BC Hydro Wind Integration Project

Next Steps:

Wind Impact Studies Plan

by

Ziad Shawwash &

Alaa Abdalla

Generation Resource Management, BC Hydro

& Civil Engineering –UBC

Wind Data Study:

Stakeholder Engagement Session

Feb. 6, 2009

BC hydro

Generation Operations (GO) Impact Study

Overall Goal: Understand the potential consequences of integrating wind power in the BC Hydro power system.

Objectives:

1. Review the state-of-the-art methodologies to assess the impacts of integrating wind into power systems, in particular hydro-dominated power systems.
2. Assess the capability and the cost to integrate wind resources in the current and in the expanded BC Hydro power system.
3. Develop an understanding and assess the expected changes in current generation operations practices and processes that will be required with increasing wind penetration & different wind diversity scenarios for a range of water & wind.

Generation Operations Impact Study

To accomplish these objectives, GO study will:

1. Determine the regulation and load following ancillary service requirements and their costs for different wind penetration and diversity levels under current and alternate future system scenarios
2. Determine the unit commitment impacts and costs in the scenarios
3. Determine the effects of wind power forecasting capabilities
4. Determine generation operational bottlenecks of integrating wind power (capacity and ramping capability)
5. Investigate the impacts of wind power curtailment

Generation Operations Impact Study

System wide impacts can be categorized into the following main areas:

- **System stability:** (time scale seconds to minutes). Different wind turbine types have different control characteristics & different impacts and support for the system in normal and system fault situations. This area also include voltage management requirement, reactive reserve.

- **Regulation and load following:** (time-scale: seconds to half an hour). Addresses how the variability and uncertainty of wind power will affect the allocation and use of reserves in the system.

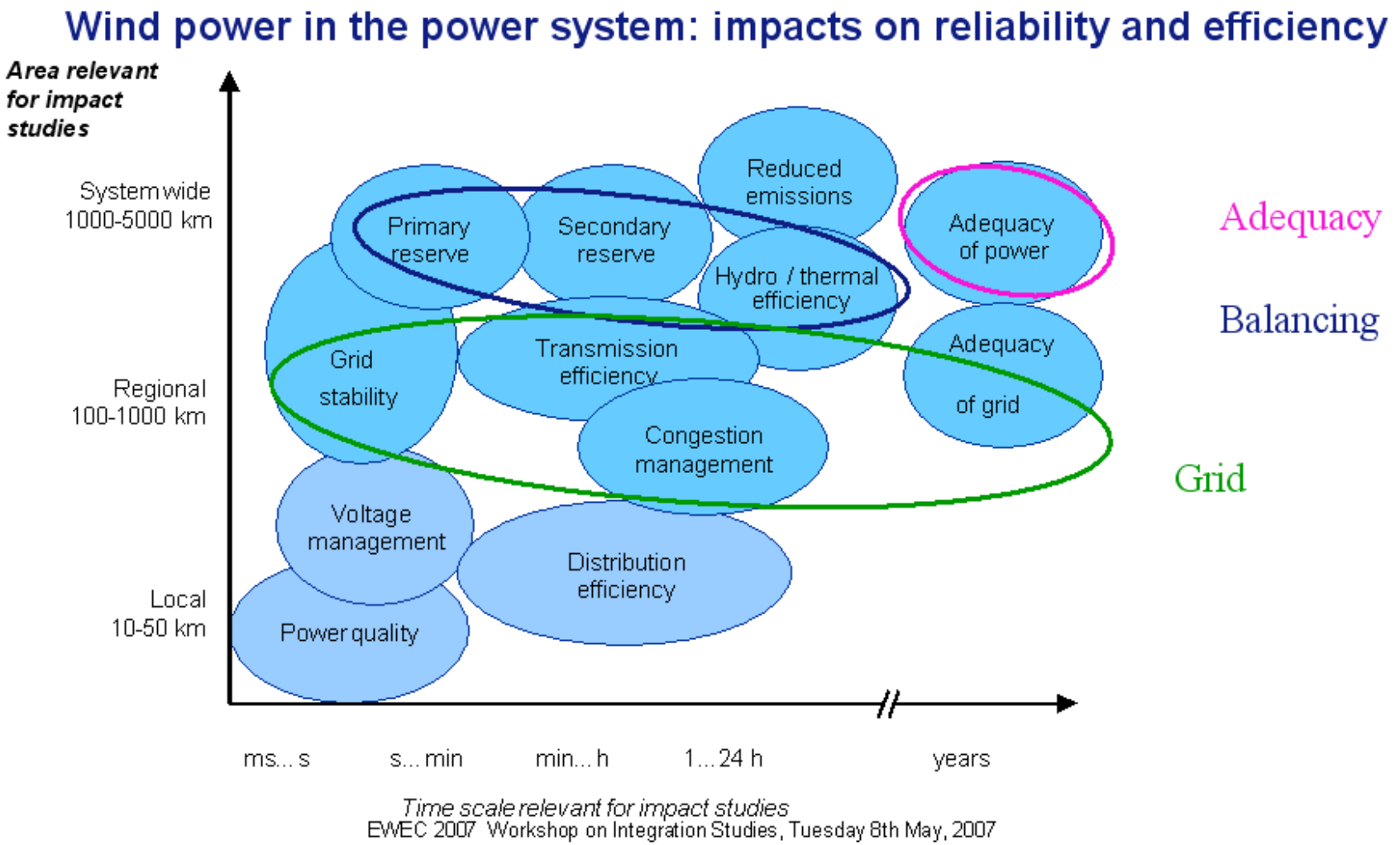
- **Efficiency and unit commitment:** (time scale: hours-days). Addresses how the production variability and forecasting errors of wind power will impact generation system efficiency and unit commitment decisions.

- **Adequacy of power generation:** (time scale: several years). This category is concerned with the total power capacity available during peak load situation. It also addresses the total energy supply of the electric system for a given area

- **Transmission adequacy and efficiency:** (time scale hours to years). Addresses the impacts of wind power on the regional transmission system, including transmission losses or benefits, depending on the location of wind power plants and the regional load, and the correlation between wind power production and load consumption.

Generation Operations Impact Study

Figure 1. Impacts of wind power on power systems. (IEA, 2007)



Generation Operations Impact Study

Söder, L. and Holttinen, H. (2008) 'On methodology for modelling wind power impact on power systems',
Int. J. Global Energy Issues, Vol. 29, Nos. 1/2, pp.181-198. **Summary of IEA WIND Task 24 Integration of Wind and Hydropower systems**

Item		1	2	3	4	5
A	Aim of study	What happens with X GWh wind	How much wind is possible			
M	Method to perform study	Add wind energy	Wind also replaces capacity	**Optimal system design**		
I	Imbalance calculation	Only wind	Wind + load	**Wind + load + production**		
B	Balancing location	Dedicated source	From the same region	**Also outside region**		
G	Grid limit on transmission	No limits	Constant MW limits	Consider voltage	N-1 criteria	**Dynamic simulation**
U	Uncertainty treatment	**Transmission margins**	**Hydro inflow uncertainty**	Wind forecasts: U3: none U4: persistence **U5: best possible**	**U6: load forecasts considered**	**U7: thermal power outages considered**
H	Hydropower modeling	**Head height considered**	**Hydrological coupling included**	**Hydrological restrictions included**	**Availability of water considered**	
T	Thermal power modeling	**Ramp rates considered**	**Start/stop costs considered**	**Efficiency variation considered**	**Heat production considered**	
W	Wind power modeling	Few wind speed time series	Many wind power time series	**Time series smoothing considered**	**Allow controllable wind power**	
S	Simulation model of operation	Deterministic simulation, one case	Deterministic simulation several cases	**Stochastic simulation several cases**		
R	Resolution of time	Day/week	Hour	**Minute/sec**		
P	Pricing method	Costs of fuels, etc.	Prices for trading with neighbours	Market actor simulation	**Market dynamics included**	
D	Design of remaining system	Constant remaining system	**Optimised remaining production**	**Optimised remaining transmission**	**Perfect trading rules**	
MAGENTA BOLD		= Söder and Holttinen's recommendation			BC Hydro's approach	

Generation Operations Impact Study: Modeling Methodology

Short – Term Operations

Incremental regulation & load following reserves, ramp up/ down

Short term system operations and the cost/ lost opportunity of ancillary services and wind forecasting errors

Mid-Long Term Operations

Wind energy infusions, seasonal & mid-term energy shifts and impacts on energy and capacity

AGC Optimizer	STOM	GOM & HYSIM
Sec – Min	Hour –Day – Week	Month - Years
Time Horizon		

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.

Generation Operations Impact Study

The main deliverables of the study will include:

1. A detailed description of the hydro generating system and the transmission system and the main assumptions used in the study.
2. Assessment of wind resources on regulating and capacity reserves.
3. Assessment of the impacts of wind energy ramp rates on the system.
4. Detailed models' outputs and analysis of the results.
5. The unit cost of integrating wind energy into the BC Hydro system.
6. Wind penetration bottleneck and limits.
7. Assessment of potential wind development limits that could arise from the bottlenecks identified above.
8. Assessment of the main changes to existing hydro scheduling and operation planning approach that will be required to integrate wind into the BC Hydro system.
9. The incremental impacts of increasing wind development scenarios on the integrated BC system generation operations.