

BC Electric Market Overview

Central Asia Delegation

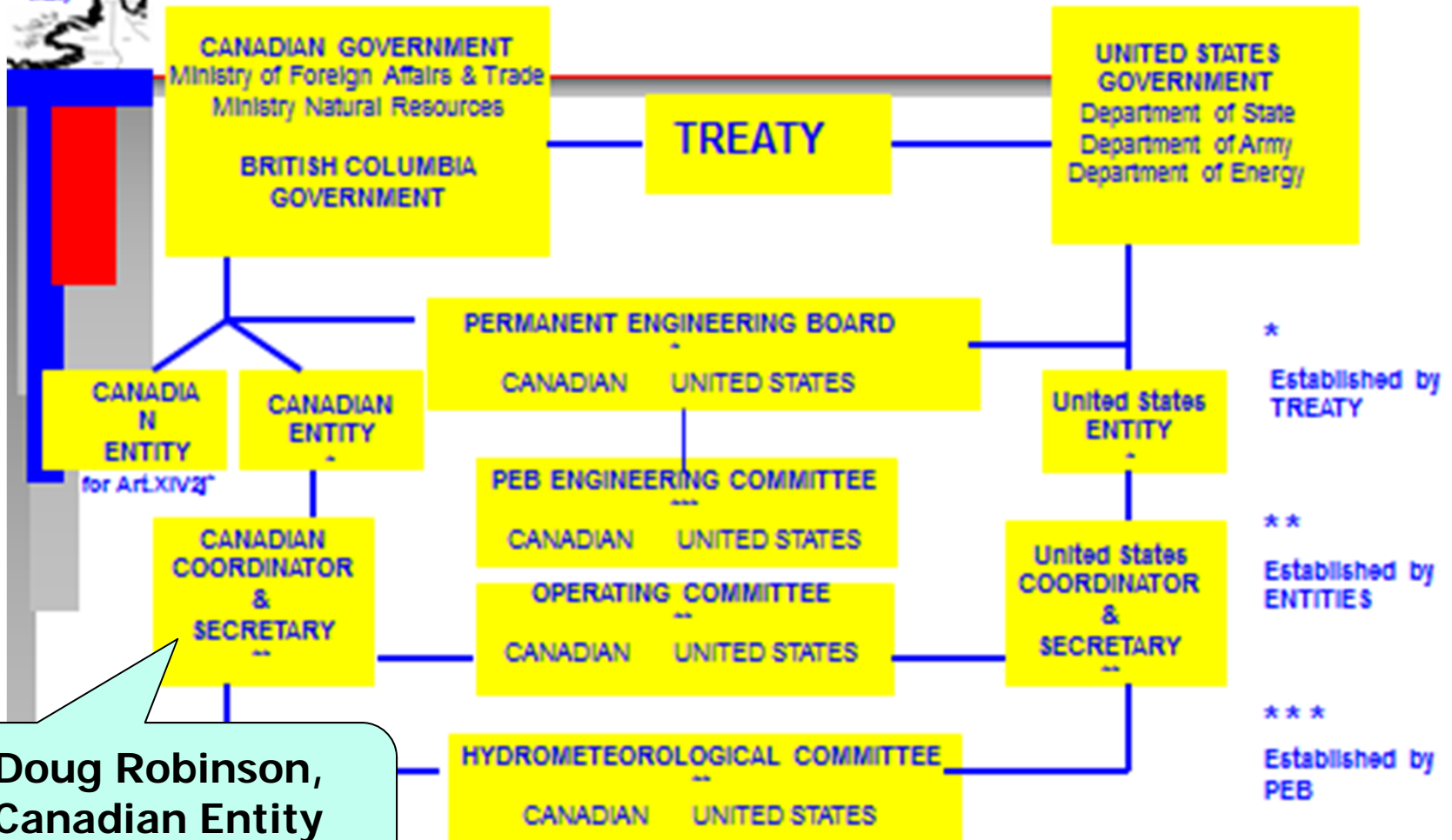
30 January 2013

Doug Robinson
Canadian Entity Secretary
BC Hydro - Generation





Columbia River Treaty Organization



Doug Robinson,
Canadian Entity
Secretary

Canada Facts

- **Population: ~ 34.3 million**
- **10 Provinces, 3 Territories.**
- **Confederation: 1 July 1867**
- **Government: Parliamentary Democracy, Constitutional Monarchy**
- **Languages: English, French [Primarily Quebec]**
- **Area: ~10 million km² [2nd largest after Russia; 6 time zones; borders 3 oceans]**
- **Capital: Ottawa, Ontario [coldest capital in world]**
- **Border with US is longest undefended border.**
- **Gross Domestic Product ~ \$1.4 Trillion**
- **Electrical Capacity ~ 131,000 MW**



British Columbia (B.C.) Facts

- **Population:** ~ 4.4 million [3rd]
- **British Colony:** 19 November 1858
- **Entered Confederation:** 20 July 1871
- **Area:** ~0.95 million km² [4 x Great Britain]
- **Vancouver Island** ~ size of Belgium.
- **B.C. was named after the Columbia River...** after the initial proposal, "New Caledonia" was rejected.
- **Capital:** Victoria, on Vancouver Island.
- **Vancouver:** Named after Captain George Vancouver; Named "World's most liveable city"
- **Electrical Capacity** ~ 12,000 MW

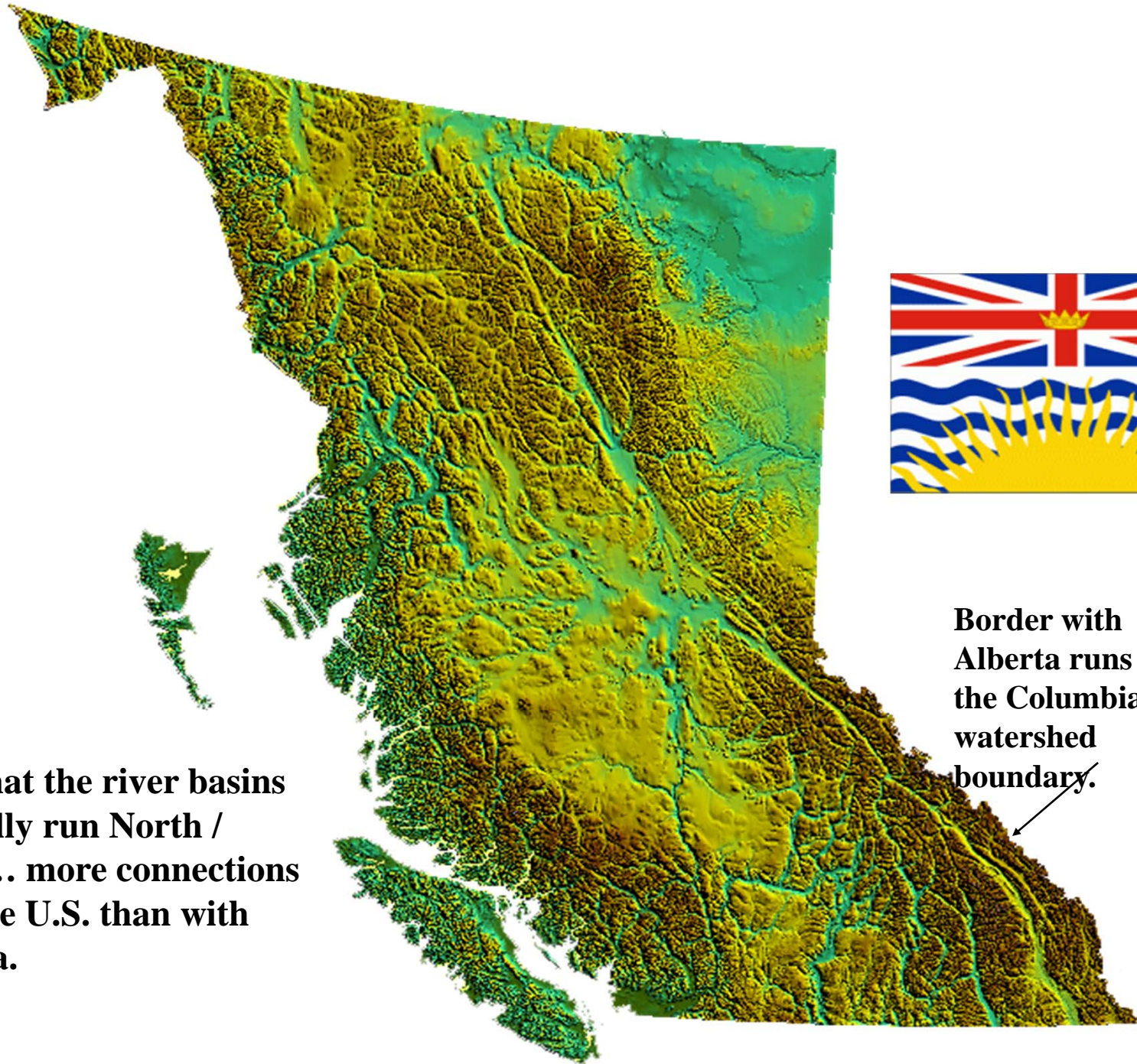


BC Hydro Facts



FOR GENERATIONS

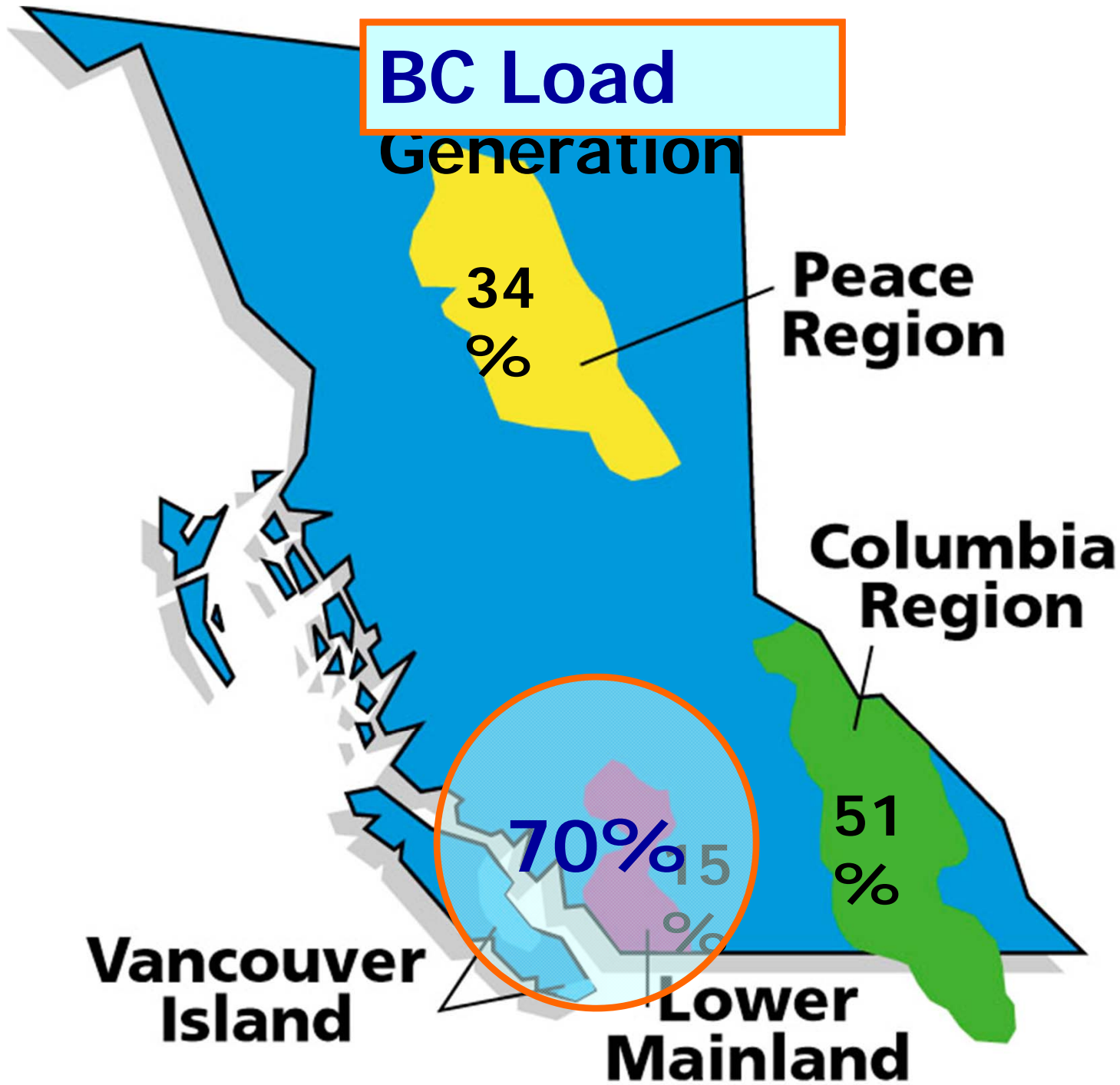
- **A Provincially-owned Crown Corporation.**
- **Serves ~95% of BC's population [FortisBC serves rest]**
- **~ 1.8 million customers.**
- **~ 5800 employees**
- **Domestic Revenues ~ \$4 billion /year**
- **Generation varies from 42,000 GWh – 52,000 GWh/year**
- **Installed Capacity ~ 12,000 MW**
- **Rates are ~ 4th lowest in North America [lower include: Quebec Hydro; Manitoba Hydro; Seattle City Light]**
- **Rates: Residential 77 \$/MWh; Commercial 69 \$/MWh; Large Industrial 45 \$/MWh**
- **57,700 km of Distribution lines**
- **18,800 km of Transmission lines**



Note that the river basins generally run North / South... more connections with the U.S. than with Alberta.

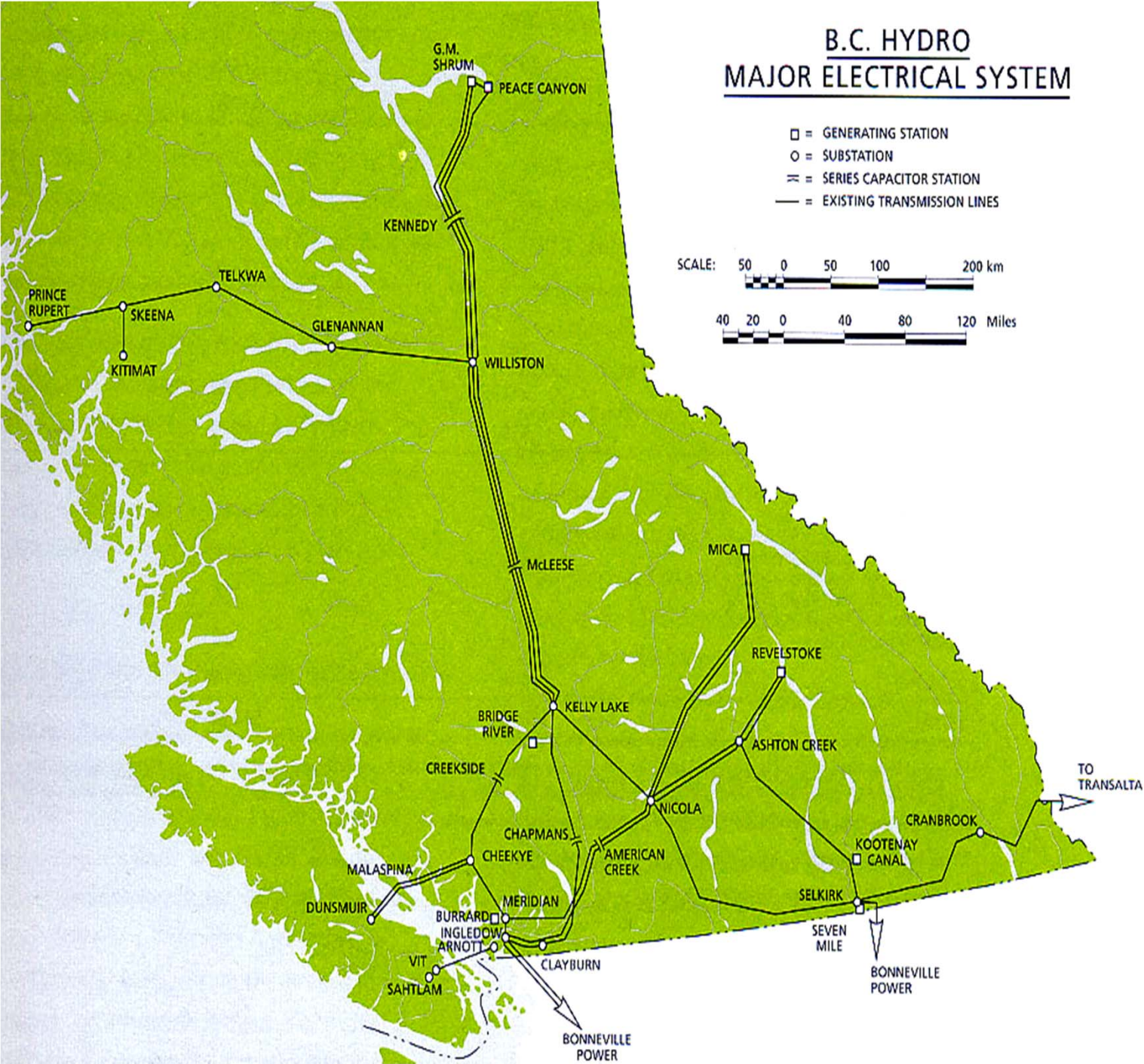
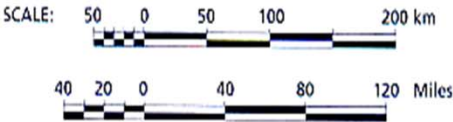
Border with Alberta runs along the Columbia River watershed boundary.





B.C. HYDRO MAJOR ELECTRICAL SYSTEM

- = GENERATING STATION
- = SUBSTATION
- ≡ = SERIES CAPACITOR STATION
- = EXISTING TRANSMISSION LINES



BC Hydro's Domestic Load

Domestic load is highest during:

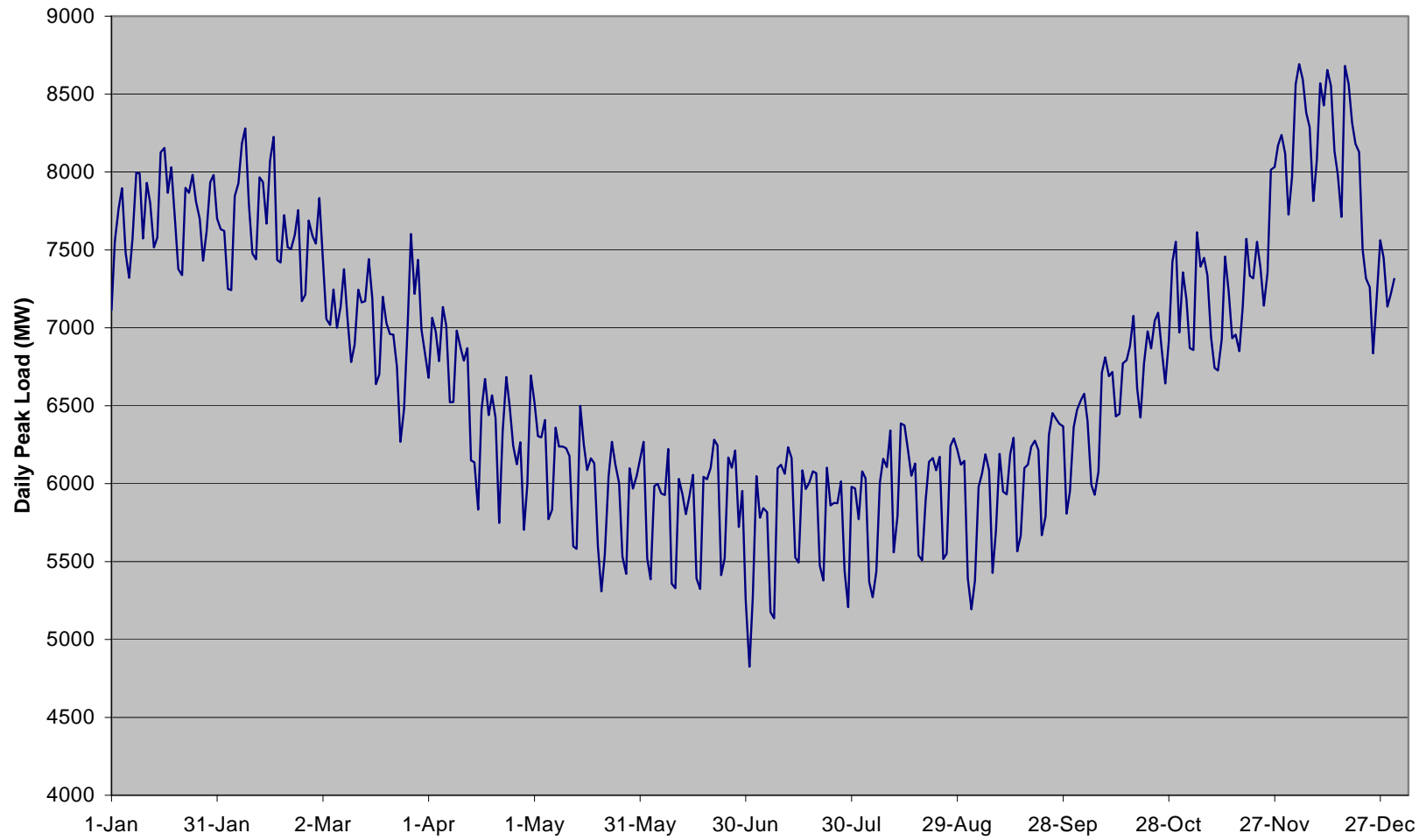
- > winter months - due to colder temperatures and shorter days (heating, lighting, and appliance loads)**
- > weekdays - due to higher industrial and commercial loads**
- > daytime and evening hours - due to higher industrial and commercial loads as well as residential loads (especially in late afternoon and evening hours)**

BC Hydro's peak load typically occurs on a very cold weekday in December or January between the hours of 5 and 6 pm (heating, lighting, electric stoves, etc.)

Remember -- At all times, supply (generation + imports) must equal demand (domestic load + exports)

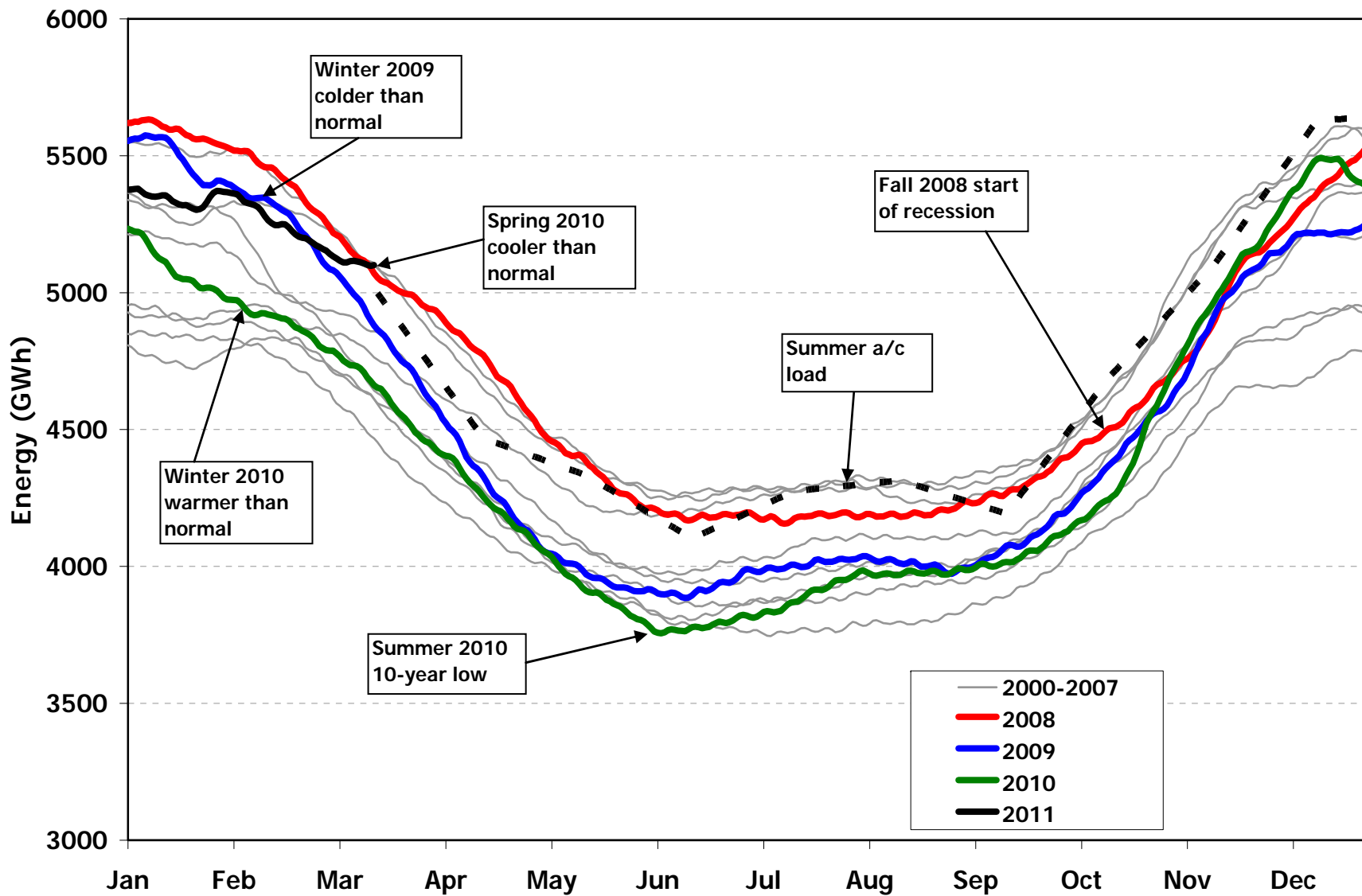
BC Hydro Domestic Load - annual pattern
- load and temperature inversely correlated

B.C.Hydro Domestic Load
Daily Peaks for Year 2001



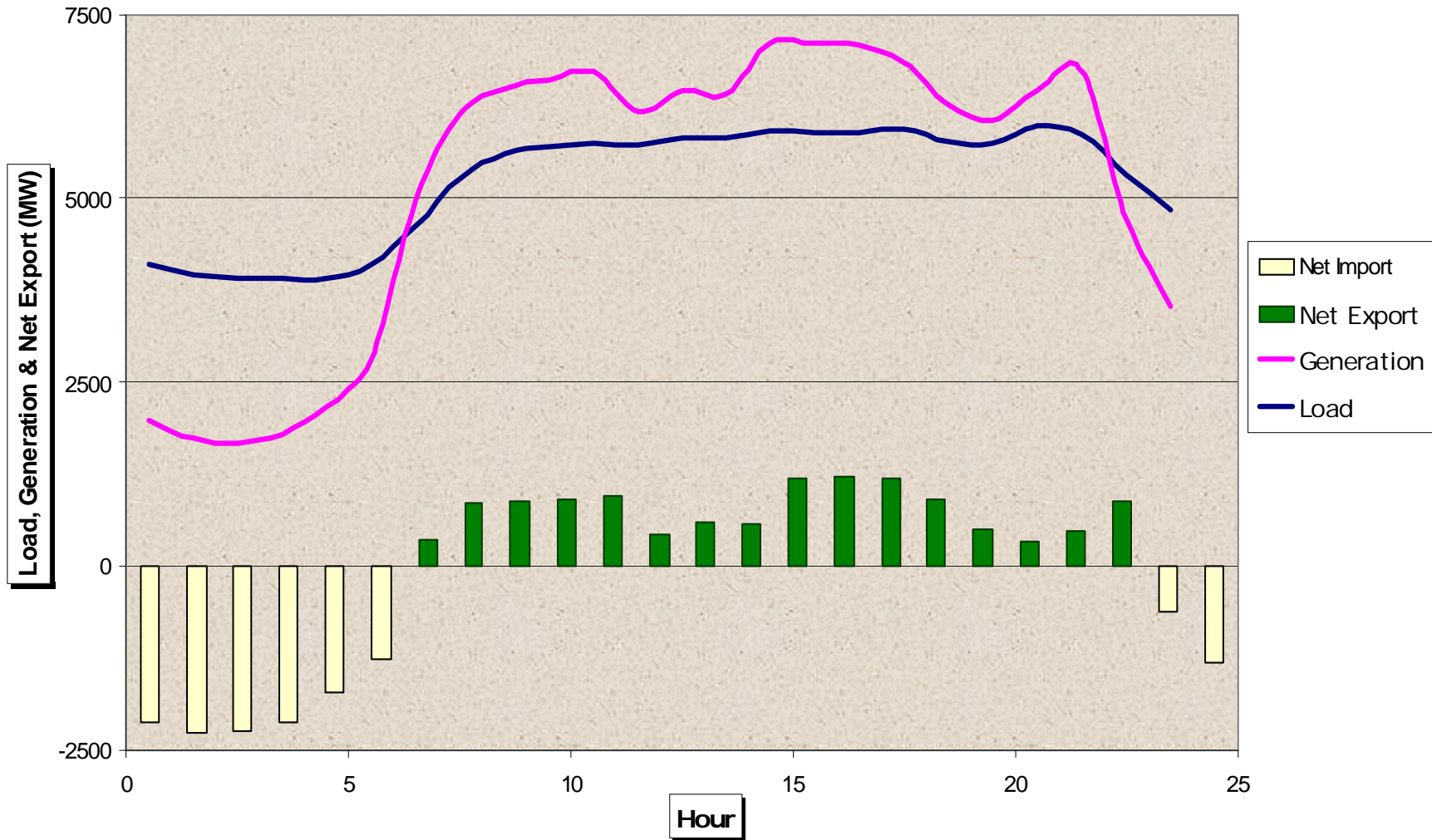
Monthly Total Load Energy

60 Day Historic Moving Average & Forecast Issued Mar 2011



BC Hydro Domestic Load, Generation, & Market Activity - typical daily pattern

BCH Load, Generation, & Net Export
for 4 Sept 2001



B.C.Hydro & Powerex - description of markets

U.S. Pacific Northwest (~ 50% hydropower)

- generation patterns dominated by Columbia R runoff patterns and operational restrictions (numerous fisheries issues) ... 11 powerplants on U.S. mainstem Columbia river plus many others on tributaries
- domestic load patterns very similar to BCH
- gas-fired generation sets the market price 75% of time

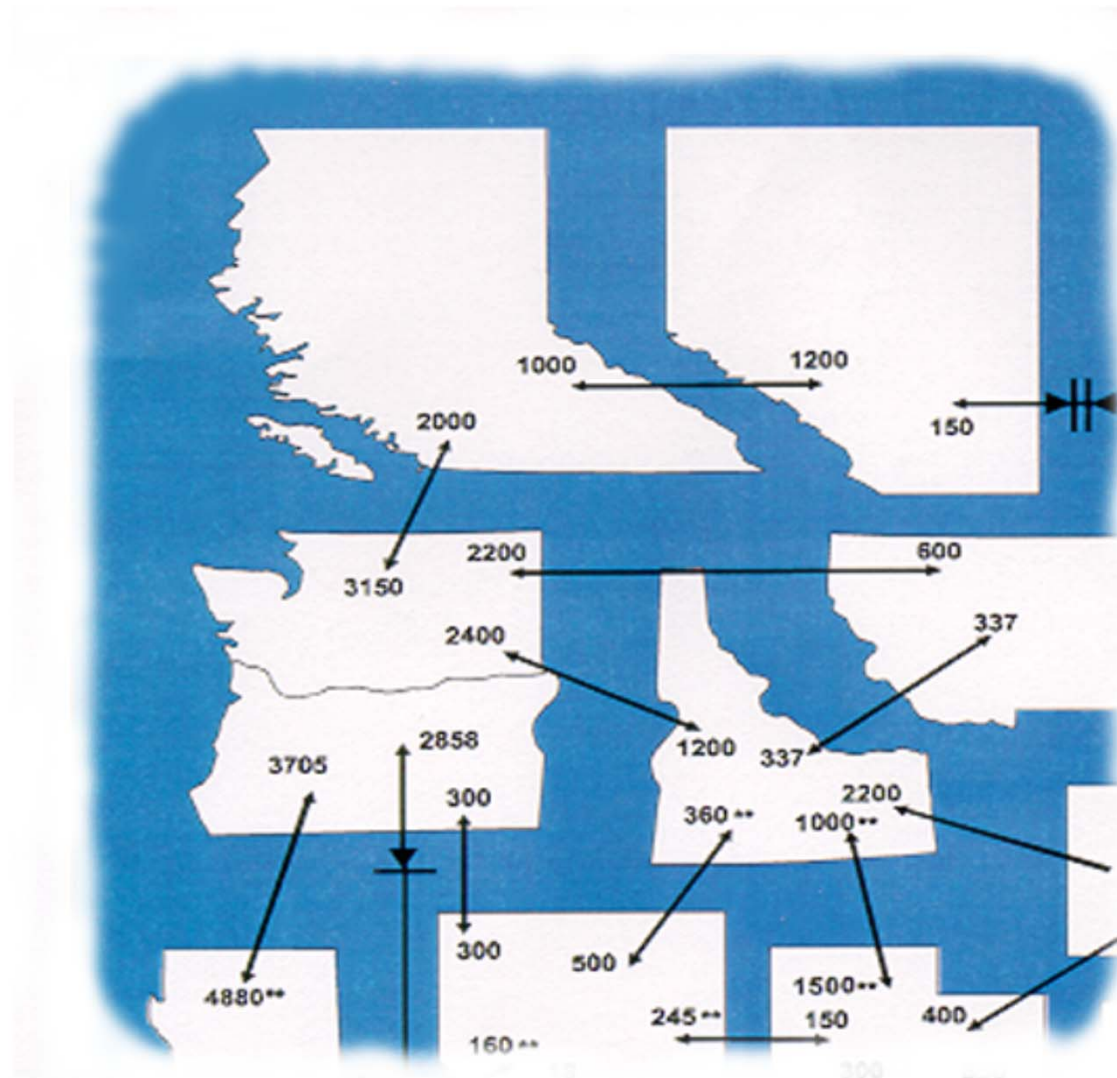
California and other U.S. Southwest

- good summer market due to air-conditioning load
- in winter, California sells energy to BCH and Northwest

Alberta

- base load is coal-fired generation
- gas-fired generation usually sets market price
- winter temperatures more extreme than in BC

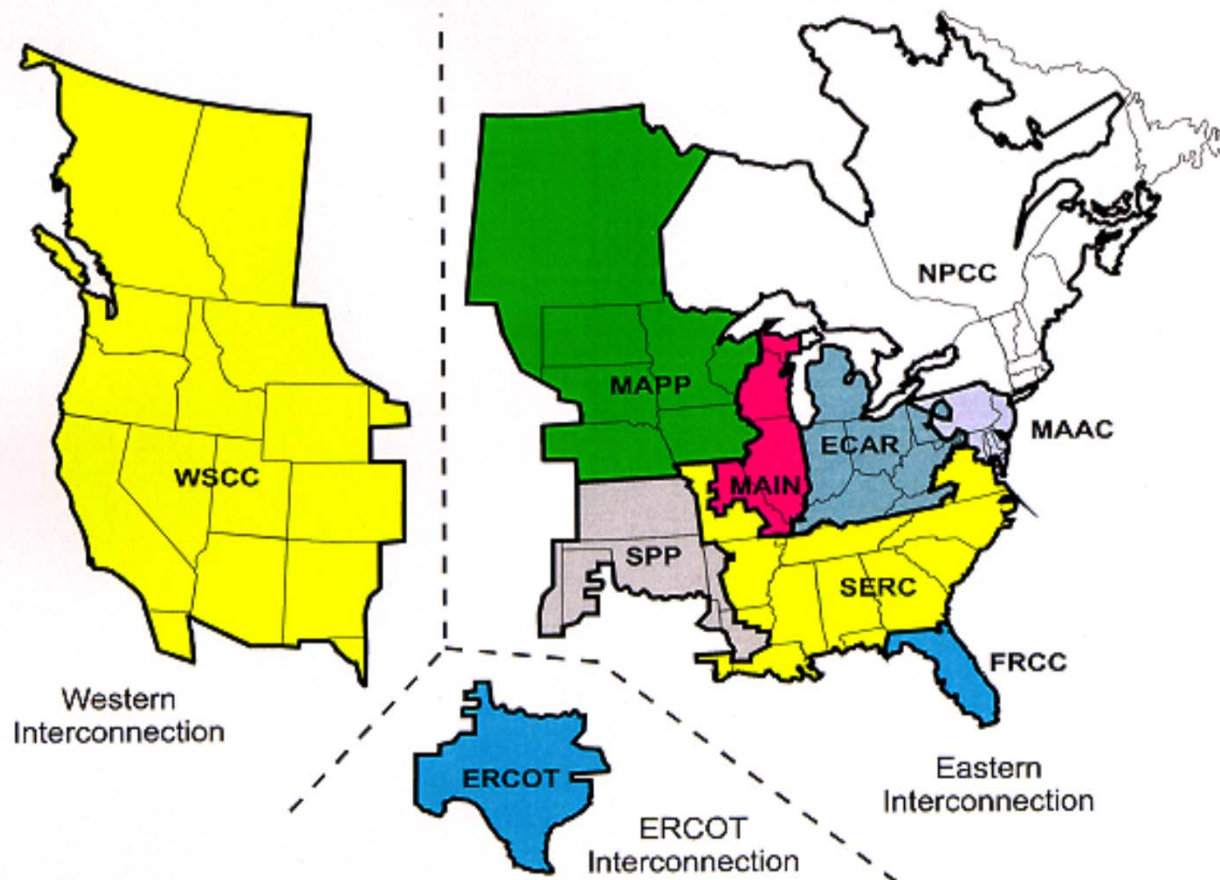
Western North America - Transmission connections



B.C.Hydro's Interconnections - Electrical Coordination

- **Western Electrical Coordination Council (WECC) and Northwest Power Pool (NWPP) formed to provide more stable electrical networks in western North America**
- **protects the reliability of the electrical grid while allowing economic trade in electricity**
- **all WECC members are required to carry "operating reserve", i.e. unloaded and reserved generating capacity that is available to help neighbouring utilities during a disturbance**
- **WECC operating reserve requirement for hydroelectric projects:
2.5 % of generation spinning +
2.5 % of generation available within 10 minutes**

North American Electrical Grid



Electricity is Unique

- **Bulk electricity is the only commodity that can not be directly stored (economically).**
- **Electricity production must exactly = aggregate load every instant, all the time!**
 - [No other commodity has this rigid requirement!]
- **Electricity users expect supply on immediate demand, at constant voltage and frequency.**
- **Failure to match load leads to system-wide frequency, voltage and stability problems.**
- **Critical need to exactly match load results in very high price volatility [the highest]!**

BC's Electric System is Unique

B.C.

- 90% Hydro (many with significant storage)
- 10% Thermal (Natural Gas)
- Low cost and flexible!

North America

- 56% Coal
- 22% Nuclear
- 10% Hydro (many with limited storage)
- 9% Natural Gas
- 3% Oil

Hydro vs Thermal Generation

Hydro Project

- High initial cost
- Low operating cost
- Energy limited and variable! [~ 10,000 GWh variation!]
- Fast starting / stopping / ramping
- No emissions
- Hydro is Flexible!

Thermal Project

- Lower initial cost
- High operating cost
- Generally not energy limited
- Slow starting / stopping / ramping
- Emissions vary with fuel and process
- Hot machinery is not!

Hourly Prices are Volatile

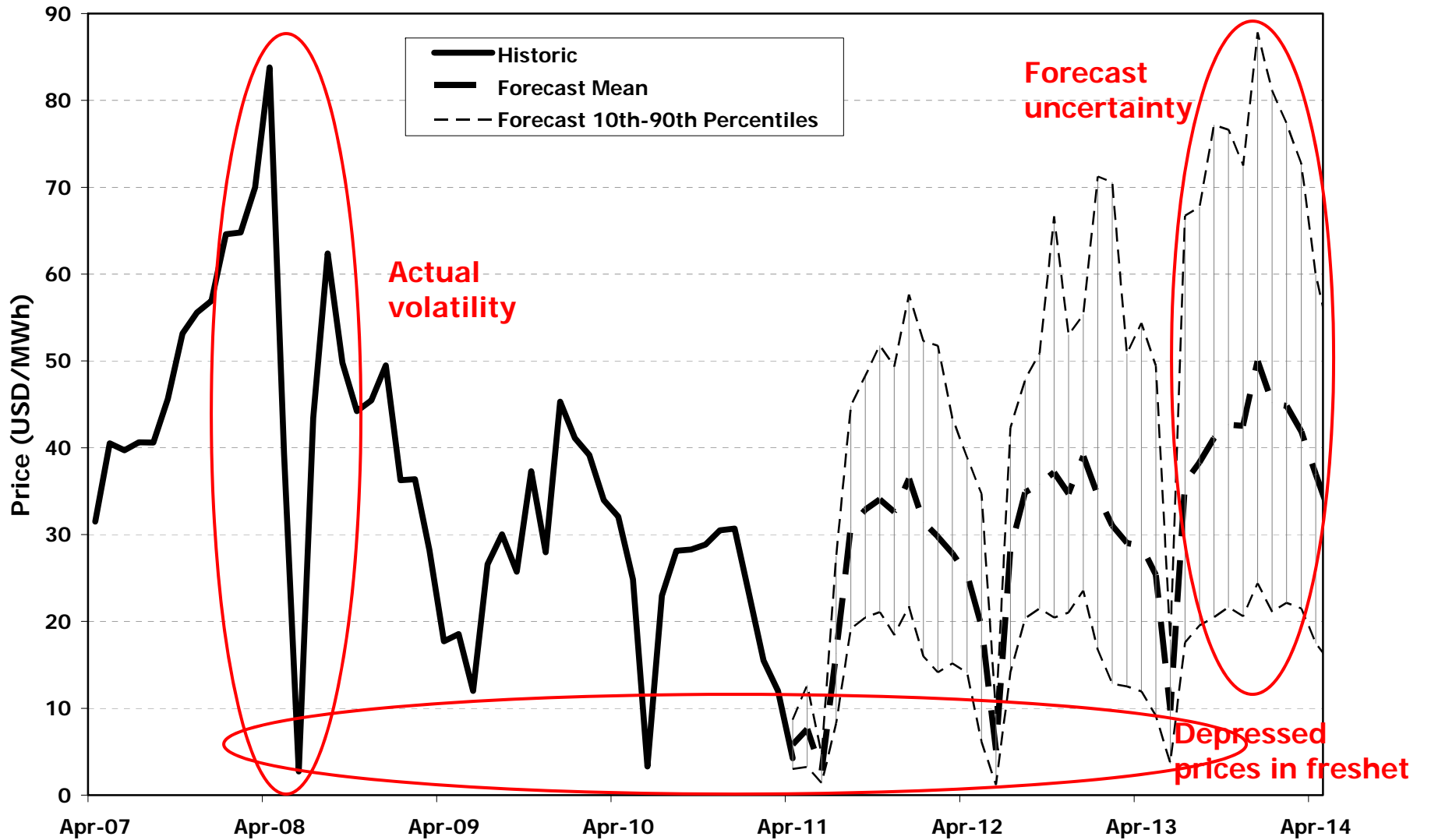
Hourly Power Pools are operating in Alberta and California (now closed):

- Generators submit hourly 'sell' bids into Pool.
- Bids for each hour are stacked from lowest to highest price.
- Hourly clearing price is determined where supply = demand.
- Clearing price is paid to all successful bidders!

Hourly prices established are highly visible and objective, but are very volatile!

Monthly Mid-C Index LLH Electricity Price - Historic and Forecast

(As of 6 April 2011)



Presentation on System
Optimization

Historical \$ Volatility: Electricity is Highest

	Standard Deviation	Min	Max	Range
Electricity (PJM)	32%	-261%	278%	539%
Henry Hub Natural Gas	4.3%	31%	21%	52%
Heating Oil	3.6%	-47%	23%	70%
Coffee	2.9%	-13%	21%	34%
WTI Crude Oil	2.6%	-17%	10%	27%
Copper	1.3%	-5%	7%	12%

Source: <http://www.gasfoundation.org/ResearchStudies/VolStudyCh2.pdf>