

Pacific Northwest Hydro-Thermal System and RTO West Market Design



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- Regional Characteristics
 - Nature of Northwest Hydro Operations
 - Hydro-Thermal Coordination Through Forward Bilateral Contracts
- Implications for Market Model
 - Unit Commitment Process
 - Transmission Rights

Northwest Resource Inventory

Table 1. Northwest Power Pool Statistics for 1999.

Resource Type	Capacity		Energy		Capacity Factor
	MW	Fraction	GWh	Fraction	
Hydro	46,604	64.4%	227,850	58.9%	55.8%
Coal	17,258	23.8%	127,312	32.9%	84.2%
Other Thermal	8,556	11.8%	31,587	8.2%	42.1%
Total	72,418	100.0%	386,749	100.0%	61.0%

- Overall system is energy constrained – not capacity constrained
- Highest NWPP actual peak load in January 2000 of 55,986 MW
- “Other Thermal” includes nuclear and combined cycle
- Intermediate and peaking units are less than 5% of capacity
- Unit commitment has never been a major issue for the Northwest
 - The bulk of the thermal units only off line for maintenance and forced outages
 - Hydro units can reach full output start up in minutes

Major Hydro Systems

- The Columbia River System
 - Storage in Canada and at Grand Coulee
 - Limited storage at downstream projects
- Peace River System w/storage capacity
- Snake River System
 - Lower Snake
 - Upper Snake

River Operations

- Diverse ownership along the river – US Federal, BC Hydro, Public Power and Investor Owned projects.
- Agreements required to coordinate operations
 - Columbia River Treaty – US & Canada agreement on storage and shared production
 - Pacific Northwest Coordination Agreement (PNCA) – Coordinating production on main stem of Columbia
 - Mid-Columbia Hourly Coordination Agreement – Daily production

Hydro Optimization

- Objective Function: Maximize ***annual firm energy*** production from the coordinated operation of all hydro system projects
- Constraints:
 - Water availability, snow pack and rainfall
 - Units are not independent, this means water leaving Grand Coulee must pass downstream projects within limited time due to limited downriver storage (pondage)
 - Multi-purpose projects (irrigation, flood control, navigation, fish and wildlife, recreation, municipal and industrial water supply, safety and power production) restrict range operational flexibility
- Result:
 - Incremental cost is difficult to determine for hydro
 - Opportunity cost has to include economic loss when departing from long term optimum

- Bilateral contracts developed to achieve hydro-thermal coordination
 - Centralized optimization would be exceedingly complex
 - Forward market serves a surrogate coordinator
- Peak and shaping provided from hydro with off-peak refill
 - Like an idealized “pumped hydro” plant:
 - Hydro energy output used on-peak to follow load with stored water
 - Energy returns off-peak allow refill of storage, as if from pumping
 - Implemented through various exchanges, purchase and sales
- Trading hubs at COB and MidC developed to meet the needs of the bilateral trade to enhance hydro-thermal coordination activity

Implications for RTO West Market Model

- Nodal prices must be based on voluntary, bid based prices
- Unit commitment process must be based on self-commitment to keep river operations with the hydro project operators
- New day-ahead and real-time markets must be consistent with and converge with the existing active bilateral forward market



Major Features of RTO West Congestion Management Proposal

- Real-time balancing market with nodal prices
- Balanced day-ahead schedules with day-ahead congestion clearing market
- Unit commitment based on balanced schedules, with penalties and supplemental commitment as necessary
- Transmission rights are financial (accept all schedules)
 - Existing rights of Participating Transmission Owners (PTOs) are pooled as Cataloged Transmission Rights (CTRs) to meet net requirement of existing uses and provide larger quantity of released rights
 - Existing contracts of PTOs honored within CTRs
 - Capacity in excess of CTRs released to market as Financial Transmission Options (FTOs) in auctions (6 Month to Daily)
- Ancillary Service Markets still a work in progress

Summary

- Market design standards should include sufficient flexibility to permit optimization of the hydro system operations
 - Unit commitment process allowing a self commitment of generation
 - Transmission rights need to be designed to enable hydro-thermal coordination through bilateral contracts