New York ISO
Independent System Operator

Price Formation in New York Markets

Preserving reliability and investment signals in New York

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Future Power Markets Forum:

Discussion on “Going Negative: Price Pattern Estimates with High Penetration Renewables.”

March 15, 2022

Public Policy and the Changing Resource Mix

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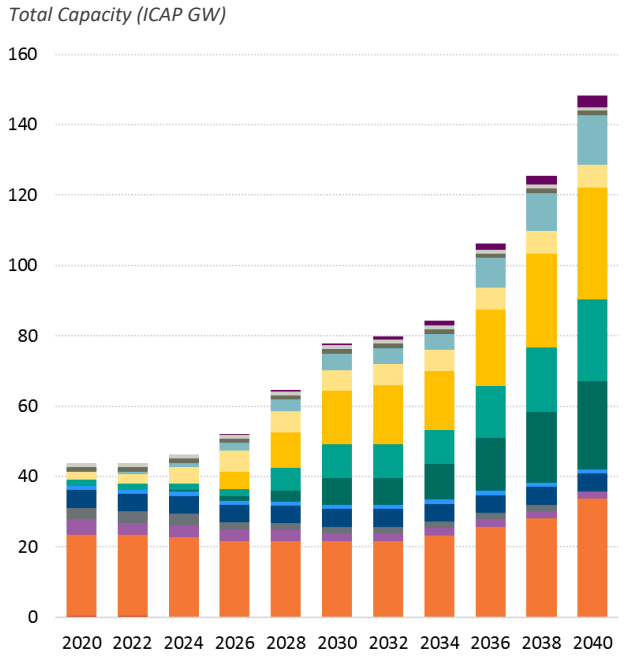
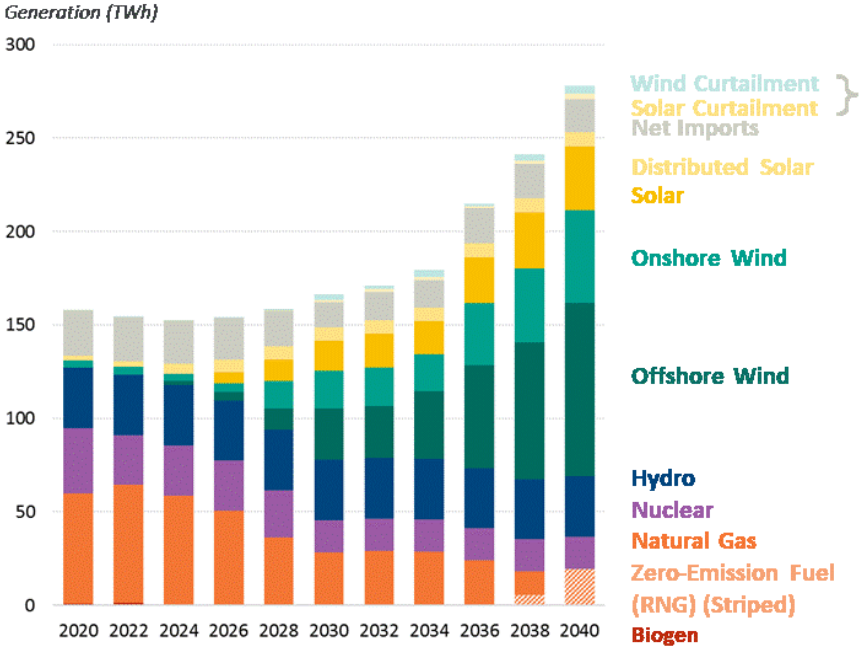
Capacity & Energy Projections with High Electrification





Source: Grid In Transition Modeling (June 2020)

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Price Formation

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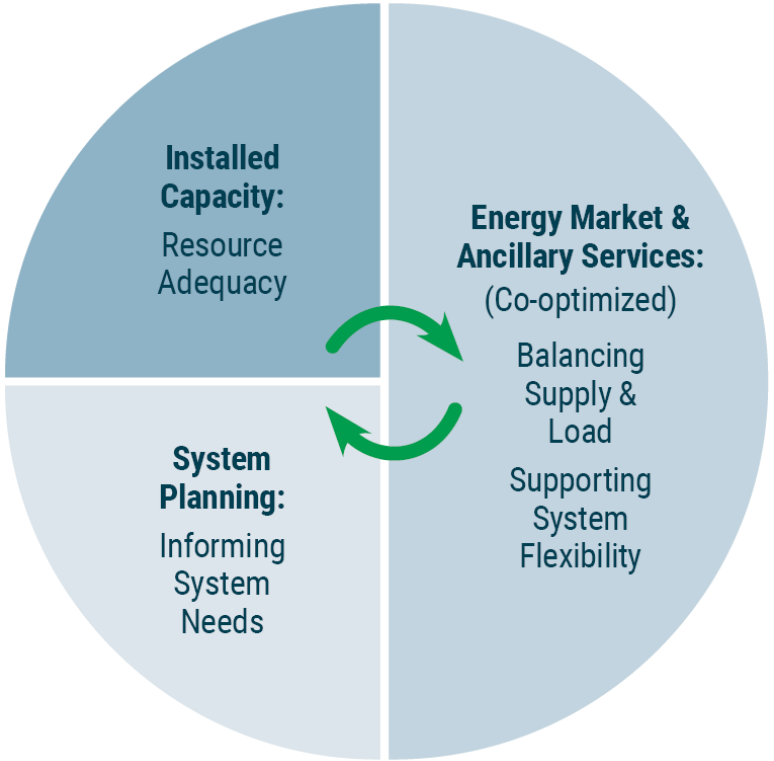
Reliability through Markets

- **The NYISO supports reliability through three complementary markets for energy, ancillary services, and capacity.**
  - Capacity Markets provide fixed cost recovery supporting a installed resource base needed to support the 1 in 10 Loss of Load Expectation Planning Criterion
  - Energy and Ancillary Markets incent real time resource performance corresponding to operational needs.
  - Though energy and ancillary services markets provide infra-marginal revenues for fixed cost recovery, the volatility of energy and ancillary service markets is not as effective in attracting and retaining needed generating resources compared to the capacity market.
  - The complementary nature of the energy, ancillary services and capacity markets allow for stable investment signals and real time system performance.



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Price Formation as the system transitions to a zero-carbon future

- **Energy Markets, the marginal resource is either**
  - Zero variable cost renewable resource, or
  - High cost zero carbon fuel (e.g., hydrogen), or
  - Price responsive demand, or
  - Opportunity cost offered by storage resources.

  (Expected to result in increased volatility of real-time prices)

- **Ancillary Services become increasingly important for price formation**
  - Set by defining granular areas for procurement of reserves and regulation
  - Guided by demand curves (anchored by value of lost load – VOLL)
  - The definition of granular areas and quantity of resources to be procured likely to be defined dynamically

  (Volatility of intermittent resources and the co-optimization with energy also increases price volatility)

- **Capacity Markets provides fixed cost recovery (net of energy and ancillary services revenues and subsidies)**
  - Capacity accreditation – important to value resources based on marginal contribution to reliability
  - Granular capacity zones allow for locational capacity prices

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Capacity Markets – the importance of accreditation

- **Accreditation – valuing resources according to their contribution to reliability**
  - 2-hour storage is worth less than 4-hour storage is worth less than 6-hour storage
  - Offshore wind is worth more than on-shore wind
  - Solar in summer is worth more than solar in winter
- **Accreditation values change with resource penetration levels (therefore the need to update accreditation values periodically)**
  - 4-hour storage currently valued at 90% expected to drop to approximately 65% when re-evaluated in 2023
  - Solar resources valued at approximately 40% in the summer period may drop to 0% if increased penetration of solar pushes the peak load period to after sunset
- **Marginal Accreditation values provides investment signals to reduce consumer costs**
  - Marginal accreditation values resources based on the reliability contribution of the next MW addition of that resource
  - As penetration of a particular resource increases marginal accreditation values may drop prompting investments to shift to a more valuable resource
  - E.g., if marginal accreditation value of off-shore wind drops, investments in storage options may become more attractive. Leads to efficient investment signals and reduced consumer costs.

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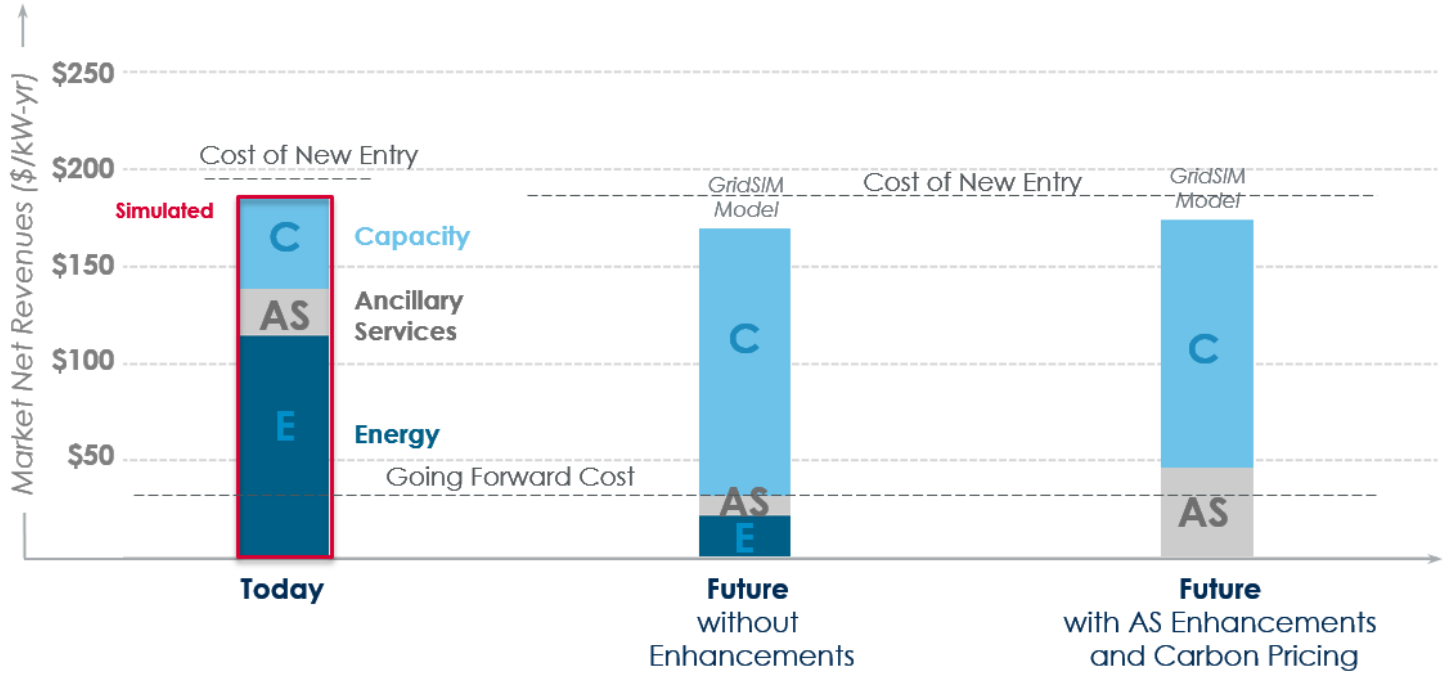
Illustrative Change in Revenues, Existing Downstate Frame Gas Simple-Cycle



Sources and Notes: From *Reliability and Market Considerations For A Grid In Transition* (December 2019). All values in 2030$. "Future" stacked bars show estimated potential market revenues in 2030, given the legislative climate goals outlined in New York State Senate (2019). Revenue estimates derived from system modeling conducted by The Brattle Group. See Appendices C and D for assumptions about resource costs, including Gross CONE. Energy and ancillary revenues are shown net of variable costs of providing each service.

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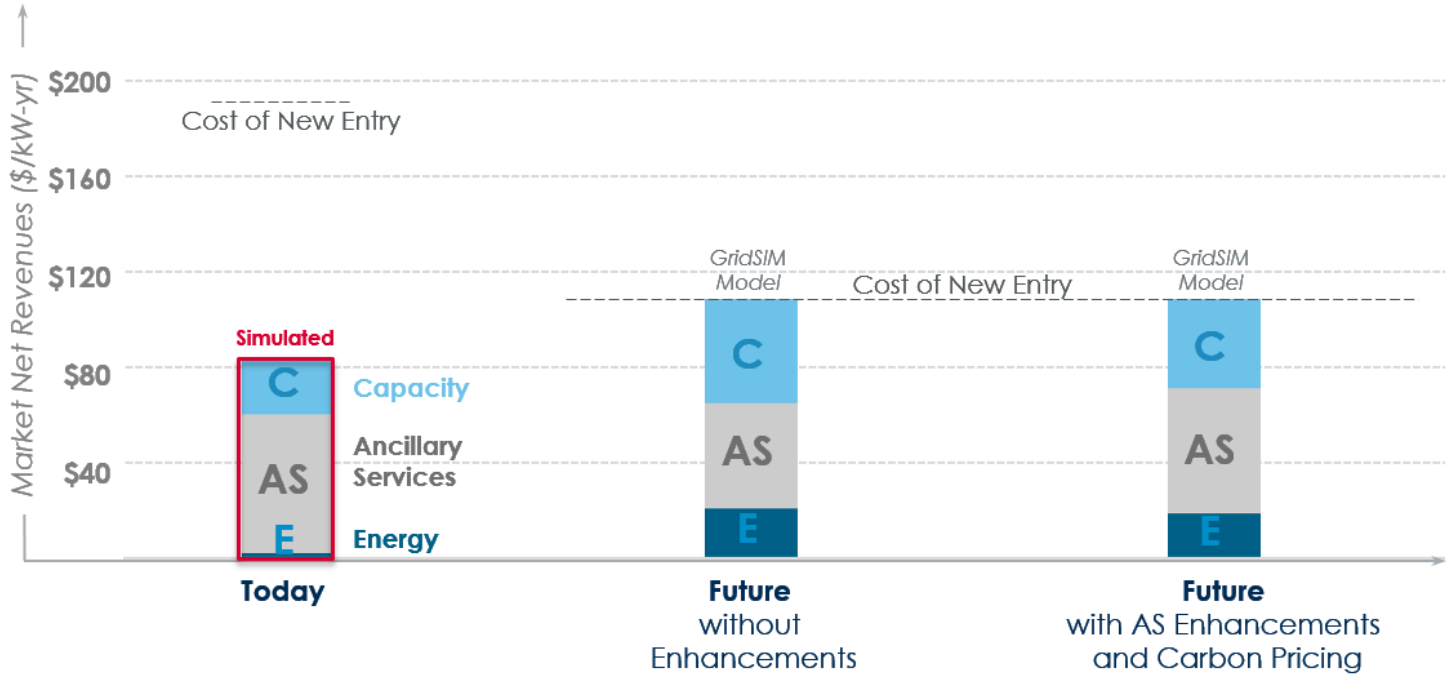
Illustrative Change in Revenues, 2-Hour Duration Downstate Energy Storage



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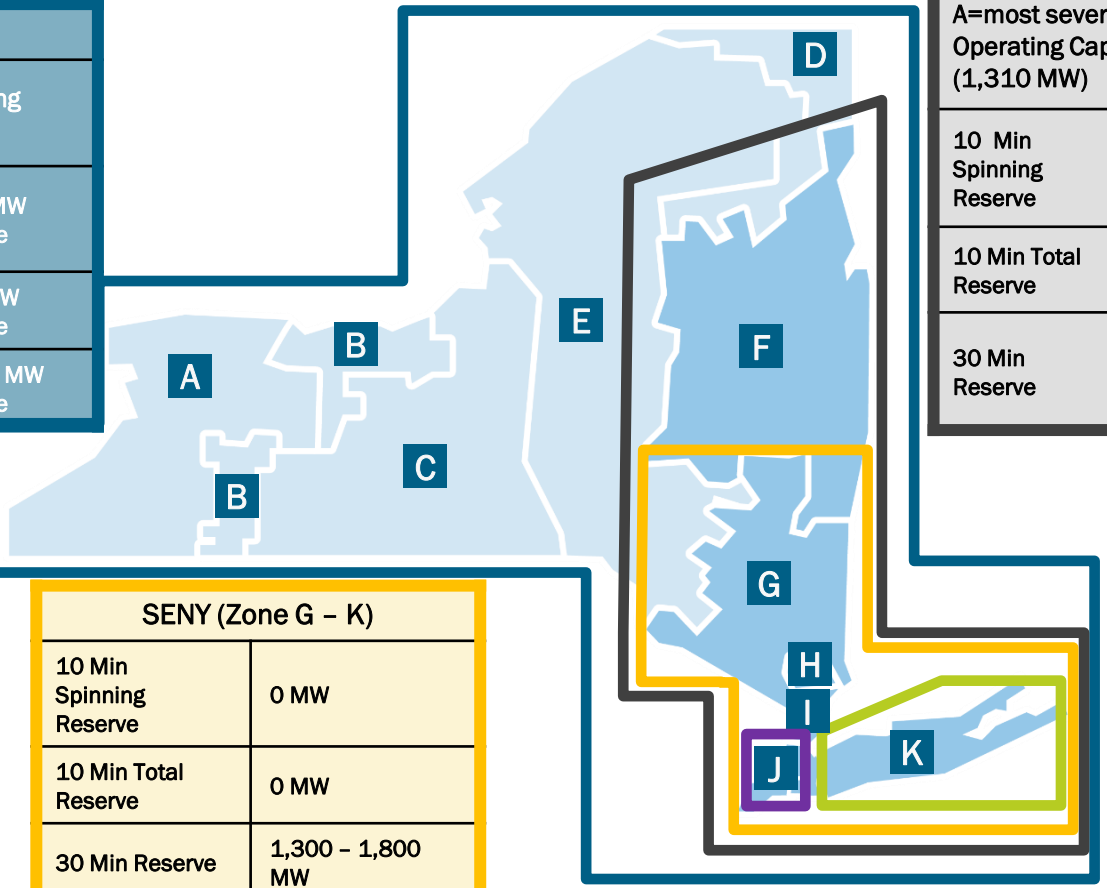
Current Operating Reserve Requirements

NYCA (Zone A – K)	
A=most severe NYCA Operating Capability Loss (1,310 MW)	
10 Min Spinning Reserve	½ A=655 MW NYSRC Rule
10 Min Total Reserve	A=1,310 MW NYSRC Rule
30 Min Reserve	2xA=2,620 MW NYSRC Rule

East (Zone F – K)	
A=most severe NYCA Operating Capability Loss (1,310 MW)	
10 Min Spinning Reserve	¼ A=330 MW NERC, NPCC Rule
10 Min Total Reserve	1,200 MW NYSRC Rule
30 Min Reserve	1,200 MW NERC, NPCC Rule

A	WEST
B	GENESE
C	CENTRL
D	NORTH
E	MHK VL
F	CAPITL
G	HUD VL
H	MILLWD
I	DUNWOD
J	N.Y.C.
K	LONGIL



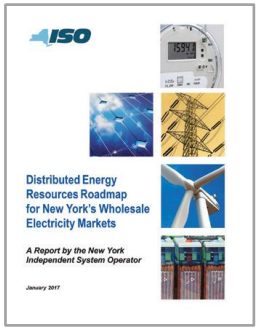
NYC (Zone J)	
10 Min Spinning Reserve	0 MW
10 Min Total Reserve	500 MW
30 Min Reserve	1,000 MW

SENY (Zone G – K)	
10 Min Spinning Reserve	0 MW
10 Min Total Reserve	0 MW
30 Min Reserve	1,300 – 1,800 MW

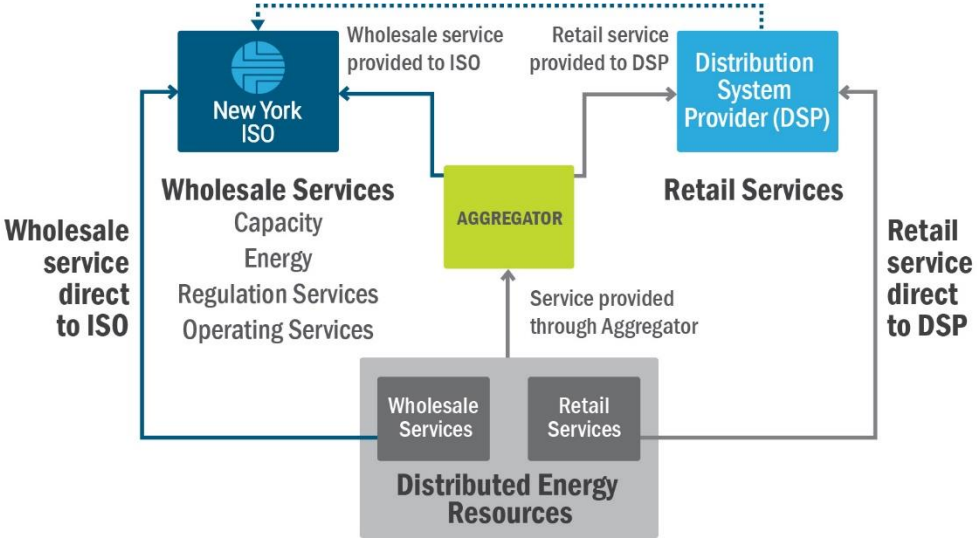
Long Island (Zone K)	
10 Min Spinning Reserve	0 MW
10 Min Total Reserve	120 MW NERC, NPCC Rule
30 Min Reserve	270 – 540 MW Max limits NYSRC Rule

Integrating Distributed Energy Resources (DERs)

NYISO DER Roadmap: Integrating DER into Energy, Ancillary Services and Capacity Markets



- Flexible Demand and Distributed Resources are a key component of transitioning to a zero-carbon electric sector
- Aggregation of behind-the-meter resources key to successful integration with distributed energy resources
- Requires coordination and enhanced communication with Distribution Service Providers (TOs)
- Current projects include:
  - DER Participation Model
  - Co-located storage Model
  - Hybrid Aggregation Model



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Questions?

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Our Mission & Vision

Mission

Ensure power system reliability and competitive markets for New York in a clean energy future

Vision

Working together with stakeholders to build the cleanest, most reliable electric system in the nation

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