Reliability Considerations Associated with Envisioning a Low-Carbon 2050

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NYSRC Reliability Concerns Related to Low Carbon 2050 Plan

- Availability of intermittent resources to serve NYCA load
- Operating characteristics of intermittent resources
- Installed capacity requirement considerations
- Impact on planning design requirements
- Impacts of increased load
- Siting of new generation and transmission
- Transition period

New York State Reliability Council

- Launched in May 1999 and approved by FERC as part of the comprehensive restructuring of the competitive wholesale electric market in NY
- The mission of the NYSRC is to promote and preserve the reliability of the New York State power system
- Assist in the maintenance of system reliability through promulgation of reliability standards and monitoring of compliance, and establishment of NYCA installed capacity requirements
- Governed by Executive Committee and three primary sub committees

	NYSRC	NYISO
Primary Responsibility	Assist in maintenance of system reliability through promulgation of reliability standards and monitoring of compliance.	Reliable operation of power system and administration of market
Role in ensuring Reliability	Set reliability standards	Under terms of NYSRC/NYISO agreement Responsible for its compliance and compliance of market participants with NYSRC reliability standards

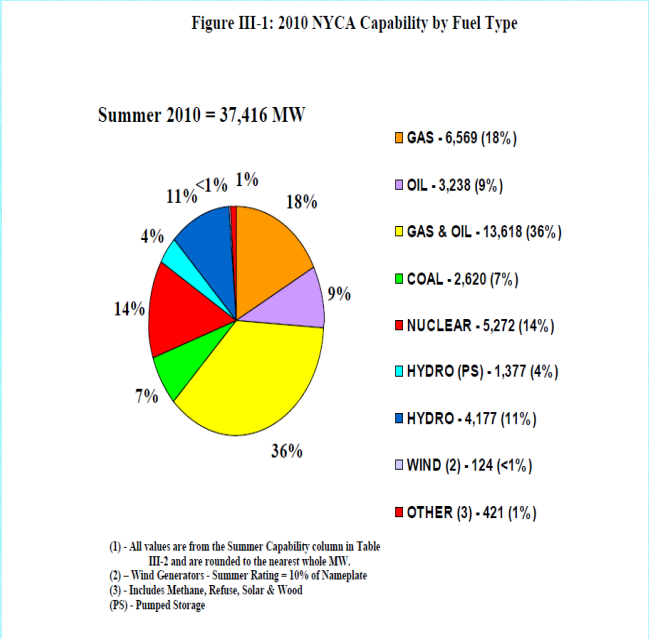
Low Carbon 2050 has potentially broad implications for reliability and design of the Electric Power System

Quotes from 3/31/10 draft "Envisioning a Lower Carbon 2050 for NYS" & Sector Vision:

- "Transforming an entire economy from largely carbon-based energy sources to carbon neutral source in a scant 40 years will be a true revolution"
- "Broad shift from reliance on burning fossil fuels to low carbon energy "
- "All strategies call for the phase-out of fossil fuel generation that free vents carbon to the atmosphere"
- "Transportation and buildings will have to move away from reliance on combustion of fossil fuels"
- "Electrification is an essential strategy"
- "Patterns of Energy Use will need to change"
- "Stranded capital investment"
- "increase the percentage of the state's electricity generated by near zero carbon sources from 38% to 70% by 2030"

Change to Low Carbon Energy Sources Will Have Unprecedented Impact on NY Generation Mix

- New York's current generation base is primarily conventional fossil and nuclear generation, or non-intermittent renewable resources whose output is relatively predictable (e.g. very large hydro)
  - Fossil fueled generation presently represents 70% of capacity in NYS
  - Less than 3% from intermittent renewable (e.g. wind and solar)
- Could lead to a ten fold increase in additional intermittent resources and significant increase in number of relatively large plants including Nuclear and Carbon Capture &Storage (CCS) units



NYCA Capacity Resources

Availability of Intermittent Renewable Resources to Serve NYCA Load

- NYCA system peaks occur during July/August during hot afternoons or early evenings
- Peak wind availability does not correlate with electrical system peak
- Peak sun availability does not correlate with electrical system peak
- In both cases, the availability of these intermittent resources is not dependable when it is necessary to produce electricity at the time of electrical system peak
- Therefore, conventional generation will still be required to back up renewable resources to maintain system reliability

Intermittent resources add uncertainty to Operations

- Significant amounts of intermittent/non-dispatchable generation (scenarios modeled up to 40%) will impact the operating characteristics of NYCA electricity system and potentially system reliability
- Additional system regulation (spinning reserve) due to short term fluctuation in wind generation or passing clouds with photovoltaic is required (e.g. instantaneous PV power output can change by up to 100 percent due to significant weather changes)
- Need for regulation relates to the relatively rapid short term adjustments needed to manage changes in output of intermittent resources to satisfy demand
- Fluctuations add additional uncertainty to system operation

Operational impact of Intermittent resources (cont.)

- Intermittent generation requires output of fossil fuel-plant (or equivalent) to be adjusted more frequently, to cope with fluctuations in output
- Fast ramping power stations will need to be operated below their maximum output to facilitate this, and extra system balancing reserves will be needed
  - Efficiency and unit stability may be compromised since generation is best when operated continuously
  - Nuclear/CCS have relatively slow ramp rates and likely unsuitable for this mode of operation
- Potential need to reduce transmission tie line loadings to leave margin for fluctuations in intermittent resource generating levels. This may significantly reduce practical transfer capabilities thus impacting reliability

Operational Impact of Intermittent Resources – Other Reliability Considerations

- At high penetrations intermittent/non-dispachable energy may need to be ‘dumped' because the electricity system cannot always make use of it.
- Voltage Regulation – Voltage sags from intermittent output and response to momentary voltages dips associated with faults needs to be considered
- Restoration practices including islanding management
- The exact point at which the integration of intermittent generation such as wind unacceptably impacts NYCA system reliability is unclear but studies of other systems suggest 20% level may be very challenging

Impact on Installed Capacity Requirements

- The system installed reserve margin needed to achieve a desired level of reliability depends on many complex factors
- Intermittent generation introduces new factors into the calculations and adds greater uncertainty in the extent to which we can be confident that sufficient generation will be available to meet peak demands
  - Increases the size of the system margin required to maintain a given level of reliability. This is because the variability in output of intermittent generators means they are less likely to be generating at full power at times of peak demand. This limits contribution that intermittent generation can make to reliability
  - e.g terrestrial wind has about 10% availability at time of system peak
  - Can combine with energy storage – but increased cost
- The smaller the reliability contribution, the more capacity needed to maintain reliability, hence the larger the system reserve margin

Installed Reserve Margin (IRM) : Annual Statewide installed capacity requirement established by NYSRC to ensure resource adequacy in NYCA.

Impact on Installed Capacity Requirements (cont.)

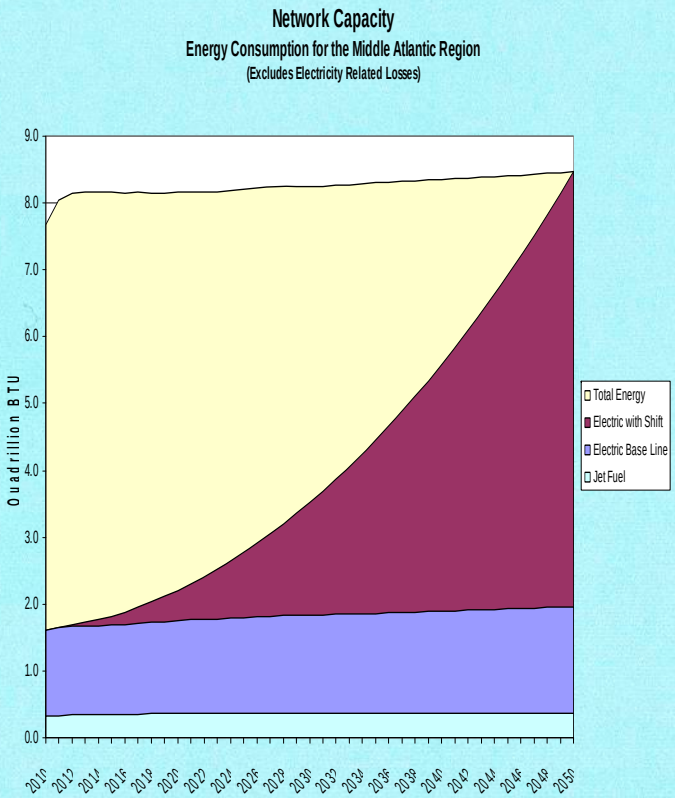
- Past IRM studies have shown about 1250 MW of wind – about 4% - increased Statewide IRM by nearly 4% (from about 14% to 18%)
- Integration of large, remotely located, nuclear & CCS plants in place of smaller fossil units will also influence reliability due to less diversity and greater impact of forced outages on the electric system
- May also impact Local Capacity Requirements
- Change in composition of resource mix to more larger units and intermittent sources adds significant risk and uncertainty that all demands can be met at all times

System Planning Requirements for Renewable & Low Carbon Resources

- Voltage Regulation/Reactive Power Management – Some technologies require added compensation (i.e. residential PV no reactive contribution)
- Recognition that climate change initiatives that involve distribution system applications, in aggregate, can impact bulk power system reliability
- System Stability – Design challenges integrating large scale low carbon resources from remote locations
- Significant penetrations may not be feasible or only be feasible given large/costly design changes to composition of electricity networks.

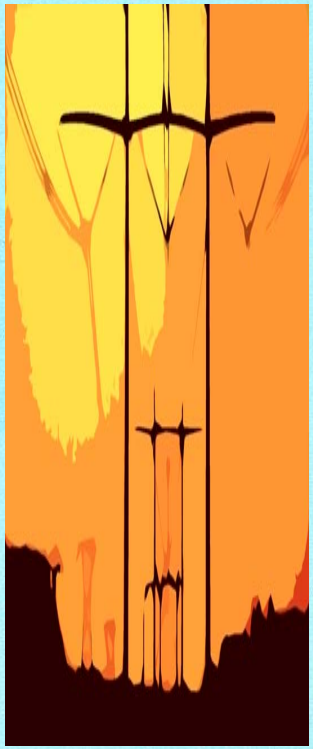
Impact of Increased Electric Loads

- Increased demands associated with electrifying the economy (heat and transportation) places great burden on T&D system while increasing its importance to society
- New requirements will alter load shape (spiked peak usage when everyone comes home and charges vehicles, need to stagger)
- Reduced security - If everything electrified (heat & transportation) the energy sources which the economy and society depend upon become less diversified and more vulnerable to natural (solar magnetic disturbance's)/ storm) or man-made (human error/terrorism) interruptions



Siting of New Generation & Transmission

- Transmission
  - New sources of low carbon energy likely from locations remote to load center (e.g. wind/nuclear or regional solutions) suggest increased reliance on transmission
  - Limited rights-of-way for new T&D expansion plus increased public activism make siting increasingly difficult
  - Long lead time to site, obtain approvals & build - could require decades to implement
  - Implication of study is need to “supersize” present T&D investment plans to accommodate future electrification of economy and potential increased load
- Generation
  - Current resources generally located to effectively satisfy reliability requirements (e.g. Locational Capacity Requirement, reactive requirements, etc.). May not be true with new resources
  - Nuclear and CCS siting and construction is vital as is siting issues associated with renewable resources



Transition Period

- Reliability concerns:
  - How do we identify 2050 needs required to meet Low Carbon 2050 goals consistent with system reliability as we transition to a new resource mix?
  - How do we coordinate the development of system wide intermittent resources and new transmission in the deregulated NYISO market place?
  - How do we incentivize private/public investment to support new generation, new transmission, gas infrastructure, etc. for today's electric system reliability needs given potential for stranded assets in the future?
  - How to phase-out 35% of existing generation by 2030 - or 70% by 2050 - to reliably achieve 2050 without fossil fueled resources?

NYSRC Recommendations

- Suggests Climate Action Council
  - Take into account potential reliability considerations when making recommendations
  - Consider attributes of constituent technologies such as their availability and impact on reliability
  - Make recommendations flexible to accommodate changes as we learn more about the impacts on reliability from research and implementation and to provide for the ability to make revisions to the Plan if necessary to protect electric system reliability
  - As the State goes forward to implement the Plan, it consult regularly with the NYISO and the NYSRC in order to monitor the impacts of the Plan on electric system reliability and the competitive wholesale market
  - Continue to monitor relevant studies to provide reliability insights