



NYSERDA



**Department
of Public Service**

Ex. 6

NYS Energy Storage Roadmap

March 16, 2018

Agenda

- **New York's Commitment to Energy Storage** –
Jason Doling, NYSERDA Team Lead for Energy Storage
- **Storage study scope** – *Jason Doling*
- **Storage study inputs, and assumptions, preliminary base case results** –
Schuyler Matteson, NYSERDA Project Manager
- **NYS Energy Storage Roadmap development** –
Marco Padula, DPS Deputy Director, Market Structure
- **Next Steps** – *Jason Doling*

Governor Cuomo's 2025 Storage Goal

- **Deploy 1,500 megawatts** of energy storage by 2025
- **Employ 30,000 New Yorkers** to establish New York as a home for this rapidly expanding clean tech industry
- **Produce \$2 billion in gross benefits** to New Yorkers by reducing reliance on costly, dirty, and inefficient infrastructure and helping to scale clean energy
- Represents the **largest commitment per capita** by any state

NYS Energy Storage Deployment

Today: 1,400 MW pumped hydro exists

+

2017

60 MW of advanced storage is deployed

2025

1,500 MW Advanced Storage Goal

2030

Public Service Commission to Establish Goal

NYS Energy Storage Roadmap Timeline

1Q18

- **Energy Storage Study** completed
 - Voice of customer/stakeholder meetings to seek input on potential policy, regulatory and programmatic actions
-

2Q18

- **Energy Storage Roadmap** released by DPS for formal public input
-

3Q18

- Technical conference(s), outreach, review and evaluation of formal public comments
-

4Q18

- PSC establishes 2030 Energy Storage Goal and actions
-

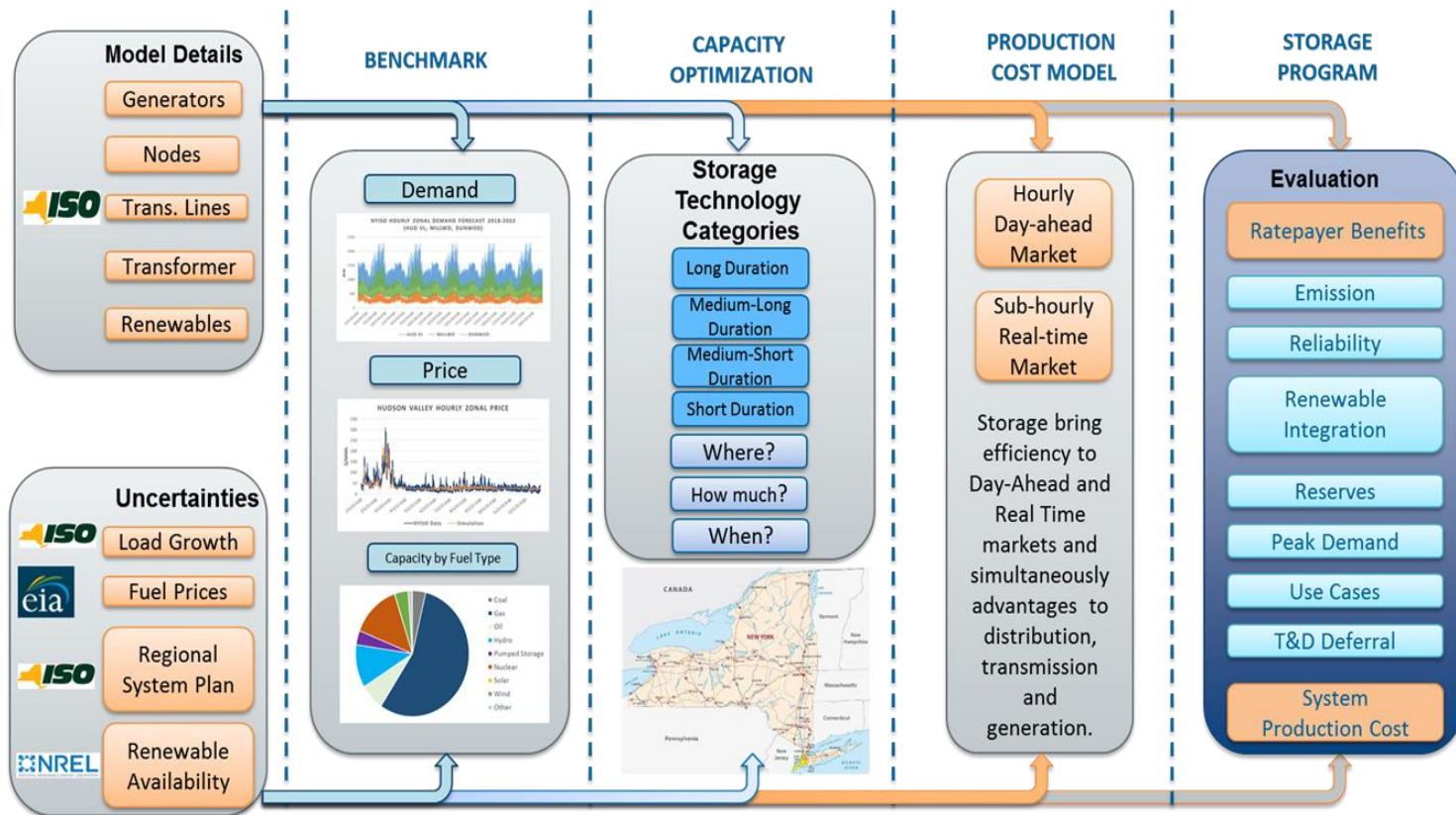
4Q18+

- Implementation

Storage Study Scope

Determine ranges of energy storage that could result in net positive benefit to ratepayers in meeting electric system needs including installed capacity, distribution and sub-transmission needs, that arise under various scenarios, sensitivities, and time horizons (2020, 2025, 2030)

Energy Storage Study Methodology



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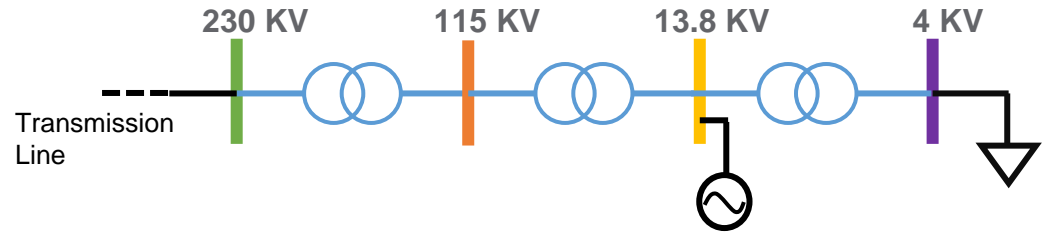
Generation and Transmission Mapping

Transmission Line Voltage Levels

| Voltage | NYISO Lines |
|----------------------|-------------|
| $\leq 13.8\text{KV}$ | 57 |
| 18KV | 0 |
| 23KV | 150 |
| 27KV | 7 |
| 46KV | 2548 |
| 69KV | 387 |
| 115KV | 1129 |
| 138KV | 420 |
| 215KV | 1 |
| $\geq 345\text{KV}$ | 212 |

Reflected in
capacity
optimization
results

currently
reflected
in production
cost model
results



NYISO

- Internal Lines: 4933
- Transformers: 1741
- Interregional lines: 54

Base Case inputs

Inputs and Assumptions

Clean Energy Standard

represents an illustrative mix of hydro, wind, PV and biomass to meet the CES target within a range of alternatives that could result in CES compliance

75,000 GWh total comprised of:

- *Existing renewables of 43,000 GWh:*
 - 35,800 GWh hydro (28,000 in-state hydro and 8,000 imported hydro)
 - 3,800 GWh land-based wind (using a 30% capacity factor)
 - 700 GWh solar PV (using 13.8% capacity factor)
 - 3,000 GWh biomass, biogas, and solid waste
- *New renewables energy of 32,000 GWh in 2030:*
 - 2,300 GWh in-state hydro
 - 1,700 GWh imported hydro
 - 20,000 GWh wind (2.9 GW onshore and 2.4 GW offshore w/ 30% and 40% capacity factors)
 - 6,700 GWh PV (2.5 GW utility scale w/ 14.5% CF and 3 GW BTM w/ 13.8% CF)
 - 1,600 GWh biomass

2030 Load

Net 150,000 GWH (185,600 GWH from CES Order less 35,600 GWH of Energy efficiency, includes 8,600 GWH of EV/ Heat Pump load)

In-State Pumped Hydro

Business as usual from historical usage profiles

Existing generators

All continue to operate

Indian Point

Unit 1 closes by April 2020 and Unit 2 closes by April 2021

Natural Gas Prices

Current NYISO Natural Gas Price Forecast

Transmission Representation

NYISO 2022 Power Flow Base Case



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Energy Storage Technologies and Cost Declines

| | Representative Technologies and Cost Declines |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Long duration (6+ hours) | <ul style="list-style-type: none"> • Li-ion, flow batteries, thermal storage, emerging battery chemistries such as metal based (could also include compressed air and pumped hydro) • <i>Cost decreases 11% annually until 2020, then declines decrease linearly until reaching 3%/year in 2028+</i> |
| Medium Long duration (4 hours) | <ul style="list-style-type: none"> • Li-ion, flow batteries, Zn-Air, Zn-Br, Advanced Lead Acid, NAS • <i>Cost decreases 11% annually until 2020, then declines decrease linearly until reaching 3%/year in 2028+</i> |
| Medium Short (2 hours) | <ul style="list-style-type: none"> • Li-ion, VRLA • <i>Cost decreases 10% annually until 2020, then declines decrease linearly until reaching 3% annual declines in 2028+</i> |
| Short (30 mins) | <ul style="list-style-type: none"> • Li-ion, Flywheel, Ultracapacitors • <i>Cost decreases 10% annually until 2020, then declines decrease linearly until reaching 3% annual declines in 2028+</i> |

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Energy Storage Technologies and Cost Declines

| Duration and Installed Cost | 2018 | 2020 | 2025 | 2030 |
|-----------------------------|---------|---------|---------|---------|
| Long (6 hrs) | | | | |
| per kW | \$2,270 | \$1,800 | \$1,200 | \$1,000 |
| per kWh | \$380 | \$300 | \$200 | \$165 |
| Medium long (4 hrs) | | | | |
| per kW | \$1,600 | \$1,280 | \$840 | \$700 |
| per kWh | \$400 | \$320 | \$210 | \$175 |
| Medium short (2 hrs) | | | | |
| per kW | \$1,080 | \$875 | \$600 | \$500 |
| per kWh | \$540 | \$435 | \$300 | \$250 |
| Short (half hour) | | | | |
| per kW | \$630 | \$510 | \$350 | \$290 |
| per kWh | \$1,260 | \$1,020 | \$700 | \$580 |

All costs are in 2018 dollars and reflect bulk distribution or transmission system installed cost including a basic estimate for land lease cost and interconnection.

Add 1.25 multiplier for NYC Zone J installations and 1.10 multiplier for Long Island Zone K installations.

Add 40% multiplier for customer sited storage located behind a customer's utility meter.

Blended cost of technologies and sources including Lazard Levelized Cost of Storage 2017, GTM Research, Bloomberg, Navigant Research and storage developers



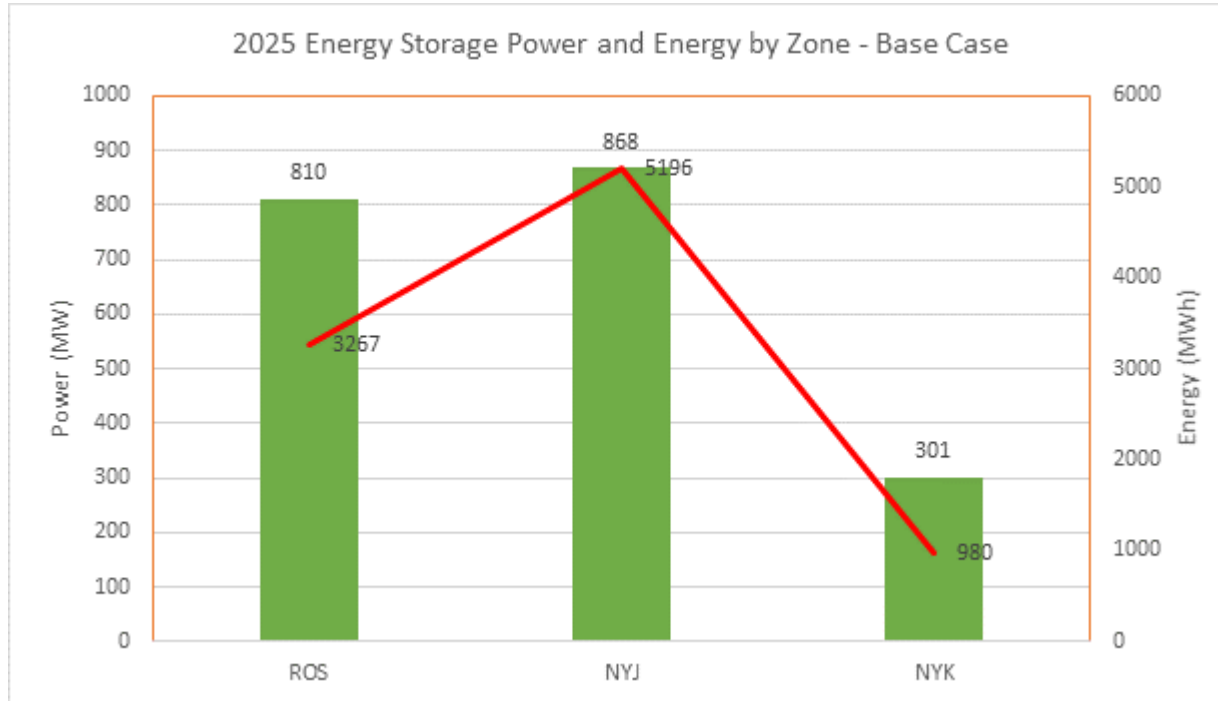
NYSDERA

Preliminary Base Case Results

Preliminary results for discussion
Subject to modification

Preliminary Base Case Results

Energy Storage Sizing Analysis for 2025

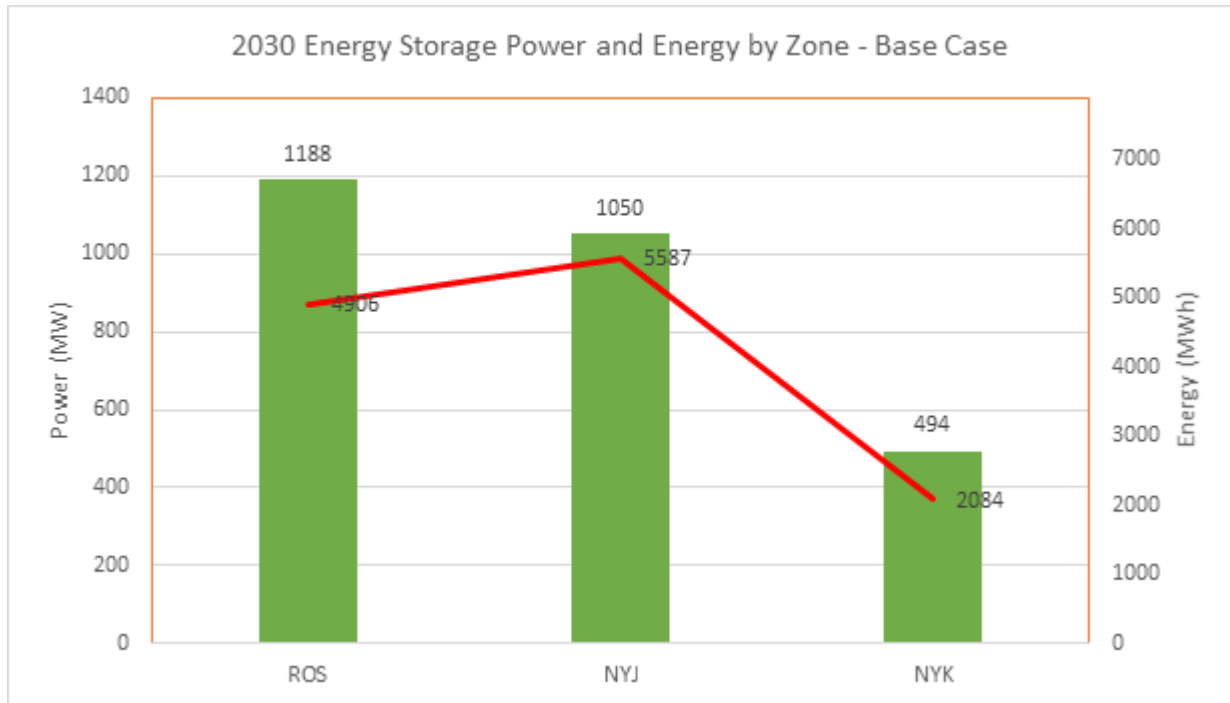


Energy Storage Buckets

| Duration | MW | MWh |
|----------------------|--------------|--------------|
| Long (4+hrs) | 1,178 | 7,068 |
| Medium Long (2-4hr) | 455 | 1,820 |
| Medium Short (1-2hr) | 248 | 496 |
| Short (<hr) | 99 | 50 |
| Total | 1,988 | 9,578 |

Preliminary Base Case Results

Energy Storage Sizing Analysis for 2030



Energy Storage Buckets

| Duration | MW | MWh |
|----------------------|--------------|---------------|
| Long (4+hrs) | 1,447 | 8,682 |
| Medium Long (2-4hr) | 714 | 2,856 |
| Medium Short (1-2hr) | 467 | 934 |
| Short (<hr) | 154 | 77 |
| Total | 2,795 | 12,557 |

Initial/Partial Base Case Benefits and Costs under a Resource Cost-Style Lifetime BCA

| 2025 (1,500 MW, 7,267 MWh) | |
|----------------------------|-----------------|
| Model Benefits | NPV in 2017 M\$ |
| Ancillary Services | \$75 |
| Capacity Value | \$516 |
| Distribution Savings | \$892 |
| FOM | \$81 |
| Gen Cost Savings | \$118 |
| Benefits | \$1,634 |
| Costs | \$1,104 |
| Net Benefits | \$530 |

| 2025 (1,988 MW, 9,578 MWh) | |
|----------------------------|-----------------|
| Model Benefits | NPV in 2017 M\$ |
| Ancillary Services | \$99 |
| Capacity Value | \$588 |
| Distribution Savings | \$1,116 |
| FOM | \$125 |
| Gen Cost Savings | \$146 |
| Benefit | \$2,074 |
| Costs | \$1,463 |
| Net Benefits | \$611 |

| 2030 (2,795 MW, 12,557 MWh) | |
|-----------------------------|-----------------|
| Model Benefits | NPV in 2017 M\$ |
| Ancillary Services | \$140 |
| Capacity Value | \$732 |
| Distribution Savings | \$1,533 |
| FOM | \$214 |
| Gen Cost Savings | \$199 |
| Benefit | \$2,818 |
| Costs | \$1,766 |
| Net Benefits | \$1,052 |

Note: Does not include quantification of any emissions benefits including carbon, SO_x, NO_x, and health impacts. Transmission benefits from congestion relief are included in lower LBMPs within “Generation Cost Savings.” Examining any potential for avoided transmission infrastructure was beyond the scope of this study and not considered in the model.

See Appendix for additional information.

NYS Energy Storage Roadmap Development

A NYS roadmap that will include specific DPS actions, as well as working with the NYISO to help implement; and other state actions such as procurement through state agencies, SUNY or CUNY.

Identify barriers that could impede deployment of energy storage systems for the *identified system need applications*.

- Emphasis on behind-the-meter and stand-alone systems to provide a market-based pathway for enabling energy storage in utility transmission and distribution systems planning and procurement decisions.

NYS Energy Storage Roadmap Development

Use cases currently included in project modeling under a variety of business models

- **Customer sited** storage + PV located behind a customer's utility meter providing customer peak load reduction and utility load relief under a variety of tariffs, VDER, and hybrids. Various customer load profiles and utilities are being examined.
- **Distribution system** for load relief, capacity, and/or providing ancillary services.
- **Bulk system** standalone storage and paired with PV or wind for energy, capacity, and ancillary services.

NYS Energy Storage Roadmap Development

Engage industry, utility, and other stakeholders to **identify state policy, regulatory, and programmatic actions** to be considered to enable the energy storage systems for the future electric grid.

Categories of Policy, Regulatory & Programmatic Actions Identified

- Rate design (time and locational aspects)
- Expand VDER value stack to storage and enhance components
- Improve load relief initiatives and revenue tenure
- Utility roles and business models (Earnings Adjustment Mechanisms, Non-Wire Solution procurements and benefit/cost analyses)
- Renewables + storage integration
- Market acceleration bridge incentives

Note: This list presents examples and is not intended to be exhaustive

Categories of Policy, Regulatory & Programmatic Actions Identified

(cont.)

- Examine wholesale market changes in conjunction with the NYISO's DER Roadmap and the NYS Energy Storage Roadmap
- Continue reducing soft costs (permitting, customer acquisition, data access, heat maps to target areas needing relief, interconnection)
- Leverage NY Green Bank's financing and NY Power Authority's financing and procurement/customer acquisition roles
- NYS leading by example through government procurement

Note: This list presents examples and is not intended to be exhaustive

Stakeholder Input

The **NYSERDA/DPS** team welcomes input from stakeholders on any aspects of the Energy Storage Study and NYS Energy Storage Roadmap, and is especially interested in the following:

- Are the assumptions for energy storage grid services provided and stacking services appropriate?
- Are the energy storage costs and cost decline projections reasonable?
- Identify the operational complexities from stacking grid services that must be considered and addressed in the roadmap.
- Provide specific recommendations on the range of policy, regulatory, and programmatic actions that should be considered in the roadmap.

Next Steps

Stakeholders are encouraged to engage with the NYSERDA/DPS team throughout the NYS Energy Storage Roadmap development and the public input phase which will begin upon the roadmap's release in the later part of the second quarter 2018

- Visit nyserderda.ny.gov/energy-storage-roadmap for updates and additional information
- Please direct any questions or recommendations to:
EnergyStorageRoadmap@nyserderda.ny.gov
- Sign up for NYSERDA energy storage updates at:
nyserderda.ny.gov/energy-storage-signup

Appendix

Base Case Outputs

Total Resource Cost-Style Lifetime BCA

Legend

- **Ancillary Services:** Storage MW or MWH x AS market price, storage participation capped at 25% of market
- **Capacity Value:** uses a 4-hour capacity requirement equivalent; Storage MW x Capacity price (by zone by year)
- **Distribution Savings:** Avoided Distribution Infrastructure (Storage MW x DRV value from utility VDER tariffs). Reflects the actual DRV by utility per kW.
- **FOM:** Difference in fixed operations and maintenance costs on the system
- **Gen Cost Savings:** Difference in Total Cost to Generate required Energy, including fuel, VOM, RGGI compliance (Base Case Total Generation Cost – Storage Case Total Generation Cost)
- **Storage Costs:** Cost is net of an average 20% accelerated federal tax benefit. VO&M including charging cost is netted into the “Gen Cost Savings” benefit.
- 7% discount rate used and 10 year average asset life including FOM costs

Energy Storage Study Input Data Sources

| Category | Current System | Forecast |
|---------------------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------|
| Generation | NYISO 2017 Load & Capacity Report | NYISO 2017 Load & Capacity Report |
| Demand | NYISO Markets & Operations Data | NYSERDA Demand and Energy Forecast Spreadsheet and NYISO 2002 Demand Profile Assumption |
| Energy Efficiency | | NYSERDA Demand and Energy Forecast Spreadsheet |
| Behind-the-meter DER | | NY Sun Forecast from NYSERDA |
| Wind | NYISO 2017 Load & Capacity Report | CES Standard |
| Solar | NYISO 2017 Load & Capacity Report | CES Standard |
| Hydro Energy | EIA | CES Standard |
| Hydro and LBW Imports | | CES Standard |
| Proposed Generator Additions | | NYISO Memo |
| Deactivated Generator | | NYISO Memo and NYSERDA Base Case Assumptions |
| Regulation Requirement | NYISO Regulation Requirements | NYISO Regulation Requirements |
| Reserve Requirement | NYISO Locational Reserve Requirement | NYISO Locational Reserve Requirement |
| New Capacity Costs | | AEO 2017 |
| Storage Costs | Blended costs from multiple market sources | Blended costs from multiple market sources |
| Emissions Prices | 2017 RGGI CO2 Allowance Auction Report | 2017 CARIS Emissions Price Forecast |
| Emissions | EPA Emission Database | EPA Emission Database |
| Market & Operational Data: | NYISO Markets & Operations Data | Acelerex Simulations |
| Interfaces Exchanges | NYISO Markets & Operations Data | NYISO Markets & Operations Data |