

An Assessment of Electricity System Reliability in an Evolving World

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Agenda

- This presentation will discuss:
 1. Reliability standards historically
 2. Shifts in the electricity industry
 3. Impact of these shifts on reliability, and price stability
 4. An example from Ontario's electricity market
 5. Opportunities for pumped-storage generation

Reliability Historically

- Historically, electricity systems were designed for large thermal and hydroelectric generators
- Focus on the cheapest sources of electricity and capability to transmit power to load centres
- Reliability standards considered two aspects:
 1. Adequacy – can system resources meet demand?
 2. Security – can the system withstand contingencies?

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Shifts in the Electricity Industry

- Major shifts in the last decade include:
 1. Demand for sustainable energy
 2. Privatisation and introduction of markets
 3. Regional integration of electricity systems
- Each shift impacts the operation and planning of a reliable electricity system

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Sustainable Energy

- Environmental awareness, particularly for climate change, is driving demand for sustainable energy resources
- Wind and solar are non-dispatchable resources unlike traditional thermal and hydroelectric generation
- Key considerations:
 - At what level of development do non-dispatchable resources become an adequacy or security concern?
 - Who bears the cost of meeting adequacy and security requirements created by non-dispatchable resources?

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Privatisation and Markets

- Several jurisdictions have privatised utility monopolies
 - E.g., Ontario, Alberta, England, numerous U.S. States
- Purpose was to encourage private investment and improve investment efficiency
- However, there is less control over the electricity system and there have been instances of market manipulation
 - E.g., California and Enron
- Key Considerations:
 - Are there mechanisms to improve the operation of the market?
 - Should there be publicly held resources to create price stability?

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Regional Integration

- Historically, most jurisdictions use imports and exports for economic reasons, not for meeting system adequacy
- Two drivers toward regional integration and dependence:
 1. Price differential between neighbouring markets
 2. Demand for sustainable energy
- Key Consideration:
 - Are there reliability concerns associated with regional integration?

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Example: Ontario's Market

- Ontario's electricity system has undergone many of these shifts:
 - Sustainable energy: *Green Energy and Green Economy Act* (2009)
 - Privatisation and introduction of markets: *Electricity Act* (1998)
 - Regional integration: expanding interconnections with neighbours
 - A new HVDC back-to-back intertie with Hydro Quebec
 - Installation of phase shifters to control flows with Michigan

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Opportunities for Pumped-Storage

- Pumped-storage generation could be developed to take advantage of several opportunities:
 1. Price differential between on-peak and off-peak
 2. Provide price stability during major contingencies
 3. Providing black start power in the event of major blackouts
- Consider each opportunity in the context of Ontario

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Price Differentials

- Traditional application of pumped-storage generation to arbitrage between times of high and low energy prices
- Ontario presents opportunity obtain more value from surplus baseload generation
- In the first half of 2009, Ontario's electricity price was negative almost 7% of the time
 - Primary driver is the drop in demand from the recent recession
 - Secondary driver is increase in non-dispatchable resources such as wind generation

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Price Stability

- Pumped-storage generation could be used to provide price stability in response to contingency
- Short-lived energy shortages resulting from outages could be mitigated by pumped-storage generation
- Questions:
 - What is the value of price stability in response to contingencies?
 - How would pumped-storage generation need to be operated to promote price stability?
- Consider the example of Ontario's electricity market on February 18, 2009

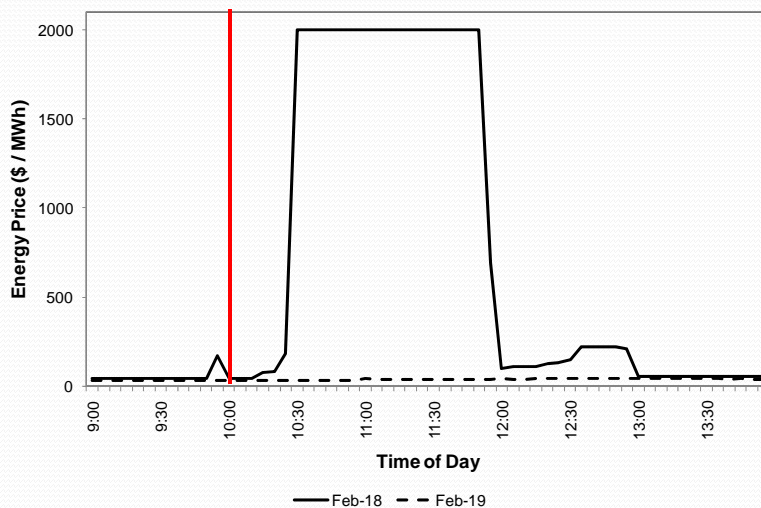
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February 18, 2009 Price Spike

- At 9:59am on February 18, 2009, a breaker outage forced a major 500 kV line out of service
- This caused 1,350 MW at Bruce Nuclear Generation Station to be forced offline
 - This was about 7% of Ontario's load at the time
- Operators re-dispatched the system to replace constrained generation
- System security was maintained, but were prices stable?

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February 18, 2009 Price Spike (2)



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Providing Price Stability

- Ontario's energy market on February 18, 2009 between 9:00 and 13:00 was valued at over \$66 million
 - The same period on February 19, 2009 was under \$3 million
- Pumped-storage generation could be used to provide replacement power to mitigate market response
 - This could have greatly reduced the cost to consumers
- No mechanisms are available in Ontario to allow for the operation of pumped-storage generation in this way

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Black Start Power

- Black start power was an issue after the 2003 blackout that affected 55 million people in Ontario and eight states
- There were difficulties re-energizing the electricity system to restart and synchronize large generators
- Black start power was provided from hydroelectric units
- Pumped-storage could be used to provide black start power and other ancillary services

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Conclusion

- Shifts in the electricity industry have created new considerations for reliability and price stability
- The versatility of pumped-storage generation provides unique opportunities to benefit electricity consumers
- Further study of pumped-storage generation's value in providing these services to consumers is needed



Sir Adam Beck Pumped Generation Station Reservoir (Source: OPG)

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