# Battery Energy Storage Analysis: A New York ISO Case Study

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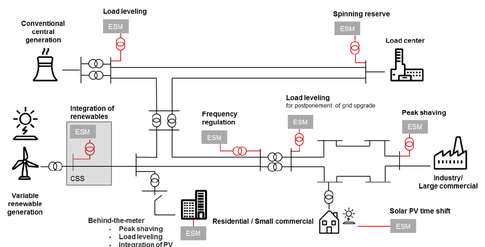
## How is the Energy Storage utilized in the grid?




Source: ABB

## Top US Energy Storage Markets

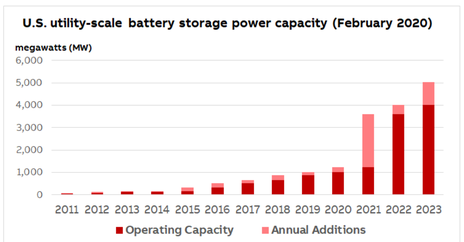
**California** — 1
- Assembly Bill 2514 – PG&E, SCE, SDG&E 1,325 MW ES mandate
- Senate Bill 100 – 100% carbon-free by 2045

**New York** — 2
- 1,500 MW Energy Storage Target by 2025 and 3,000 MW by 2030
- Ravenswood Energy Storage under construction with 316 MW capacity

**PJM** — 3
- Over 300 MW existing battery storage

**ISO-NE** — 4
- Massachusetts target 1,000 MWh by 2025
- Solar+ Storage Awarded in Forward Capacity Market

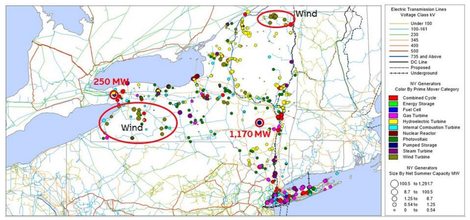
## Energy Storage Penetration in the US




Source: U.S. Energy Information Administration, Annual Electric Generator Report and the Preliminary Monthly Electric Generator Inventory, February 2020

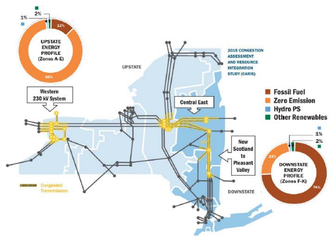
## New York ISO – Existing Generation and Storage

**Pumped Storage: 1,420 MW**
**Wind: 2,600 MW and 700 MW Under Construction and Utility Solar: 500 MW**




Source: ABB Velocity Suite

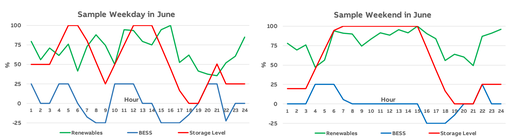
## New York ISO – Transmission Congestion




Source: NYISO 2017 Congestion Assessment and Resource Integration Study Report, April 2018.

## Hourly BESS Charging and Discharging

**Sample weekday and weekend for a 4-hour energy storage**




## Phase I: BESS Scenario Assumptions

| Scenarios | | Scenario 1 Paired with Wind and Solar at Upstate | Scenario 2 At Congested Flowgates near Capital Region | Scenario 3 At the Load Center in NY City | Scenario 4 Combination of Scenarios 1-3 |
|---|---|---|---|---|---|
| BESS Capacity Levels (MW) | 1 | 500 | 500 | 500 | 500 |
| | 2 | 1,000 | 1,000 | 1,000 | 1,000 |
| | 3 | 1,500 | 1,500 | 1,500 | 1,500 |
| | 4 | 2,000 | 2,000 | 2,000 | 2,000 |

- Used Energy Market Advisor's Nodal Reference Case as the base case. Nodal reference case is updated once every year. It provides bus LMPs for all the buses in North America. and enables congestion, curtailment, and basis risk analysis.
- Implemented PROMOD electric market simulation tool. PROMOD is an integrated electric generation and transmission market simulation tool, which forecasts hourly energy prices, unit generation, revenues and fuel consumption, external market transactions, transmission flows and congestion and loss prices.

## NY Storage Scenarios LMP Impact – PROMOD®

| Scenario | MW | On Peak LMP Delta NY East | NY South | NY West | Off Peak LMP Delta NY East | NY South | NY West |
|---|---|---|---|---|---|---|---|
| 1. Paired with Wind and Solar | 500 | -0.05 | -0.05 | -0.30 | 0.20 | 0.20 | 0.31 |
| | 1,000 | -0.01 | -0.01 | -0.70 | 0.47 | 0.45 | 0.53 |
| | 1,500 | -0.14 | -0.08 | -1.20 | 0.68 | 0.67 | 0.71 |
| | 2,000 | -0.25 | -0.21 | -1.37 | 0.83 | 0.79 | 0.76 |
| 2. Next to Congested Flowgates | 500 | -0.08 | -0.06 | -0.02 | 0.23 | 0.24 | 0.21 |
| | 1,000 | -0.27 | -0.20 | -0.11 | 0.49 | 0.49 | 0.43 |
| | 1,500 | -0.40 | -0.25 | -0.22 | 0.71 | 0.74 | 0.53 |
| | 2,000 | -0.57 | -0.35 | -0.28 | 0.90 | 0.92 | 0.68 |
| 3. At the Load Center | 500 | -0.16 | -0.33 | -0.09 | 0.17 | 0.21 | 0.14 |
| | 1,000 | -0.44 | -0.76 | -0.01 | 0.47 | 0.58 | 0.30 |
| | 1,500 | -0.67 | -1.02 | -0.03 | 0.67 | 0.85 | 0.36 |
| | 2,000 | -0.74 | -1.01 | -0.07 | 0.84 | 1.06 | 0.41 |
| 4. Combination | 500 | -0.12 | -0.15 | -0.14 | 0.25 | 0.28 | 0.26 |
| | 1,000 | -0.28 | -0.37 | -0.22 | 0.46 | 0.49 | 0.46 |
| | 1,500 | -0.44 | -0.55 | -0.43 | 0.65 | 0.68 | 0.65 |
| | 2,000 | -0.57 | -0.70 | -0.50 | 0.84 | 0.88 | 0.82 |

## Phase I: Promod IV Simulation Results

**Locating BESS at NY-J (Scenario 3) provides largest benefits**

**Carbon Emission Benefits**
- Base Case total emission and cost for New York: 33.5 Million tons and $264 Million cost
  - Annual emission cost reduction ranged between $300k and $2M. Scenarios 2, 3 and 4 provided highest benefits.
  - Up to 260k tons less CO2 emissions

**Congestion Costs**
- Base Case total flowgate congestion Cost: $207 Million
  - Scenario 3 provided highest congestion benefits up to $6M annually and Scenario 4 following with $3M benefits.
  - Scenario 1 and 2 were not beneficial to reduce congestion.

**Total System Costs**
- Base Case NYISO System Cost: $4.9 Billion
  - $16M annual reduction for Scenario 3 while Scenario 2 and Scenario 4 benefits follow closely

## Recent Regulatory Developments in New York

**Climate Leadership and Community Protection Act was adopted in July 2019**
- 70% RPS requirement by 2030, 6 GW of distributed solar (DG) by 2025, 1.5 GW energy storage by 2025 and 3 GW of energy storage by 2030, and 9 GW of offshore wind by 2035.

**$NO_x$ Peaker Rule adopted in January 2020**
- Simple cycle CTs have to emit below 100 ppmvd by May 2023. Gas and oil fired units have to emit below 25 ppmvd and 42 ppmvd, respectively, by May 2025. Options are either to retire (expected ~650 MW in downstate) or comply by:
  - Not operating during ozone season (expected ~800 MW)
  - Meeting weighted avg. emission limits when combined with nearby renewables or storage

## Phase II: BESS Scenario Assumptions

**New York's new RPS targets mandate higher renewables by 2025**
- 3.8 GW of Onshore Wind, 1.8 GW of Offshore Wind (Empire, Sunrise, South Fork at NY-J and NY-K) and 5.4 GW Utility Solar additions are expected.
- Based on ABB's reference case, energy storage is expected to be distributed to all zones, majority in Zones J and K.

**Neighboring regions are expected to add more renewable as well**
- 1.8 GW offshore wind, 1 GW of onshore wind and 4 GW solar are expected in ISONE.
- Over 1 GW wind and 7 GW solar are expected in PJM.

| Scenarios | | New Base Load center of each zone | Scenario 1 Pair with Wind at upstate and with solar at downstate | Scenario 2 Pair with Wind at upstate and with offshore at downstate |
|---|---|---|---|---|
| BESS Capacity Levels (MW) | Base | 450 | 450 | 450 |
| | 1 | 900 | 900 | 900 |
| | 2 | 1,800 | 1,800 | 1,800 |

## Phase II: BESS Scenario Results and Conclusions

**Locating BESS at the down state offshore wind has the highest benefit**

**Total System Costs**
- New York system cost reductions reach up to $237M among the scenarios. Benefits are higher as the storage penetration increase and as the storage paired with the offshore wind (Scenario 2).
- PJM and ISONE has some reductions in cost only with the 1,800 MW storage installation, $2M, and $11M, respectively.

**Carbon Emission Benefits**
- New York only has benefits when the NY-J storage is located close to load (Base) rather than paired with solar or offshore wind (Scenario 1 and 2).

**Conclusions**
- Energy Storage provides highest benefits if it is located close to the load center (i.e. down state instead of up state) with more volatile electricity prices.
- Higher storage penetration resulted in less energy generated by Natural Gas and Oil in New York. This results in more imports from PJM and ISONE generated by Coal and Natural Gas.
- Total system benefits are highest when the batteries are paired with the offshore wind resources in down state. Transmission improvements that makes offshore wind more available to load centers could make batteries more beneficial when located closer to the load.

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