



Keeyask Generation Project

Environmental Impact Statement

Supporting Volume
Public Involvement



June 2012

The Manitoba Hydro System and its Operation

Harold Surminski

Power Supply
December 15, 2010

Broad Overview of...

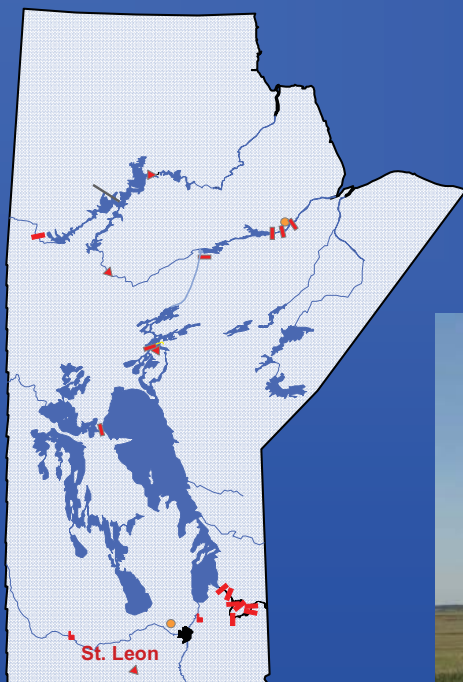
- Key components
 - Generation
 - Transmission
 - Water Control
- System Operation
 - Water Supply
 - Manitoba Load
 - Export markets
 - LWR and CRD

MH Generating Stations and Control Structures

- **Hydro (4,900 MW)**
 - Winnipeg River
 - Grand Rapids
 - Jenpeg
 - Kelsey
 - Laurie River
 - Lower Nelson
- **Lake Winnipeg Regulation**
 - Jenpeg Control
- **Churchill River Diversion**
 - Notigi Control
 - Missi Control
- **Thermal (500 MW)**
 - Selkirk Gas
 - Brandon Coal and GT



Wind Power

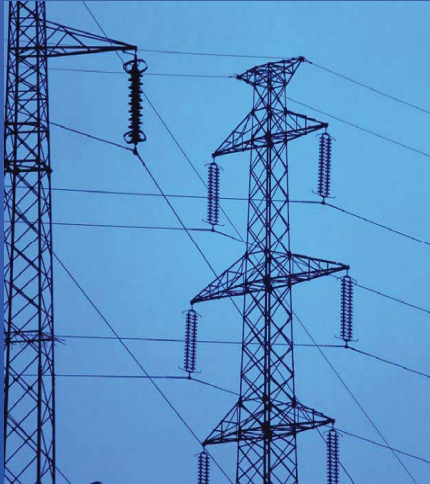


St. Leon Wind Energy LP

- 63 turbines
- 99 MW
- Privately owned
- P.P.A with MH



Imports



Firm

- Seasonal Diversity
 - Capacity swap
 - 350 MW NSP
 - 150 MW GRE
 - 20% winter season capacity factor

Non Firm

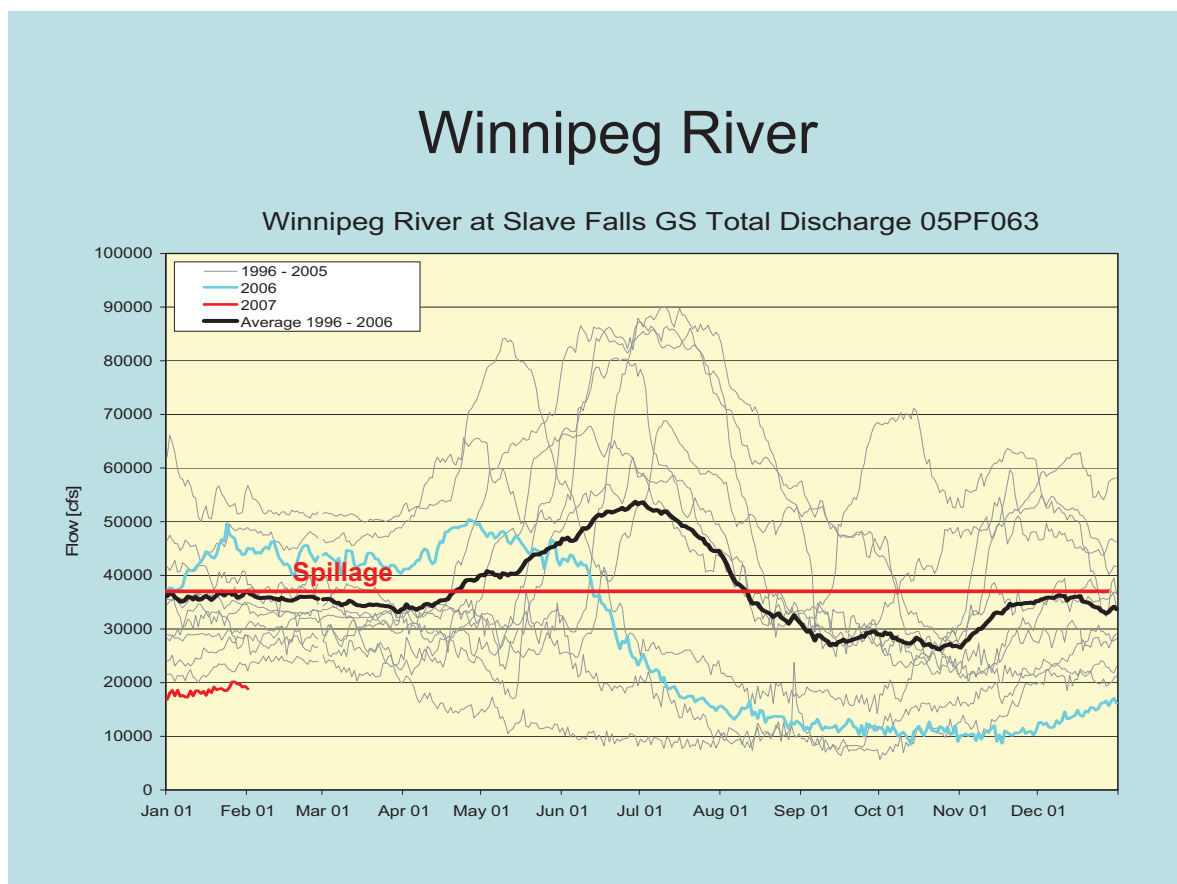
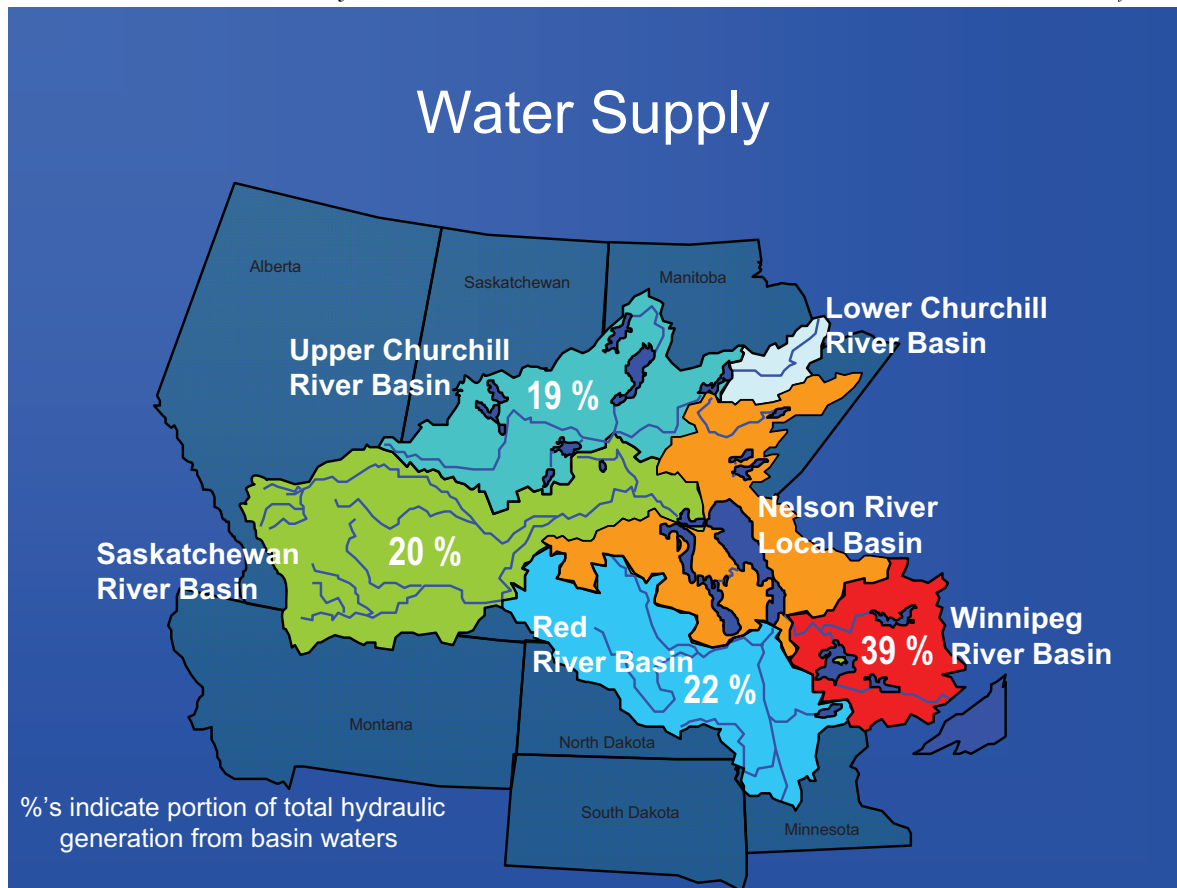
- 750 MW – 1800 MW
- Market purchases
 - MISO
 - Ontario
 - Bid curve

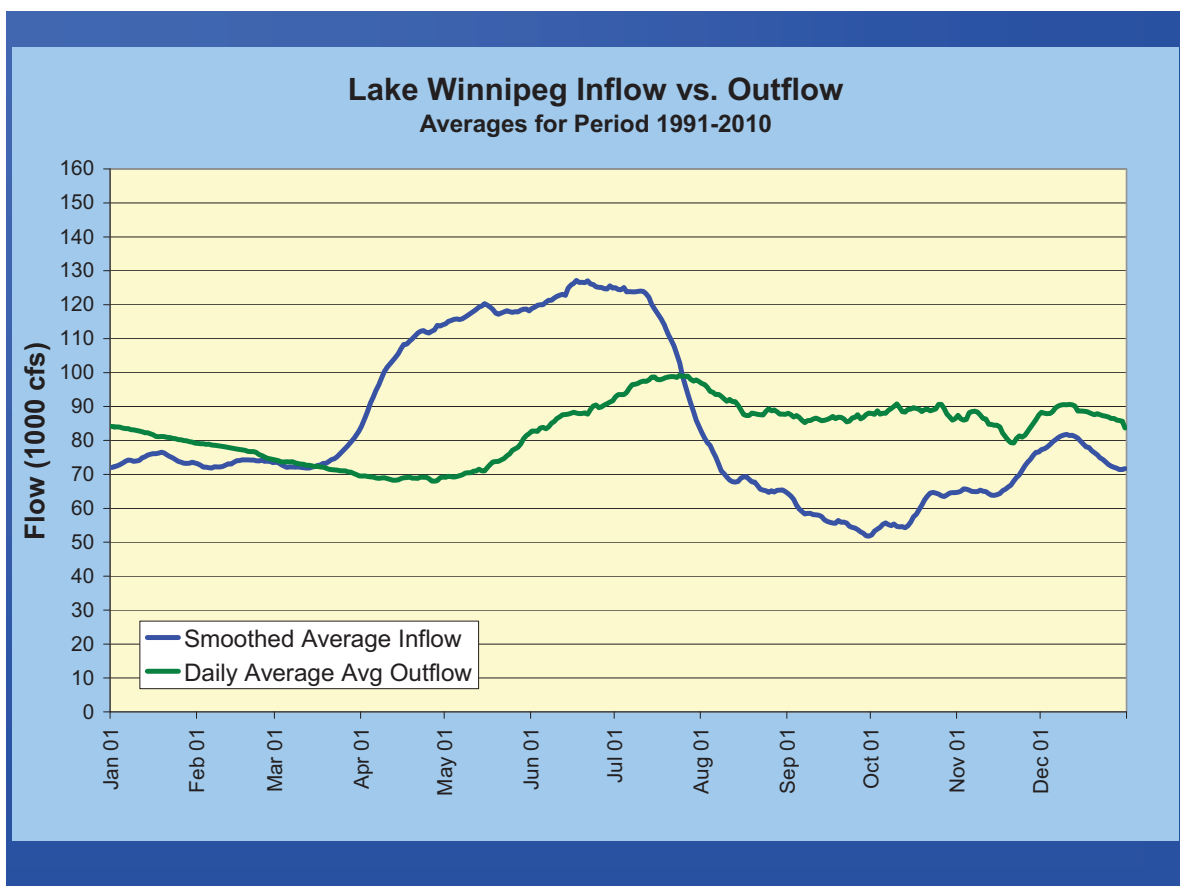
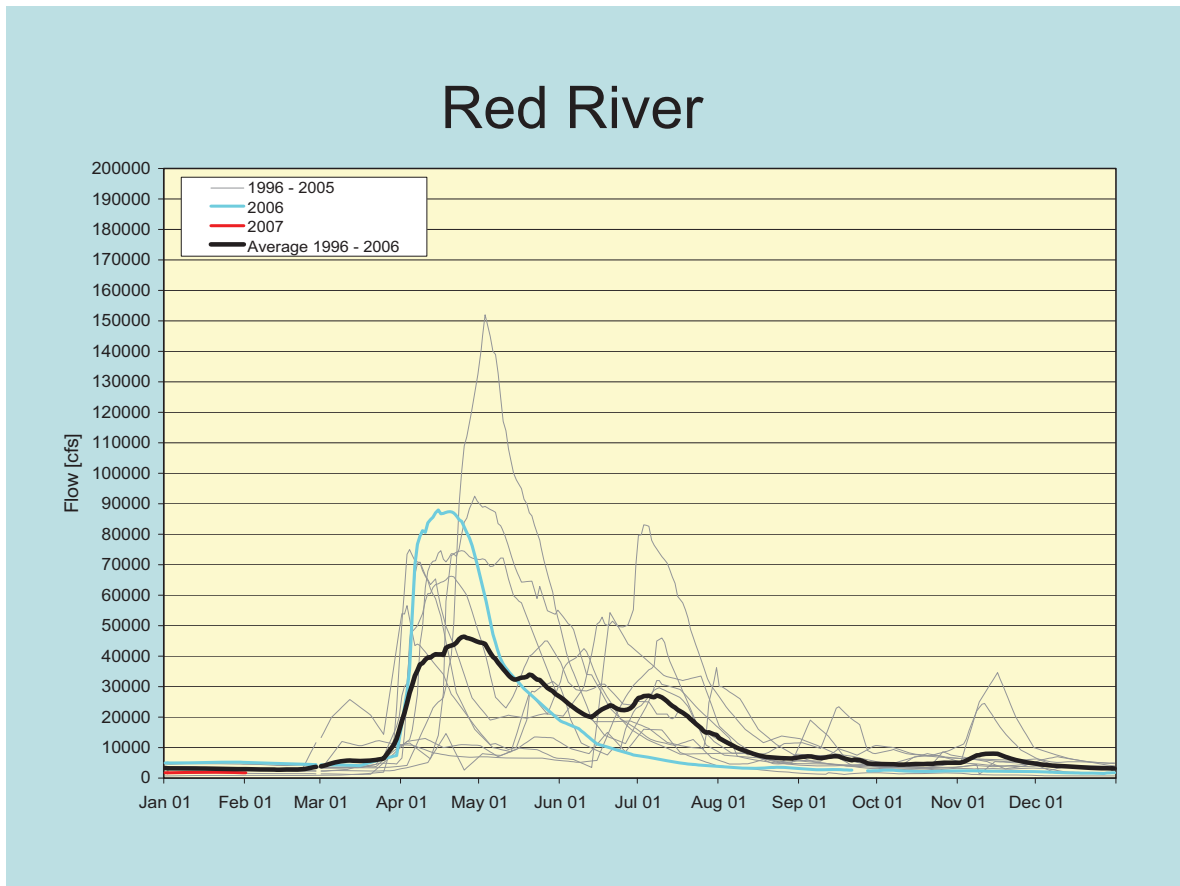
MH Generation Costs

(Fuel and O&M)

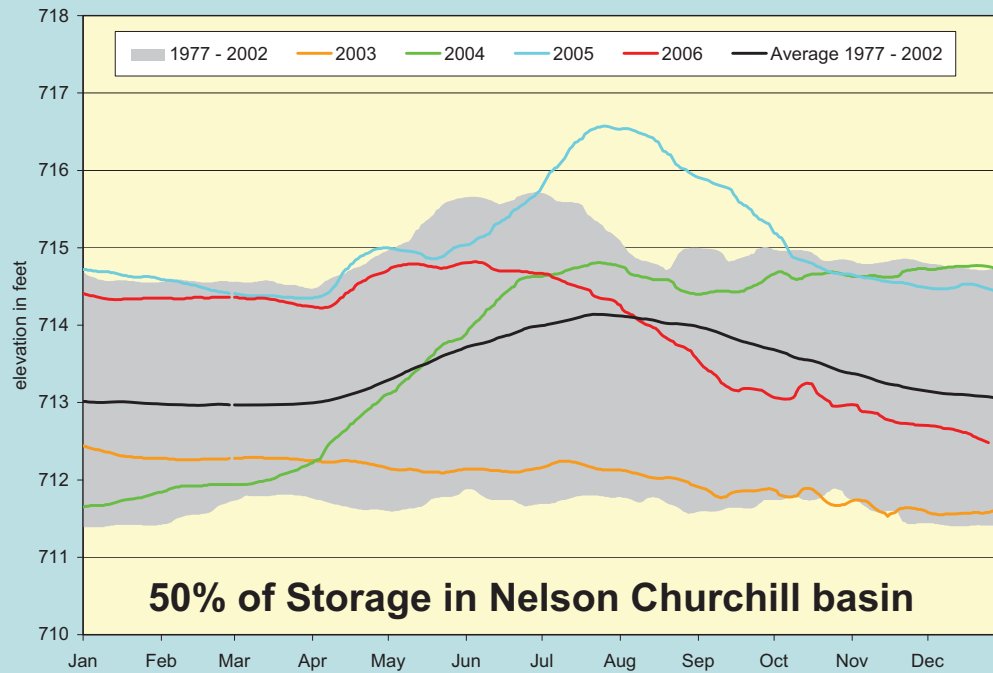
Source	Cost	% of Time ITM
		(since 01/04/2005)
Hydro	\$3/MWh	99.7%
Coal	\$25/MWh	65%
Wind	\$60/MWh	41%
Gas	\$40 - \$100+/MWh	8%
Market Purchases		
On Peak	\$30 - \$80+/MWh	
Off Peak	\$15 - \$30+/MWh	



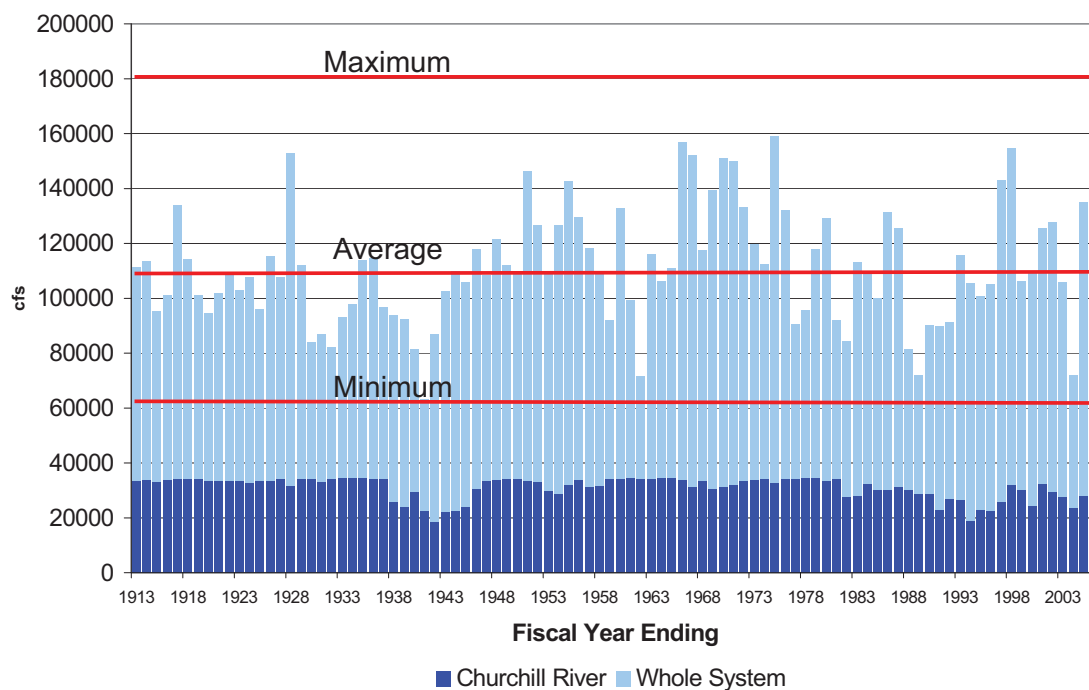




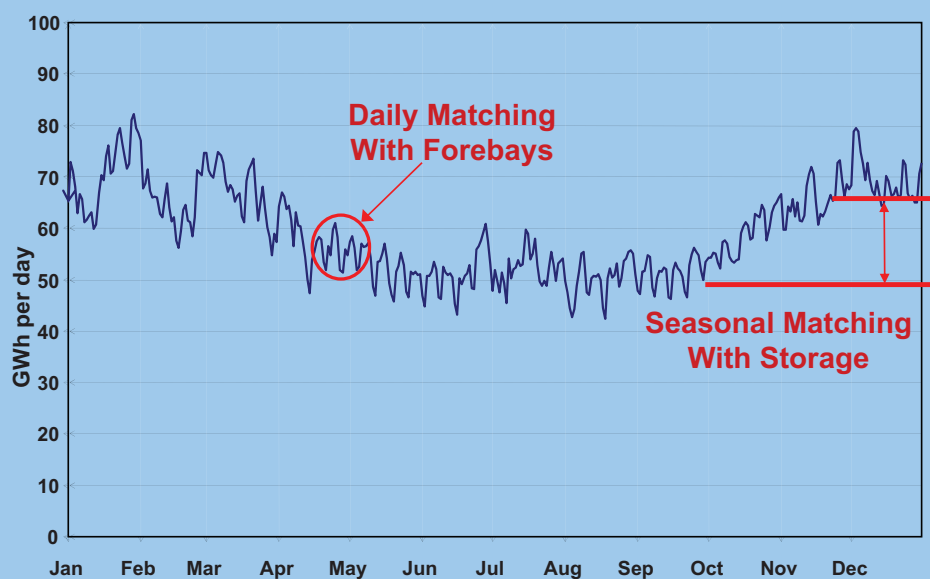
Lake Winnipeg



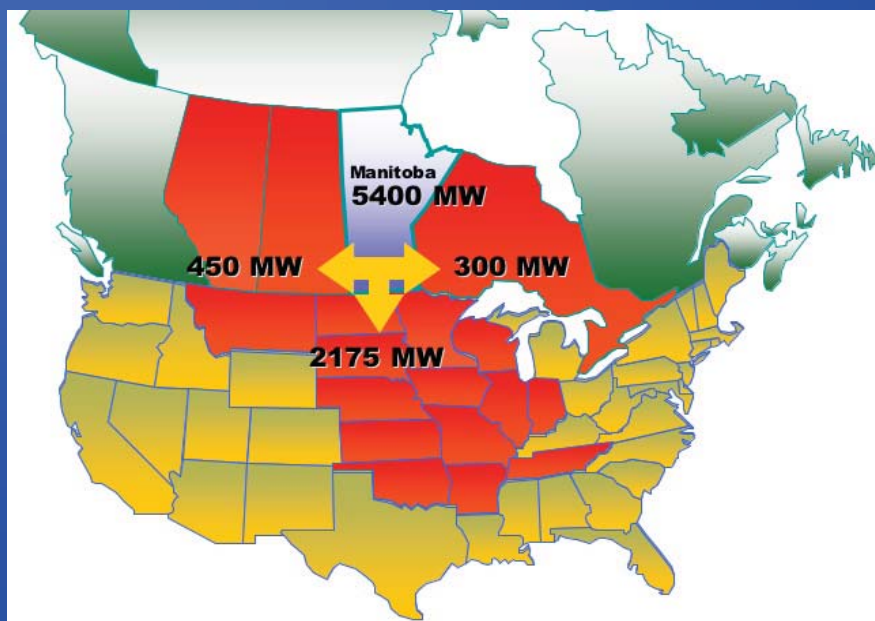
Nelson River Water Supply (Inflows)



Manitoba Electricity Demand Varies Hourly, Daily and Seasonally



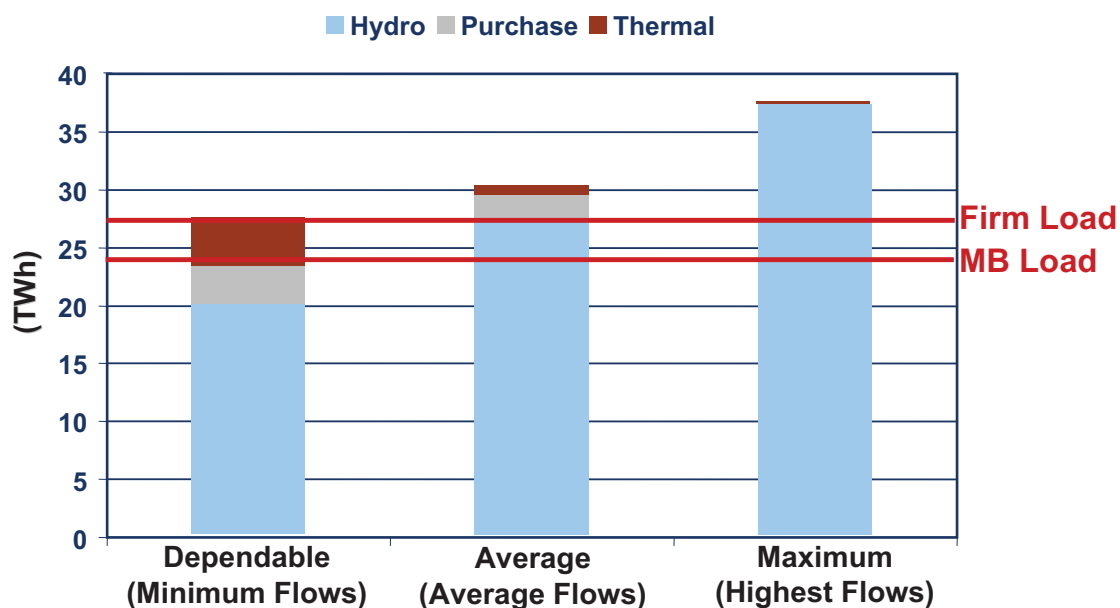
Manitoba is Strongly Interconnected



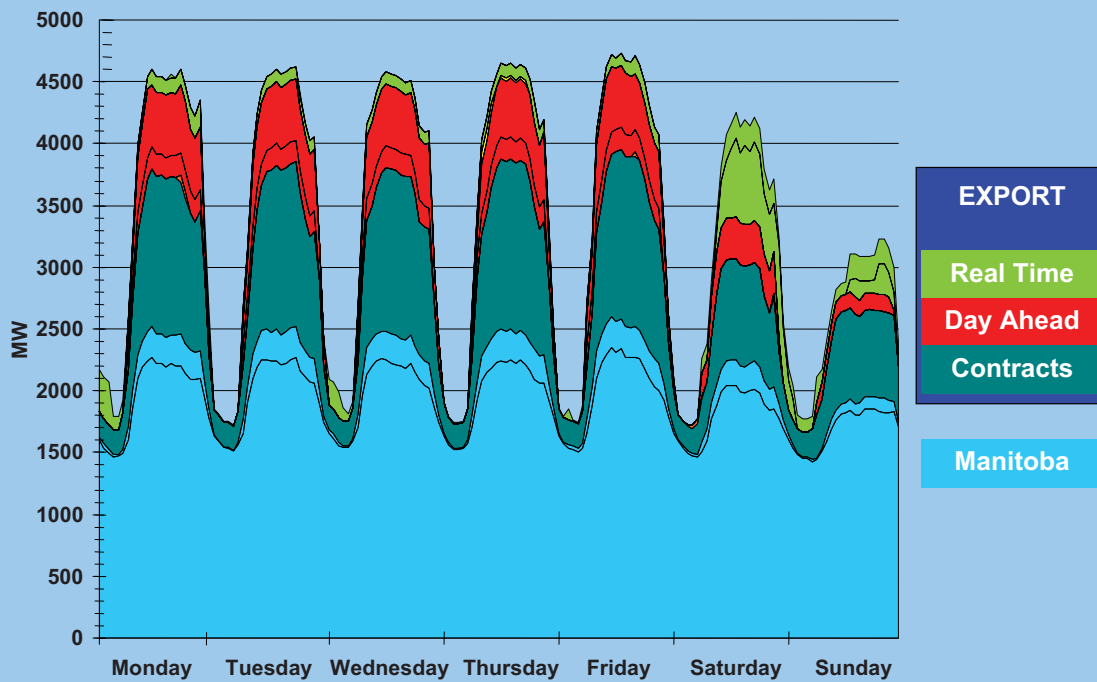
Interconnections Provide

- Reliability
 - Emergency response
 - During Maintenance Outages
 - Drought support
- Economy
 - Use of Capital
 - Generation Expansion
 - Load Diversity
 - System Operations (Sales and Purchases)
 - Reserve Sharing (Reserve Sharing Pools)
- Efficiency
 - Competitive markets

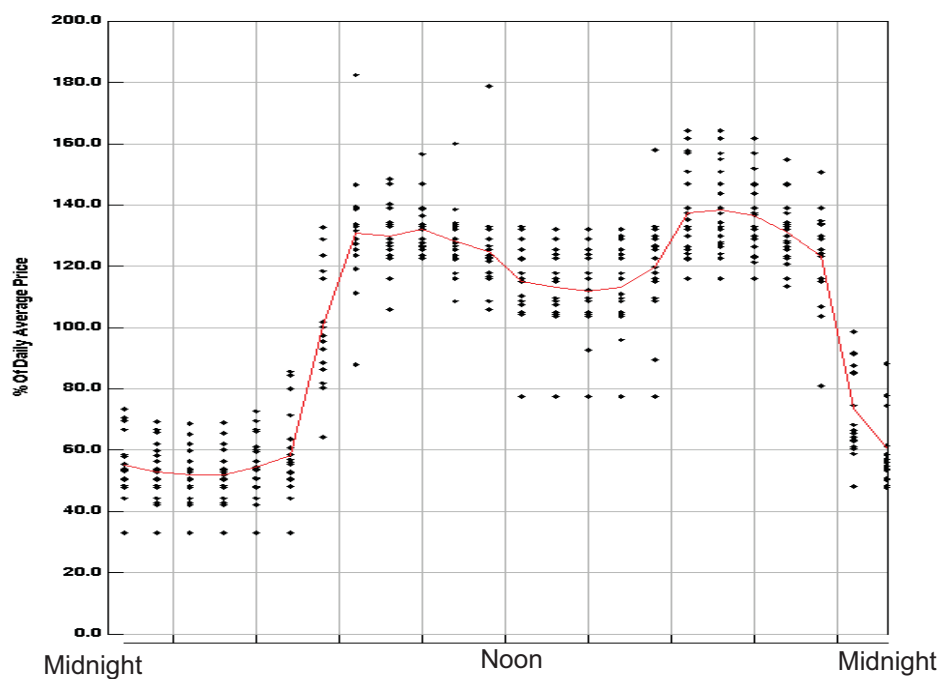
Energy Sales/Purchases Depend Upon Water Supply

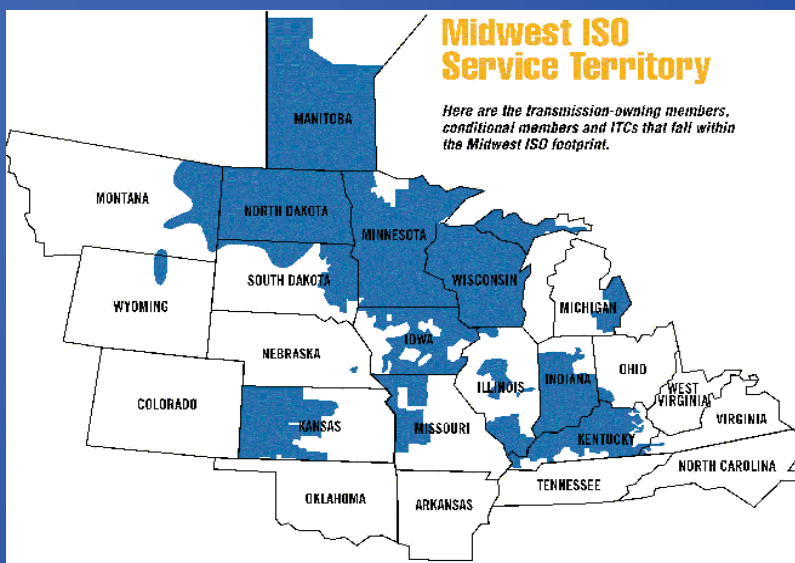


Hourly Variation in Generation



Hourly Market Price Variation





Load	93,800 MW	119,000 MW
Generation	120,000 MW	131,000 MW

What is MISO?

- Midwest Independent System Operator
 - Regional Transmission Organization
 - Operates transmission grid on behalf of transmission owners
- Independent, non discriminatory
 - Ensure all generators have equal access to grid
- Energy Market Operator
 - MH full market participant
 - External generator

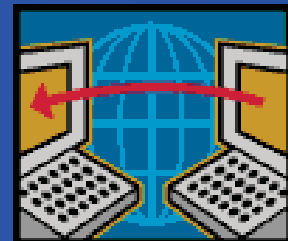


How is Energy Sold?

- Buyers / Sellers enter into negotiated fixed price contracts
 - Multi-year, seasonal, monthly
 - Over 90% of electricity
 - Provides price and supply certainty
- Balance of energy is sold
 - Day Ahead (based upon a forecast)
 - Real Time (based upon actual demand)



How do the MISO Balancing Markets Work?



- Electronic Commodity Market
- Day Ahead Market
 - Generators offer in,
 - Energy price is determined by most expensive generator used to serve load
 - Market clears and is settled
- Real Time Market
 - MISO dispatches generation
 - 5 minute prices set by most expensive generator

MH Day Ahead Offers to MISO for April 4th 7-8 am

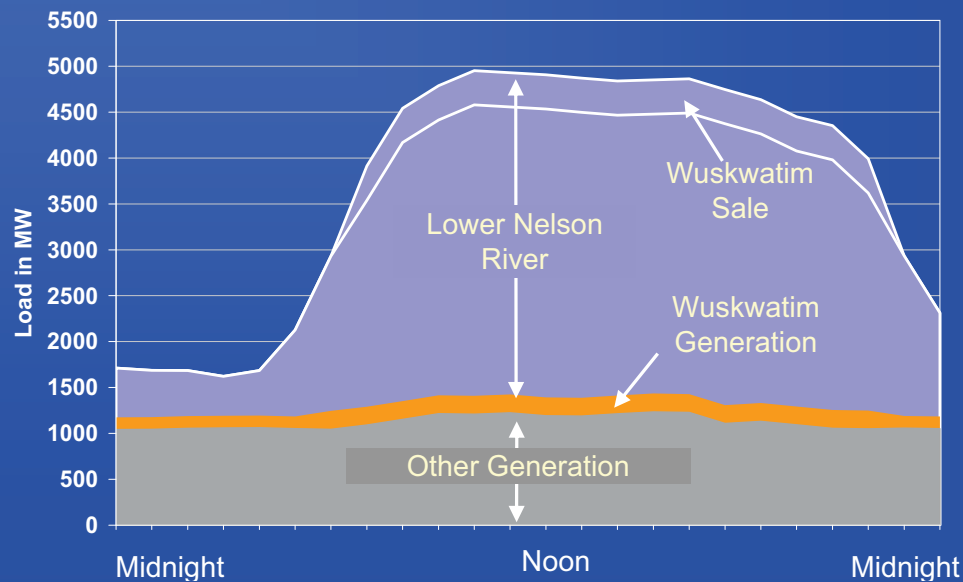
<u>Source</u>	<u>MW</u>	<u>US\$/MWh</u>
Nelson 1	100	10
Nelson 2	100	11
Nelson 3	100	14
Nelson 4	250	15
Nelson 5	250	15
Nelson 6	100	15
Nelson 7	100	19
Nelson 8	100	23
Grand Rapids	59	25
Brandon Gas Turbines	37	190

MH DA Offers for April 4th 7-8 am

<u>Source</u>	<u>MW</u>	<u>US\$/MWh</u>
Nelson 1	100	10
Nelson 2	100	11
Nelson 3	100	14
Nelson 4	250	15
Nelson 5	250	15
Nelson 6	100	15
Nelson 7	100	19
Nelson 8	100	23
Grand Rapids	59	25
Brandon Gas Turbines	37	190

At 5 pm April 3rd MISO Accepted These
Offers from MH @ US\$55.00/MWh

Lower Nelson Provides 90% of Hourly and Daily Matching of Supply to Demand



Lower Nelson Operations

Stephen's Lake

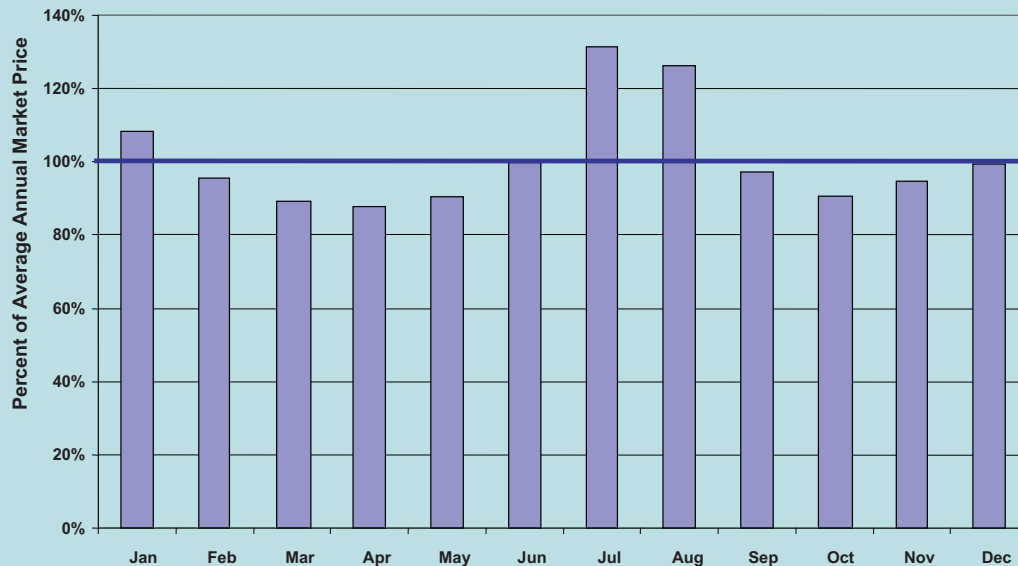
- 10 ft Operating Range
- 250,000 MWh
- provides daily storage
 - Kettle
 - Long Spruce
 - Limestone

Long Spruce/Limestone

- near constant level
- hourly storage
 - time delays



Export Prices Vary Seasonally



Lake Winnipeg Is Used to Shift Surplus Energy To Higher Value Months if Possible

Lake Winnipeg Regulation

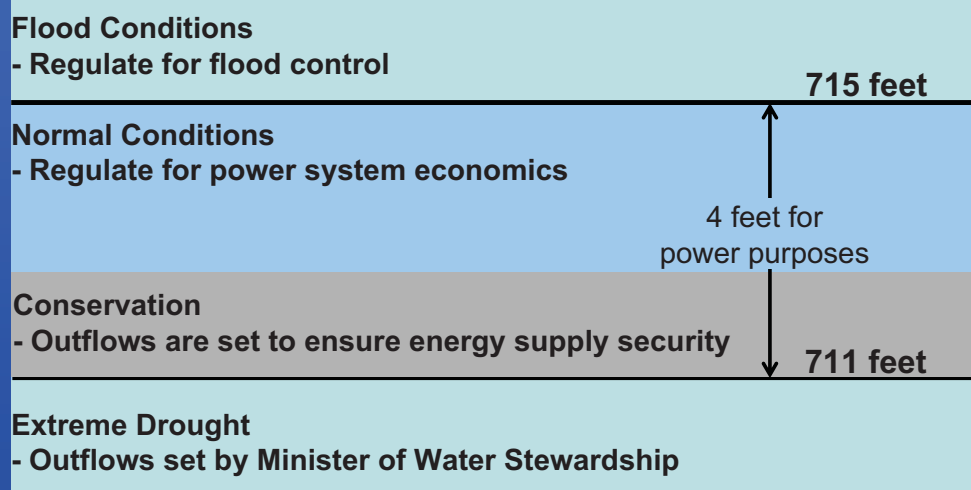
- Seasonal balancing reservoir
- 50% increase outflow capability
- 4 ft storage for power
- 3,000,000 MWh per foot
- Shape water supply to power demand
- Jenpeg controls 85% of the outflow
- East Channel is uncontrolled



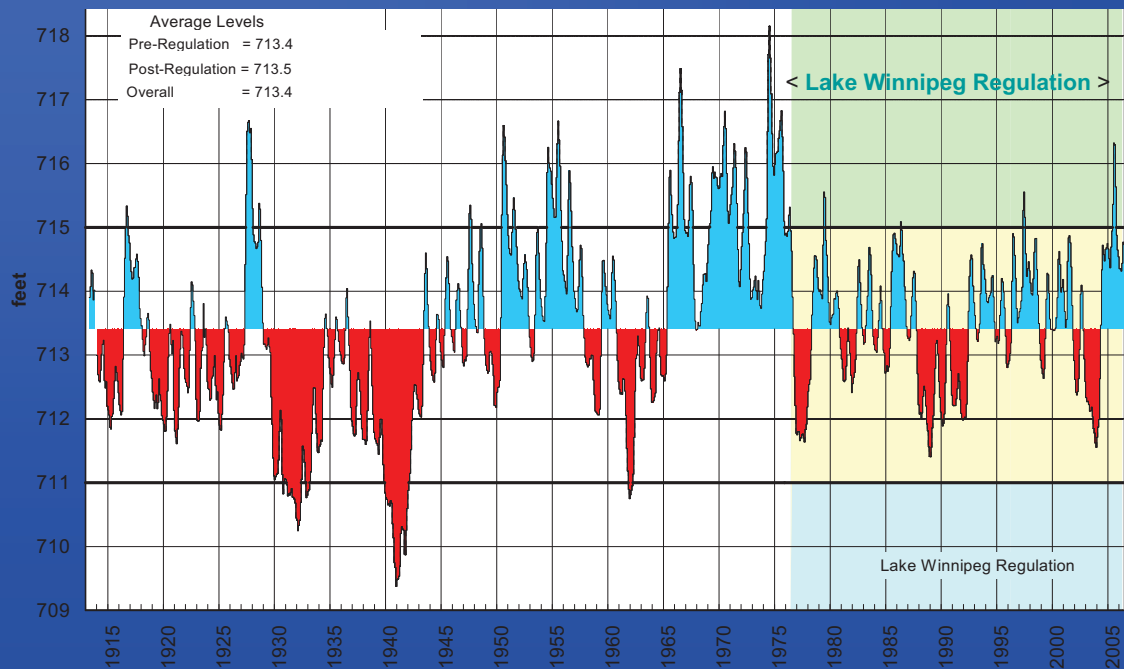
Ominawin Bypass Channel



Lake Winnipeg Regulation *Modes of Operation*



Lake Winnipeg Monthly Average Levels 1913 - 2006



Jenpeg Operations

**LWR Primary Objective:
Meet the Downstream
Power Demand**



**LWR Secondary Objective:
Efficient Powerhouse Operations
at Jenpeg**

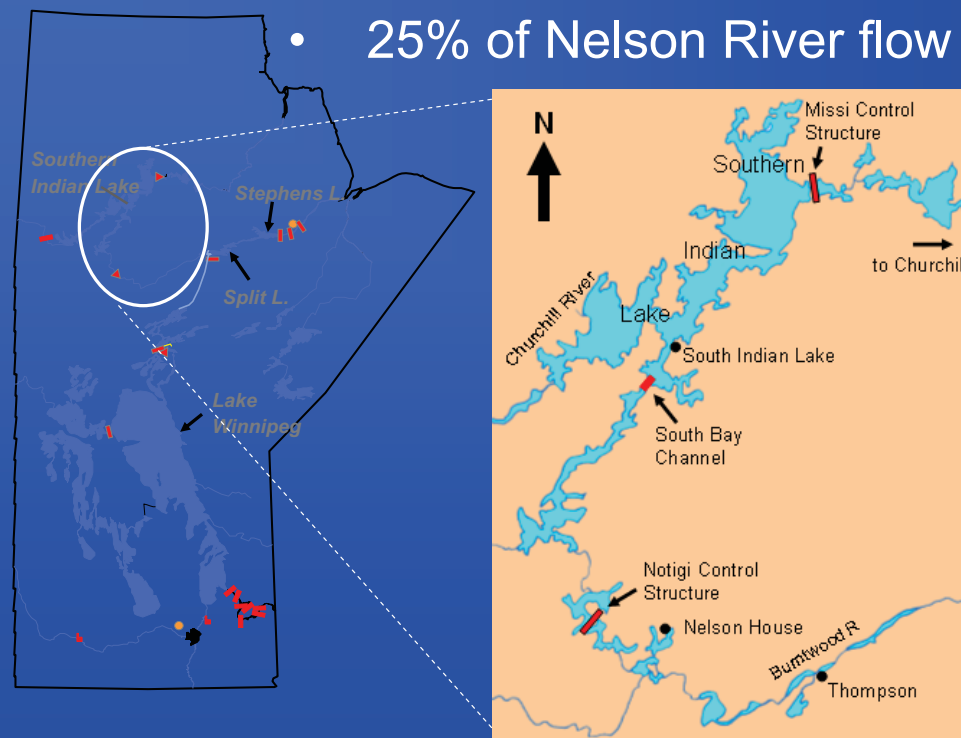
Ice Restrictions Still Limit Lake Winnipeg Outflow Capability



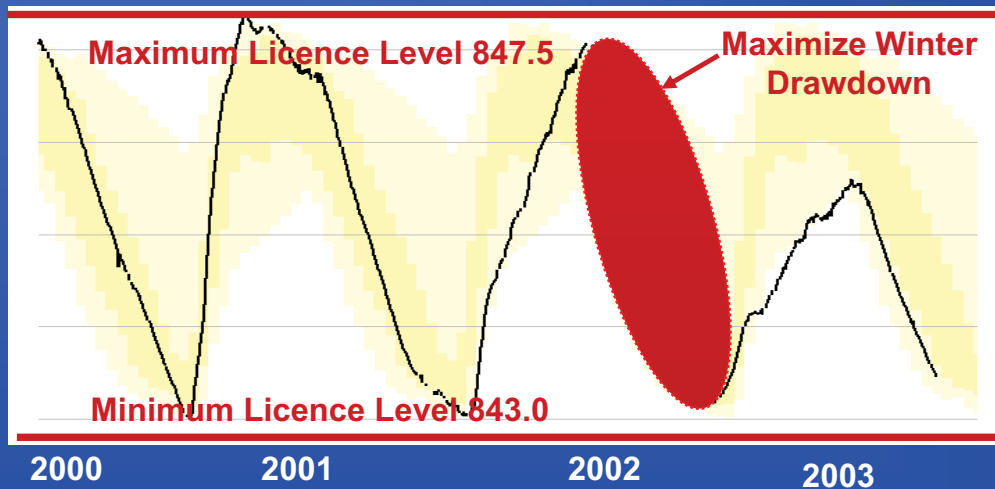
Churchill River Diversion Water Is Most Useful in Winter

Churchill River Diversion

- 25% of Nelson River flow



Southern Indian Lake Water Levels



CRD Operation Follows Predictable Seasonal Patterns

REGULATORY CONSTRAINTS

- Water Power Act licences include 25 constraints under which Manitoba Hydro must operate
- Constraints apply to:
 - Generating Stations
 - Control Structures
 - Reservoirs (Lakes)
 - Rivers
- Nature of constraints:
 - Minimum and Maximum Elevations
 - Minimum and Maximum Outflows
 - Maximum Outflow Rates of Change



QUESTIONS?



The Manitoba Hydro System and its Operation (Summary)

Harold Surminski

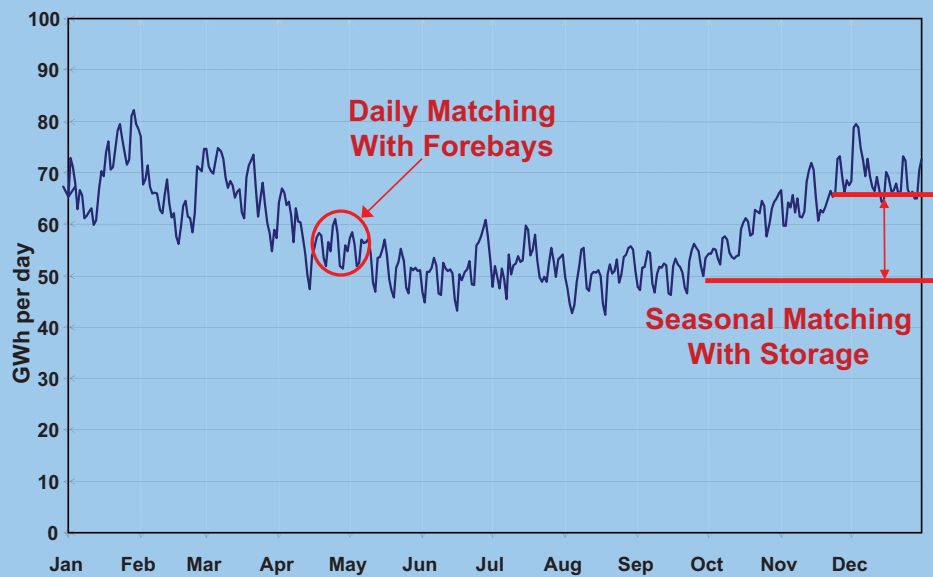
Power Supply
February 3, 2011

MH Generating Stations and Control Structures

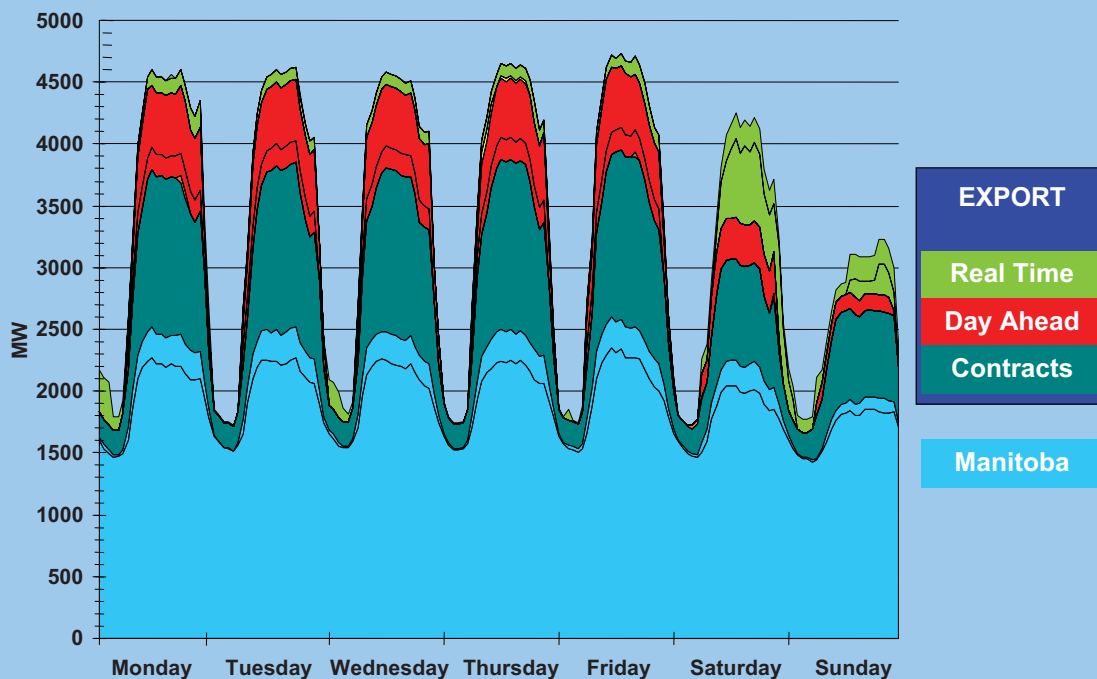
- **Hydro (4,900 MW)**
 - Winnipeg River
 - Grand Rapids
 - Jenpeg
 - Kelsey
 - Laurie River
 - Lower Nelson
- **Lake Winnipeg Regulation**
 - Jenpeg Control
- **Churchill River Diversion**
 - Notigi Control
 - Missi Control
- **Thermal (500 MW)**
 - Selkirk Gas
 - Brandon Coal and GT



Manitoba Electricity Demand Varies Hourly, Daily and Seasonally



Hourly Variation in Generation



Lower Nelson Operations

Stephen's Lake

- 10 ft Operating Range
- 250 GWh
- provides daily storage
 - Kettle
 - Long Spruce
 - Limestone

Long Spruce/Limestone

- near constant level
- hourly storage



Jenpeg Operations

**LWR Primary Objective:
Meet the Downstream
Power Demand**



Jenpeg (120 MW)



Lower Nelson (3600 MW)

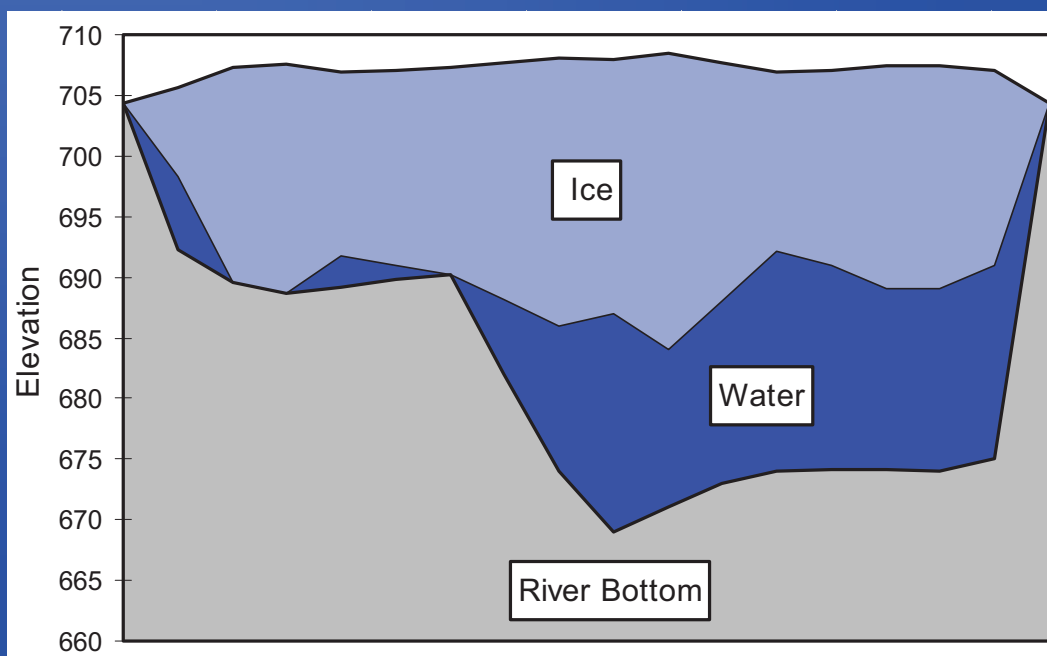
**LWR Secondary Objective:
Efficient Powerhouse Operations
at Jenpeg**

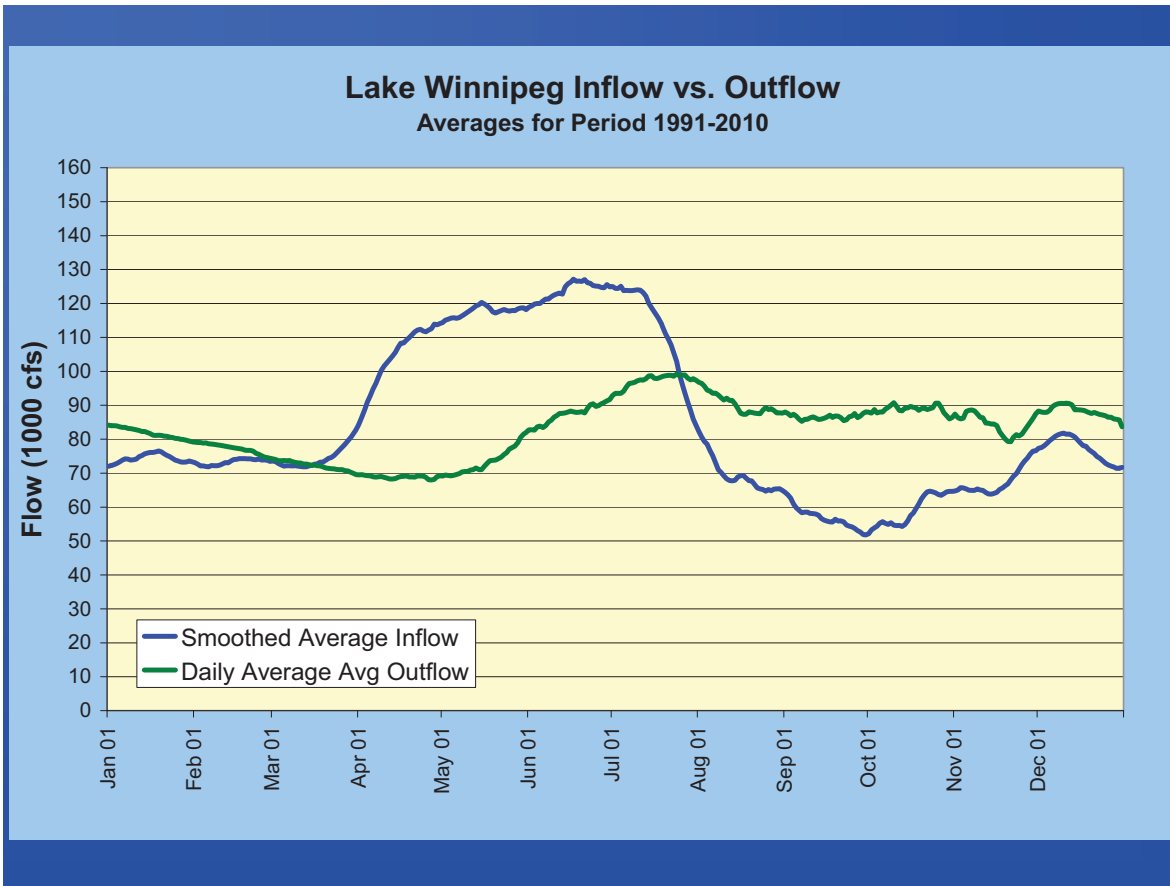
Lake Winnipeg Regulation

- Seasonal balancing reservoir
- 50% increase outflow capability
- 4 ft storage for power
- 3,000,000 MWh per foot
- Shape water supply to power demand
- Jenpeg controls 85% of the outflow
- East Channel is uncontrolled



Lake Winnipeg Ice Limits Winter Outflows





Lake Winnipeg Regulation

Modes of Operation

Flood Conditions

- Regulate for flood control

715 feet

Normal Conditions

- Regulate for power system economics

4 feet for
power purposes

Conservation

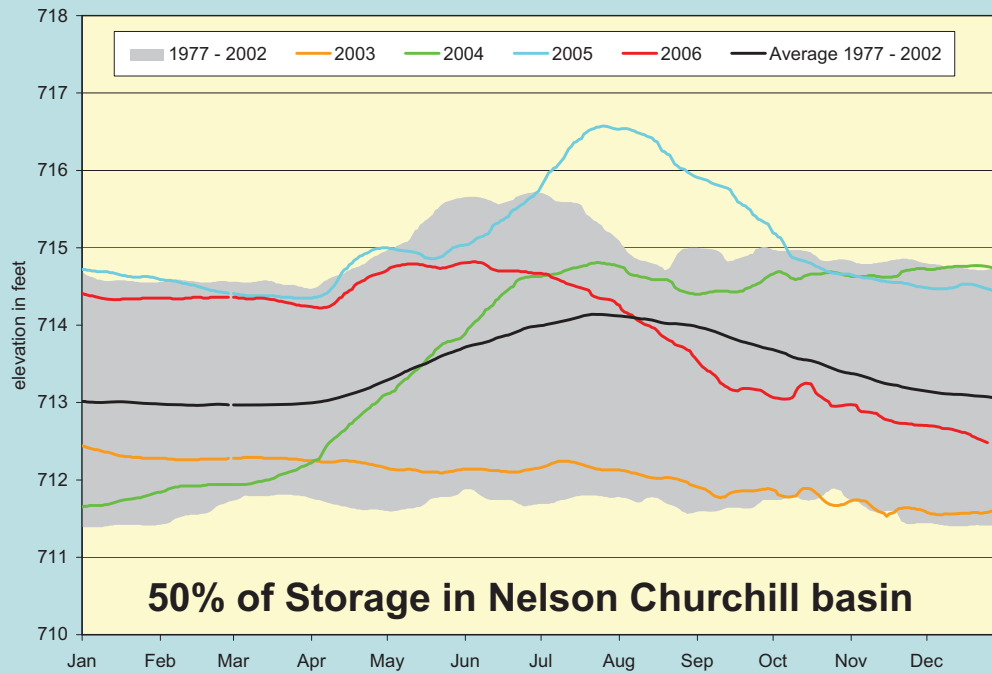
- Outflows are set to ensure energy supply security

711 feet

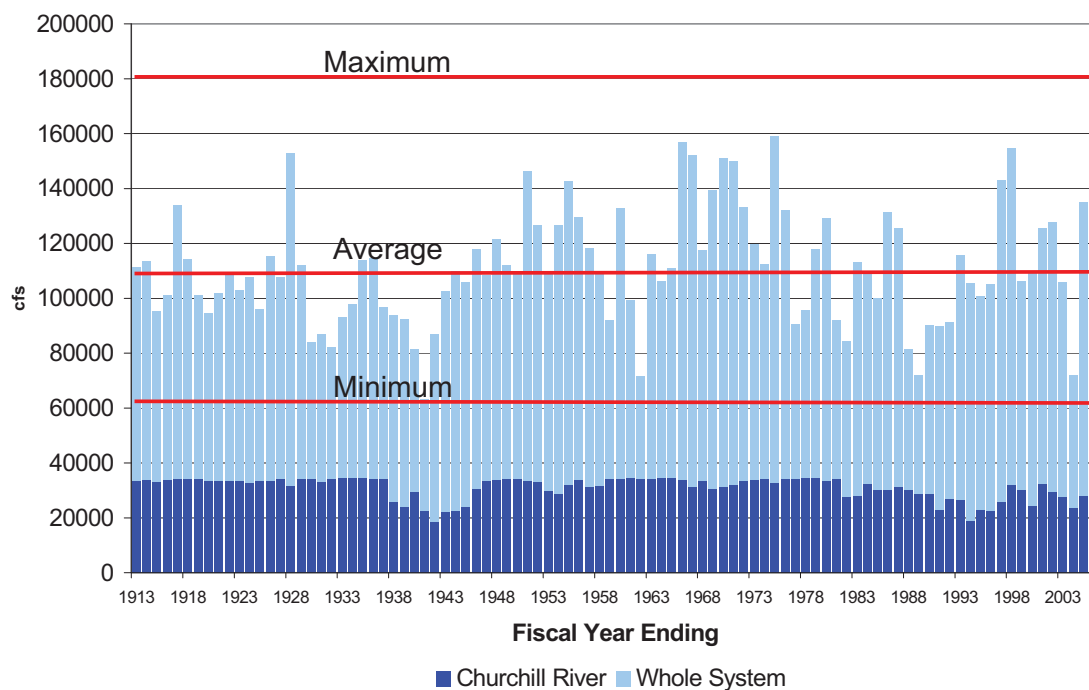
Extreme Drought

- Outflows set by Minister of Water Stewardship

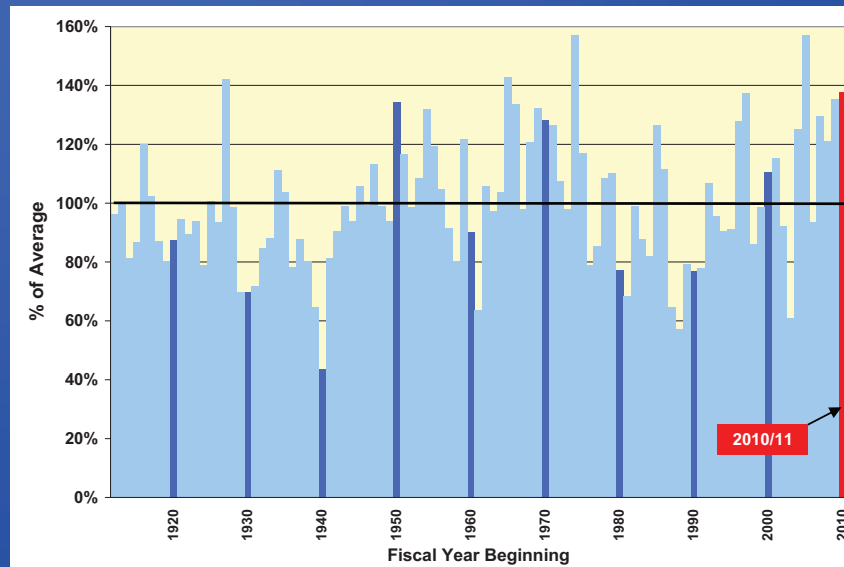
Lake Winnipeg



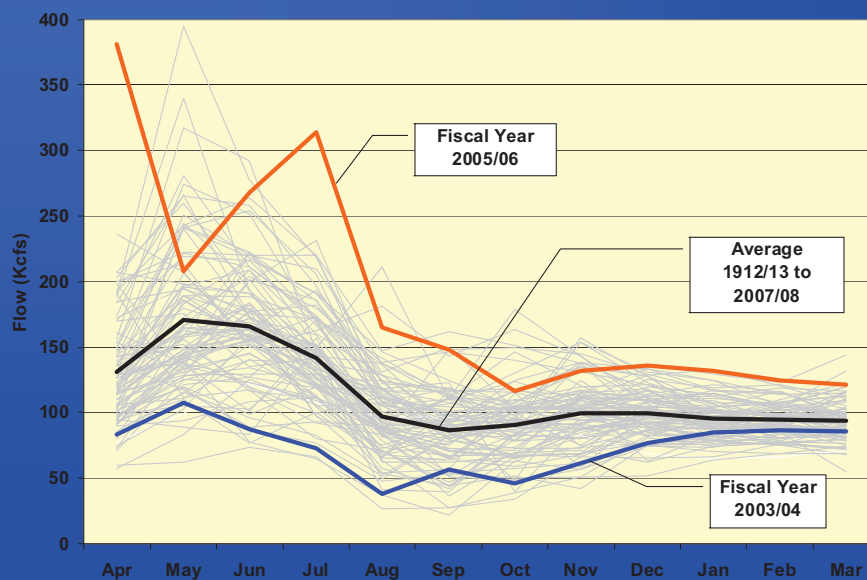
Nelson River Water Supply (Inflows)



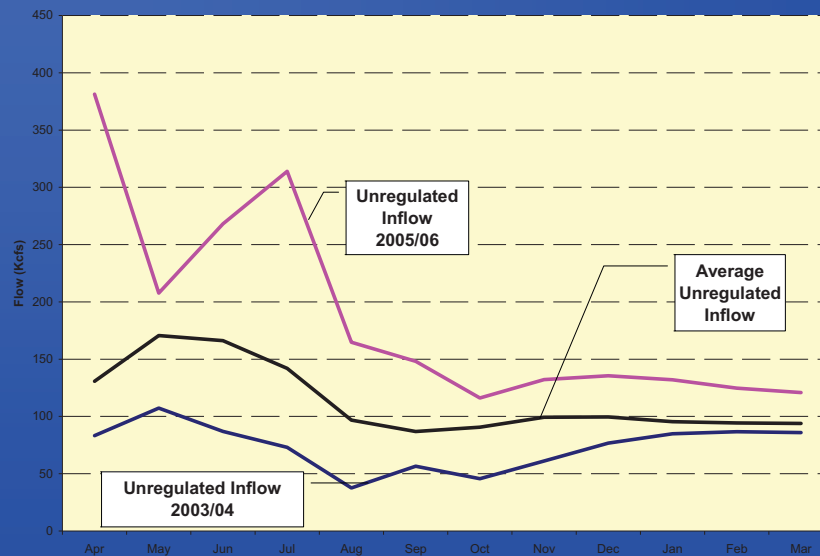
Unregulated System Inflows



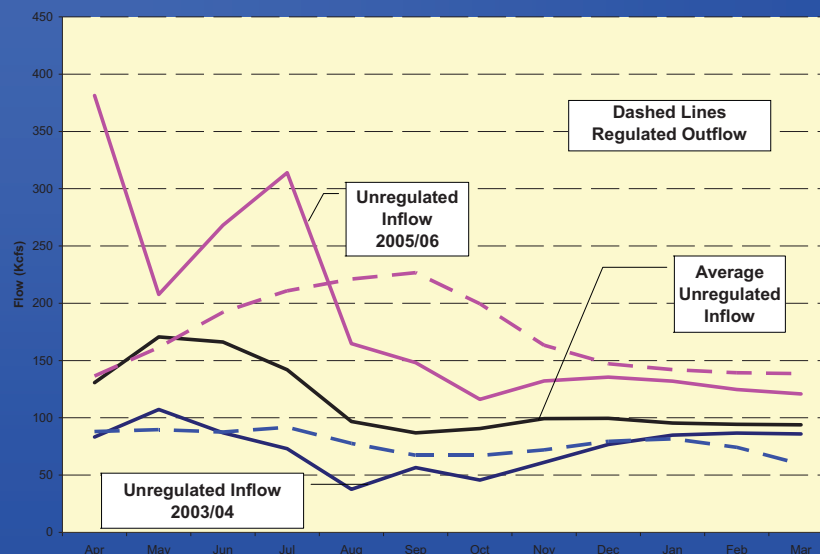
Unregulated System Inflow



Unregulated System Inflow



Unregulated System Inflow and Regulated Outflow



QUESTIONS?

