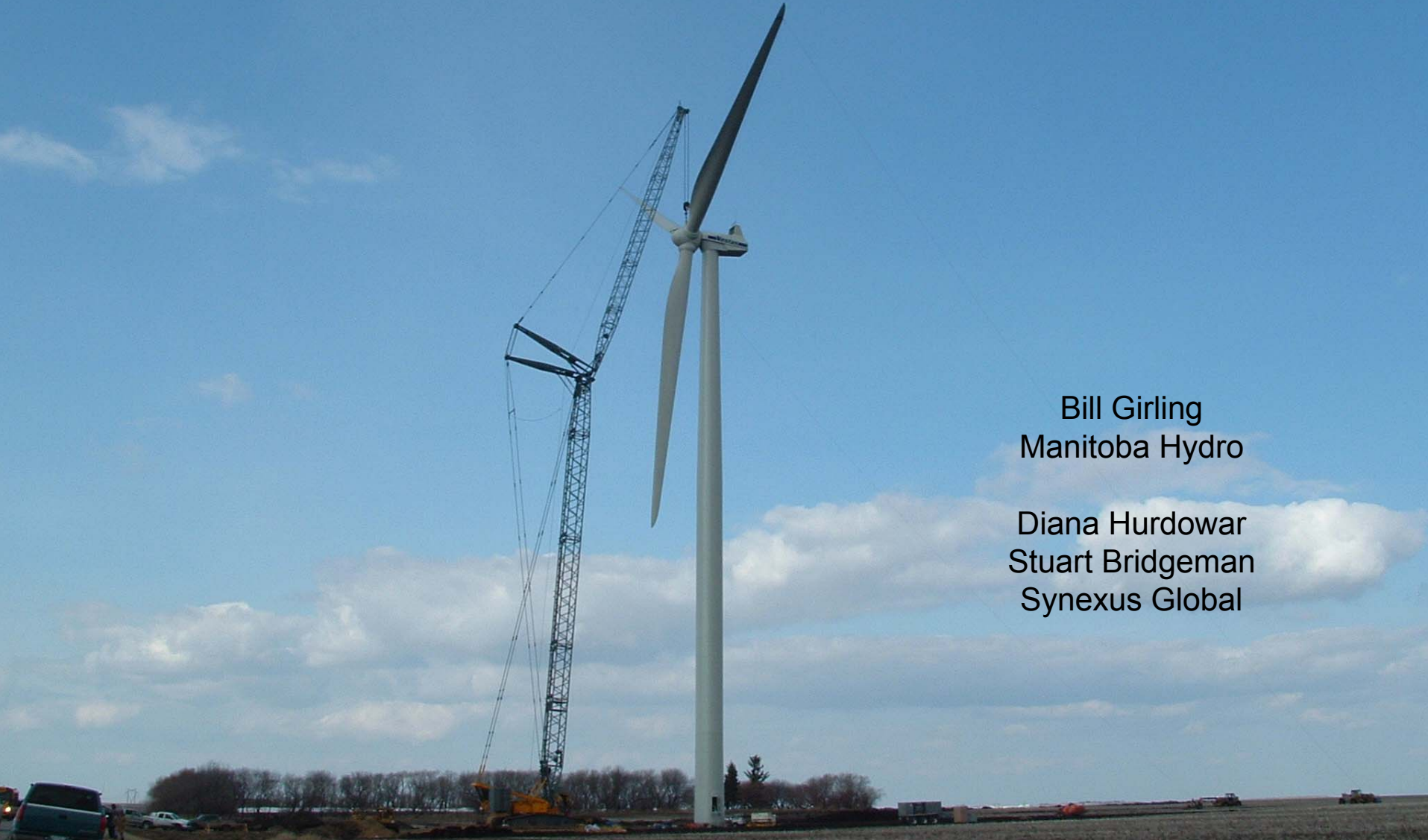


# Application of DSS to Study Wind Generation for Manitoba Hydro

Bill Girling  
Manitoba Hydro

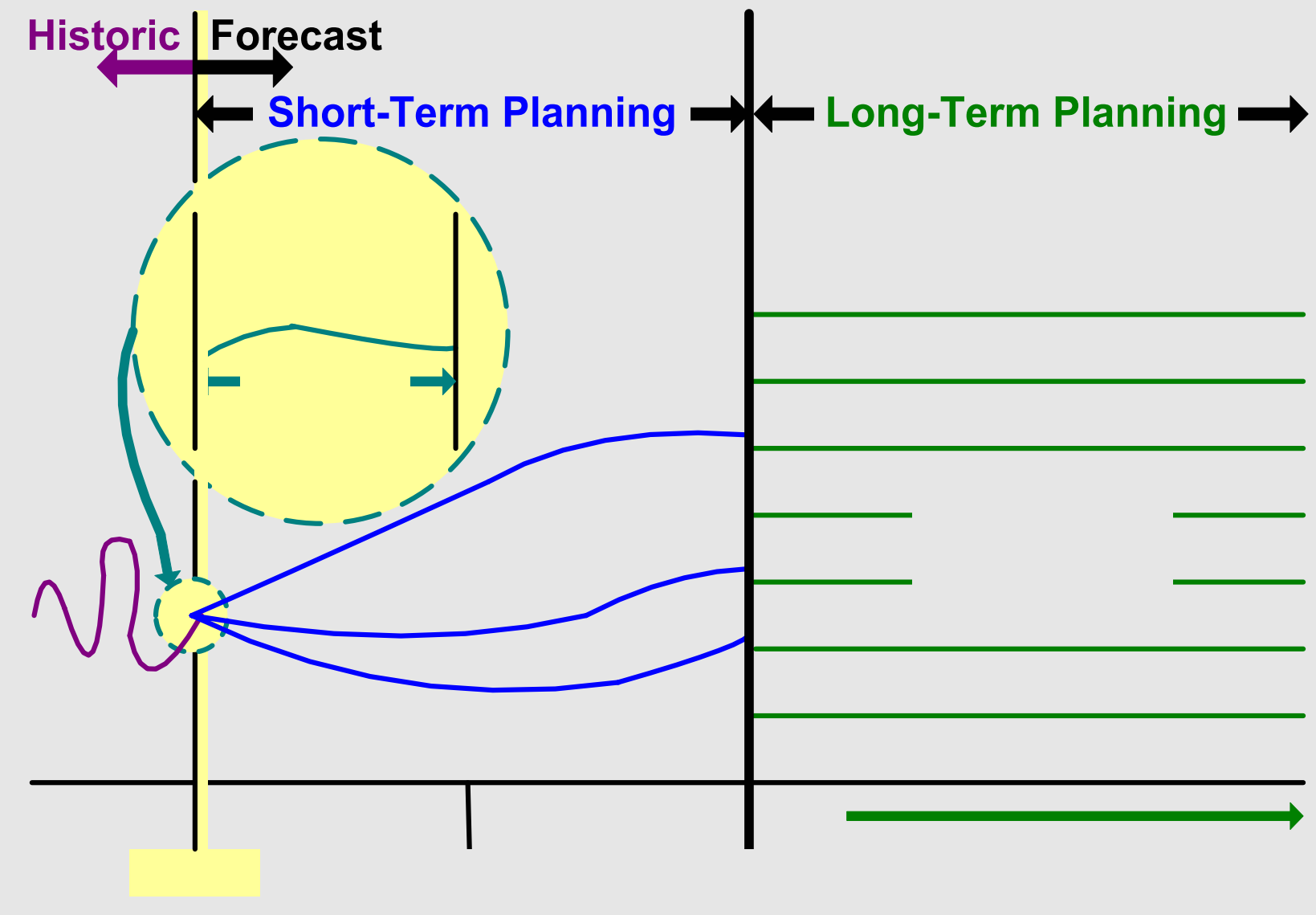
Diana Hurdowar  
Stuart Bridgeman  
Synexus Global



# Outline

- Wind Power in Manitoba
- Wind Integration issues
- Short-Term Wind Uncertainty and Variability
- Short-Term Model- '*Vista*' DSS Tool
- Application of *Vista* to Wind Integration

# Planning Horizons & Inflow Forecasts



# Why is Manitoba Hydro studying Wind Power?

- Manitoba does not require new generation for domestic load until around 2020 but wind power can be exported.
- Alternative source of power during drought periods when expensive thermal is needed.
- Can be put into service in 1 to 2 years.

# Integrating Wind and Hydro



- Manitoba Hydro operates a hydropower system with large reservoirs capable of storing wind energy and shifting it to more valuable periods.

- Integrating wind with hydro operations can create a product with high value on export market.
- Need to know value of wind power to Manitoba Hydro's system in order to determine purchase price from independent wind developers.

# Integrating Wind and Hydro

The ability to get wind power to the market is dependent on flow conditions:

- Low Flow
  - Reduced import (on-peak & off-peak)
  - Reduced operation of thermal
  - Increased firm export opportunities
- Moderate Flow
  - Increased export opportunities to the limit of installed generation or tie-line
- High Flow
  - Virtually no value

# Wind Power Integration Issues

- Wind is inherently variable, it can neither be dispatched nor scheduled accurately
- Sub-optimal hydro operations due to short-term variability and uncertainty of wind generation
- Increased reserves for wind

# Modelling Framework

## Types of Wind Integration Costs in Different Time Horizons

	Transmission Service Costs	Generation Service Costs			
	Regulation, Load Following & TRM Impacts	Impacts on Short Term Operations		Impacts on Longer Term Operations	
	e.g. Need more generation on AGC	e.g. Reduced S.T. operating flexibility to accommodate wind uncertainty		e.g. Increased spill when system can't absorb more energy	
	Electrotek	Model with VISTA ST/ MOST		Model with SPLASH	
Time Horizon	Next Hour	Next Day	Next Week	Next Month	Next Year

# SPLASH Model

- SPLASH models the system monthly operations for a 35 year period, using 86 years of flow history.
- SPLASH used to predict changes in monthly & seasonal hydraulic operations due to addition of wind
- SPLASH cannot address some of the short-term operating costs associated with wind energy, such as:
  - Cost of increased operating reserves
  - Regulation and Load-following
  - Operational inefficiencies due to the uncertainty of wind generation

# Short Term Modelling Issues

1. Evaluate sub-optimal hydro operations due to short-term variability and uncertainty of wind generation
2. Evaluate lost opportunity cost from increased capacity reserve requirement for wind
  - Regulation reserve for uncorrelated minute to minute variations in net load (on AGC control)
  - Load following reserve for sub-hourly ramp in net load and next hour forecast error (idle capacity reservation)

# Vista used to Study Short-term Operational Aspects of Wind

- Short-term hydro operations planning tool used to compare economics of paired cases

*Synexus Global will now describe the short-term model (Vista) used to Study Short-term Operational Aspects of Wind*

# The Short Term Model

## *Vista DSS Suite*

- Suite of programs developed under the Hatch-Acres umbrella within Synexus Global.
- An operations model used by dispatchers to schedule generation in a manner that maximizes revenue.
- ST (hour to week) -- LT (week to year) – AUTO (Planning)

# “Vista” Analysis Tool

A DSS is an computer tool that uses

- Forecasting
- Optimization and Simulation

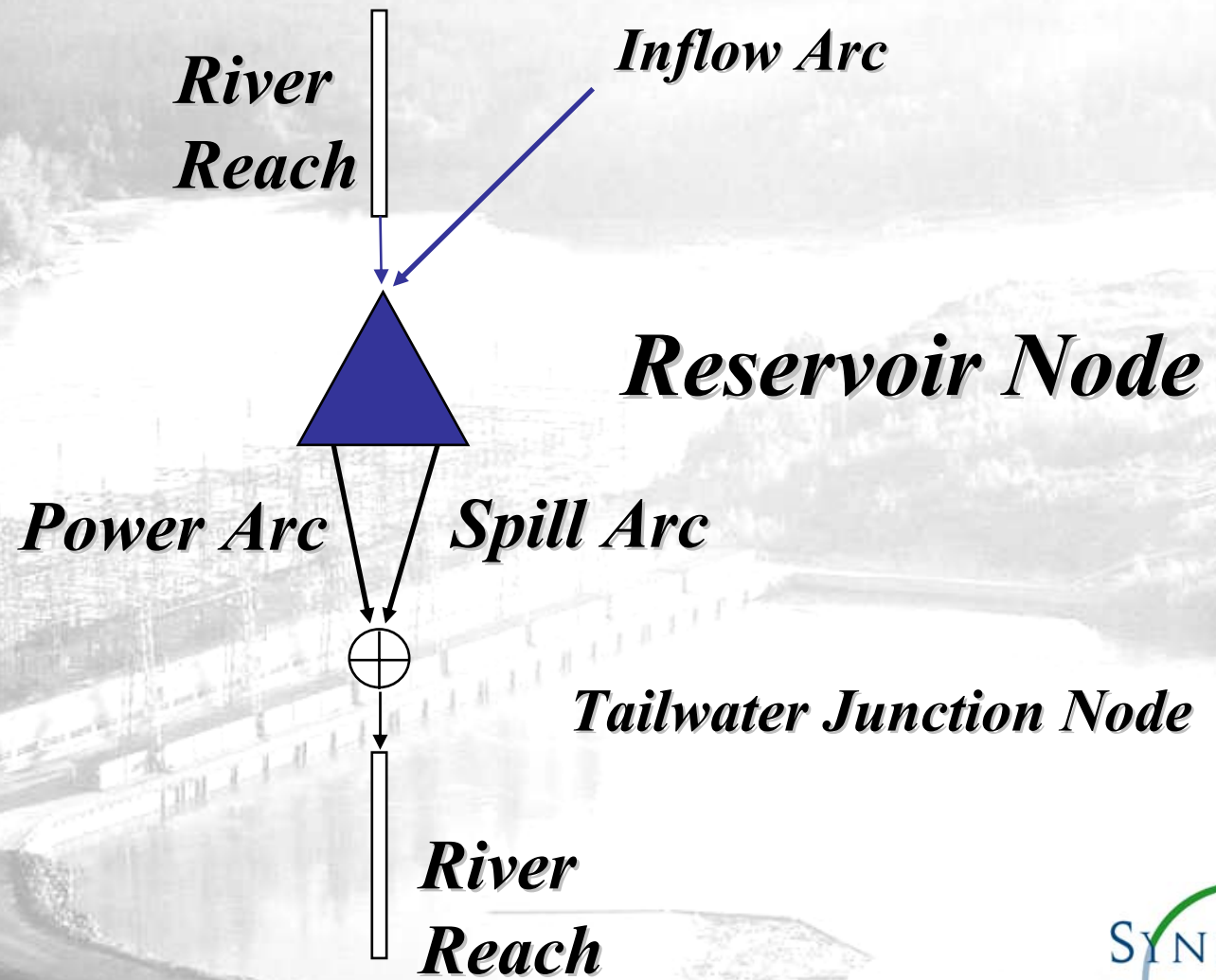
to find cost effective solutions for :

- Long term energy management
- Short term scheduling
- Facility upgrading
- Strategic Planning
- Water Management Planning

**Operations**

**Studies**

# Vista Hydro System Components

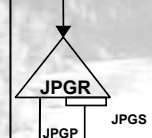


# Manitoba Hydro Nelson River

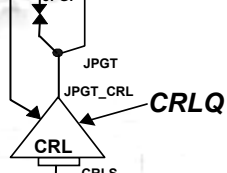
Lake Winnipeg



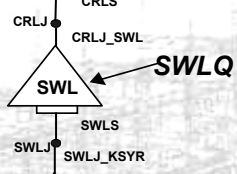
Jenpeg



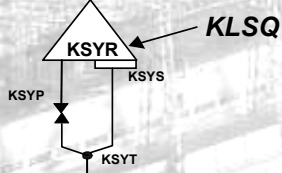
Cross Lake



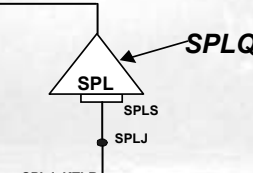
Sipiwesk Lake



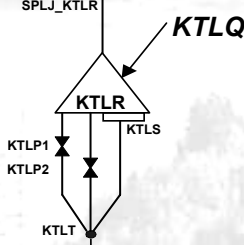
Kelsey



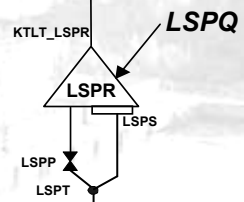
Split Lake



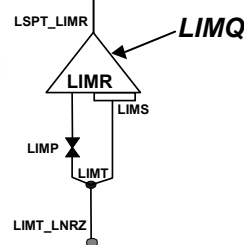
Kettle



Long Spruce



Limestone

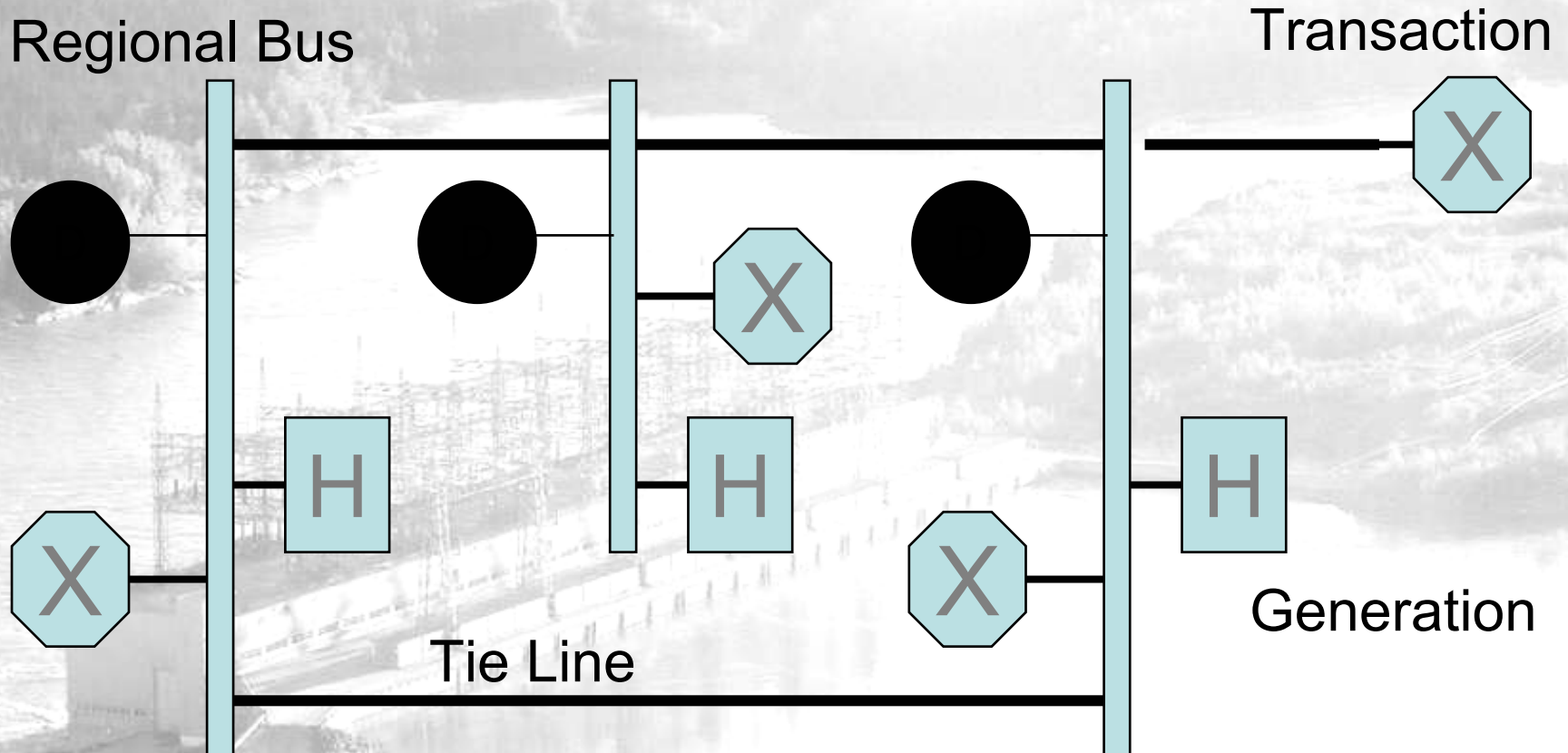


LNRZ

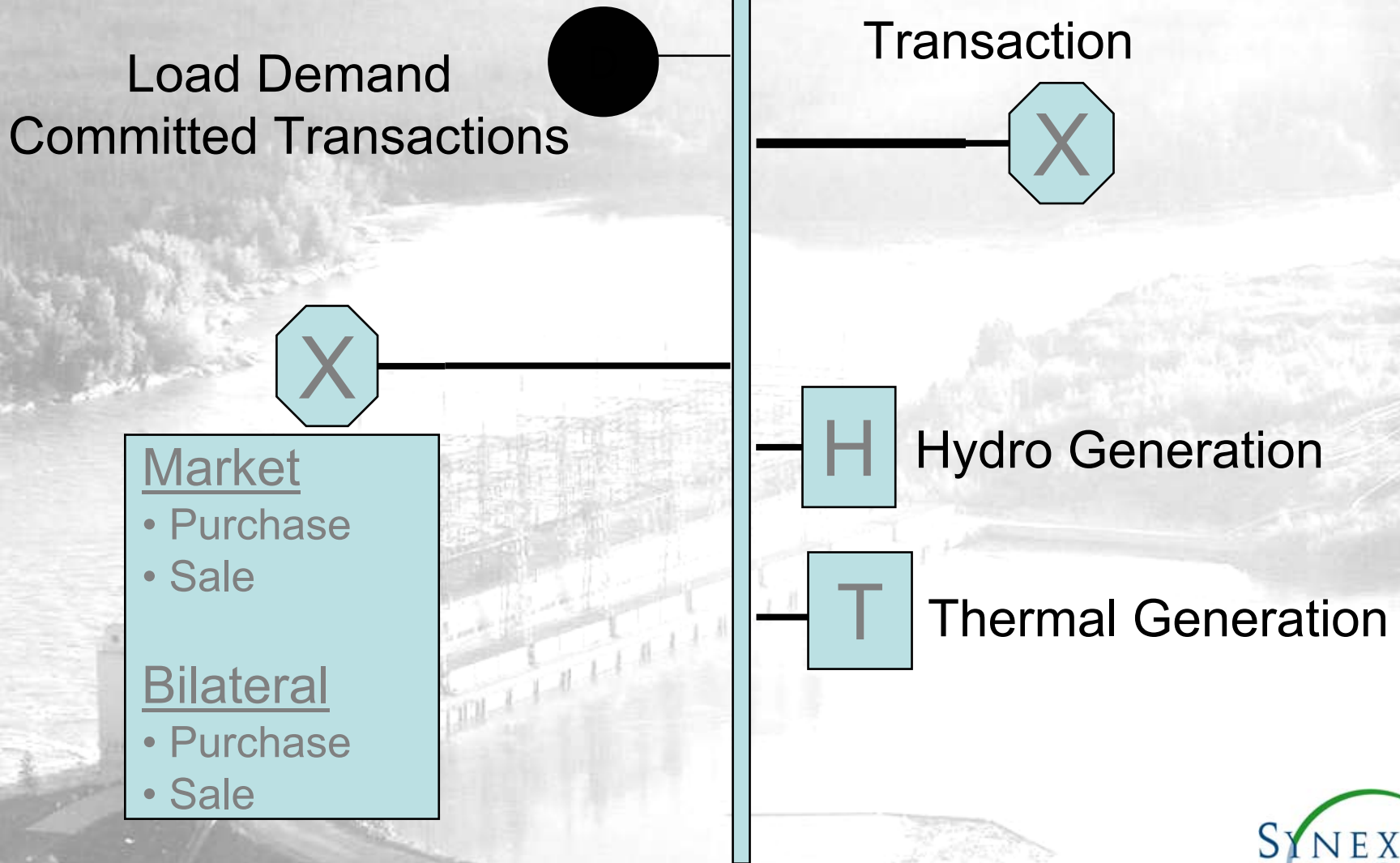
# Modeling the Manitoba Hydro System

- System Related (Manitoba Hydro)
  - Uncontrolled Lakes and channels
  - Long river reaches and lag times
  - Ice conditions in winter
- Wind Related
  - Uncertainty in wind forecasts
  - Variability in wind energy delivery

# Vista Transmission System Components



# Vista Transmission Area



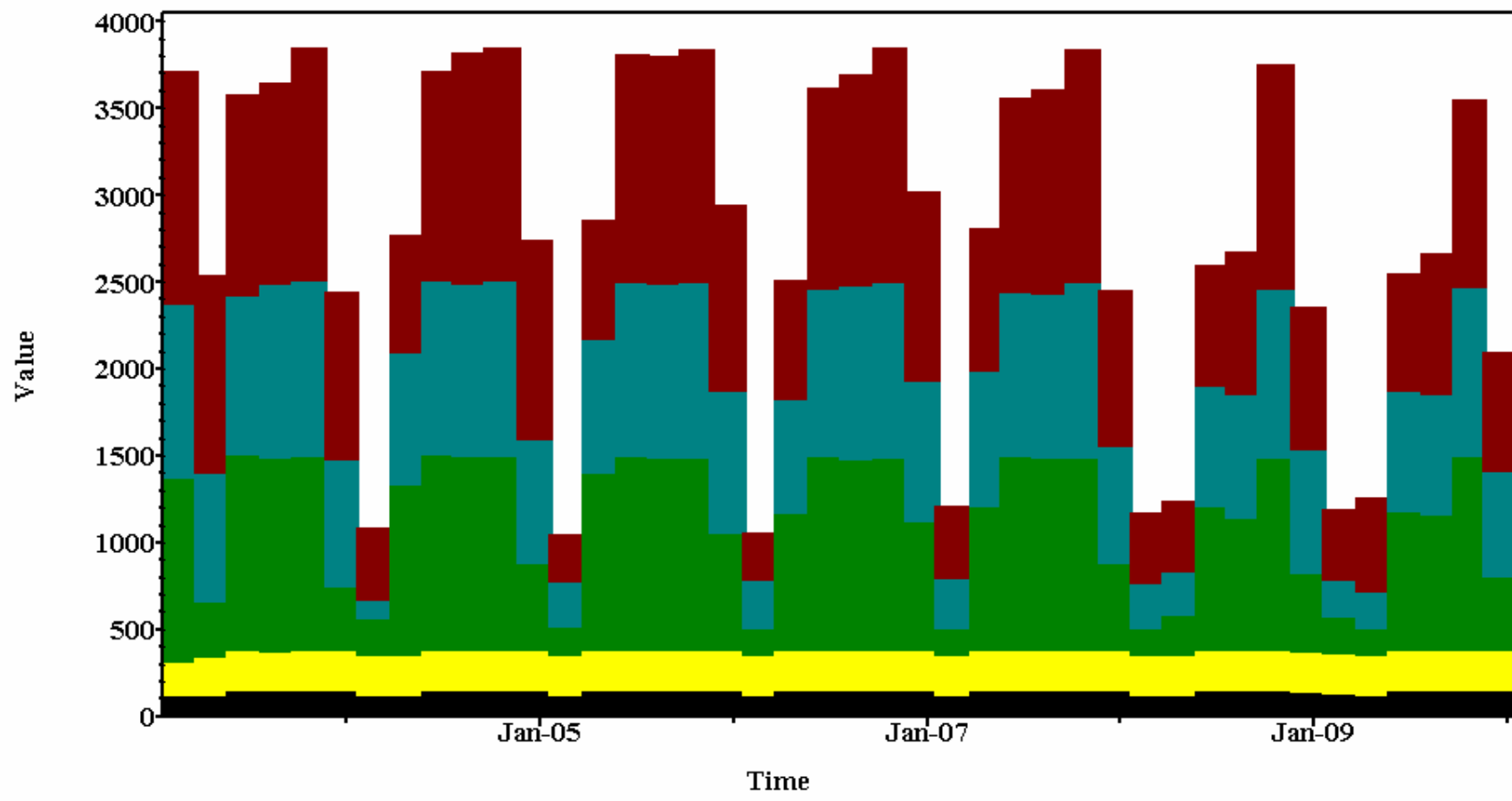
# Vista Workings

- Model workings
  - Physical/hydraulic/transmission characteristics and constraints
  - Market Price forecasts
  - Firm Contracts
  - Historical/forecast Inflow sequences
  - Load demands
  - Within-plant dispatch (Unit Operations)
  - Transaction opportunities
- *AUTO Vista*
  - Performs analysis over 1 year

# Nelson River Plants Generation

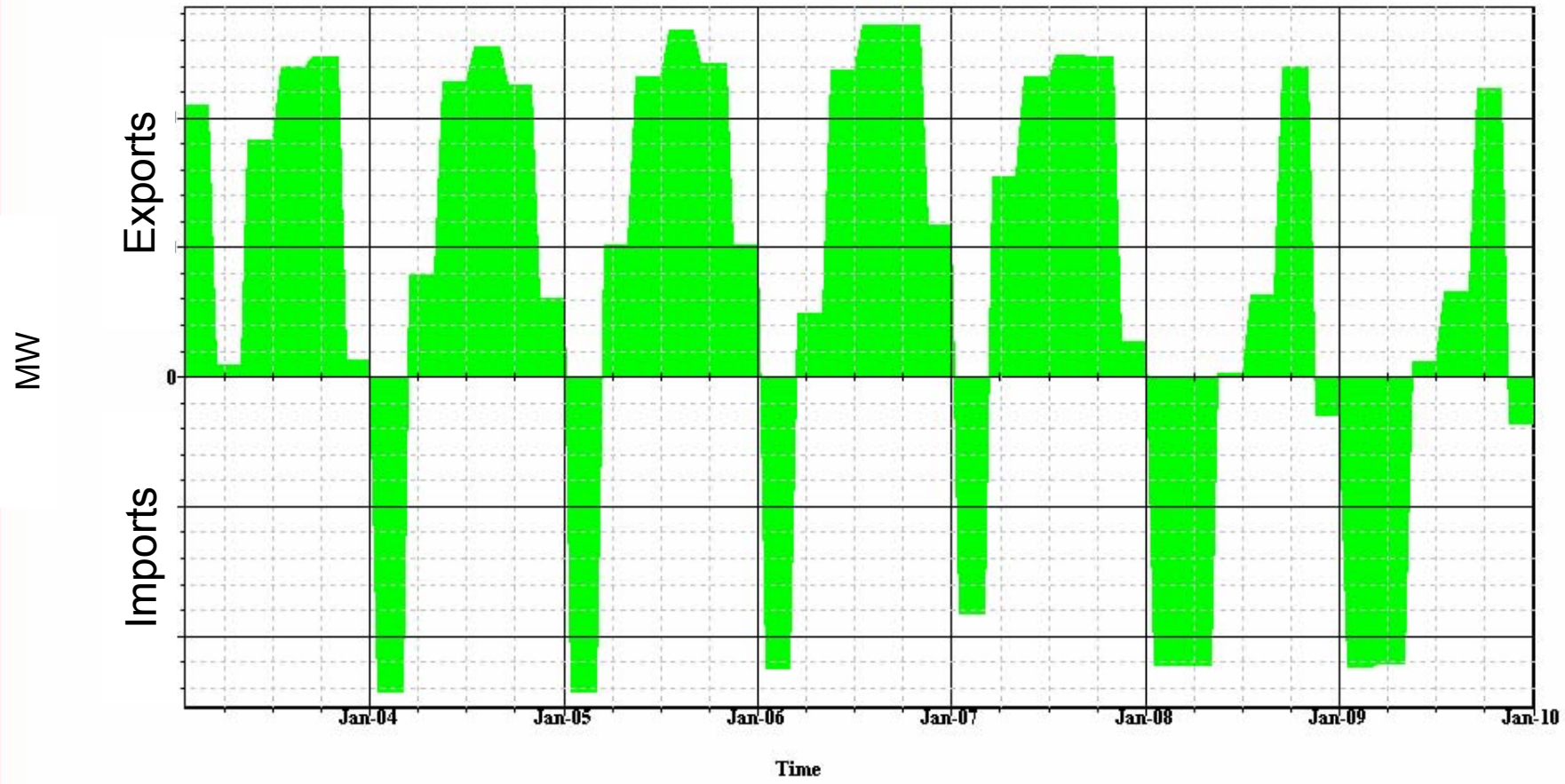
Wednesday, November 09, 2005  
Ref Time: Monday, January 03, 2011 01:00:00

- JPGP\_GEN(MW)
- KSYP\_GEN(MW)
- KTLP1\_GEN(MW)
- LSPG\_GEN(MW)
- LIMP\_GEN(MW)



**Net Transactions** **Wednesday, November 09, 2005**  
**System** **Ref Time: Monday, January 03, 2011 01:00:00**  
**From Mon Jan 03 2011 01:00 to Sun Jan 09 2011 24:00**

■ SYS\_TRANS(MW)



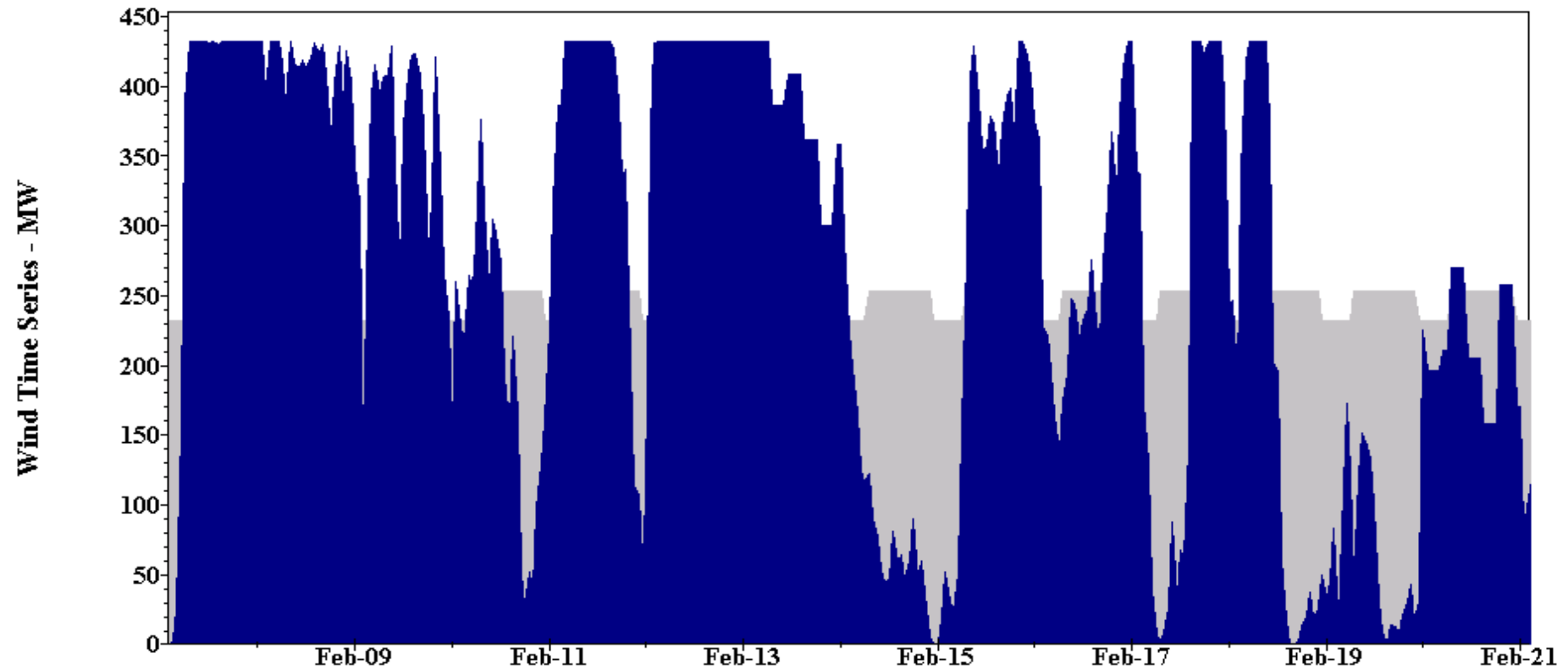
# Short Term Model

- ⇒ *Vista* can model the hour-to-hour, day-to-day operations of the Manitoba hydro system
- ⇒ Reservoirs can redistribute wind energy to peak hours and/or offset off peak imports or both because it models market opportunity. (Energy reshaping)
- ⇒ Can model multi-reservoir systems and their hydraulic considerations (*Vista* is ideal)
- ⇒ To model wind we need to capture the effects of wind variability and uncertainty on reservoir operations.

# Wind Uncertainty and Variability

■ Average Wind

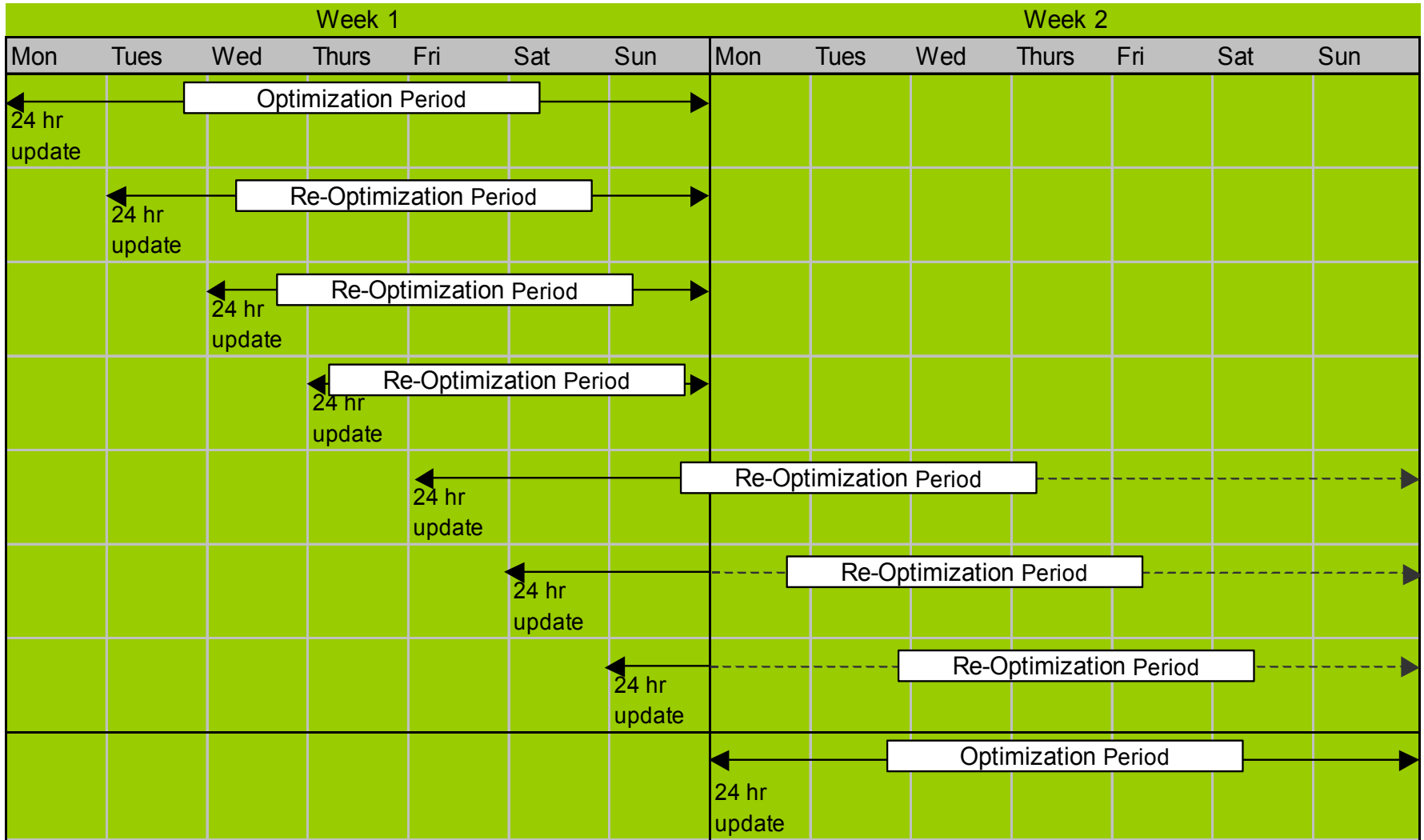
■ Actual Wind



# Modeling Wind

- Could assume perfect foreknowledge of wind much like we do for hydrology – does not capture the uncertainty
- Could assume an average energy for the week, derived from the wind time series – does not capture wind variability
- Adopt perfect foreknowledge for the first 24 hours and average for the remainder of the week.
- *AUTO Vista* enhanced to re-optimize periodically (e.g. daily); new wind forecast for the current day

# Wind Updating

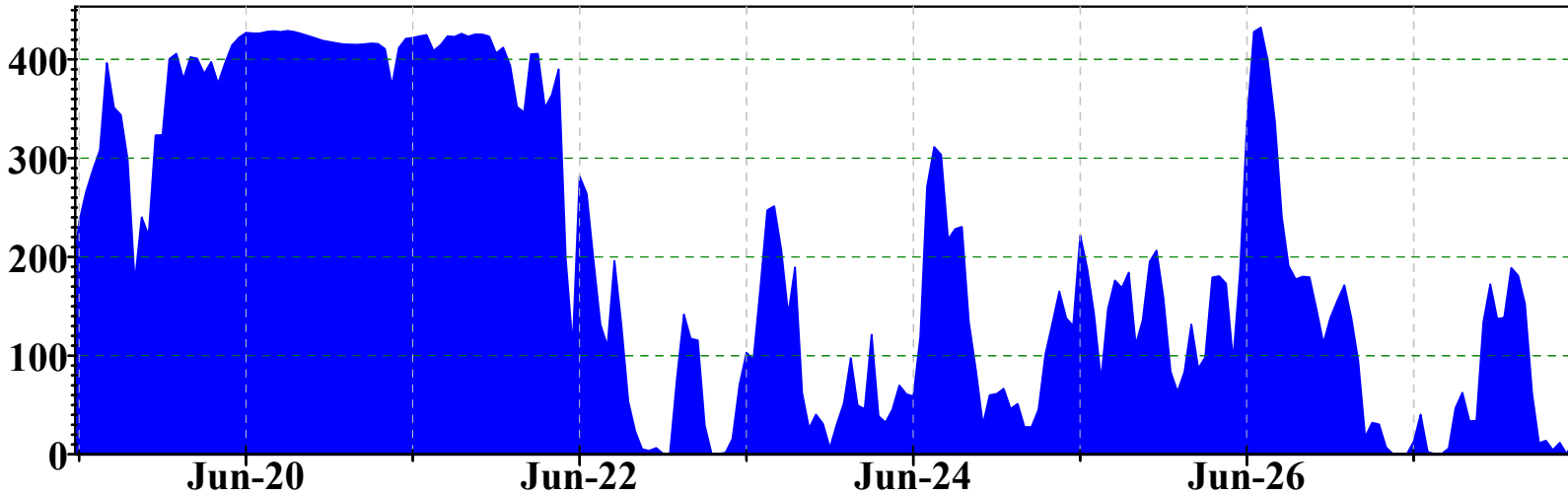


# System Transactions

Ref Time: Monday, April 05, 2010 01:00:00

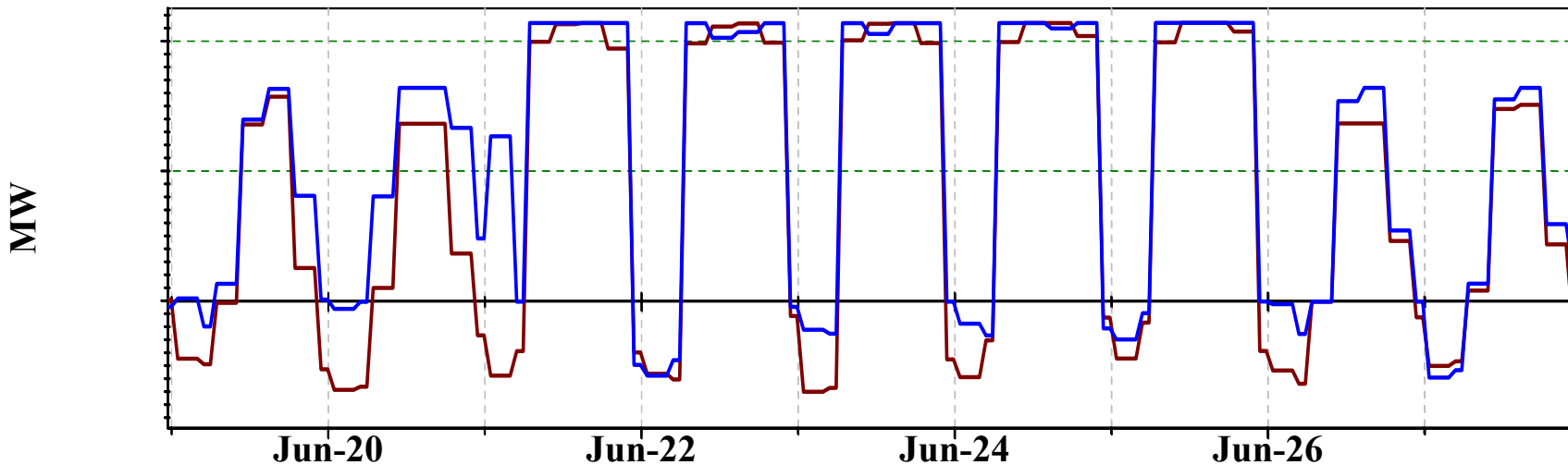
UserID: DHurdowar-Castro

## Wind Time Series



## - Base No Wind

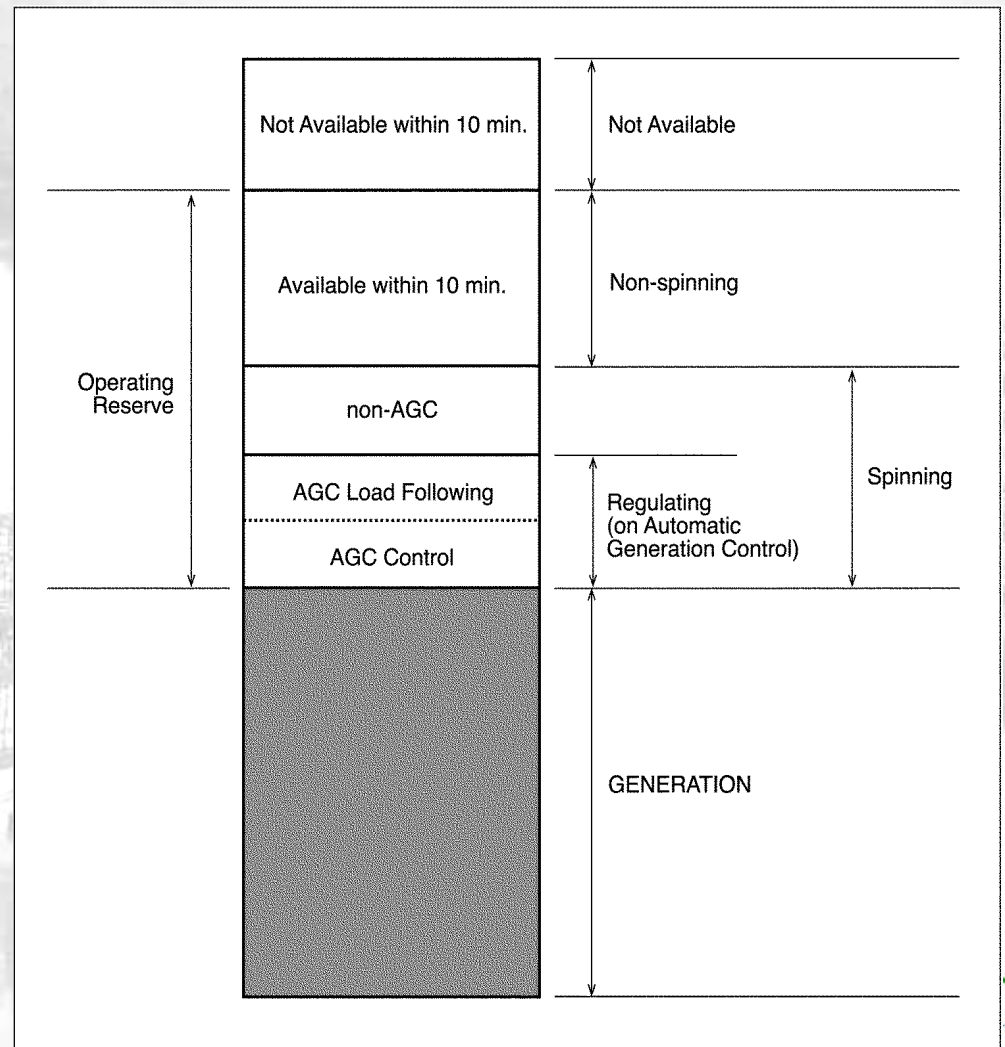
## - 500 MW Wind Capacity

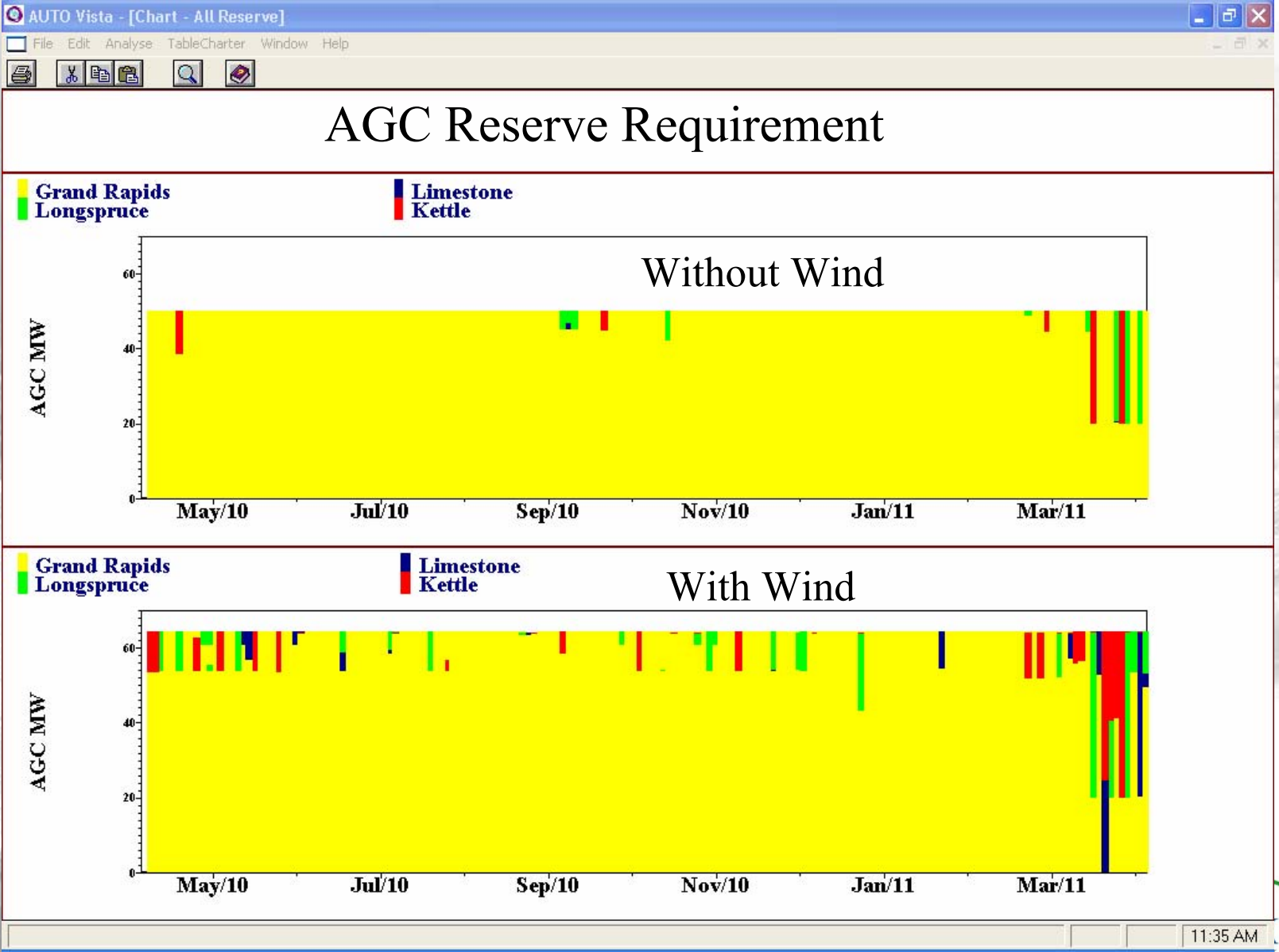


# Modelling Reserves

Can model both the variability and uncertainty of wind and the associated reshaping of operations.

Need to incorporate additional reserve requirement

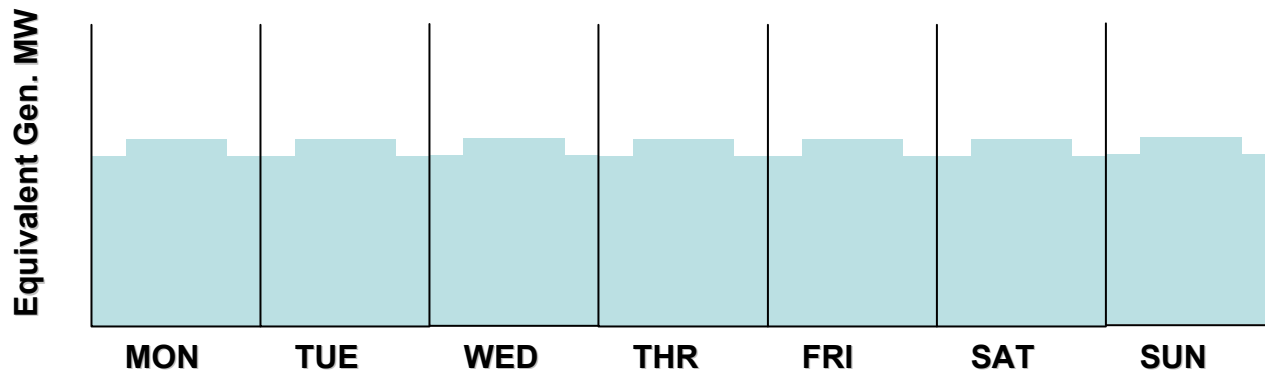




# Modeling Short Term Wind Uncertainty/Variability

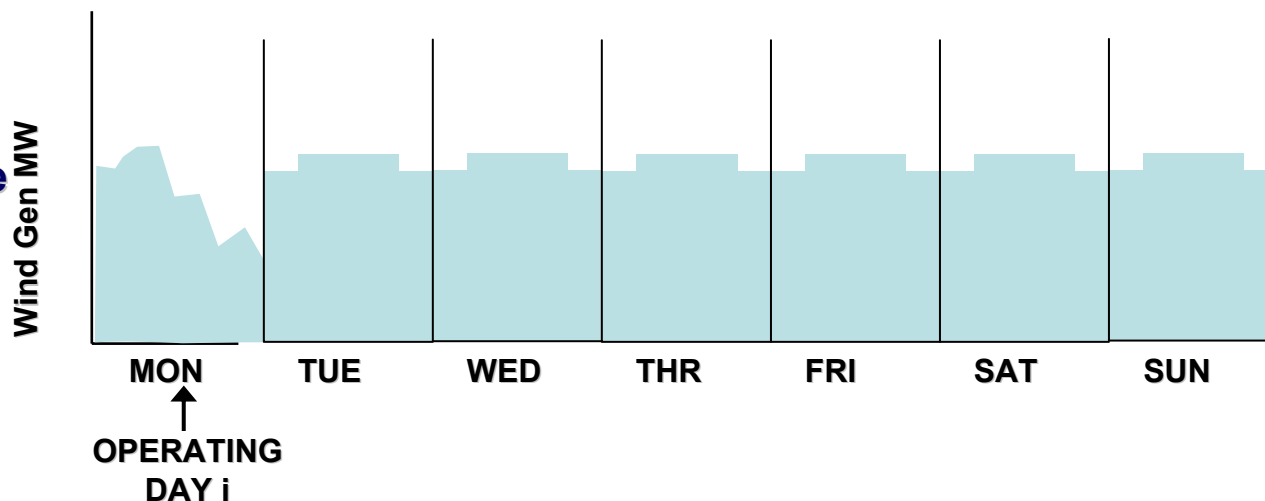
## CASE 1

- Monthly average energy
- No added reserves



## CASE 2

- Perfect foreknowledge on operating day
- Assume monthly average for subsequent days
- Advance daily
- Added reserves



# Wind Time Series

Median Wind Time Series

Median Hydrology

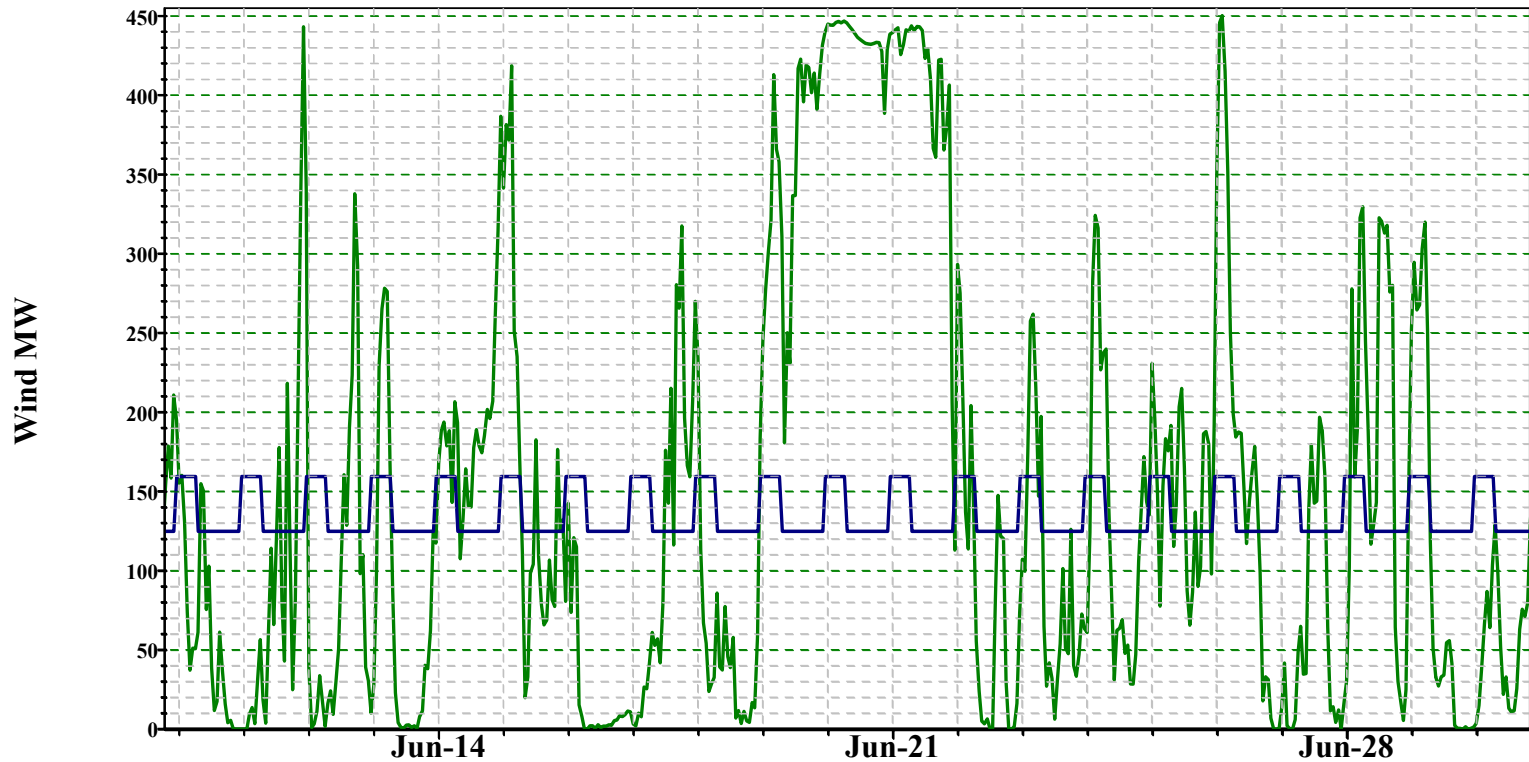
From Fri Jan 01 2010 01:00 to Sun Jan 01 2012 01:00

Ref Time: Monday, April 05, 2010 01:00:00

UserID: DHurdowar-Castro

— Wind MW

— Average Wind MW



# Net Transactions

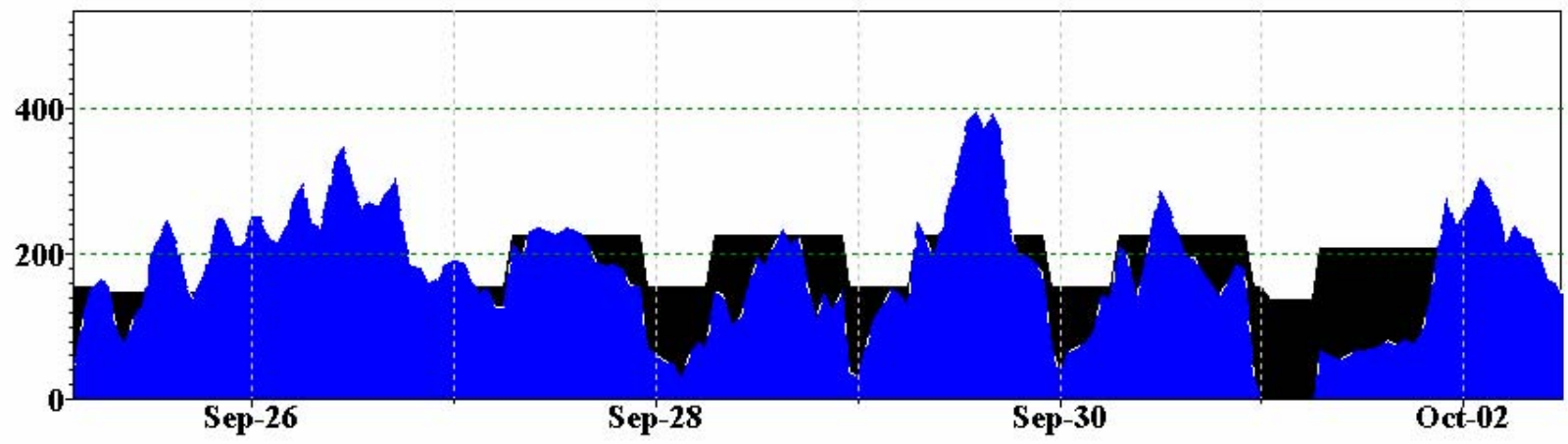
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Graphs

From Fri Jan 01 2010 01:00 to Sun Jan 01 2012 01:00

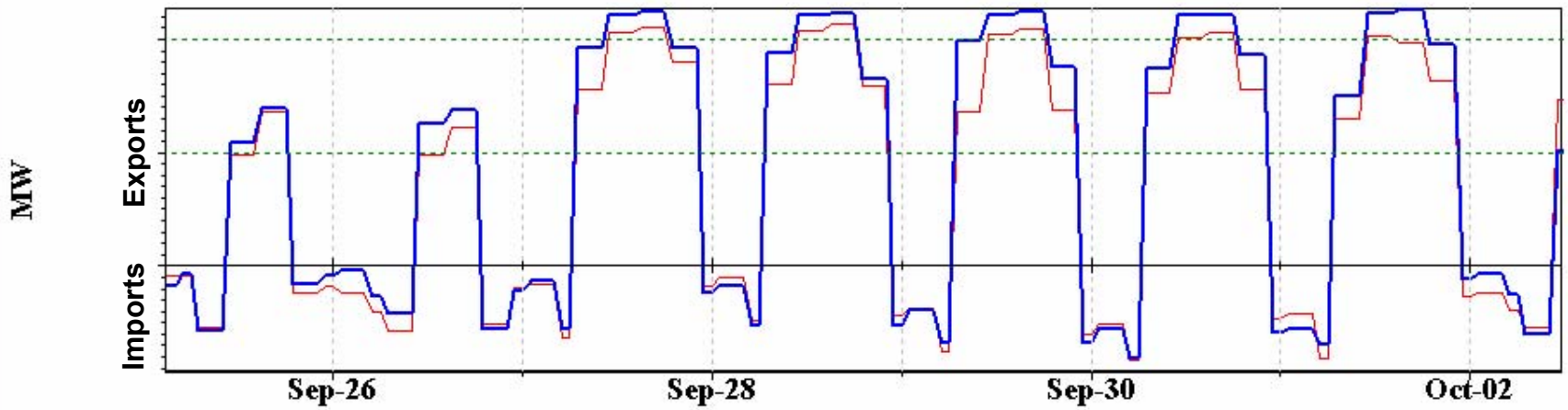
█ Equivalent Energy Case

█ Wind Case



- Equivalent Energy Case

- Wind Case



# Tie Line Activity

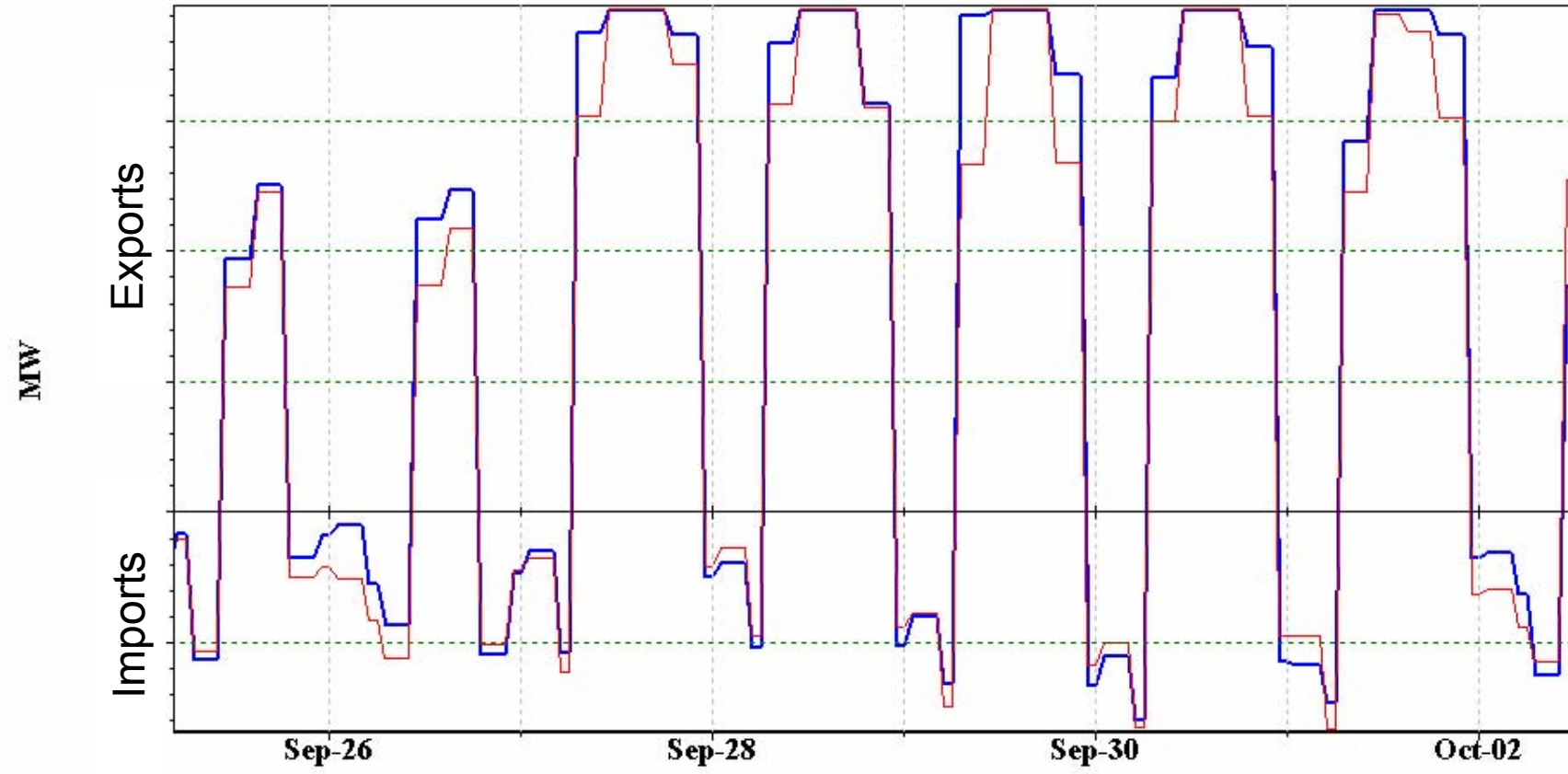
Activity

Ref Time: Monday, April 05, 2010 01:00:00

From Fri Jan 01 2010 01:00 to Sun Jan 01 2012 01:00 for tieLOAD@CNT\_USA(MW)

— Wind Case

— Equivalent Energy Caes



# Final Points

- Using MOST (*ST Vista*)
  - Able to determine the incremental cost of reserves associated with a wind supply source
  - View the change in Hydro operations to accommodate wind
- Further we can
  - Assess different levels of wind capacity
  - Assess the impacts to the transmission system
  - Determine a point of saturation, at what point will the system be saturated and spill is just directly traded off with wind energy.