Brookfield Renewable

Transitioning to the 21st Century Electricity Grid

May 4, 2017
ONE OF THE LARGEST PUBLIC PURE-PLAY RENEWABLE BUSINESSES IN THE WORLD

100 YEARS OF EXPERIENCE IN POWER GENERATION

FULL OPERATING, DEVELOPMENT AND POWER MARKETING CAPABILITIES

OVER 2,000 OPERATING EMPLOYEES

TOTAL ASSETS

$28B

260 power generating facilities

MW OF CAPACITY

10,700

15 markets in 7 countries

HYDROELECTRIC GENERATION

88%

Located on 82 river systems
Brookfield Renewable  

**The Role of Hydropower in a 21st Century Grid**

It is increasingly clear there is a growing need for power market reform and longer-term thinking on how to meet environmental objectives.

Hydropower is emblematic of these issues:

- Hydropower is a valuable non-emitting resource that provides unique market services, and is becoming more important on the system as the grid evolves toward more distributed and intermittent technologies.
  - 1/5 of nation’s carbon-free electricity, preventing more than 150 million tons of CO2 emissions per year
  - More than 60 GW of incremental hydro potential, including 12 GW from unpowered existing dams alone
  - Dispatchable resource providing valuable market services, generally unique among non-emitting generation sources.

- However, hydro’s value is often unrecognized:
  - In electricity markets, particularly ancillary services related to the flexibility of the resource;
  - In environmental markets, which value new renewable generation but ignore the contributions of existing non-emitting generation.

- This lack of recognition impairs the ability of hydropower to be maintained and optimized to provide a foundation for the 21st Century Grid.

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**Carbon-Free Power Generation in US (2014)**

- **Nuclear**: 63%
- **Hydropower**: 20%
- **Wind**: 14%
- **Solar**: 2%
- **Geothermal**: 1%

83% of existing non-emitting generation is from nuclear and hydropower. This base must be both maintained and modernized for the 21st Century grid.
The power sector is evolving significantly as a result of renewable and low-carbon policies, placing ever increasing demand on non-emitting generation.

Most emissions-related programs in the power sector, like RPS programs, discriminate on technology, vintage, and geography. This makes the achievement of longer-term carbon targets more difficult and more costly over time.

Environmental objectives have been decided inconsistently at the state level through RPS programs, a trend that is increasing.

State actions on greenhouse gas emissions have been increasing, including ever more aggressive targets for Northeast and West Coast.

Electrical sector targets are underpinned by aggressive binding economy-wide GHG targets.
Power markets are designed to meet reliability objectives on a least cost basis. But technological advances, changing consumer behaviours, and environmental policies are driving unprecedented transformation of the grid.

States performing actions outside of the market to meet policy goals can lead to higher cost to consumer and create inadvertent consequences where new non-emitting generation is displacing existing non-emitting generation.

Integration between public policy and markets will allow ISOs to have a comprehensive approach how to meet public policy and reliability on a least cost basis.

Rapid technological change on distributed generation, demand response and the potential for electrification is shifting power markets.

Congress has recognized that the grid must be equipped for 21st century challenges and is reviewing the Federal Power Act.

Should RTOs be required to implement market-based solutions for environmental goals set by policy-makers?

Source: The Economist, ABB
Evolving Landscape: Non-Emitting Baseload Generation

- As power markets evolve, wholesale markets are not sending appropriate price signals reflecting the value of existing non-emitting generation, which offers flexible and reliable baseload generation that complements intermittent resources.
- Existing baseload generation is crucial to meet affordability, reliability and state policy objectives.
- Many of the same challenges plague the nuclear industry, threatening the viability of reactors and potentially impairing reliability and the availability of non-emitting baseload generation.

Power markets are not designed to support customers’ and policymakers’ preferences for clean, reliable and flexible electricity generation.

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Customer & Policymaker Preference:
- Nuclear Plants, Announced Closures
  - Kewaunee (556 MW)
  - Oyster Creek (625 MW)
  - Crystal River (860 MW)
  - Diablo Canyon (2,240 MW)
  - San Onofre (2,150 MW)
  - Vermont Yankee (620 MW)
  - Fort Calhoun (476 MW)
  - Clinton (1,069 MW)
  - Pilgrim (688 MW)
  - Quad Cities (1,871 MW)
  - FitzPatrick (838 MW)

New York has intervened to prevent the closure of the FitzPatrick plant through its Clean Energy Standard.

Eleven nuclear reactors have either shut down or announced their plans to shut down in the coming years.
PILLARS OF SUCCESS FOR THE 21ST CENTURY POWER GRID:

State Action will Continue
- State procurement policies where needed
- Continue to build on RPS successes.
- Don’t delay
- Don’t restrict eligibility unnecessarily

Valuing Baseload Generation
- Broader recognition of non-emitting attributes
- Existing and new resources on level playing field

Power Market Reform
- Reconcile state policy and reliability objectives
- Leverage FERC authorities

Capitalize on Information
- Enable wholesale markets to provide better real-time information
- Empower customers via direct market signals
THANK YOU