

New Hydro Integration Planning Tool

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Wind Integration Studies using *Vista*

- **BPA**
- **Idaho Power**
- **Manitoba Hydro**

Introduction

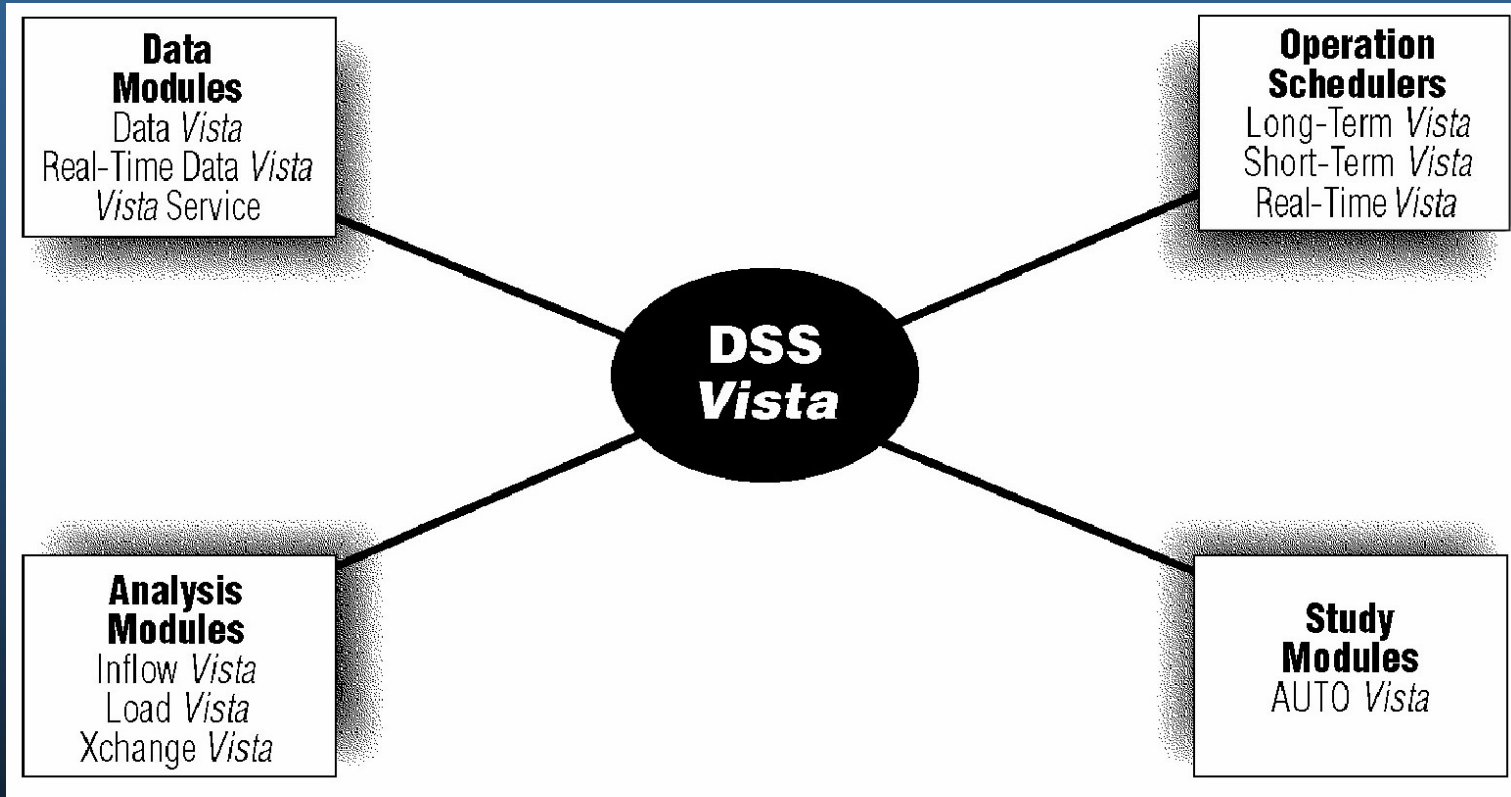
The key to assessing the benefits and costs associated with generation from wind is being able to accurately represent the system operation both before and after wind injection.

Vista Software

Vista is a software system intended for use by the system operators and dispatchers and engineering operations staff, to assist them in short and long-term scheduling to achieve maximum value for the water resource and generation systems.

It optimizes the hourly operations of all reservoirs, units, spillways, in view of external energy sources, market prices, load, inflow, and operational constraints defined.

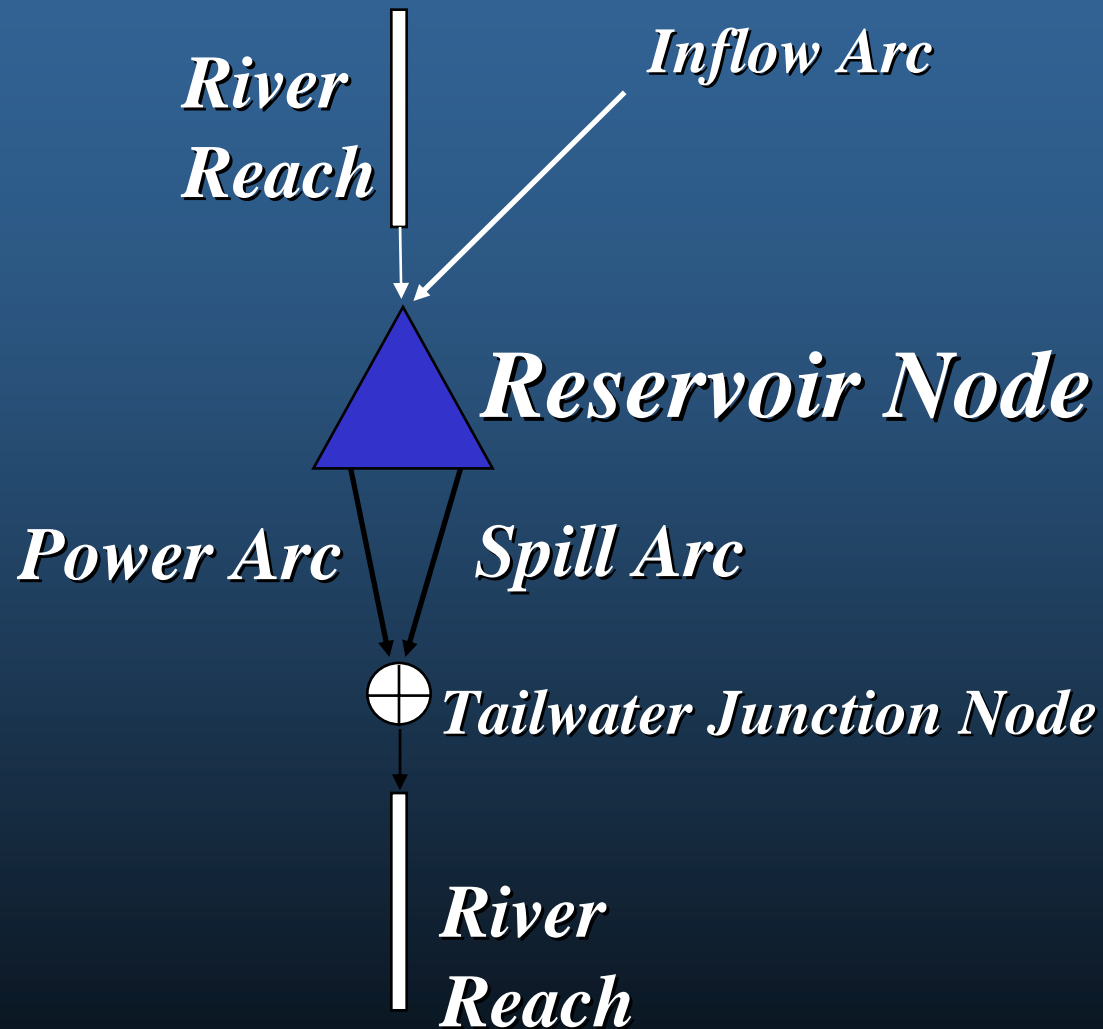
Vista Modules



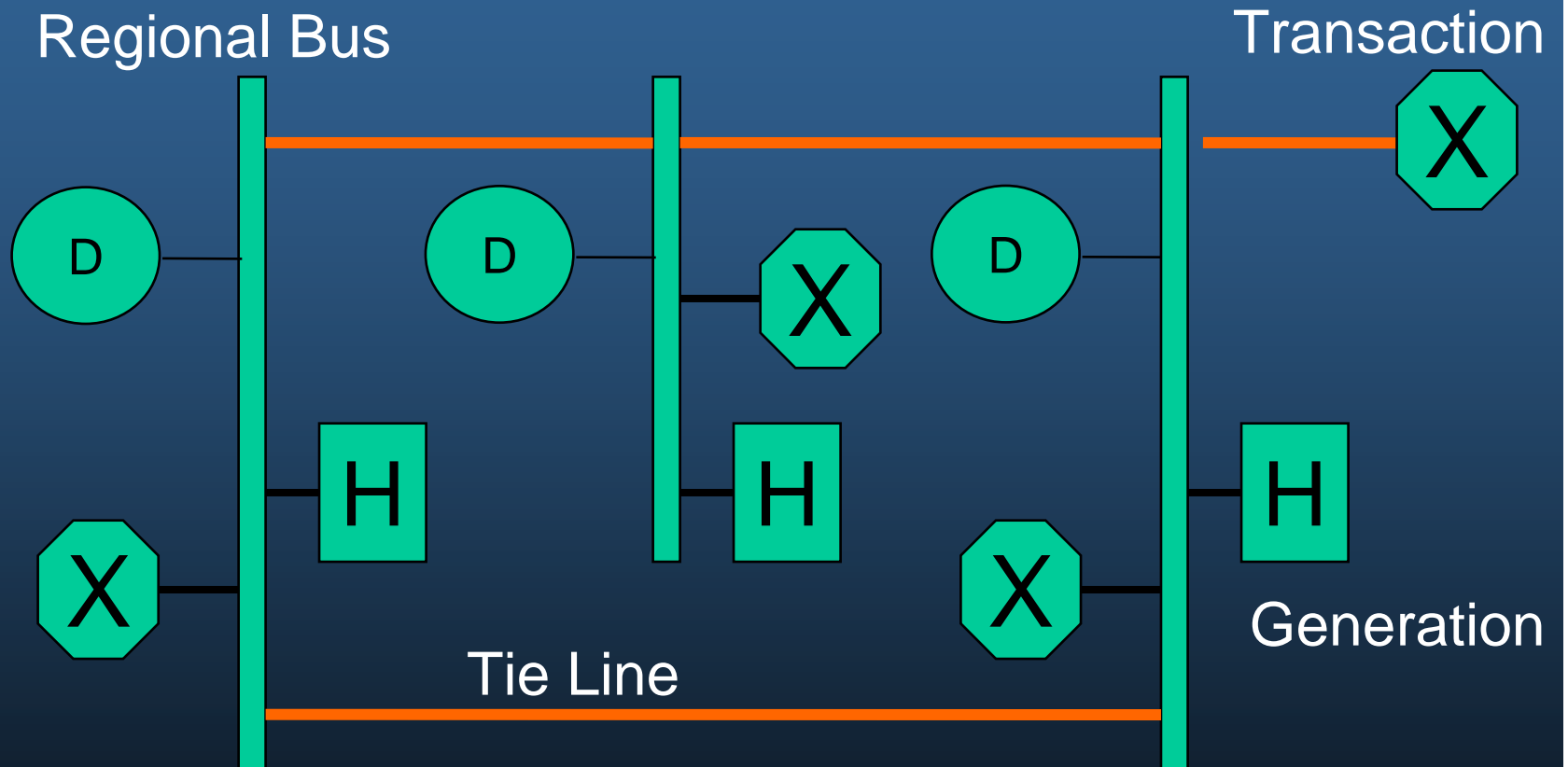
Vista Workings

- Model workings
 - Characteristics and constraints in hydrologic and transmission systems
 - Market Price forecasts
 - Firm Contracts
 - Historical/forecast Inflow sequences
 - Load demands
 - Inflow and wind forecasts
 - Within-plant dispatch (Unit Operations)
 - Reserves
- For planning this data is required over a year or more

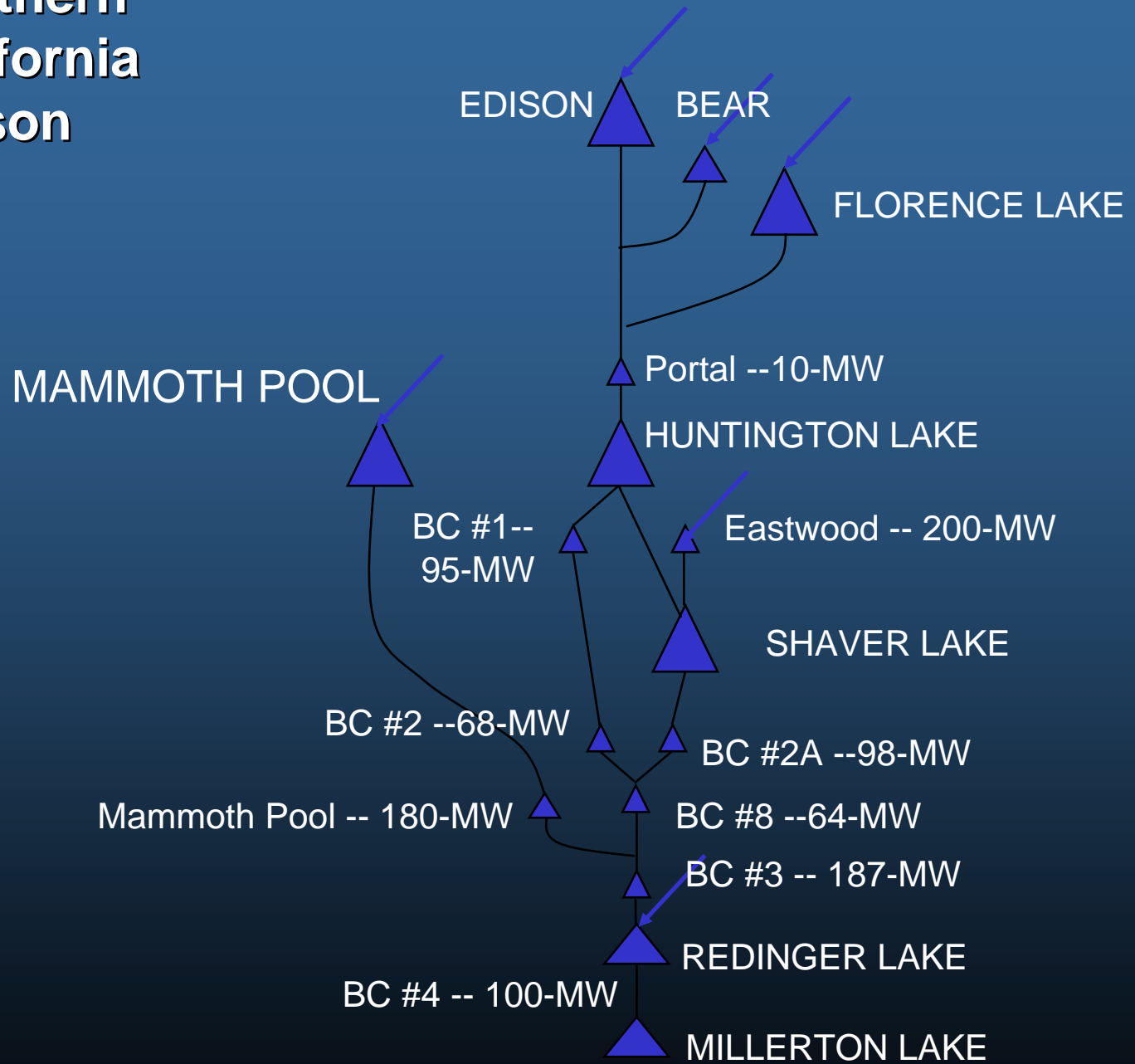
Vista Hydro System Components



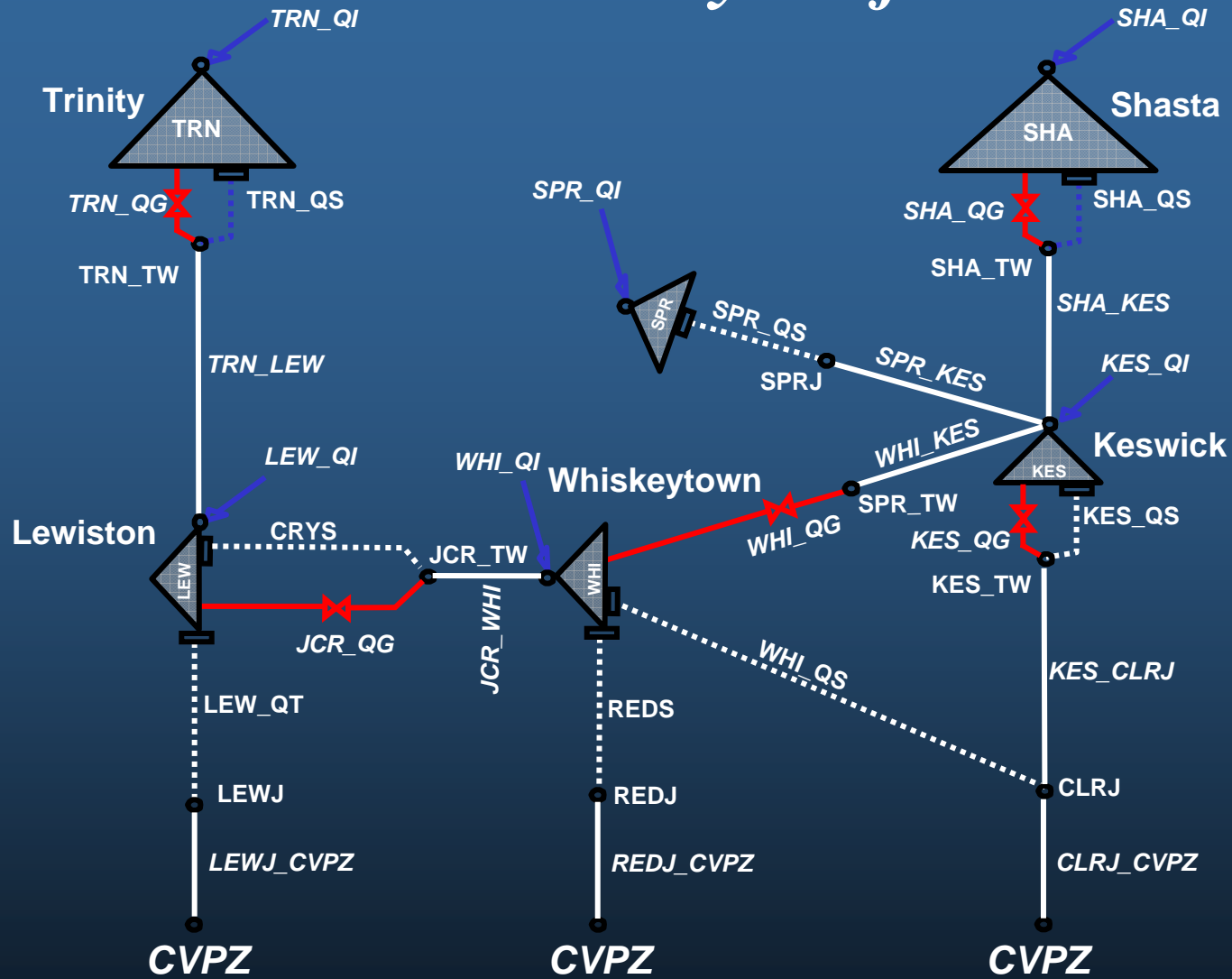
Vista Transmission System Components



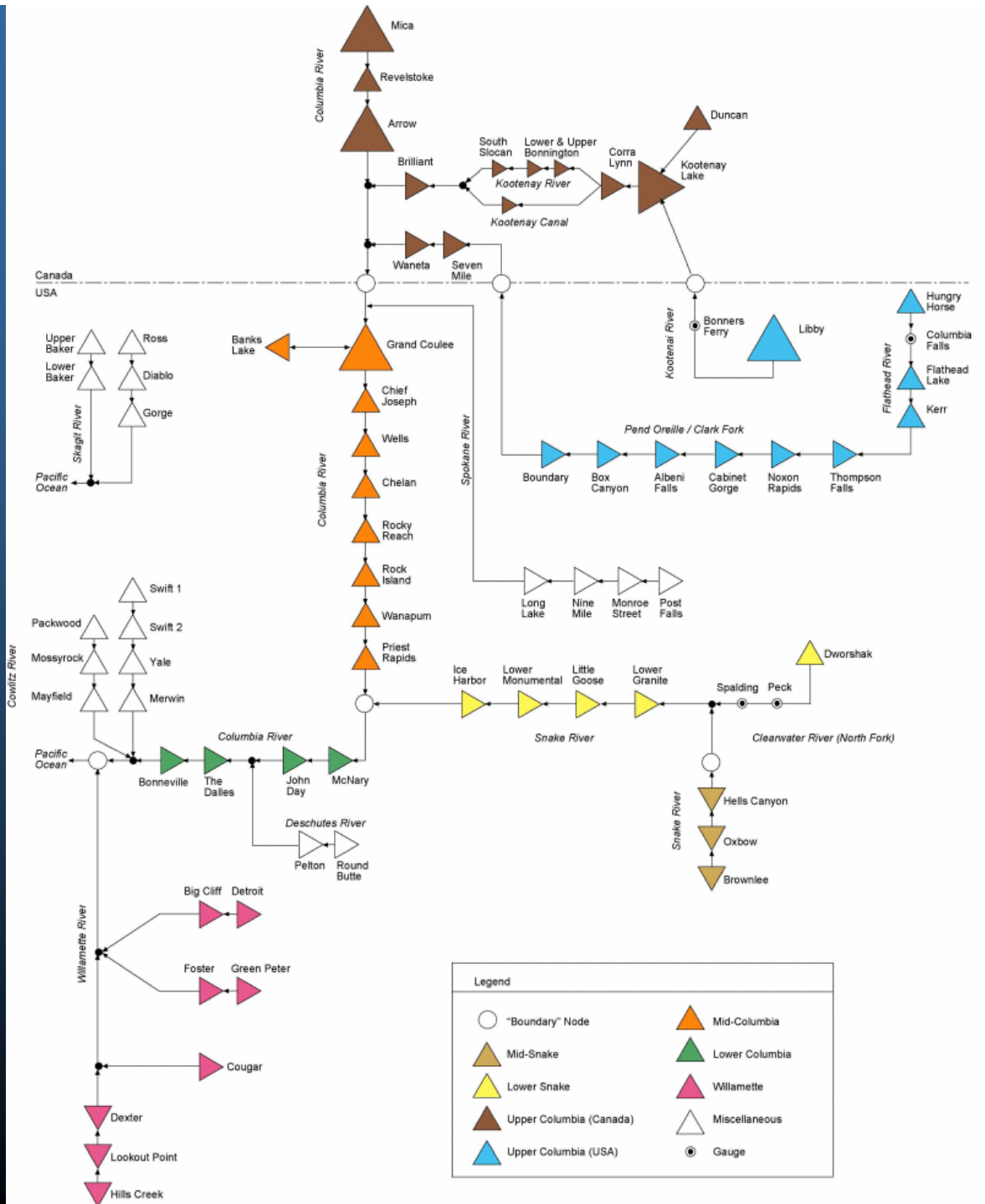
Southern California Edison



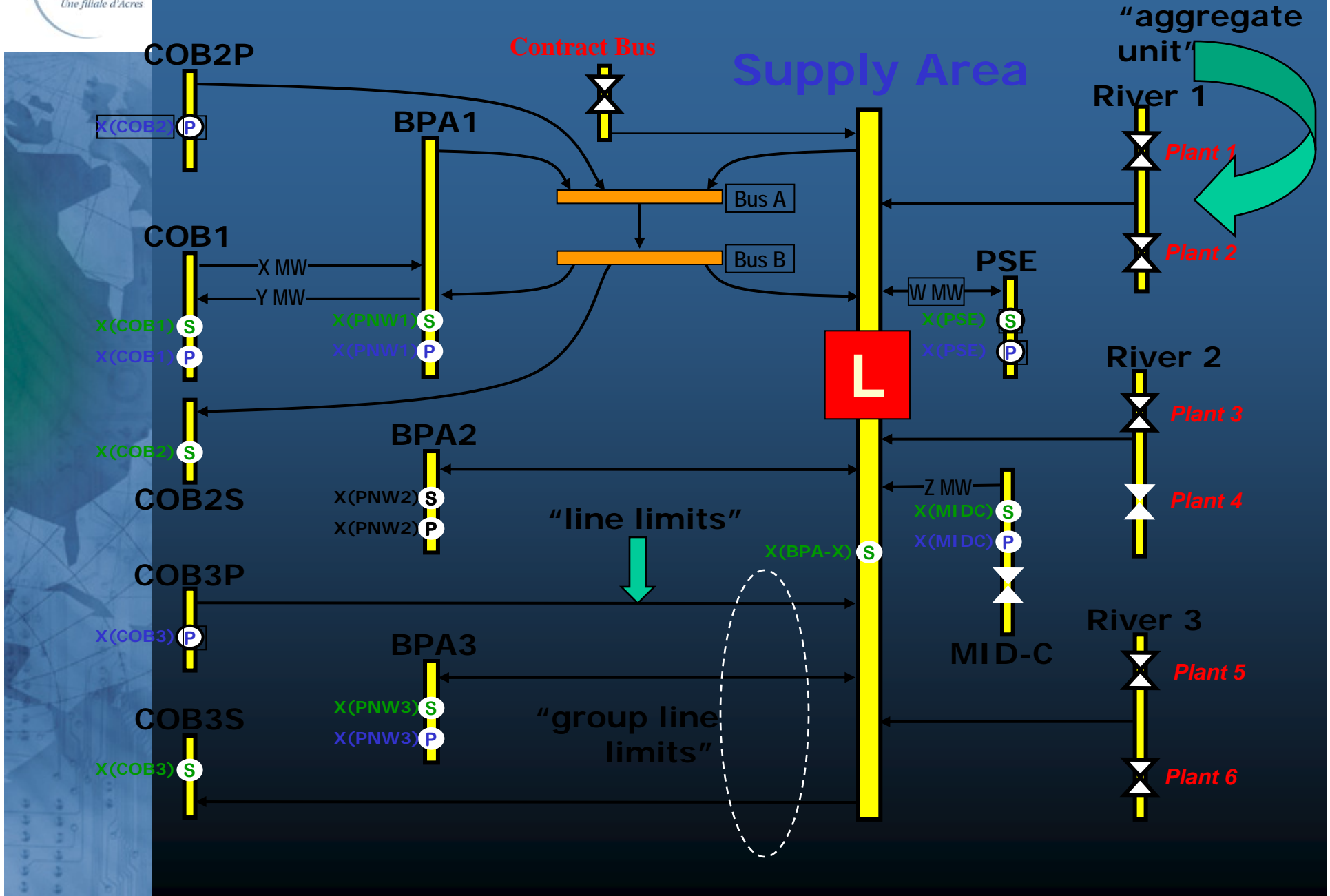
Central Valley Project Schematic



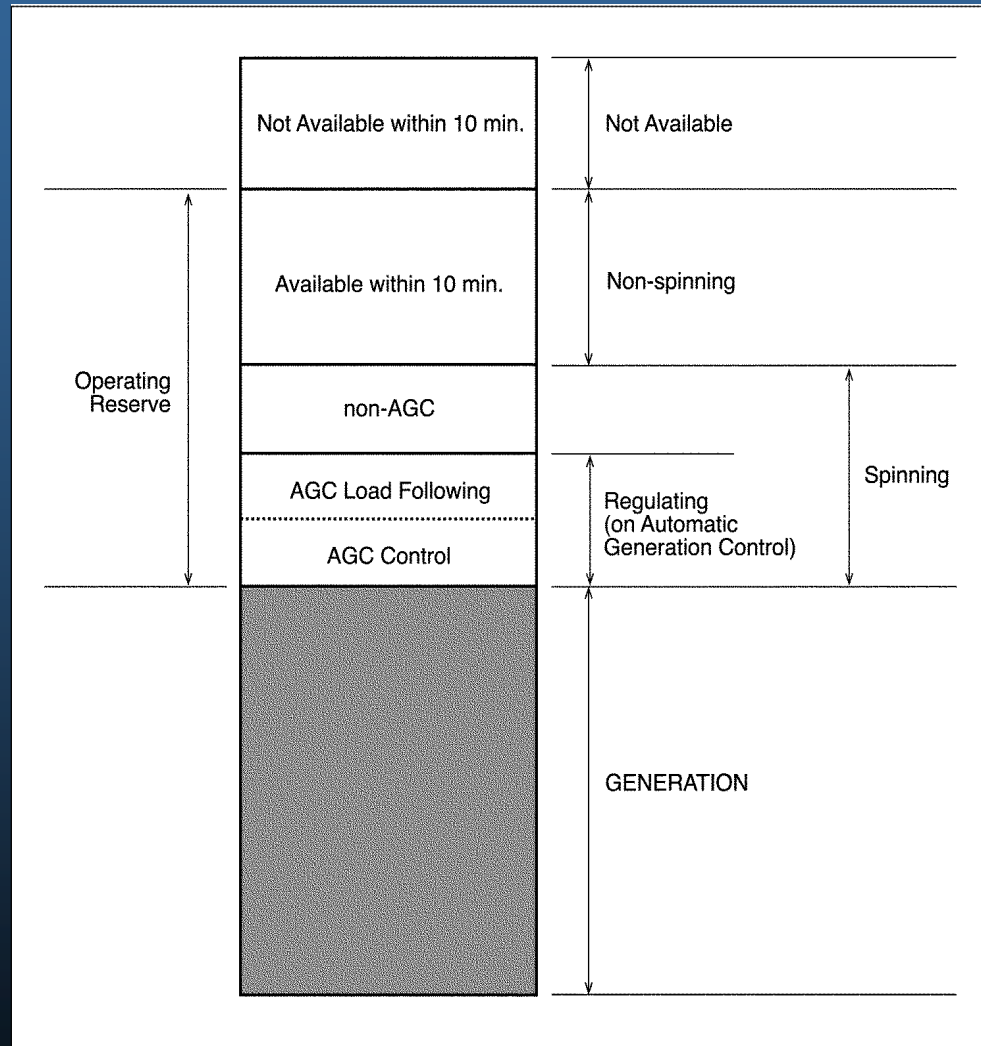
Columbia River System



Bus Configuration



Modeling Reserves



Vista Capabilities

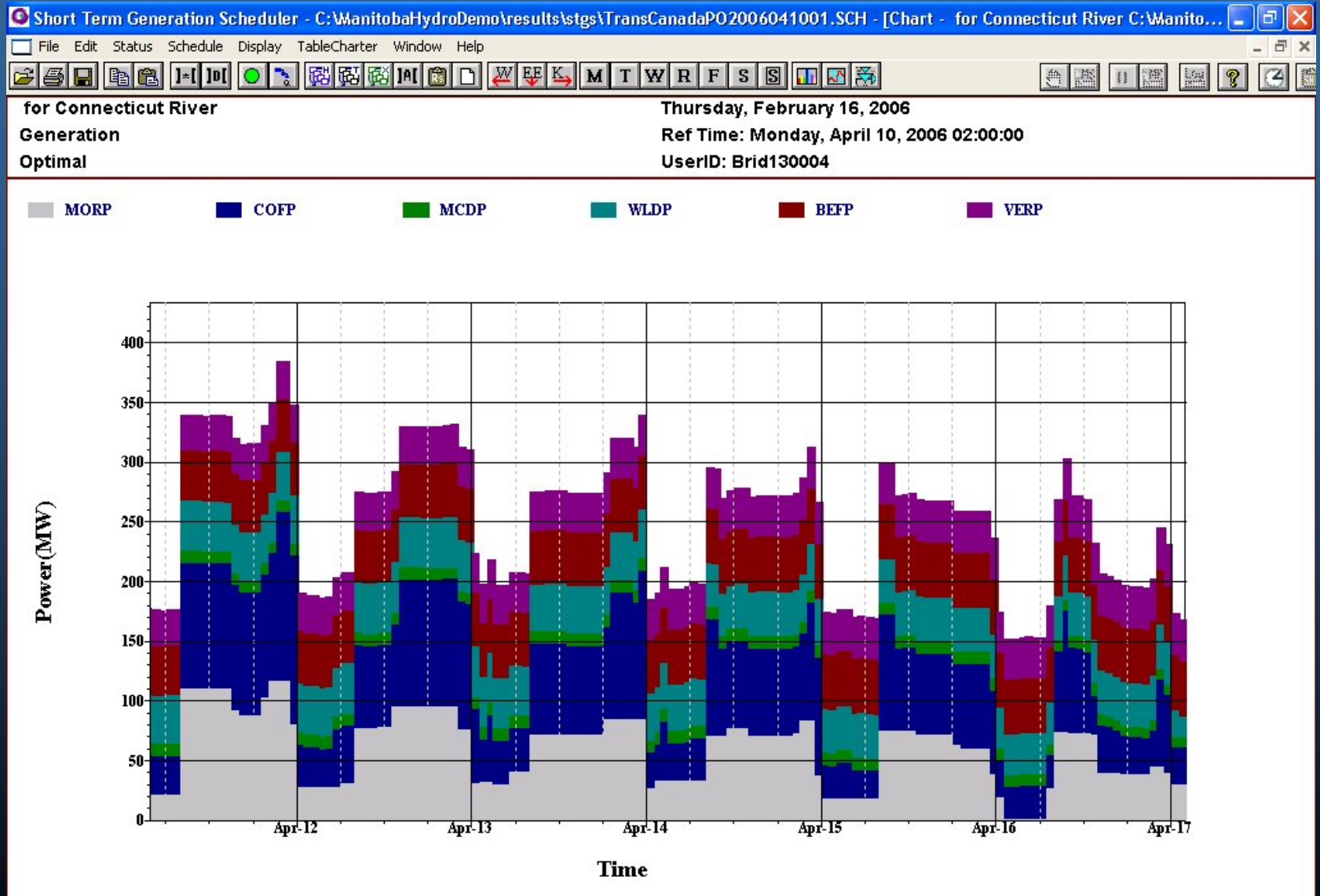
Long Term Planning

- Reservoir drawdown and recovery
- Minimize spill
- Forecast of probabilistic system operation
- Direction for short term scheduling
- Probabilistic in hydrology, price and load

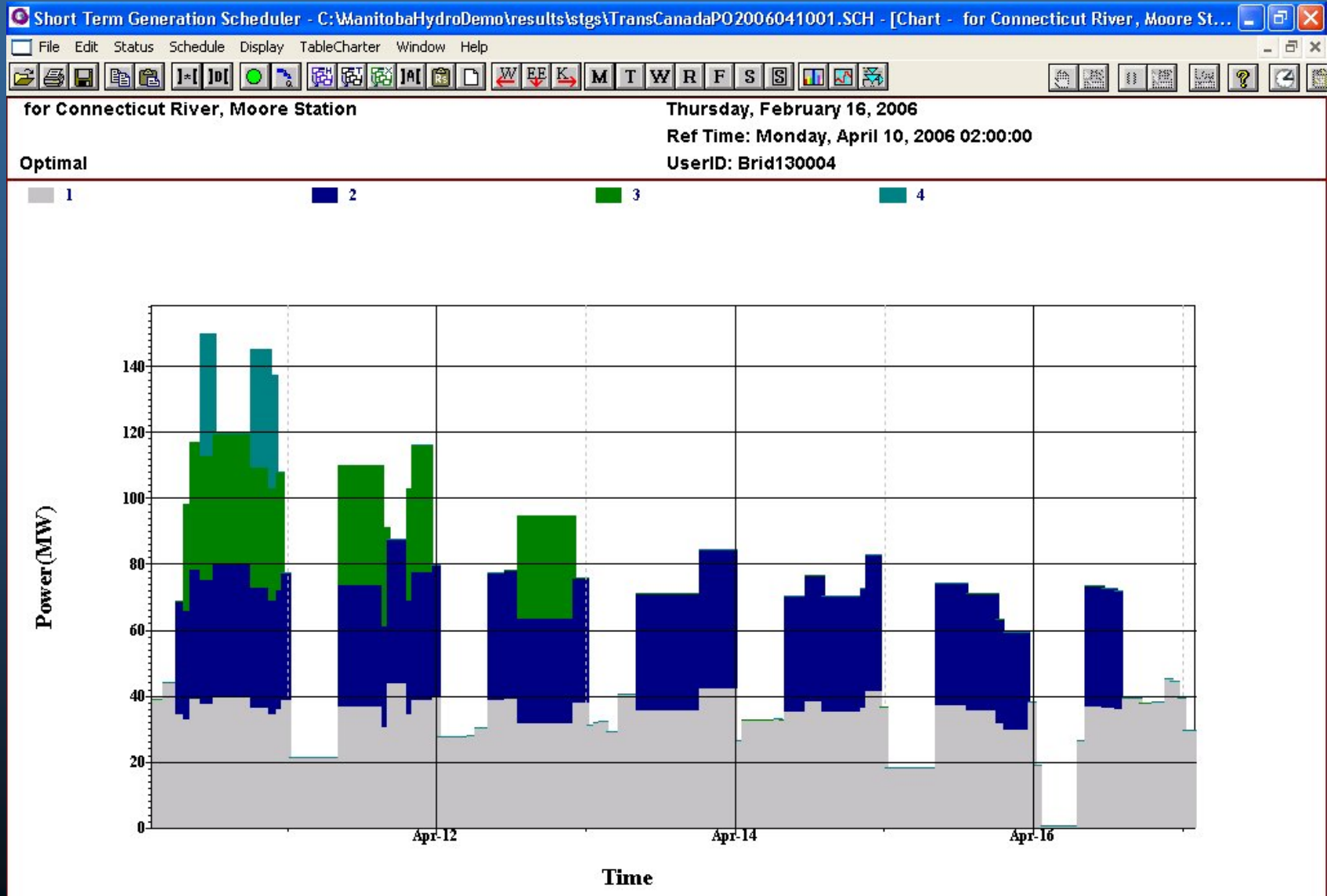
Short and Near term Scheduling

- Optimize operations to maximize net benefits
 - Timing with market
 - Timing for ancillary service
 - Minimize spill
- Forecast of deterministic system operation studies

ST Generation Plot



ST Unit Schedule



ST Water Level Plot

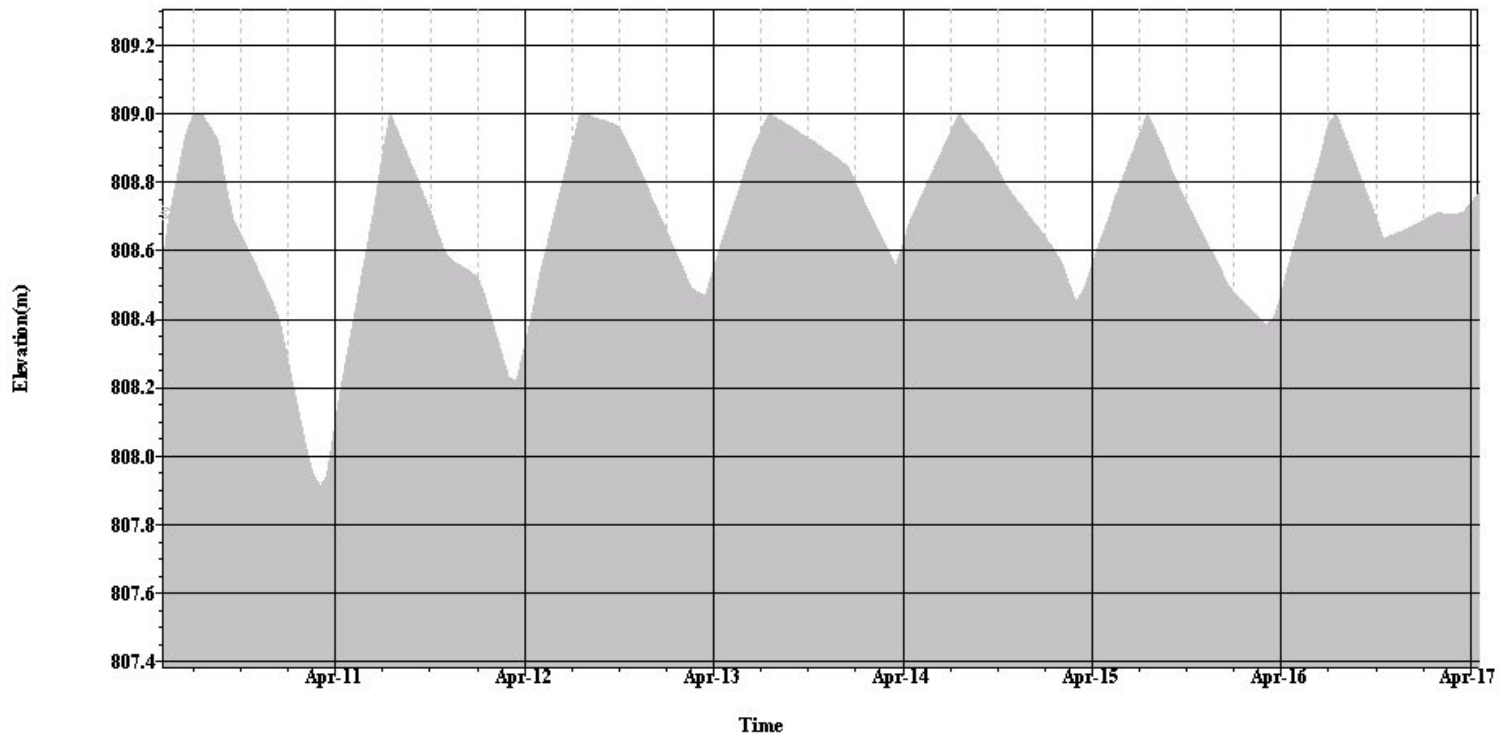
Short Term Generation Scheduler - C:\ManitobaHydroDemo\results\stgs\TransCanadaPO2006041001.SCH - [Chart - for Connecticut River C:\Manito...

File Edit Status Schedule Display TableCharter Window Help



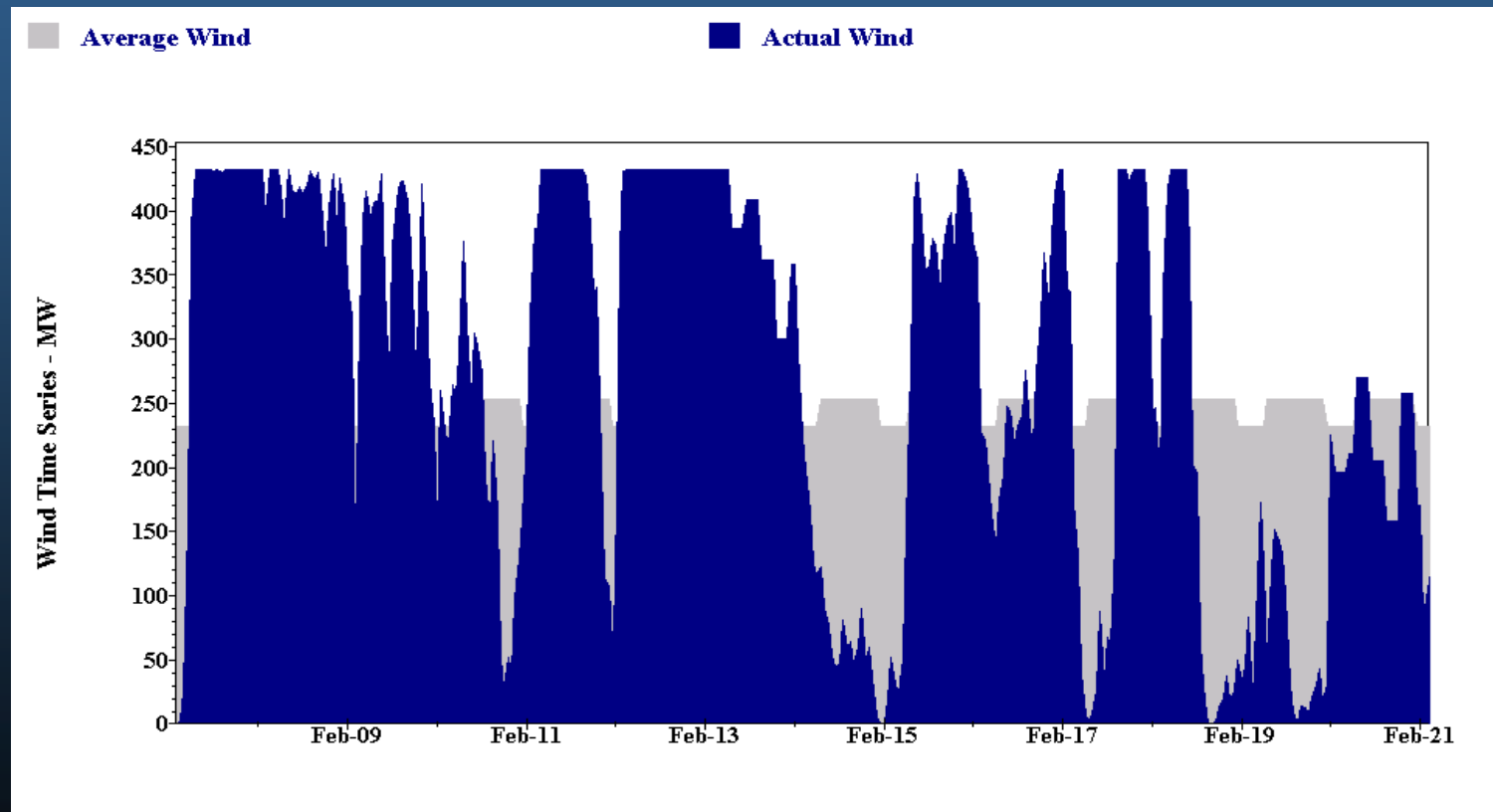
for Connecticut River
Levels for Moore Reservoir
Optimal

Thursday, February 16, 2006
Ref Time: Monday, April 10, 2006 02:00:00
UserID: Brid130004



Sample Wind Time Series

Wind can be quite variable, transitioning between full output and zero MW within a very short period.



Wind – Hydro Integration

Things to know

Reservoir storage

- Large reservoir storage capability is valuable, it can reshape the wind generation.

Reserve

- Need to provide additional reserve to offset the variability and uncertainty of wind generation.
- Can use hydro to provide reserve to wind.
- Expect lost opportunity from increased reserve capacity.

Wind – Hydro Integration

Need to Estimate the Cost of:

1. Sub-optimal operations due to variability and uncertainty of wind generation.
2. Lost opportunity cost from increased capacity reserve requirement for wind
 - Regulation reserve for uncorrelated minute to minute variations in net load (AGC control).
 - Load following reserve for sub-hourly ramp in net load.
 - Reserve to accommodate wind generation forecast error.

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 “n” 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.

Modeling Short-term Wind

CASE 1

Monthly average
energy

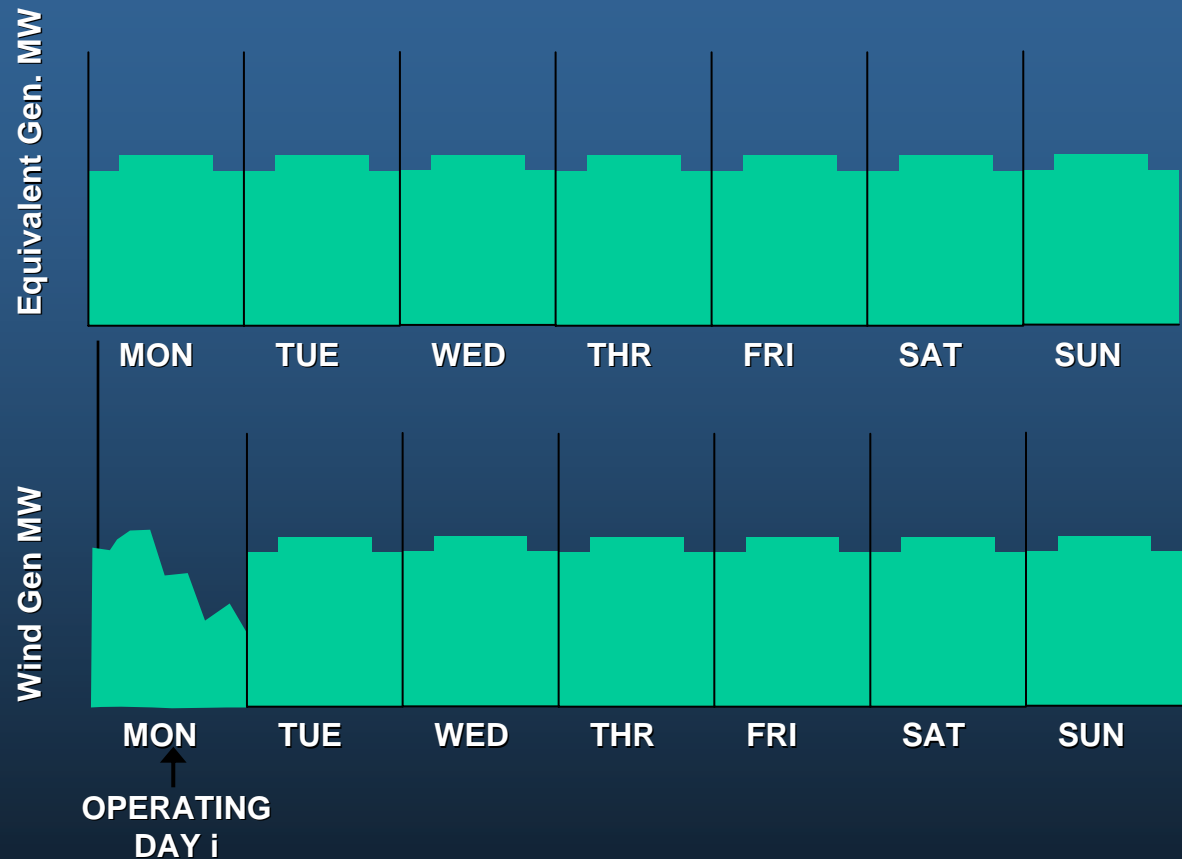
No added reserves

CASE 2

Perfect
foreknowledge
on operating day

Assume monthly
average
for subsequent days

Advance daily
Added reserves



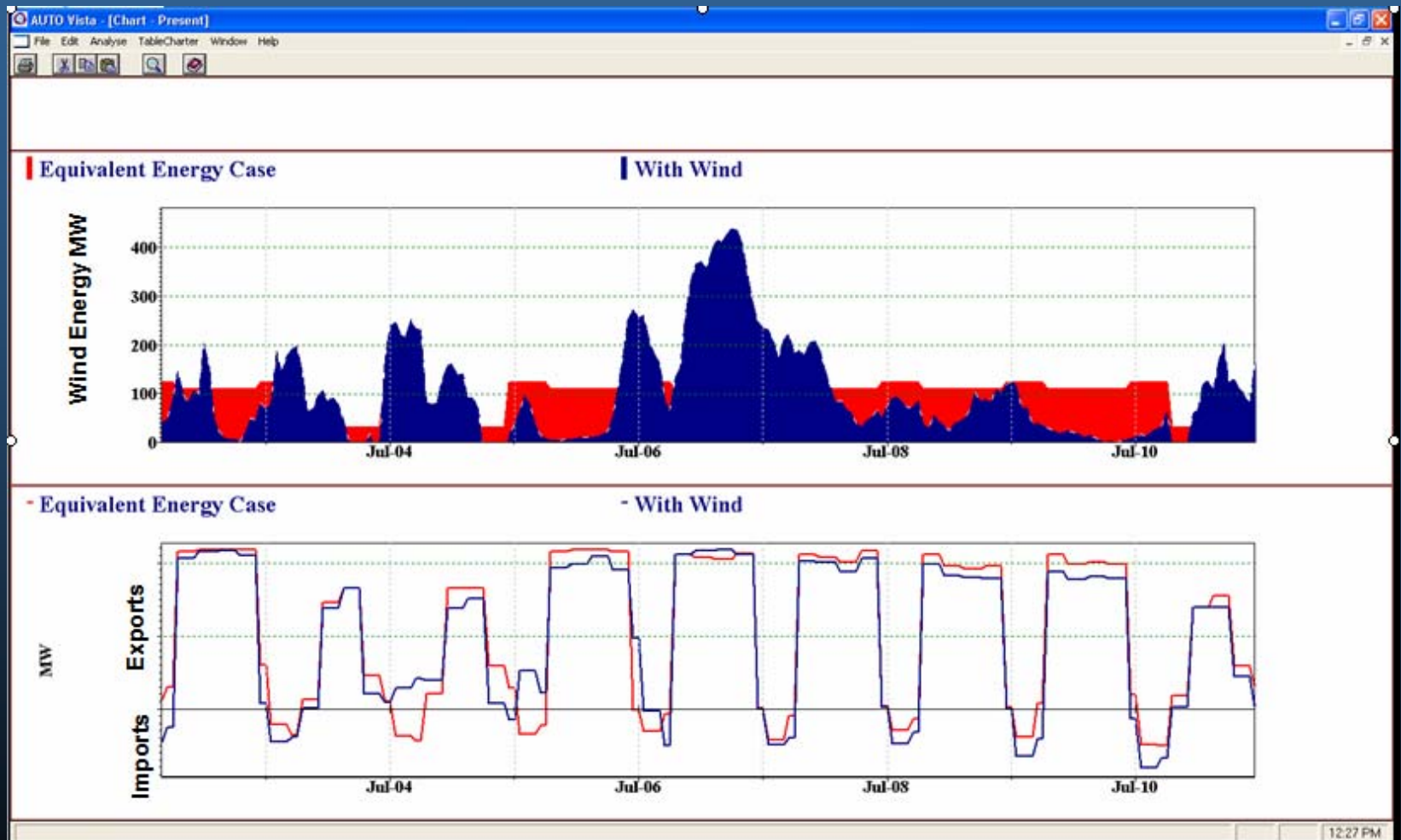
Source: Manitoba Hydro

Wind-Integration Study Results

- Determines the incremental cost of reserves associated with a wind supply source.
- Views the hourly change in hydro operations to accommodate wind.
- Assesses the impacts of different levels of wind capacity.
- Assesses the impacts to the transmission system.
- Determines additional spill incurred.

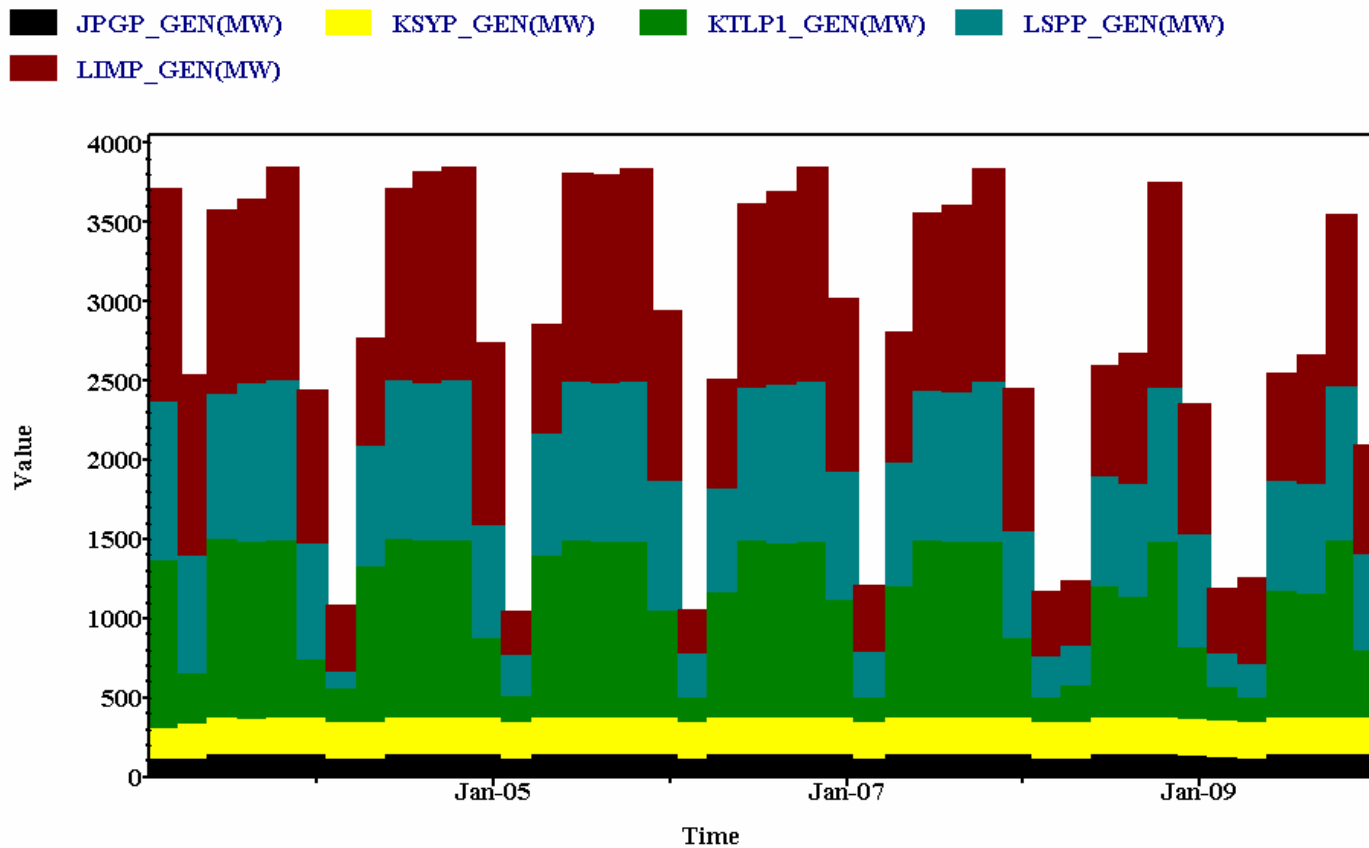
Results of Wind Integration

View the hourly export and import requirements



Results of Wind Integration

View the hourly generation at each plant



AUTO Vista - [Chart - Water Levels]

File Edit Analyse TableCharter Window Help



Water Levels

Lower Nelson

From Sat Jan 01 2011 01:00 to Sun Jan 01 2012 01:00 for resWL@KTLR(m)

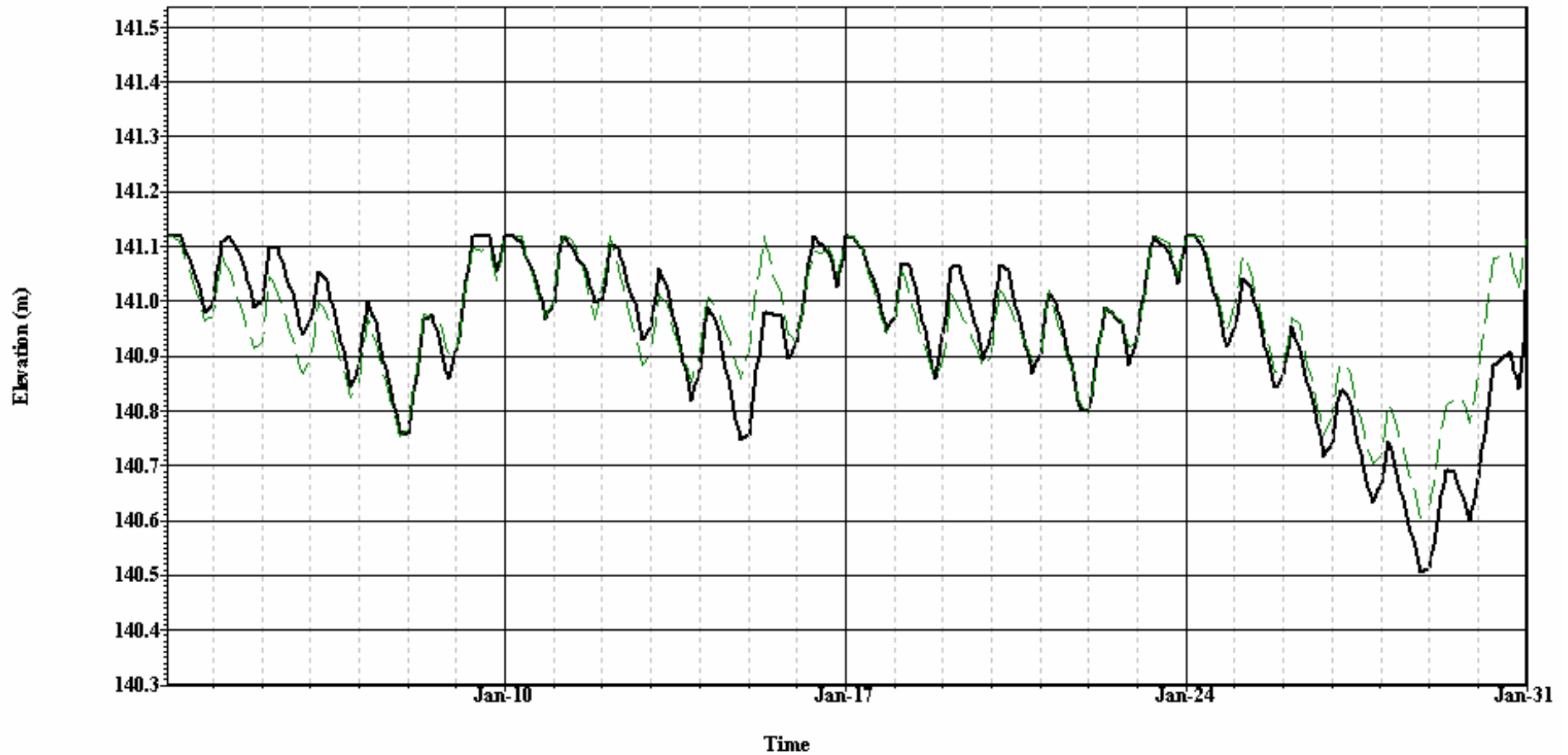
Monday, November 01, 2004

Ref Time: Monday, January 03, 2011 01:00:00

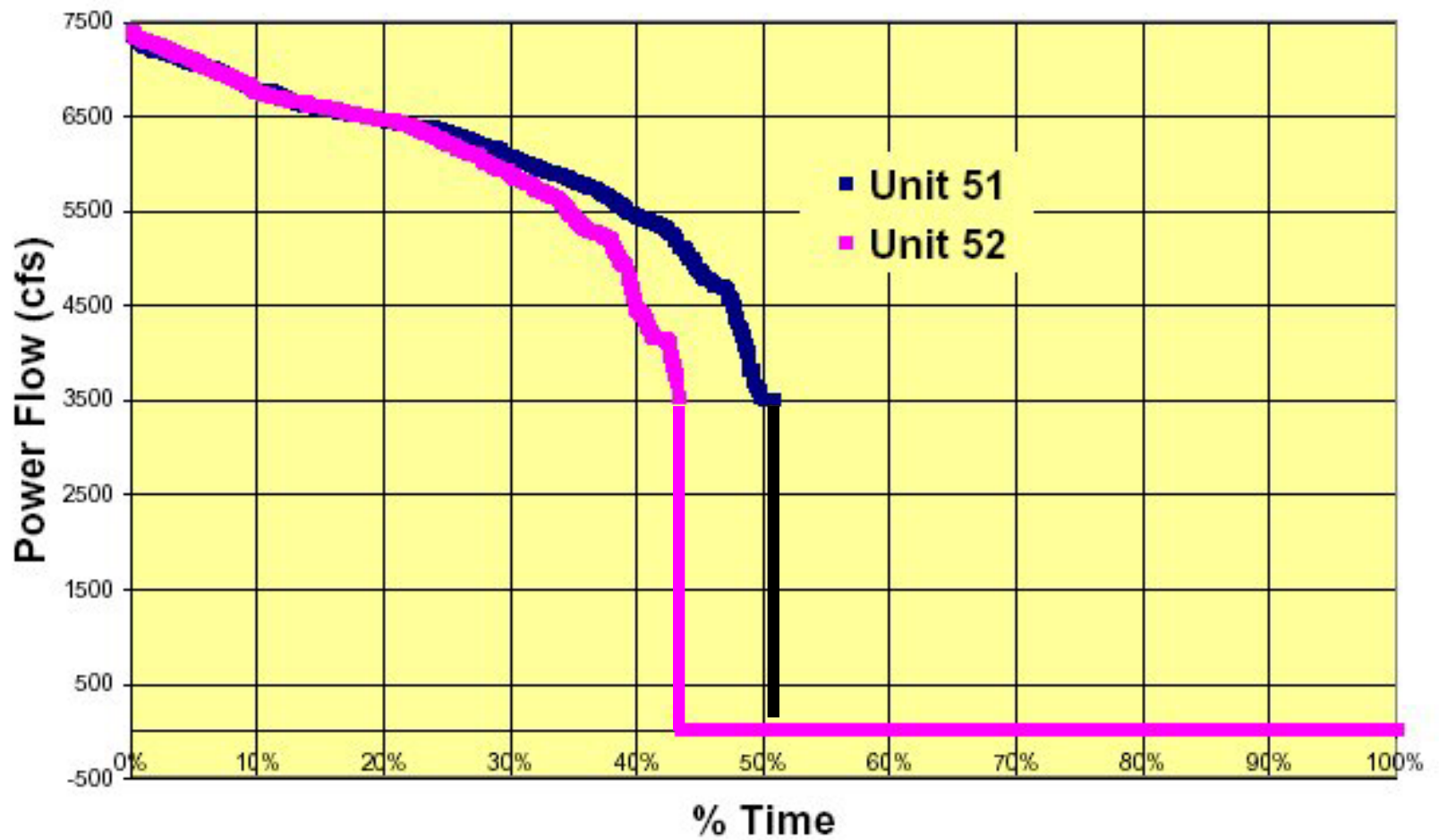
Synexus Global

— 500 MW Wind

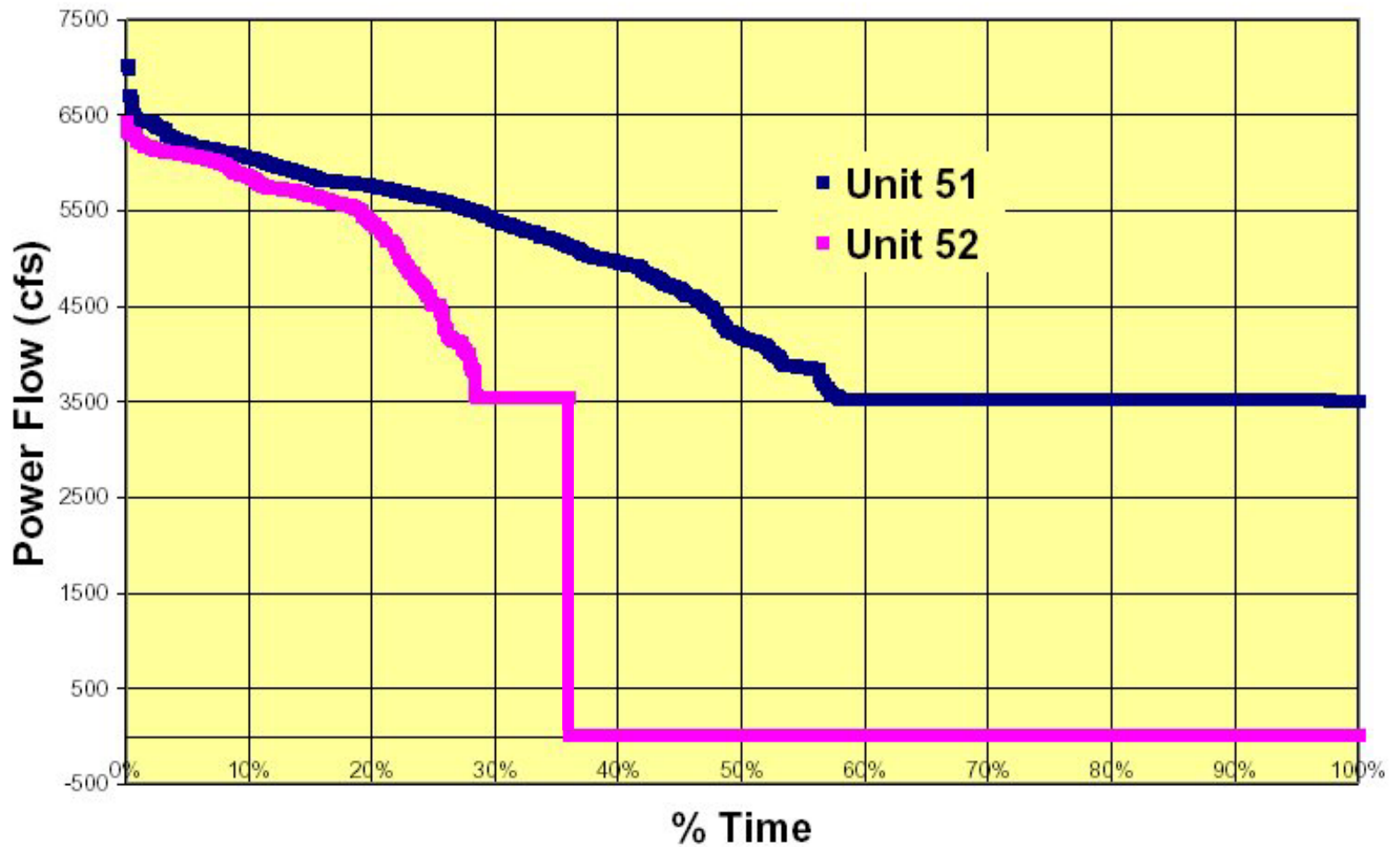
— No Wind



Unit Duty – Before Wind



Unit Duty – After Wind



Levels of Wind Integration

- **Level 1**
 - Wind statically defined (no recursion)
 - Reserves statically defined (block)
- **Level 2**
 - Wind dynamically defined with recursive updating
 - Reserves statically defined (block)
- **Level 3**
 - Wind dynamically defined with recursive updating
 - Reserves dynamically defined (varies with wind magnitude)

Conclusions

- **DSS technology can accurately simulate operations of hydro and hydro-wind systems**
- **Analyses are detailed and very complex**
- **Key issue is assumptions/inputs:**
 - **Critical period for reserves (10-min, 30-min, 60-min?) ... which determines:**
 - **Magnitude of regulation and operating reserves**
 - **Wind forecast sequences**