend to draw on varying information and divergent methods, so their errors will frequently offset one another."

- Professor Armstrong "has found that [the] technique [of averaging forecasts] reduces forecasting errors by up to 58% - a massive improvement over individual forecasts."

Source: "Making Sense of Market Forecasts," Wall Street Journal, January 8, 2011

IV. ANALYSIS OF MH DROUGHT RISKS

IV.1 Assessment of Drought Risks Assumed in Selling Long-term Dependable Energy

IV.2 MH's Drought Risk

IV.3 Contractual Risk Management Mechanisms

IV.4 Review of MH Drought Planning

IV.5 Review of MH's Management of the 2003/2004 Drought

IV.6 Review of MH's Quantification of Risk Exposure Related to an Extended Drought

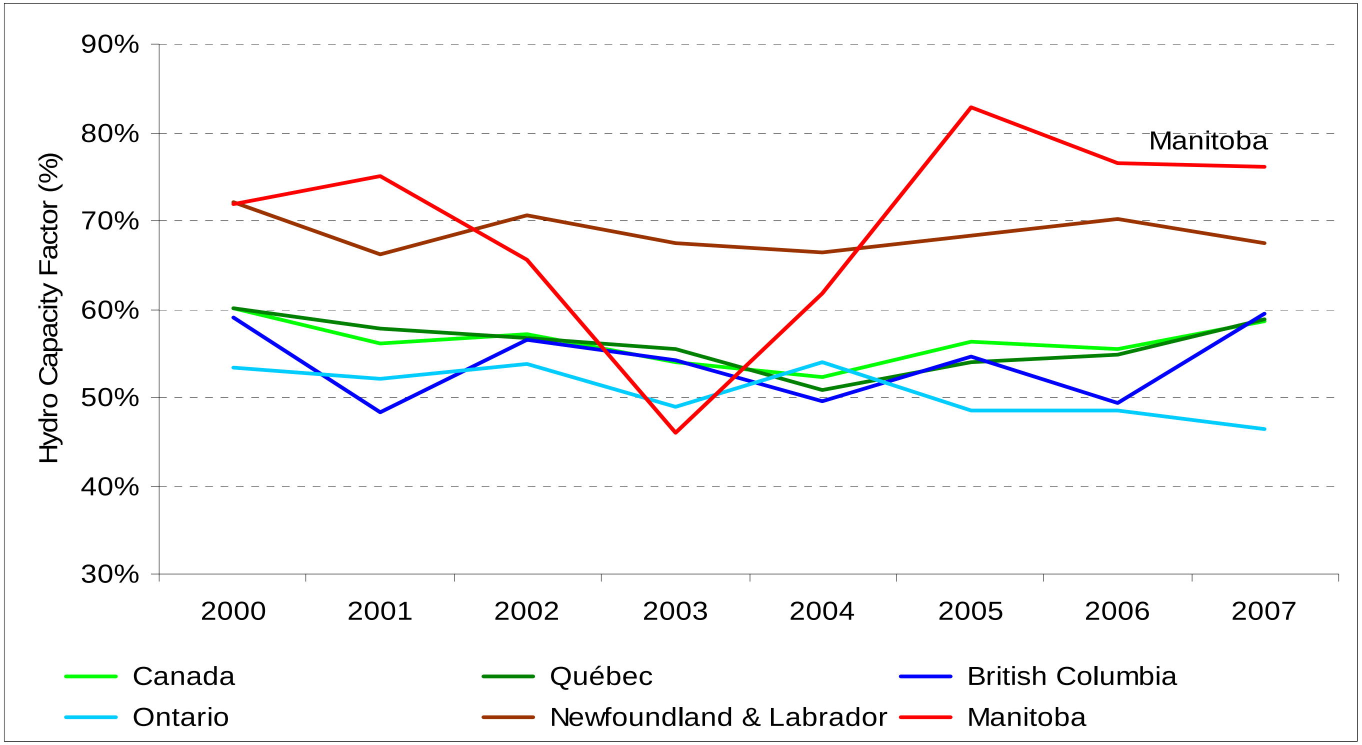
IV.7 ICF Response to KM Comment that ICF's Calculation of a 3.1 Percent Chance that Any Year will be the First of a Drought of Five Years Duration or Longer is an Underestimation

Major Risks Assumed in Selling Long-term Dependable Energy

- Hydrology Risks: Droughts
- Manitoba's Domestic Electricity Demand Risks (economic, population, industrial tariff, weather, fuel switching, etc)
- Seller's Regret – Pricing Below Market; new hydro development costs, delays
- Infrastructure Unavailability, financial, exchange rate
- Compounding Risks – e.g., High Fuel Market and/or Power Pricing and Droughts; Droughts and Very High Demand

When considering risks, it is useful to separately identify risks of power supply shortage to domestic MH load regardless of price and risks of higher financial costs of supply. MH treats the two differently.

Canadian Utilities Historical Hydro Capacity Factor (%)



Source: 2000-2007 Annual Electric Power Generation, Transmission and Distribution Reports, Statistics Canada

Manitoba Hydro's Drought Risk

- Drought is a key non-infrastructure related risk facing MH because it has power supply (i.e., providing electricity to MH domestic customers, regardless of price) as well as financial implications.[1] Drought is expected to occur and affects all aspects of MH activities. However, drought is not an emergency, especially with appropriate planning.

- It is a part of business for a hydro utility, especially one with over 90 percent reliance on hydro resources and a climatic history of droughts.

- For example, to the extent demand growth is stronger than expected, there will be less surplus generation to meet export sales obligations. Also, in the event of a severe drought, the Drought Preparedness Plan may increase the amount of assumed MH domestic demand that must be supplied (e.g., assume a colder than normal winter) in consideration of the potential for a worse drought than the worst on record.

[1] MH analysis indicates that infrastructure problems are less likely, but could have very large impacts – e.g., loss of the Dorsey Terminal.

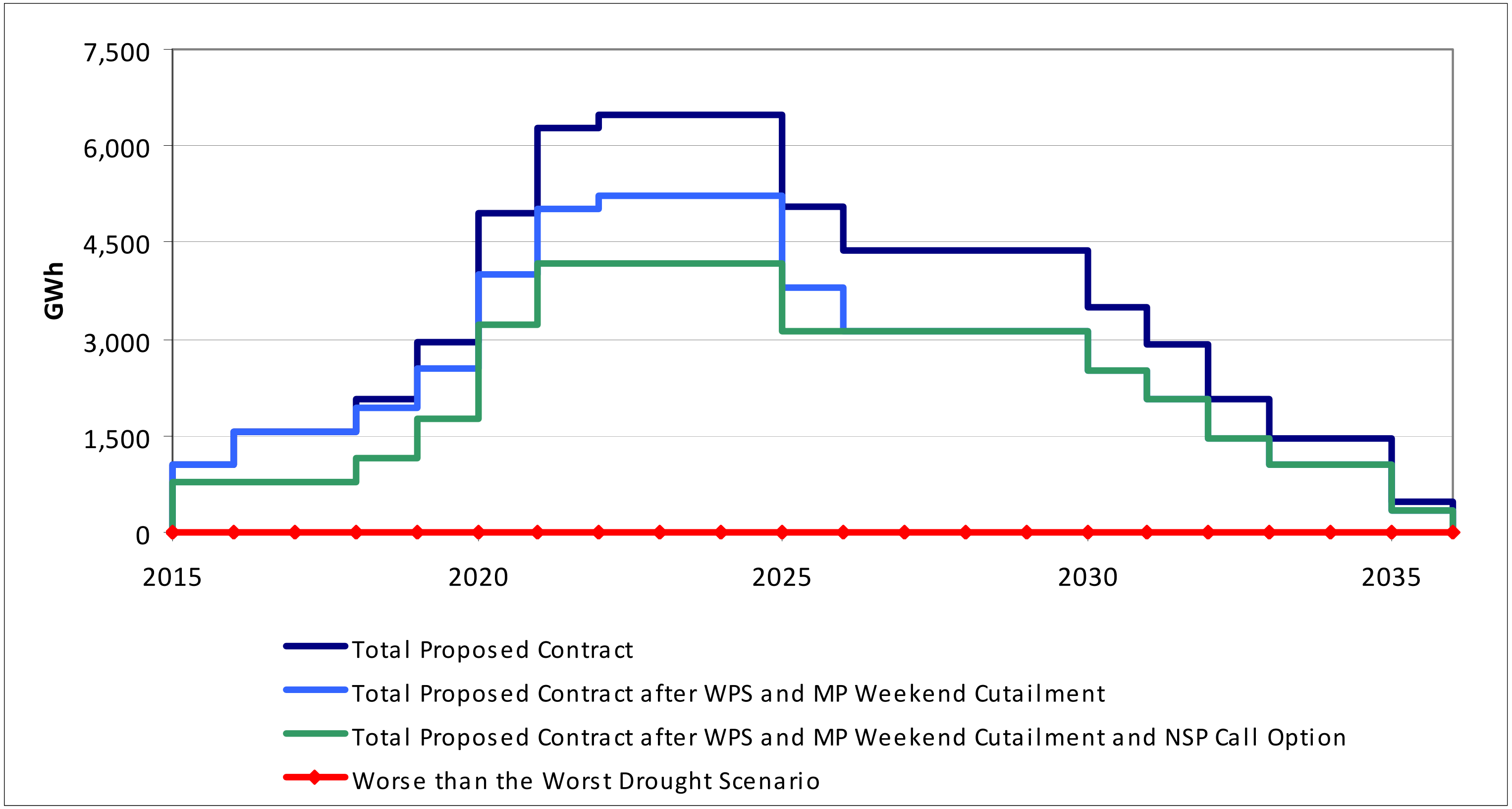
Manitoba Hydro's Drought Risk (cont.)

- The key is to plan for it and have appropriate mechanisms in place including:
  - Contractual protections
  - Planning and Operational Mechanisms
  - Equity Reserves
  - Risk Management Procedures and Systems

Contractual Risk Management Mechanisms: Adequacy of Contractual Risk Mitigation

- **Sourced from Dependable Hydro in WPS and MP Term Sheets Rather than Dependable System Resources as in Past Contracts. In this context, sourcing from dependable hydro allows for:**
  - Weekend volume flexibility on two proposed key long-term contracts (up to 29%)
  - Drought worse than worst on record – volume flexibility (up to 100 percent)
- **Diverse Pricing Terms and Formulas (e.g., account for inflation, index to market) to Minimize Variance**
- **Diverse Time Periods – Staggered Renegotiations**
- **Multiple Buyers – Less Execution Risk**
- **Credit Worthy Buyers – Less Execution Risk**
- **Contracts Part of Reasonable Mix of Commitments: Short-Term and Long-Term**
- **Adequate Pricing and Diversity Exchange**

Contractual Risk Management Mechanisms: Adequacy of Risk Mitigation



Source: Potential contract term sheets

The exhibit above show the flexibility in MH's proposed contracts that is part of transferring MH system risk to purchaser. MH's existing long-term export sale contracts do not have similar flexibility to decrease firm sales in the event of a drought within the historical record because they are system dependable, not hydro dependable. ***Thus, the company has succeeded in decreasing its exposure to the risks of a drought by decreasing the firmness of some export volumes.***

MH Maintains Adequate Volume Flexibility in its Long-Term Export Sales Commitments

- In order to mitigate risks associated with droughts, MH designs and operates its facilities, both generation and transmission, to ensure that firm demand can be met even with a repeat of the worst drought since 1912.

- The Corporation limits firm export sales in any given year such that even during a repeat of the worst drought on record, these contractual obligations can be met from dependable hydro energy supply net of Manitoba's expected domestic load. And, based on the terms and conditions of its term sheets, Manitoba Hydro is relieved of its firm export obligations in the event of a drought worse than the worst on record.

- Moreover, the term sheets have curtailment clauses that give the Corporation the right to curtail energy delivery under the following circumstances:

  (i) in the event of the unavailability of any portion of MH's generation and/or transmission system, including MH's HVDC system;

  (ii) due to a transmission service curtailment which results in the loss of the capability in the transmission path between MH and the counterparty;

  (iii) due to Force Majeure reasons; and

  (iv) other general rights of curtailment.

Review of MH Drought Planning

Key Documents

- System Operation Priorities
- Management Control Plan (2003 Drought)

Key Oversight Bodies

- Manitoba Hydro Electric Board (MHEB): various external oversight bodies
- Executive Committee
- Export Power Risk Management Committee (EPRMC): oversight of the management of the energy supply and financial risks resulting from participation in the export power market.
- Power Sales and Operations Market Committee (PSOMC): oversight for system financial products.
- Drought Financial Management Working Group

Key Implementation

- Front office: responsible for export marketing strategies, market access, long-term contract negotiations and power trading
- Middle office: responsible for oversight of risk management activities associated with wholesale power transactions – *Enhancements of the Middle Office are being made.*
- Back office: ensures the integrity of systems and processes for transaction settlements.

Key Tools

- Modeling – HERMES, SPLASH, PRISM, Load Forecasting, IFF

Corporate Activities

- Enterprise Risk Management
- Contract Design
- Transmission Planning
- Capital Plan
- Drought Financial Management Plan

Management Discretion

- To account for rapidly changing circumstances

DROUGHT PREPAREDNESS

Drought Preparedness Plan

- The company has an approach to Drought Management that involves all parts of the company planning and operations. For example, subsequent to the 2003 drought, MH established the Drought Financial Management Working Group. Under its Terms of Reference, the Group is tasked with updating the 2003 Drought Management Strategies using the PRISM model, and with developing a drought leading indicator or index for the Corporation. The work of this group is continuing. The company does not have a written Drought Preparedness Plan in place at this time, and would benefit from one.

- The expectation is that the key elements of a written plan would include:
  - MH load would be served normally at a high level of certainty.
  - Water in the reservoirs will be conserved as appropriate, reflecting the potential for droughts of greater severity and duration than the historical record, other contingencies, and MH's limited import capability.
  - Greater storage in reservoirs in response to a drought does not change the amount of energy available, and has only limited effects on total expected net revenues. Rather, it creates cash flow issues. This is because, on average, the expected prices in one year will be similar to the next, though some additional costs may be undertaken as precautions such as hedging higher wholesale prices. While it is a priority to manage cash flow and maximize the economic benefits of MH operations, as discussed below, it is a lower operational priority than reliability.

Drought Preparedness Plan (cont.)

- – Given the long time lags from reservoir to generation, and the fact the MH system is energy constrained, it is necessary to plan for a severe winter.
- – MH water supply is mean reverting, and hence, a gradual approach to purchasing power is required to avoid over purchasing in a drought.
- – Planning for Black Swan event – worse drought than worst on record already discussed.

- In some cases, these elements are already part of the System Operation Priorities.

Review of MH's Management of the 2003/2004 Drought

- In 2003, MH took a number of steps to deal with the drought (2003 Drought Management Plan):
  - thermal generation and imports in addition to river flows to meet domestic load including a one in ten winter demand level in the event the drought turned out to be beyond the record
  - maintain sufficient hydro reserves in storage
  - negotiate bookout agreements with export sales customers
  - remaining shortfall was managed through the purchase of power call options (since these call options were tied to gas prices and MH potentially had to use its gas-fired plant to meet domestic load -- MH effectively managed this risk through natural gas hedging arrangements)

Review of MH's Management of the 2003/2004 Drought (cont)

- Today it has several additional tools to deal with droughts:
  - In 2003, in bilateral market -- had difficult time hedging except through counterparties. Now markets more liquid and MH capable of hedging with all available financial instruments
  - MH has renegotiated contracts so financial settlement is now possible (not held hostage to contracts); have bought transmission rights which is a significant improvement
  - MH has changed future contract term sheets with WPS and MP to be based on *dependable hydro*, not dependable system energy. MH has a history of very reliable supply and is viewed as a reliable source of power by counterparties. Thus, it has a business interest in avoiding use of this and the other mitigating options to its firm obligations. Nonetheless, MH has succeeded in decreasing its exposure to the risks of a drought by decreasing firmness of some of the volume, and therefore, the term sheet commitments are inherently less risky than existing contracts lacking these provisions.

- Also, having the same performance every year is not possible, performance needs to be seen in the appropriate multi-year average context and with a balanced view vis-à-vis what is feasible with the counterparties.

Manitoba Hydro Annual Energy Supply and Demand: Normal Hydro v. Drought Conditions

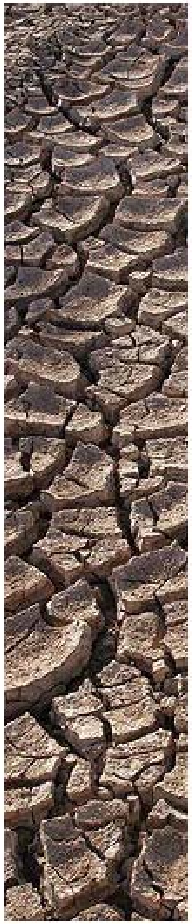
Supply and Demand	Median Hydraulic Condition (GWh)	Drought Conditions (GWh)	% Change
Hydro Generation	31,170	19,930	-36%
MH Thermal Generation	210	4,100	1852%
Import & Wind Purchases	1,730	4,800	177%
Export Sales	8,450	4,200	-50%

Source: 2010 Forecast of Generation Costs and Interchange Revenue; Fiscal Year 2012/13

Notes:

1. 'Median Hydraulic Conditions' represents an average of three (3) flow cases in which flow levels are approximately equal to median (i.e. 50th percentile) values.
2. 'Drought Conditions' represents hydraulic flows for fiscal year 1940/41, only dependable imports and wind purchases.

MH's Capability to Respond to a Drought Has Significantly Evolved Since the 2003-04 Drought



2003/04 vs. 2010/11

Parameter	2003 (Mar, Jun)	2010 (Mar, Jun)
Winter precipitation	Lowest on Record	Lowest on Record
Energy in storage (TWh)	4, 7	11, 16
Energy from inflow (GWh/d)	50, 35	100, 150
Coal Generation	Unrestricted	Restricted
Annual Manitoba firm load (TWh)	22.0	24.2
Annual Firm export contracts (TWh)	5.8 Buyback Possible	2.8 Financial Market Settle
Market	Bilateral	Open
Brokerage capability	No	Yes
US Firm Import Transmission Summer Winter	 Not MH Controlled Not MH Controlled	 Mostly MH Controlled All MH Controlled
Winter gas price forwards	6.8 $CDN/GJ* (exp) 12 $CDN/GJ (high)	5.0 $CDN/GJ** (exp) 8.1 $CDN/GJ (high)
Delivery risk for winter gas	Low	Very Low
Retained Earnings	$1.2 B	$2.2 B

* Oct 2003 Forward for Nov-Apr ** Jun 2010 Forward for Nov-Apr

Review of MH's Quantification of Risk Exposure Related to an Extended Drought

- The assessment of the stressfulness is based on the review of: (1) general approaches to characterizing financial risks such as the choice of confidence intervals, (2) the interaction of drought with other risk events such as high wholesale power prices, (3) starting point of adverse event, (4) availability of mitigation strategies, (5) duration of adverse event, and, (6) a comparison of Manitoba Hydro's quantification of risks with those of other organizations.

Review of MH's Quantification of Risk Exposure Related to an Extended Drought

MH's quantification of risk exposure to drought via use of a historically based five year episode is reasonable.

- The scenario examined by MH is reasonably stressful. It is almost equivalent to adopting a 95 percent confidence interval for a given future year.[1]
- The 2003 drought resulted in less of a financial impact than the stress test case. This was one of the three worst single years in MH hydrological history. This supports MH's choice of its stress case.
- The stringency is comparable to other stress tests – S&P liquidity test; U.S. bank stress test; these organizations have less recovery potential.
- We observe that some other financial stress tests involve more than one risk factor changing simultaneously, while MH's does not. However, these organizations examine more common events than extended droughts, e.g., recessions. Hence, they need to examine a broader range of events including simultaneous changes in more than one variable in order to reach the confidence levels that MH reaches when varying only one variable, i.e., is there an extended drought or not. Hence, as a general matter, MH does not need to simultaneously examine multiple risk events.

[1] Starting from a non-drought year and looking forward.

MH's Quantification of Drought is Reasonable

Case	Description	Probability (%)	Equivalent Confidence Interval (%)
Baseline Stress Case	5 Year Drought	3.1	93.8
Sensitivity Case – Longer Drought	7 Year	1.0	98
Sensitivity Case – Base Case Plus Higher Power Prices	5 Year Drought and High Power Prices	1.5[A]	97
Sensitivity Case – Longer Drought Plus High Power Prices	7 Year Drought and High Power Prices	0.5	99

Note: (A) This probability is part of the following four outcomes: (1) five year drought and high prices (1.5%), (2) five year drought and low prices (1.5%), (3) no drought and high prices (48.5%), and (4) no drought with low prices (48.5%).

Using a five year drought is equal to a 94 percent confidence interval and is reasonable. The principal quantitative alternatives are equivalent to using a 97 percent to 99 percent confidence interval which is too stringent.

Stress Test Comparison

	Manitoba Hydro	S&P Power Trading Liquidity Test	U.S. Bank Test
Duration (years)	5	2	2
Recapitalization Potential	High	Low	Low
Number of Variables	1	2 – 3[1]	3[2]
Probability	3%	Similar to MH	Similar to MH

Notes: [1] Variables include downgrade, and lower power and gas prices
[2] Variables include unemployment, GDP change, and house price decrease

Other Considerations Related to Quantification of Drought

As discussed, MH's quantification of risk exposure to drought is reasonable.

- The scenario examined by MH is reasonably stressful. It is almost equivalent to adopting a 95 percent confidence interval. This is in line with what is typically done in stochastic analysis.
- The main alternative stress case, a seven year drought increases the potential reserve need by over 14 percent from $2.8 billion to over $3.2 billion.[1]
- The assessment of the mechanics of the quantitative simulation is based on our review of Manitoba Hydro's forecasting and simulation tools and a comparison with other approaches. Manitoba Hydro relies primarily on its own system modeling tools such as SPLASH and HERMES, and most recently, a tailored application of PRISM. These models and the company's Integrated Financial Forecasts are employed by the Corporation to quantify the risks associated with an extended drought.

[1] Though the impact on retained earnings of a seven year drought (at expected prices) was not fully estimated, it was estimated that a seven year drought would result in a further decrease in net export revenues by $0.5 billion in comparison to net export revenues for the five year drought with a net impact on retained earnings of $2.8 billion. See MH Response to PUB Order 117/06. Thus, the impact on retained earnings of a seven year drought can be expected to be more than $3.2 billion due to financing and other charges.

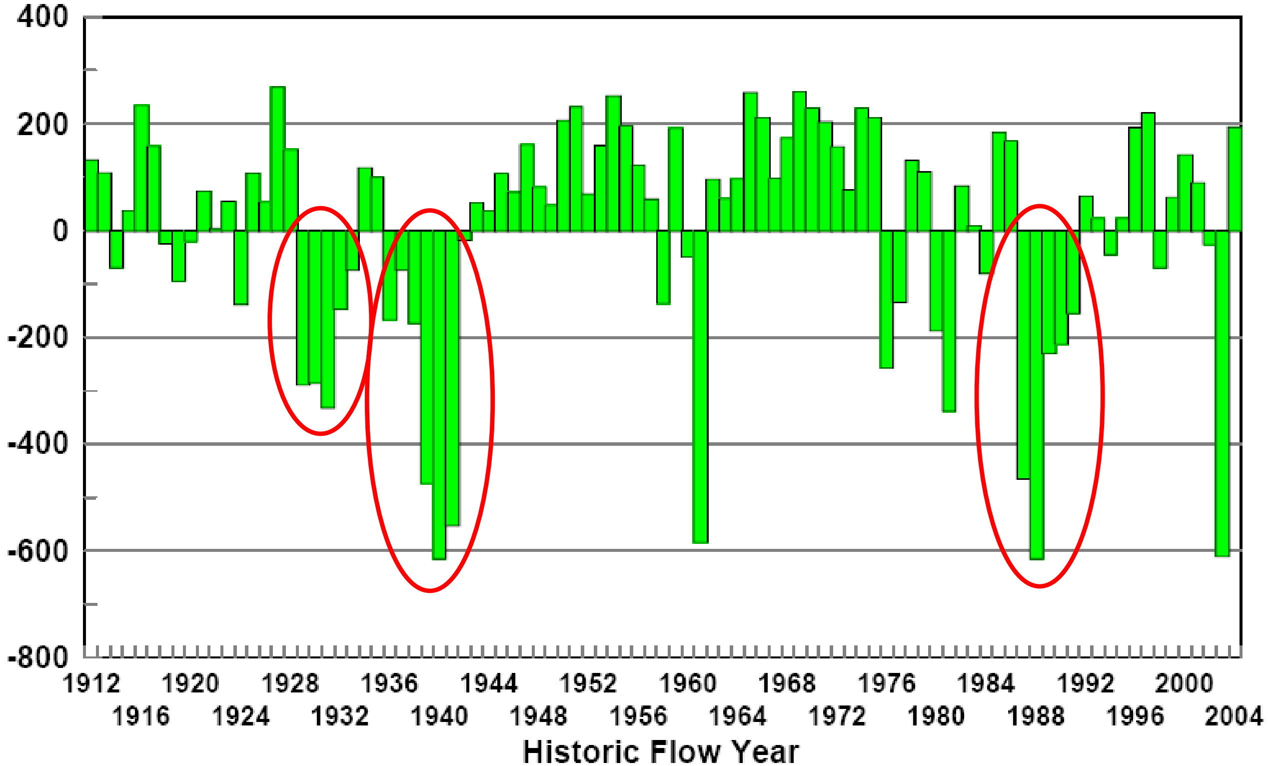
Other Considerations Related to Quantification of Drought (cont.)

- While the quantification approach is reasonable, once in a drought, quantification using multiple variables may be reasonable (e.g., Monte Carlo simulation of cash flow at risk using a PRISM IFF combination) in part to better track risks and to facilitate communication across the company and with stakeholders regarding the progress of the drought and the likely financial impacts of the Drought Preparedness Plan. This would build on on-going PRISM work and also facilitate additional examination of short-term (1-2 years forward) hedging tools. Also, some additional examination of the consequences of depleting retained earnings would be useful in terms of impact on rates.

- While quantification is a good discipline, judgment also has to be used – i.e., the right balance has to be found. Models are useful and their absence would be a concern, but it is dangerous if overly relied upon by decision-makers.

ICF Response to KM Comment that ICF's Calculation of a 3.1 Percent Chance that Any Year will be the First of a Drought of Five Years Duration or Longer is an Underestimation

Variation of Flow Related Revenue ($ million)



Source: Response to PUB Order 117/06, p.1

Notes:

The calculations for the graph above assume current generation capability and a single base case for other parameters.

2. The circled time periods indicate extended drought years

ICF Response to KM Comment that ICF's Calculation of a 3.1 Percent Chance that Any Year will be the First of a Drought of Five Years Duration or Longer is an Underestimation (continued)

- ICF's estimation that in any given year (assuming that each future year has the same chance of being the first year in one of the 97 records available) there is a 3/97 or 3.1 percent chance that the year will be the first of a drought of five years duration or longer is correct – in any given future year, this is the probability[1]; this is a very reasonable approach.

- The ICF report also concludes that using simultaneous events as baseline stress test to be too stressful (e.g., drought + high power prices for example) for a given future year.

- However, once in a drought, additional precaution is warranted (given serial correlation[2] issues) - and the ICF report suggests the need to consider multiple events (such as drought + high power prices) once MH is already in a drought. This is because there is a larger probability of additional years of low water conditions (i.e., there is serial correlation).

[1] This assumes that the future year is independent of the current year, which is appropriate in most cases – see later discussion.
[2] The probability of a drought is higher if the prior year has a strong drought.

ICF Response to Kubursi and Magee Comments

> There are a few problems with these calculations. First, the probability of occurrence of a 5 years drought is not 3.1% unless one assumes that the historical series is made of events having equal chances of occurrence. Considering this value to fall within the 2.5% tail of the distribution is based on considering the historical series to define a normal distribution. Furthermore, the assumption that higher electricity prices are a totally independent event and are not correlated with a drought is perhaps unrealistic.
>
> Source: Manitoba Hydro Risks: An Independent Review, Kubursi and Magee, November 15, 2010, p.189

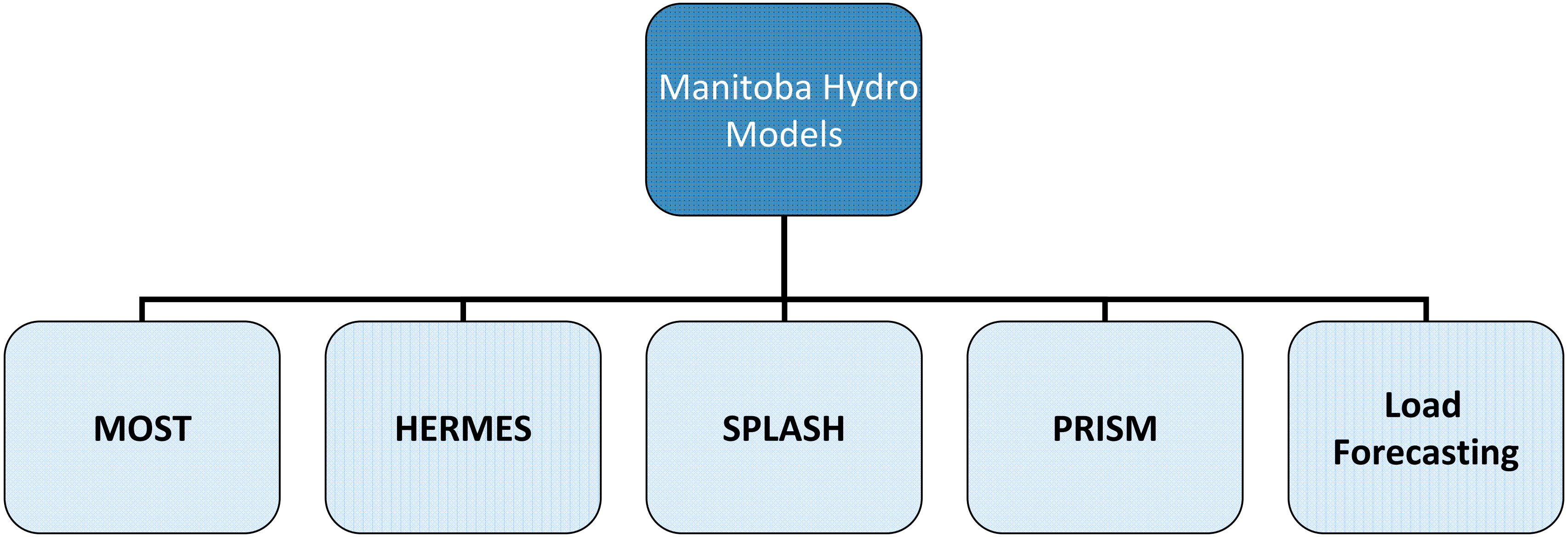
- In future years, it is appropriate to assume that each year has an equal chance of occurring. Knowledge of future periods several years forward is too limited to assume otherwise. All evidence supports the likelihood of a five year or greater drought being approximately 3 percent.

- U.S. MISO is primarily a thermal system and much bigger than MH (approximately 140 GW of capacity versus 6 GW for MH). Assuming MISO prices are independent of droughts in Manitoba is entirely appropriate.

V. MH MODELING, FORECASTING, AND PLANNING

V.1 Review of Performance of MH's Models
V.2 Conclusions on Use of Multiple Models
V.3 Conclusions on Type of Models Employed
V.4 Use of Historic Stream Flow Record
V.5 Use of Synthetic Data Sets on Stream Flow
V.6 Assessment Of Accuracy Of Long Range Precipitation Forecasts And Drought Management
V.7 Analysis of Dependable Energy Treatment: Planning and Response to KM

Manitoba Hydro Suite of Models



- MH employs multiple models for system planning and operations – a common practice among electric utilities (as discussed later).

Manitoba Hydro Suite of Models (continued)

Model	Feature					
	Period	Stochastic (S) or Deterministic (D)	Linear (L) or Non-Linear (NL)	Focus	Methodology	Origin
HERMES	0-2 Years	D[1,2]; S[3]	L	System Operations	Linear Programming	In-House
SPLASH	Long-Term	D[1,2]	L	System Planning	Linear Programming	In-House
MOST	Very Short-Term – 24 Hours	D	L	System Operations	Linear Programming	Synexus Global Inc. Now In-House
PRISM	0-5 Years	S	L; NL	Operations Planning	Monte Carlo	RiskAdvisory Now In-House
Load Forecasting	Short- and Long-Term	S	L	Operations, Planning	Statistics	In-House

[1] Multiple hydro scenarios each solved deterministically
[2] Supplemented by Scenarios
[3] Employs statistical relations between data describing current conditions such as the latest snow pack, precipitation, temperatures, etc., to determine the likely near-term hydrological system operation

Modeling Criticisms

- ICF has found no deficiencies with operational impacts of MH models. However, ICF has recommended continued development of MH's PRISM model.

- KM's criticism of MH modeling include:
  - failure to integrate MH models
  - excessive use of linear programming as opposed to non-linear programming

MH's Practice of Having Different Models for Real Time Operations (MOST), Mid-term Operations Planning (HERMES), and Long-term Generation Planning (SPLASH) is Reasonable

- **Common practice in the electric utility industry is to limit run times to avoid implementation failures; excessive integration results in implementation failures. This problem is avoided by:**
  - Aligning models with decision timeframes, e.g., planning models for long-term investment decisions, short-term models for operations
  - Aligning models with application – e.g., operations, planning, finance, detailed transmission
  - Use a combination of deterministic models with multiple scenarios and stochastic models
  - Use linear and non-linear optimization models/solution approaches such as Monte Carlo

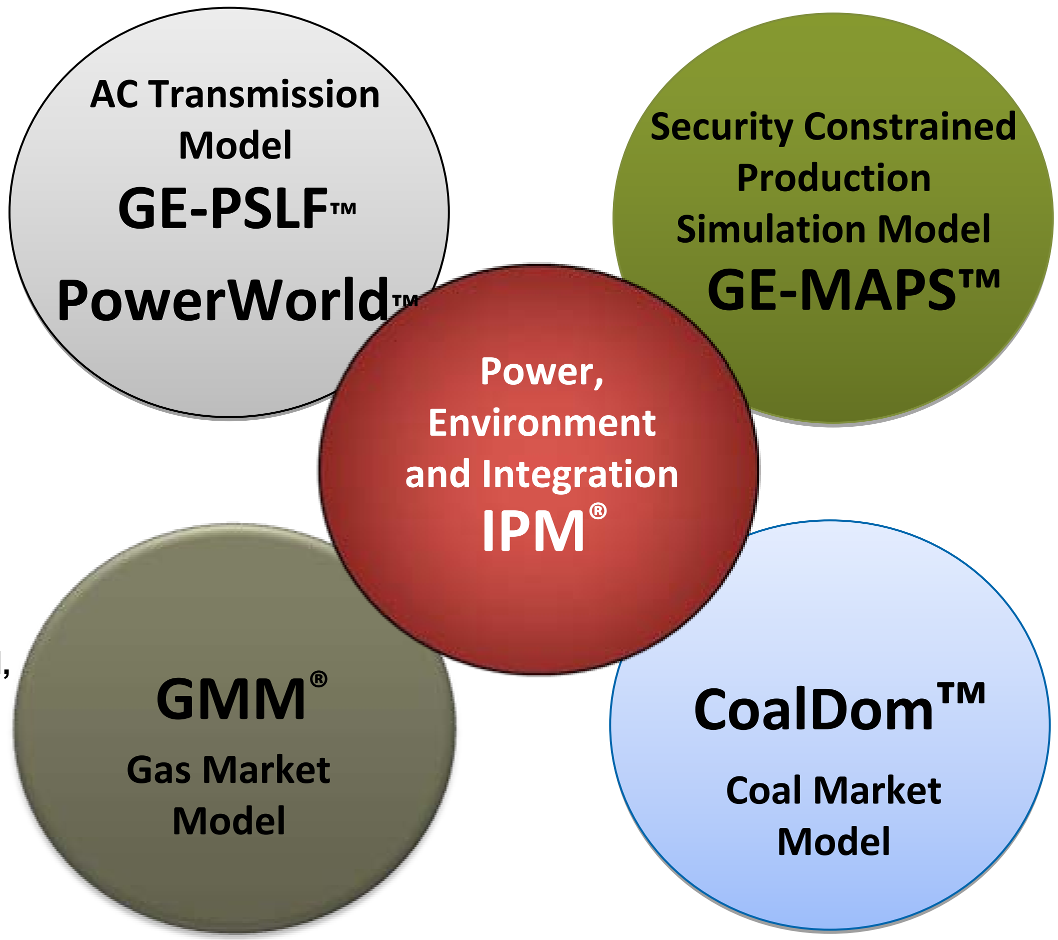
- **Manitoba Hydro uses a range of tools including:**
  - Linear Programming
  - Non-linear Solutions
  - Stochastic Modeling
  - Deterministic Modeling

- **Manitoba Hydro 's use of models is similar to other utilities.**

ICF Uses Multiple Tools: Each Plays a Different Role

Evaluates the transmission grid, interface capabilities, and critical contingencies

Analysis of LMP, congestion, and losses



Gas supply/demand, transmission, and price and basis forecast

Coal supply demand, price basis, forecast

Additional ICF Energy Market Models: Stochastic and Deterministic

Utility Planning Models

Vendor(s)	Model	Optimization Methodology
ICF	IPM®	Linear Programming
Ventyx	ProSym	Linear Programming
Ventyx	ProMod	Linear Programming
Ventyx	System Optimizer (SO)	Linear Programming
LCG Consulting	U Plan	Linear Programming with Iteration
CRA	NEM	Linear Programming
GE	MAPS	Linear Programming
GE	PSLF	Non-Linear
Epis	AURORAxmp	Dynamic Programming + Monte Carlo
Power World	Power World	Non-Linear
NERA	ENER RISE	Linear Programming
BC Hydro (in-house)	Hydrological System Stimulation Model (HYSIM)	Simulation Model
BC Hydro (in-house)	Multi-Attribute Portfolio Analysis (MAPA)	Discounted Cash Flow
BC Hydro	Operations Planning Tool (OPT)	Linear Programming
Great Lakes Environmental Research Laboratory	Hydrological Response Model	Numerical Finite Difference Solution
Black & Veatch, Brattle	Various Spreadsheet Models	None

ICF and Industry Experience

- ICF is heavily involved in power and energy modeling. ICF employs multiple models rather than one large model to avoid excessive run times and implementation failures; in ICF's experience, excessive integration results in implementation failures.

- ICF also relies primarily on linear programming, though not exclusively.

- Most production cost, operations and planning models use linear optimization because it is a proven and practical approach to economic modeling
  - other options (such as stochastic options) may not buy much and can take too long to solve and conduct Quality Assurance and Quality Control;
  - as computers are becoming more powerful, trend is to disaggregate more rather than fully integrating complex models
  - linear programming is flexible; non-linear relationships can be approximated in many cases and can be supplemented with closely related integer programming models

Stochastic Modeling

- MH has also been criticized for excessive use of deterministic modeling versus stochastic modeling. The development of PRISM addresses this concern.

- PRISM is stochastic in nature which is more appropriate for risk management models. Risk management models, with the exclusion of capacity expansion, have simplified production costing treatments.

Reasons for Developing PRISM

- **To analyze the financial impact of variations in:**
  - Water conditions (volume risk)
  - Manitoba load
  - Gas and electricity prices
  - Forward contracting risk (export sales)
  - Transmission access (intertie connections)
  - Wind energy (variability in generation)
- **Provide Monte Carlo simulation**
  - Probabilistic analysis
- **To provide an overview, not a precise analysis**
- **Used to identify range of outcomes associated with defined scenarios**
- **Recommended and initial development by RiskAdvisory**
- **Now an In-house Model**
  - Therefore functional, and easily modified

Scope of PRISM Applications

- **Focused and Relevant Resolution**
  - Seasonal Representation
- **Energy Focus**
- **Near and Intermediate-term Focus**
  - 5 to 7 year analysis period set in long-term planning horizon

MH is continuing to develop and enhance the capabilities of PRISM.

Hydro Modeling

- According to the KM report, the advantage of Quebec's and BC's hydro modeling is in the stochastic nature of their systems, which makes them more complex and perhaps more useful tools for risk management.
- Also, according to the KM report, Quebec has developed "GESTAU" a stochastic and dynamic optimizing model. Dynamic programming is difficult when considering capacity expansion.
- KM also advocates increased reliance on hydro modeling via synthetic as opposed to historical hydro flow data sets.

Utilities Customize Models Based on Their System Configurations

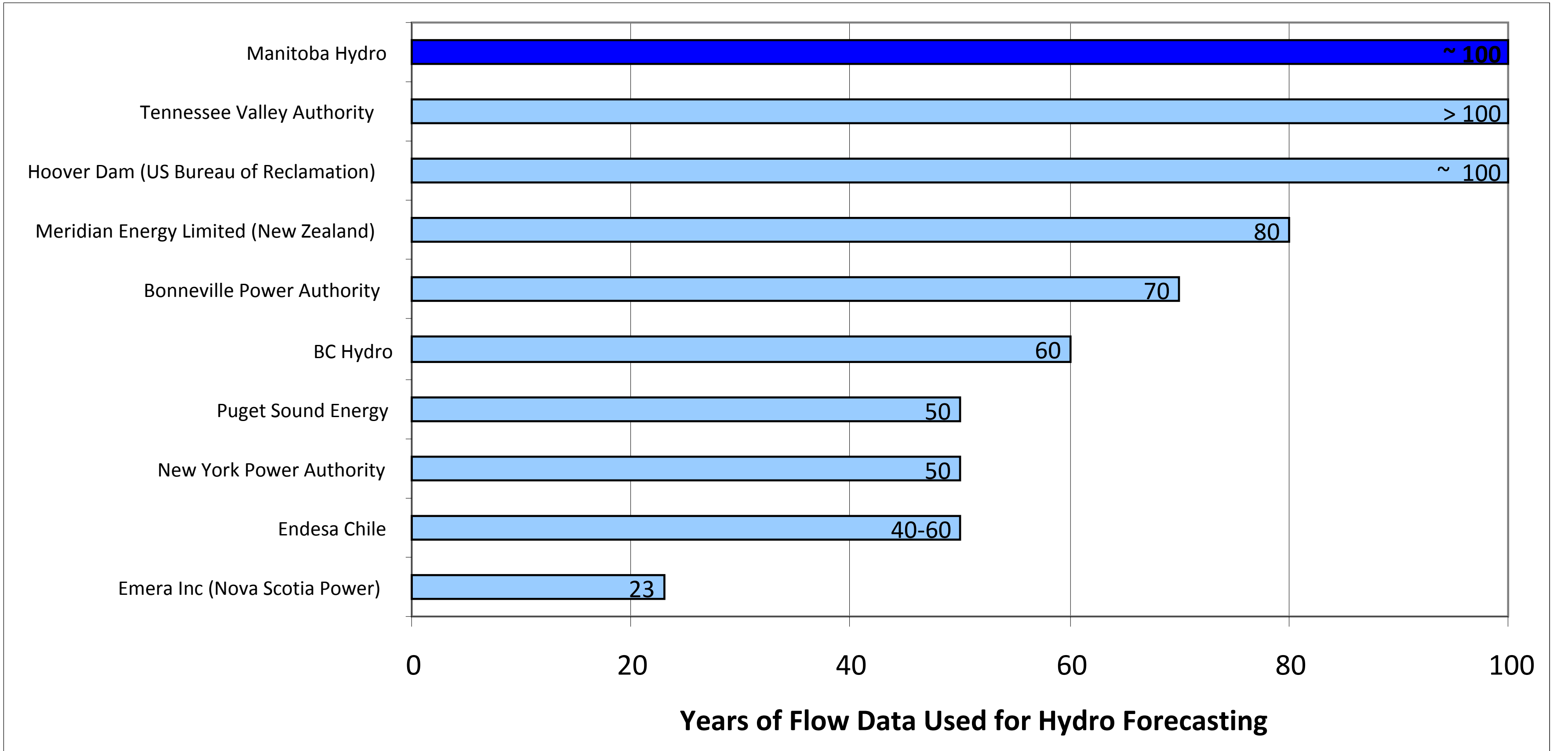
- Each utility's system configuration is unique – as such, the models employed by them are also different. For example, BC Hydro uses the models discussed below for resource planning. While the models are customized to system configurations, certain basic elements remain similar across models utilized by different utilities (e.g., the use of stream flow data by hydro-utilities for hydro simulation).
  - **System Optimizer ("SO") model:** This model is used to select an optimal resource expansion sequence of generation and transmission additions for a given set of input assumptions (e.g. load forecast) and constraints (e.g. transmission line limits, annual hydro generation profile - from HYSIM, as discussed below). It is a linear and mixed integer programming optimization model.
  - **Hydrological System Stimulation Model ("HYSIM"):** This model is used for system simulation under a range of stream flow conditions and for production costing. It simulates system operation with year-to-year variability of reservoir inflows over a 60-year period of historical record.
  - **Multi-Attribute Portfolio Analysis ("MAPA") model:** This spreadsheet-based model is a financial extension of HYSIM – it uses the HYSIM energy generation profiles to perform discounted cash flow analysis. The HYSIM/MAPA combination takes the expansion sequence as an input from SO and calculates the portfolio costs and provides the generation distribution in terms how much is generated by the hydro and thermal parts of the system and how much energy is imported and exported.
- Prior to 2008, HYSIM/MAPA combination was used to construct resource expansion sequences. Since this combination is not an optimization model, the expansion sequences were manually developed and optimized by iteration.

Source: BC Hydro 2008 Long Term Acquisition Plan, Appendix F15

MH's Practice of Utilizing the Historic Streamflow Record as the Basis of its Operations, Generation and Financial Planning is Reasonable – Comparison with Other Hydroelectric Utilities in North America

Utility	Use of Historical Data for Hydro Forecasting	Years of Data	Consider Paleo Climatic Information
Manitoba Hydro	√	~ 100	√
Tennessee Valley Authority	√	> 100	
Hoover Dam (US Bureau of Reclamation)	√	~ 100	√
Meridian Energy Limited (New Zealand)	√	80	
Bonneville Power Authority	√	70	
BC Hydro	√	60	
Endesa Chile	√	40-60	
New York Power Authority	√	50	
Puget Sound Energy	√	50	
Emera Inc (Nova Scotia Power)	√	23	
Hydro Quebec	√		
Nalcor Energy (Newfoundland and Labrador)	√		
Ontario Power Generation	√		

MH's Practice of Utilizing the Historic Streamflow Record as the Basis of its Operations, Generation and Financial Planning is Reasonable – Comparison with Other Hydroelectric Utilities in North America (continued)



Role of Synthetically Generated Streamflow Data Sets

- Manitoba Hydro is fortunate to have a large amount of data upon which to base its quantitative assessment of extended droughts. The Corporation bases its assessment of hydrological conditions on the 97 years of available hydrological information between 1912 and 2008. The analysis of most financial risks by most other organizations uses less data. Use of synthetic data is appropriate for organizations with much less data.

- MH is also sensitive to the fact that while records have been kept for the last 97 years, the Corporation nonetheless faces the risk of droughts of potentially even longer duration or greater severity than those experienced since hydrological records have been maintained. For example, a once in 500 year event that is significantly more severe than the seven year episode experienced during the 1937-1943 period. In this light, MH has considered the use of paleo-climatic and other information to extend the historical record. However, broad-based research efforts within the scientific community have thus far failed to create the needed information for the modeling.

- MH is also sensitive to the fact that once in a significant drought, there is a higher chance of the next year also being a drought.

- Once there is a realization of the potential for an even more extreme drought, additional quantification via auto regressive time series models and Extreme Value Model risks creating a false sense of precision and does not significantly support the practical planning needs of the company.

Assessment Of Accuracy Of Long Range Precipitation Forecasts And Drought Management

- Long range forecasts based on weather analysis are not reliable; somewhere between 10 days and 30 days, the evidence supports the view that long-term averages are more predictive than forecasts.[1]
- Furthermore, the consequences of error are large, and hence, reliance on weather forecasts is not appropriate.
- Once in a drought, one must plan for its continuation and heavy reliance on weather forecasting is not appropriate.

[1] "Lorenz is the MIT atmospheric science researcher whose work led to the development of the idea of chaos in physical systems. In meteorology, one of the important implications is that small differences in the initial conditions of the atmosphere can lead to big differences in the weather that results only a few days later. These differences can be too small to detect. This is why scientists say that day-to-day forecasts of the weather for more than about two weeks ahead will never be possible. Today, five days is about the limit of useful day-to-day forecasts. And, forecasts for five days ahead are, at best, little better than using "normal" climatic values." Jack Williams, USA Today.com, May 2005.

Reasonableness of MH's Assumption of Dependable Energy: IR Kubursi and Magee #26

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Reference: Chapter 5 - Page 214

"The inclusion of wind and out of money thermal energy in dependable energy is a stretch but they represent such a small portion of total generation that their inclusion or exclusion is not a material concern."

a) Please explain why in your view it is not appropriate to rely on MH's thermal and wind energy resources as dependable energy resources.

ANSWER:

a) KM's view is that when an energy resource cannot be dispatched such as wind, it would be difficult to rely upon it to meet dependable demand. Actually NERC does not include wind energy in its reliability criteria. Furthermore, when thermal energy resources are typically too expensive (and inefficient) and out of money, their inclusion in dependable energy is problematic. Their physical induction is there, but it is often too costly.

Reliability and Economics in Utility Planning

- MH has sufficient real-time energy storage to avail itself of the reliability contribution of wind energy.

- In hydroelectric systems, reliability is not determined by meeting peak demand plus a reserve margin; the peak capacity constraint is rarely binding at system peak. Rather, hourly energy supply requirements are typically binding. The goal is to minimize costs/maximize profits subject to meeting binding hourly energy constraints.

- The capacity requirement approach can theoretically be used even for systems with energy producing non-dispatchable power plants like wind and hydro. This is done by adjusting the capacity contribution of the non-thermal elements finding the thermal capacity equivalent. Thus, there is no avoiding energy simulation. The less thermal the system, the less appropriate is a peak reserve margin approach because it gives a misleading impression that meeting peak demand is binding and sufficient to determine reliability.

- MH is using the right approach given its highly hydro-based system: it focuses on hourly energy requirements and it ignores wind resources in planning its capacity obligations.

Reliability and Economics in Utility Planning (continued)

- Kubursi and Magee are confusing reliability planning and economic analysis. The thermal units are undoubtedly contributing to reliability. The only consideration for existing thermal is that they be kept on-line as long as it is economic to do so, i.e. that the going forward benefits outweigh the going forward costs. As long as such capacity is available for meeting reliability, this is largely an economic consideration.

VI. SELECTED RISK AND FINANCIAL ISSUES

VI.1 Comment on whether MH Should Have an Explicit Drought Fund / Rate Stabilization Fund That is Linked to Hydrology

VI.2 Standard Utility Practice Regarding Floating v. Fixed Rate Debt Portfolio

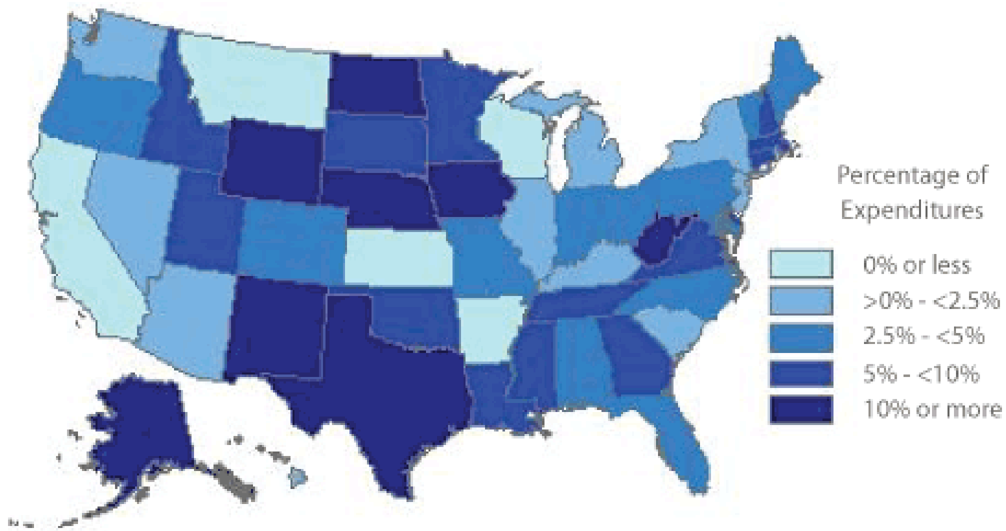
Comment on Whether MH Should Have an Explicit Drought Fund / Rate Stabilization Fund That is Linked to Hydrology

- MH's current policy is to maintain adequate retained earnings to tide over financial consequences of a drought. Having an explicit drought fund is not recommended.
- It is not standard practice for corporations to have explicit funds for explicit problems. There are many potential causes and circumstances for needing equity. Exceptions are usually in debt covenants that are negotiated as needed, and not set by the corporation.
- Additional restrictions can complicate MH financing.
- States are not corporations. 47 U.S. states plus D.C. maintain rainy day funds (intended for use during times of unexpected revenue shortfall or budget deficit).[1] However, these are typically much smaller percentages of expenses than the retained earnings MH maintains (as discussed in the next slide). Also, in practice it is not uncommon that they get used for other purposes deemed appropriate by the governor and the state legislature – therefore end up being like a general fund and corporate equity for entities lacking equity.
- It can be difficult to have pre-set rules for using funds; ultimately discretion based on the circumstances is required. MH has in place consultative mechanisms and other structures to permit consideration of the issues. A consequence of having a large corporation with highly complex operations and financial arrangements is the need to have reasonable management discretion combined with existing oversight structures.

[1] State and Local Tax Policy: What Are Rainy Day Funds and How Do They Work (taxpolicycenter.org).

Comment on Whether MH Should Have an Explicit Drought Fund / Rate Stabilization Fund That is Linked to Hydrology (continued)

Rainy Day Fund Balances as a Percentage of Annual Expenditures (End of Fiscal year 2008)



Source: National Association of State Budget Officers, Fiscal Survey of the States, Spring 2009 (Washington, June 2009).

As shown above, rainy day funds are generally a much lower percentage of expenditures compared to equity target of MH as a percent of expenditures. Specifically, US states' rainy day funds overall accounted for approximately 5 percent of the combined general fund expenditures in 2008 (state level variation is shown in the figure above). MH retained earnings by contrast were approximately 130 percent of its expenses (i.e., significantly higher).[1]

[1] MH retained earnings in 2009 were $2,120 million, while its expenses were $1,635 million. See MH 2009 Annual Report.

Standard Utility Practice Regarding Floating v. Fixed Rate Debt Portfolio

	Floating Debt as Percent of Total Debt	
	Source	
Manitoba Hydro	[1]	20.8%
BC Hydro	[2]*	32.5%
Hydro Quebec	[3]	12.60%
TVA	[4]	0%
Regulated U.S. IOUs	[5]	9.6%
Mostly Regulated U.S. IOUs	[6]	8.5%

[1]: See document "MH Debt Management Strategy", Oct 2009
[2]: BC Hydro 2009 Annual Report, page 74, March 2009 *includes current portion of long-term debt
[3]: Hydro Quebec Financial Profile 2009-1010, page 19
[4]: TVA 2009 10K
[5]: Average across 29 "Regulated" IOUs, sourced from IOU 2009 10Ks
[6]: Average across 17 "Mostly Regulated" IOUs, sourced from IOU 2009 10Ks

- MH's current policy of maintaining primarily fixed rate debt to prevent exposure to sudden changes in debt costs is similar to that of other utilities and greater reliance on floating debt is not recommended especially given drought risks.
- Excessive reliance on floating debt was a key element in the recent US and international financial crisis.

VII. GOVERNANCE AND RISK-RELATED COMMENTS

Assessment of MH's Governance Structure: Appropriate Controls are in Place

- MH has developed and instituted a **Management Control Plan (MCP)** under which:
  - oversight and plan Implementation occurs;
  - transaction controls are put in place; and
  - report requirements are adhered to

- **Oversight Bodies:**
  - Manitoba Hydro Electric Board (MHEB): general oversight
  - Executive Committee: general oversight
  - Export Power Risk Management Committee (EPRMC): oversight of the management of the energy supply and financial risks resulting from participation in the export power market
  - Power Sales and Operations Market Committee (PSOMC): oversight for system financial products

- **Plan Implementation:**
  - Front office: responsible for export marketing strategies, market access long-term contract negotiations and power trading
  - Middle office: responsible for oversight of risk management activities associated with wholesale power transactions – *Enhancements are being made of the Middle Office*
  - Back office: ensures the integrity of systems and processes for transaction settlements

- **Transaction Controls and Reporting Requirements:**
  - There are numerous transaction controls and reporting requirements (with appropriate levels of management included)

Assessment of MH's Middle Office Function: Enhancements are Being Made

- MH's power sales are asset-backed. The company does not and in ICF's view should not engage in speculative trading i.e. non arbitrage non asset based trading. This is in part because public entities usually do not pursue such high risk transactions, and they create potential for rate shocks. Moreover, MH management is not interested in such transactions.

- ICF concluded that in order to fully mitigate risks during non-drought and drought periods, MH needs to continue to work to bring its risk management infrastructure (documentation, structures, procedures and systems) up to standard industry practices. It should be noted that the Corporation has been taking appropriate steps in this direction. For example, it has been developing and expanding the role of its Middle Office.

- The Middle Office is primarily responsible for oversight of risk management activities associated with wholesale power transactions. To bring its risk management infrastructure (documentation, structures, procedures and systems) up to standard industry practices, MH has been developing and expanding the role of its Middle Office. It is my understanding that to date the following enhancements have been made to the Middle Office function:

  - To enhance the independence and oversight of decisions made in PS&O, a new position in the Middle Office was created to assume duties of the credit risk function and has been staffed.

Assessment of MH’s Middle Office Function: Enhancements are Being Made (cont.)

- To enhance the independence and oversight of decisions made in PS&O, a new position to perform market risk analytics and measurement was created and has been staffed. The Middle Office will be obtaining risk software to support risk quantification and close the gaps of functionality that currently exist in WebTrader. An RFP for consulting support has been issued. Once this has been awarded the next step will be to issue an RFP for the software solution. It is anticipated that software should be chosen and implemented by Spring of 2011.
- The Middle Office is expected to be included in the review process of long-term export contracts and term sheets. This is expected to be reflected in revised policy and procedure documents.
- Policy and procedures regarding power risk management for opportunity sales are being reviewed for improvements and gaps. Middle Office will participate in this process.

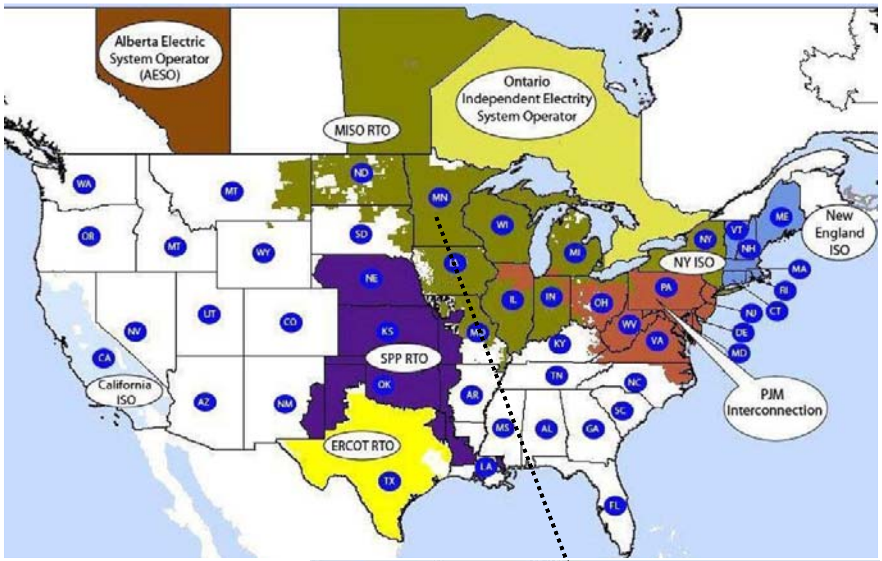
APPENDIX

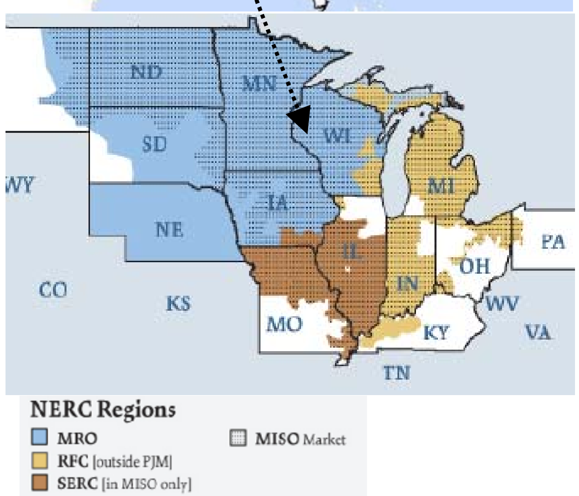
Annual MISO Wholesale Spot Power Prices (1997 - 2010): Low Prices of 2009 and 2010 Followed Record High Prices in the 2005-2007 Period

Year	MISO On-Peak Power Price (Nominal US$)	MISO Spot Prices (2010 US$/MWh)		
		On-Peak	Off-Peak	All-Hours
1997	22.1	30.1	14.5	21.9
1998	29.2	38.7	15.7	26.4
1999	39.5	51.2	14.1	31.5
2000	39.0	49.4	18.7	32.4
2001	37.5	46.3	18.7	31.6
2002	27.8	33.5	17.0	24.7
2003	44.7	52.5	20.8	35.7
2004	46.6	53.4	23.5	37.5
2005	64.7	72.2	33.5	51.7
2006	59.4	64.7	30.5	53.2
2007	71.3	75.8	31.4	61.0
2008	62.0	64.3	26.2	51.7
2009	30.1	30.8	13.7	25.1
2010	35.1	35.1	17.0	29.1
Standard Deviation (1997-2010)	15.3	15.2	6.8	12.5
Average Price (1997-2010)	43.5	49.9	21.1	36.7
Average 1997 – 2003	34.3	43.1	17.1	29.2
Average 2004 – 2008	60.8	66.1	29.0	51.0
Average 2004 – 2010	52.7	56.6	25.1	44.2

Source: 1997-2000 MAPP Weekly Index; 2001–2005 Northern MAPP Weekly Index; and 2005-2010 MINN HUB Weekly Index, from Power Market Week

Deregulated U.S. Wholesale Power Markets Enhance MH's Access to U.S. Power Markets





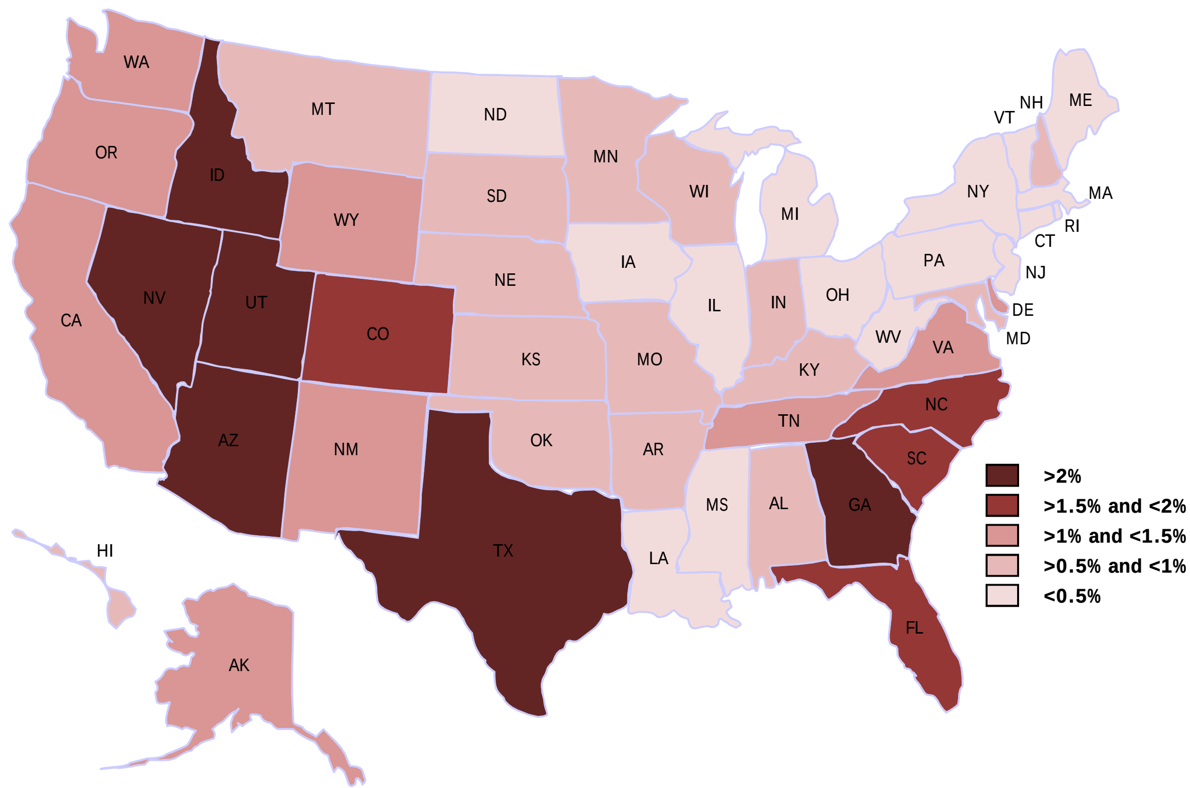
Top Panel: North American Regional Transmission Organizations

Right Panel: The dotted area shows US Midwest ISO and is color coded to show the NERC regions

- Market oriented reforms have made pricing and market structures more transparent and have afforded Manitoba Hydro improved access to the U.S. markets, especially the short-term open markets. Since 2003, these include:
  - Full Day 2 Market in MISO with nodal prices
  - MISO capacity market
  - Joint optimization of ancillary services and energy
  - Joint transmission planning
  - Transmission planning requirements and incentives
  - 2005 Energy Policy Act
  - FERC Order 890
  - FERC 2010 Transmission NOPR
  - NERC as ERO
  - Enforceable reliability standards
  - Greater short financial hedging and settlement options

U.S. Historical Regional Population Growth

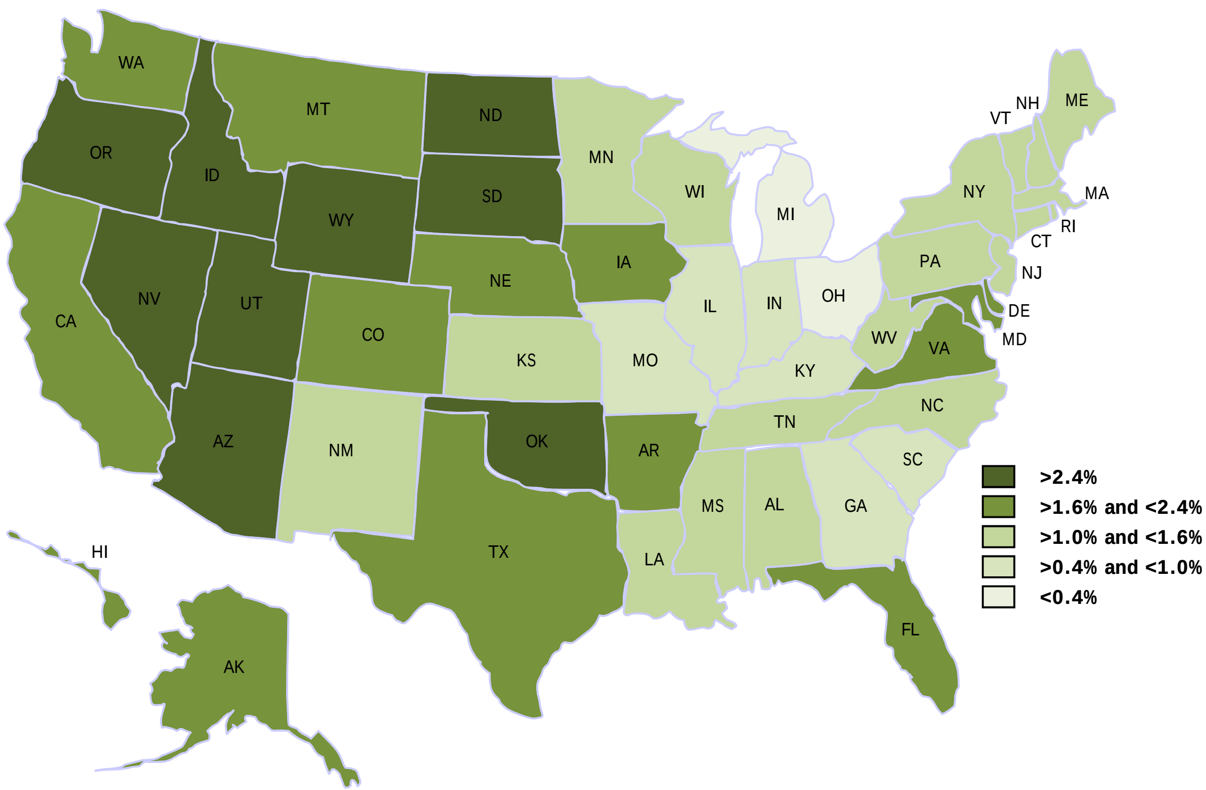
- Population growth is one of the most important determinants of electricity demand growth.
- In the last 10 years, U.S. population grew at an average annual rate of 1.0 percent.
- Nevada experienced the greatest rate of annual growth with 3.7 percent.
- Other fast growing states were Arizona with 3.2 percent growth, Utah with 2.7 percent growth, and Georgia, Idaho, and Texas all with about 2.2 percent of annual growth.
- The states with the slowest population growth were Michigan, Louisiana, North Dakota, Rhode Island, and West Virginia, all with approximately 0.1 percent of annual growth.



CENSUS: Cumulative Estimates of Resident Population change for the United States - April 1, 2000 to July 1, 2009

U.S. Historical Regional Real Gross State Product Growth

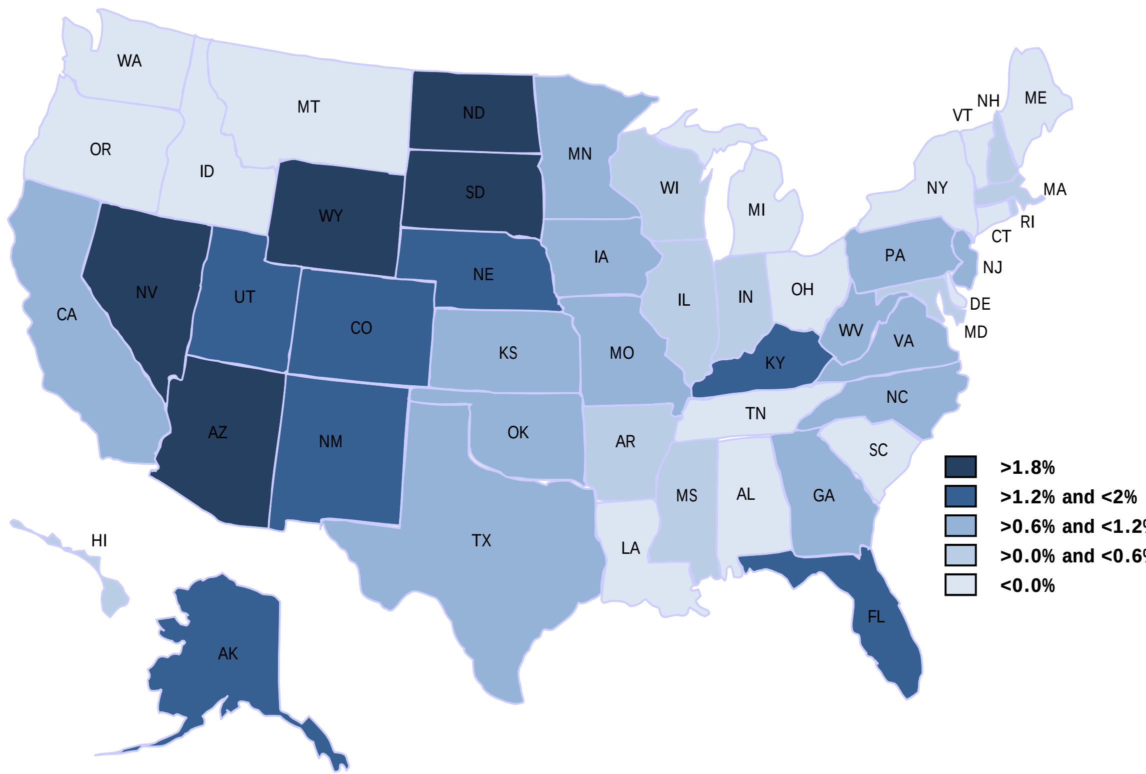
- Economic activity is another important determinant of electricity demand growth.
- In the last 10 years, U.S. Gross State Product grew at an average annual rate of 1.6 percent.
- Wyoming experienced the greatest rate of annual growth with 3.6 percent.
- Other fast growing states were North Dakota with 3.3 percent growth, Oregon with 2.8 percent growth, and Arizona with 2.7 percent of annual growth.
- The two most struggling states were Michigan with -0.9 percent growth and Ohio with 0.0 percent growth.



BEA: Real Gross State Product Average Annual Growth 2000 – 2009.

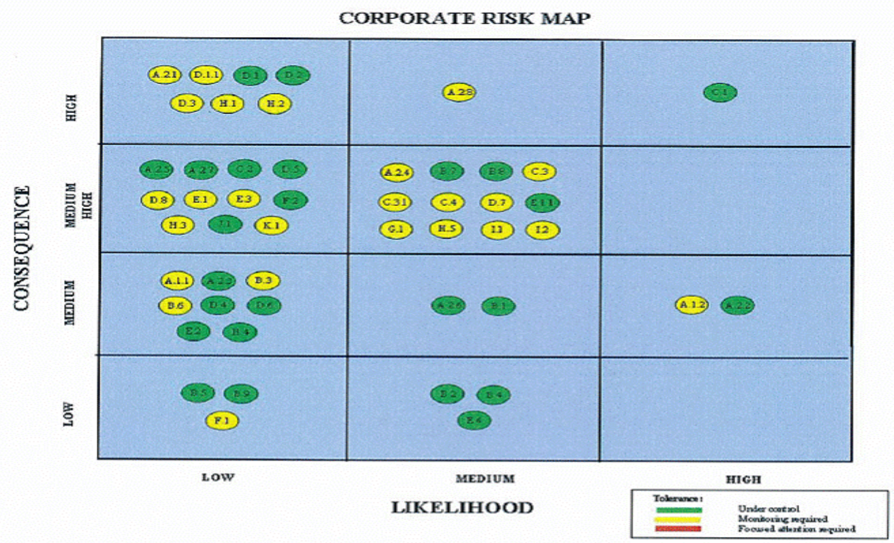
U.S. Historical Regional Electric Sales Growth

- Between 2000-2009, U.S. average total electric sales grew at an annual rate of 0.7% largely due to lower demand during the recession.
- Many of the states that showed either high population growth, economic growth, or both, also showed higher levels of electricity sales growth.
- Arizona and Nevada are examples of states where both high population and economic growth translated to higher electric sales.
- States of North and South Dakota and Wyoming did not grow their population at above average rates but their high level of growth in economic activity translated to higher electric sales.
- States with high population and economic activity growth but no significant growth in electricity sales, such as Oregon and Idaho, are some of the leaders in energy efficiency savings.



BEA: Real Gross State Product Average Annual Growth 2000 – 2009.

MH Assessment of Drought and Other Risks



A. Market
  1. Domestic
     1. Competition
     2. Uneconomic Loads
  2. Export
     1. Regulatory Environment
     2. Competition
     3. Transmission
     4. Special Interest Groups
     5. Protectionism
     6. Domestic Requirements
     7. Commodity Availability
     8. Term Sheets with WPS and MP

B. Financial
  1. Exchange
  2. Interest Rates
  3. Credit
  4. Inflation
  5. Gas Price Volatility
  6. Gas Derivative Instruments
  7. Capital Structure
  8. Shortage Pricing / Fuel Price Volatility
  9. Power Financial Instruments

C. Environmental
  1. Water Supply/ Drought
  2. Climate Change / Water Resources
  3. Operational Impact and Infrastructure
     1. Legal - Species at Risk Act
  4. Reliability of Supply

D. Infrastructure
  1. Loss of Plant (all property, all perils)
     1. Dam and Dyke Structures
  2. Insufficient Supply (drought peril)
  3. Prolonged Loss of System Supply
  4. System Shutdown (Short Term)
  5. System Shutdown (Natural Gas - S.T.)
  6. Technology
  7. Special Interest Groups.
  8. Emergency Management Program

E. Human
  1. Safety and Health
     1. Infectious Disease
  2. Union / Employee Issues
  3. Succession Planning
  4. Technology

F. Business Operational
  1. Supply Chain
  2. Operational Controls

G. Reputation
  1. Reputation

H. Governance / Regulatory / Legal
  1. Regulation and Licensing
  2. Export Market Access
  3. Legal Compliance
  4. Contracts and Ventures
  5. NERC/MRO Reliability Standards

I. Aboriginal
  1. Relationships
  2. Legal

J. Emerging Energy Technologies
  1. Emerging Energy Technologies

K. Strategic
  1. Strategic Direction and Implementation