Draft Generic
Environmental Impact Statement

CASE 18-E-0130 – In the Matter of Energy Storage Deployment Program

Prepared for:
New York State Department of Public Service and
New York State Energy Research & Development Authority

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ACS	American Community Survey
BCA	Benefit-Cost Analysis
bgd	billion gallons per day
BMPs	Best Management Practices
BTM	"Behind the meter"
C&D	Construction and Demolition
CAA	Clean Air Act
CAES	Compressed Air Energy Storage
CAFO	Combined Animal Feeding Operation
CEF	Clean Energy Fund
CEQR	City Environmental Quality Review
CHG&E	Central Hudson Gas & Electric Company
CES	Clean Energy Standard
CO	Carbon monoxide
CO_2	Carbon dioxide
Commission	New York State Public Service Commission
Con Edison	Consolidated Energy Company of New York
CPP	Clean Power Plan
CRIS	Cultural Resources Information System
CRRA	Community Risk and Resiliency Act
CSA	Combined statistical areas
CWA	Clean Water Act
DAM	Department of Agriculture & Markets
DER	Distributed energy resources
DG	Distributed generation
DOE	U.S. Department of Energy
DOITT	Department of Information Technology and Telecommunications
DOS	Department of State
DOT	Department of Transportation
DR	Demand Response
DSIRE	Database of State Incentives for Renewables and Efficiency
EE	Energy Efficiency
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Statement
EJ	Environmental Justice
EMFs	electric and magnetic fields
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act of 2005
ESCOs	Energy Service Companies
ESRs	Energy Storage Resources
ETSAP	Energy Technology System Analysis Programme

EVs	Electrical vehicles
FCZMA	Federal Coastal Zone Management Act
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FOM	"Front of the meter"
FPA	Federal Power Act
GEIS	Generic Environmental Impact Statement
GETS	Grid-Interactive Thermal Storage
GIS	Geospatial Information System
GWh	Gigawatt hours
Hg	Mercury
IOU	Investor-Owned Utility
IPP	Independent power producers
IRENA	International Renewable Energy Agency
ISO	Independent System Operator
kV	Kilovolts
kWh	Kilowatt-hour
LESR	Limited Energy Storage Resources
LGIA	Large Generator Interconnection Agreement
LGIP	Large Generator Interconnection Procedures
LILCO	Long Island Lighting Company
LIPA	Long Island Power Authority
LNG	Liquefied Natural Gas
LPC	Landmarks Preservation Commission
mG	Milligauss
MODA	Mayor's Office of Data Analytics
MSA	Metropolitan Statistical Area
MSW	Municipal Solid Waste
MTA	Metropolitan Transportation Authority
MW	Megawatt(s)
MWh	Megawatt-hour
NAAQS	National Ambient Air Quality Standard
NaS	Sodium-sulfur
NEPA	National Environmental Policy Act
NIMO	Niagara Mohawk Power Corporation
NO_2	Nitrogen dioxide
NO_X	Nitrous oxides
NPCC	Northeast Power Coordinating Council
NPS	National Park Service
NREL	National Renewable Energy Laboratory
NRHP/SRHP	National and State Registers of Historic Places
NSPS	New Source Performance Standards
NWA	Non-Wires Alternatives
NYCA	New York Control Area
NYCHA	New York City Housing Authority
NYCRR	New York Codes, Rules and Regulations
NYGB	New York Green Bank
NYISO	New York Independent System Operator
NYNHP	New York Natural Heritage Program
NYPA	New York Power Authority
NYSDEC	New York State Department of Environmental Conservation

NYSDPS	New York State Department of Public Service
NYSEG	New York State Electric & Gas Company
NYSERDA	New York State Energy Research and Development Authority
NYSOPRHP	New York State Office of Parks, Recreation and Historic Preservation
NYSRC	New York State Reliability Council
O&M	Operations and Maintenance
O&R	Orange & Rockland Company
OSHA	Occupational Health and Safety Administration
OTR	Ozone Transport Region
Pb	Lead
PEJAs	Potential Environmental Justice Areas
PJM	PJM Interconnection LLC
PM	Particulate matter
Port Authority	New York and New Jersey Port Authority
ppm	Parts per million
PSL	Public Service Law
PV	Photovoltaic
R&D	Research and development
RBS	Regenerative Braking System
RCRA	Resource Conservation and Recovery
REC	Renewable Energy Credits
RES	Renewable Energy Standard
REV	Reforming the Energy Vision
RG&E	Rochester Gas & Electric Company
ROW	Right-of-way
RPS	Renewable Portfolio Standard
RPT	Real estate property taxes
RTM	Real-Time Market
RTO	Regional Transmission Operators
SEQRA	New York's State Environmental Quality Review Act
SHPO	Historic Preservation Office
SIR	Standardized Interconnection Requirements
SOx	Sulfur dioxide
SPDES	New York State Pollutant Discharge Elimination System
The Board	State Energy Planning Board
UPS	Uninterruptible Power Supplies
U.S.	United States
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
V2G	Vehicle-to-grid
VDER	Value of Distributed Energy Resources
WTE	Waste-to-Energy

EXECUTIVE SUMMARY

In 2014, New York State (the State) launched Reforming the Energy Vision (REV), an energy policy intended to transform the ways in which the State generates, distributes, and manages energy, with the goal of developing an integrated energy network that harnesses and combines the benefits of a central grid with locally generated power. Energy storage plays a key role in achieving these goals. On January 2, 2018, Governor Andrew M. Cuomo announced a new initiative to deploy 1,500 megawatts (MW) of energy storage by 2025 and employ 30,000 New Yorkers to establish the State as a home for this rapidly expanding clean tech industry.[1] As part of this Energy Storage Deployment initiative, Governor Cuomo tasked the New York State Public Service Commission (the Commission) and New York State Energy Research and Development Authority (NYSERDA) with the development of an Energy Storage Roadmap (the Roadmap) to identify policies, regulations, and initiatives that will accelerate the growth of the State's energy storage market to achieve the 2025 goal. The enactment of Public Service Law (PSL) §74 further directs the Commission to establish a 2030 target for the installation of qualified energy storage systems and programs.

On June 21, 2018, NYSERDA and the New York State Department of Public Service (NYSDPS) filed the "New York State Energy Storage Roadmap and NYSDPS/NYSERDA Staff Recommendations" (the Roadmap), which outlines the market-supported policy, regulatory, and programmatic actions necessary to achieve the State's near-term energy storage installment goals and recommendations for the Commission to consider when designing the energy storage deployment program per PSL §74. Broadly, the recommendations are separated into seven categories: (1) retail rate actions and utility load management programs, (2) investor-owned utility roles and business models, (3) direct procurement, (4) market acceleration bridge incentives, (5) cross-cutting actions to reduce barriers, (6) "clean peak" actions, and (7) wholesale market actions. The Roadmap specifically supports the State's initiative to deploy 1,500 MW of energy storage by 2025 and a secondary energy storage deployment target for 2030 pursuant to PSL §74.

This Generic Environmental Impact Statement (GEIS), prepared pursuant to the New York State Environmental Quality Review Act (SEQRA), analyzes the potential environmental impacts associated with the Roadmap. The Reforming the Energy Vision (REV) and Clean Energy Fund (CEF) programs, which have been previously approved by the Commission, have directly or indirectly supported energy storage technologies and deployment. Although the environmental reviews for REV and the CEF did consider the impacts of energy storage, they did not contemplate establishing a target for energy storage deployment. The Roadmap does consider

[1] Governor Cuomo Unveils 20th Proposal of 2018 State of the State: New York's Clean Energy Jobs and Climate Agenda. Accessed on April 27, 2018 at: https://www.governor.ny.gov/news/governor-cuomo-unveils-20th-proposal-2018-state-state-new-yorks-clean-energy-jobs-and-climate.

such a target – which is intended to accelerate the growth of the energy storage market – and necessitates the development and consideration of this GEIS.

The Proposed Action under consideration is the implementation of the Roadmap recommendations. While the Commission will determine the ultimate capacity target within the context of the Roadmap recommendations, based on the available modeling, this GEIS considers the impacts of energy storage levels up to 3,633 MW of incremental energy storage capacity. For certain components of the evaluation, and to reasonably capture the potential environmental impacts of 1,500 MW to 3,633 MW of incremental energy storage capacity, this GEIS considers one modeling scenario that yields 2,795MW of incremental storage capacity by 2030. This scenario serves as an illustrative example of the full range of potential impacts associated with a 2030 target for energy storage deployment up to 3,600 MW of installed energy storage capacity.

The Commission may identify a No Action alternative as the reasonable alternative to the Proposed Action, wherein the energy storage deployment program target by the year 2030 is 0 MW. Under the No Action alternative, the State still expects to achieve its Clean Energy Standard (CES) mandate that 50 percent of all electricity consumed in New York State be supplied by renewable resources by 2030 (the 50 by 30 goal) by employing a variety of resources, including energy storage, although the amount of installed storage capacity is expected to be lower during the period of analysis without the Roadmap. Under the No Action alternative, there could be more, fewer and different potential impacts on the environment, depending on the other types of resources that ultimately would be used under the No Action alternative to achieve the "50 by 30" goal.

The environmental setting of this GEIS includes the entire state of New York. Potential impacts are assessed across three types of energy storage technologies – batteries, thermal storage and flywheels – and 11 resource areas, including: land use, water resources, physical geography, climate and air quality, waste management, public health, community character, cultural and historical resources, transportation and socioeconomic resources. The scope of the GEIS was limited to those three types of energy storage technologies because they are commercially available and cost-effective, per the definition of "qualified energy storage system" contained in PSL §74. The analysis of environmental impacts is largely qualitative because the Roadmap is technology agnostic. As a result, the exact mix and location of energy storage technologies that will be implemented under the Roadmap is uncertain, although there is a general expectation that a greater amount of storage will likely be deployed in the more heavily populated downstate areas in and around New York City. Energy storage's flexibility in terms of modularity, potential multi-use applications, and in some cases mobility, further complicates projecting the likely types, sizes, and application of energy storage into the future.

Given these circumstances, and consistent with SEQRA regulations, 6 New York Codes, Rules and Regulations (NYCRR) §617.10(a), this GEIS is broader and more general than a site- or project-specific environmental impact statement (EIS), and identifies potential areas where environmental impacts could be caused by the construction, operation and disposal of energy storage facilities. Overall findings suggest that adverse direct environmental impacts of the Roadmap are likely to be minimal and a variety of mitigation measures exist to minimize such impacts. On a generic level, the potential for adverse environmental impacts includes: risk of soil and groundwater contamination due to improper disposal of battery-related waste, and public safety risks from the operation of batteries and flywheels. Measures to mitigate (i.e., minimize or avoid) the potentially adverse environmental impacts that may result from greater deployment of energy storage, include:

- Federal, state and local regulations, notably Resource Conservation and Recovery Act (RCRA) regulations and New York Department of Environmental Conservation (NYSDEC) Part 364;
- Site-specific permitting regimes, such as the SEQRA process, NYSDEC Commissioner Policy 29 on Environmental Justice and Permitting (CP-29), and Article 10 and Article VII of the New York Public Service Law; and
- Use of best management practices during site-specific design, planning, and siting efforts.

If successfully implemented, the roadmap should result in positive environmental impacts due to reductions in peak load demand during critical periods, increases in the overall efficiency of the grid, and/or displacement (or accelerated displacement) of fossil fuel-based generation (e.g., by allowing greater integration of renewable energy resources). Such outcomes will lead to an array of public benefits, including economic, health and environmental benefits. Specifically, these benefits may include:

- Creation of approximately 30,000 jobs associated with energy storage research and development, development, manufacturing, installation and other support services;
- Mitigation of the impacts of climate change from approximately 2million metric tons of avoided greenhouse gas (GHG) emissions; and
- Improvement in public health from avoided emissions of criteria air pollutants, such as nitrogen oxides (NOx), sulfur oxides (SOx) and particulate matter (PM2.5). To the extent that these avoided air emissions occur from the displacement of peaker plants located in Potential Environmental Justice Areas (PEJAs), the associated benefits may accrue to these vulnerable communities.

This GEIS also considers the unavoidable impacts, irreversible and irretrievable commitment of resources, and effects on energy consumption of the Proposed Action. Since the GEIS does not address site- or project-specific actions, there are no unavoidable adverse impacts or irreversible and irretrievable commitments of resources associated with the Proposed Action. Any resulting development of energy storage encouraged by the Proposed Action would consider site- or project-specific potential impacts during applicable federal and state approval processes. Furthermore, while the Proposed Action may affect the State's electric generation portfolio, it is not expected to directly or indirectly affect the amount of electricity used in the State or the amount of energy conserved in the State.

CHAPTER 1 | SEQRA AND DESCRIPTION OF THE PROPOSED ACTION

In 2014, New York State (the State) launched REV, an energy policy intended to transform the ways in which the State generates, distributes, and manages energy, with the goal of developing an integrated energy network that harnesses and combines the benefits of a central grid with locally generated power. More broadly, REV seeks to rethink two key principles that have governed energy over the last hundred years: that demand is inelastic and that centralized energy generation is the most economic approach for producing power due to economies of scale. The 2015 New York State Energy Plan (the 2015 State Energy Plan), in combination with the reforms called for in REV, sets forth three long-term energy goals, further driving the transformation of the State's energy system:

- Generate 50 percent of the State's electricity from renewable resources by 2030;
- Reduce greenhouse gas (GHG) emissions from 1990 levels by 40 percent by 2030; and
- Increase statewide energy efficiency by 600 trillion Btu compared to forecasted primary energy use by 2030.

Energy storage will play a key role in achieving these goals. One of the key limitations of the current electrical grid is the inability to store large amounts of electricity that could then be used to feasibly supplement load demand at different times. While energy commodities like natural gas, oil, and coal can be readily stored in large quantities, storage of electricity is relatively expensive and complex. As a result, in today's electrical grid, electric system operators rely on reserves of conventional generation to meet changes in demand (i.e., consumption) and maintain equilibrium between supply and demand in the grid. Advances in energy storage technology, however, would mitigate this limitation of the State's energy system, allowing for greater reliance on renewable energy sources and improving efficiencies in energy distribution and management.

In response to this critical system need, the need to create jobs in research and development, and to further New York's climate and clean energy leadership, on January 2, 2018, Governor Andrew M. Cuomo announced a new initiative to deploy 1,500 megawatts (MW) of energy storage by 2025 and employ 30,000 New Yorkers to establish New York as a home for this rapidly expanding clean technology industry.[2] As part of this Energy Storage Deployment initiative, Governor Cuomo tasked the New York State Public Service Commission (the Commission) and New York State Energy Research and Development Authority (NYSERDA) with the development of an Energy Storage Roadmap (the Roadmap) to identify policies, regulations, and

[2] Governor Cuomo Unveils 20th Proposal of 2018 State of the State: New York's Clean Energy Jobs and Climate Agenda. Accessed on April 27, 2018 at: https://www.governor.ny.gov/news/governor-cuomo-unveils-20th-proposal-2018-state-state-new-yorks-clean-energy-jobs-and-climate.

initiatives that will accelerate the growth of the State’s energy storage market to achieve the 2025 goal and also establish a supplemental energy storage target for 2030.

The remainder of this chapter provides further background and context concerning the development of a Generic Environmental Impact Statement (GEIS). **Section 1.1** describes the purpose of New York's State Environmental Quality Review Act (SEQRA) and the requirement to prepare a GEIS for an action or plan that has a state-wide application. **Section 1.2** and **Section 1.3** provide an overview of the public need, purpose, and actions proposed under the Roadmap. **Section 1.4** provides a summary of the public benefits anticipated from the successful implementation of the Roadmap. This chapter concludes with a brief overview of other energy programs that are intertwined with the Roadmap.

1.1 COMPLIANCE WITH THE NEW YORK STATE ENVIRONMENTAL QUALITY REVIEW ACT

New York's SEQRA, which is contained in Article 8 of the Environmental Conservation Law, declares that it is the State’s policy to:

> “… encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and enhance human and community resources; and to enrich the understanding of ecological systems, natural, human and community resources important to the people of the state.”

The basic purpose of the SEQRA is to incorporate the consideration of environmental factors into the existing planning, review, and decision-making processes of State, regional, and local government agencies at the earliest possible time. Consistent with this intent, the SEQRA requires all State and local government agencies to analyze and mitigate potentially significant environmental impacts when deciding to approve or undertake an action. To accomplish this overarching goal, agencies are required to assess the environmental significance of all actions they have discretion to approve, fund, or directly undertake, unless exempt or excluded by the SEQRA statute or regulation, which may include development of an Environmental Impact Statement (EIS).

Preparation of a Generic Environmental Impact Statement

When an EIS is required under SEQRA, that requirement may be satisfied by the preparation of a GEIS in several circumstances, including, as here, where the Roadmap consists of an entire program or plan having wide application or restricting the range of possible future alternative policies or projects. 6 NYCRR §617.10 indicates that a GEIS is the appropriate mechanism for assessing environmental impacts.[3] A GEIS is broader and more general than a site- or project-specific EIS, providing a discussion of the potential constraints and consequences of a proposed action(s) based on the analysis of a limited number of hypothetical scenarios.

A GEIS also may identify the important elements of the natural resource base, as well as existing and projected cultural features, patterns, and character. The SEQRA requires that a draft GEIS be

[3] 6 NYCRR § 617.10(a)(4). The required contents of an EIS are listed in the regulations that implement SEQRA (6 NYCRR §§ 617.9 and 617.10).

made available for public comment. The lead agency then must consider the comments and prepare a final GEIS before reaching a decision on the action being considered.

The SEQRA further contemplates that after preparing a GEIS for a broader program, the appropriate state, local, or federal agency may need to conduct additional, project- or site-specific environmental review when specific components of the program are proposed. As the state agency that serves to carry out the Commission's legal mandates, the NYSDPS serves as the lead agency under SEQRA for the energy storage actions that are the subject of this GEIS.

In this case, the Commission anticipates that environmental review would be conducted for future energy storage projects at the time they are proposed, which would assess, at a site-specific level, all relevant potential environmental impacts. This GEIS's identification and discussion of the potential impacts of the Proposed Action do not substitute for future site-specific analyses of potential environmental impacts for particular projects.

Public Comment and Final GEIS

Under 6 NYCRR §617.9(a)(3), once a draft EIS is accepted as complete, the analysis must be made available to the public for review and comment for a minimum of 30 days. This DGEIS will be posted to the Environmental Notice Bulletin (ENB), an official publication of the New York State Department of Environmental Conservation, to solicit public comment that may be submitted to the Secretary to the Commission. The lead agency must consider the comments submitted and prepare a final GEIS, taking into consideration the comments and information provided.

1.2 PURPOSE AND OBJECTIVES OF THE ENERGY STORAGE ROADMAP

Consistent with New York Codes, Rules and Regulation (NYCRR) 6 NYCRR §617.9(b)(5)(1), this section provides a concise description of: (1) the need and purpose of the Roadmap, and (2) the actions proposed to achieve the Roadmap goals. The framework and mechanisms under which the goals of the Roadmap would be achieved are detailed in the Roadmap. Accordingly, this section is not intended to be an exhaustive or definitive discussion of the Roadmap, but rather a targeted discussion of the Roadmap for the purposes of the GEIS, as required under the SEQRA.

Energy Storage Roadmap Background, Purpose and Need

The Roadmap is part of a broader suite of policies and initiatives designed to respond to a number of challenges facing the State's energy system. For example, while average residential electricity prices have fallen in recent years from $19.57 cents per kilowatt-hour (kWh) in January 2014 to $17.74 cents/kWh in January 2018, the State's residential electricity prices remain among the highest in the U.S. In New York City, which accounts for 60 percent of the State's energy consumption, the average electricity price in January 2018 was $20.20 cents/kWh.[4] In contrast, the State's per capita energy consumption was the lowest in the U.S. in 2015 (the most recent year for which data are available).

[4] Bureau of Labor Statistics. Average Energy Prices, New York-Newark-Jersey City-February 2018. Accessed on April 27, 2018 at: https://www.bls.gov/regions/new-york-new-jersey/news-release/averageenergyprices_newyorkarea.htm.

A further challenge is the State's large and aging energy infrastructure. For example, most of the State's transmission lines went into service before 1980[5] and two-thirds of the generating facilities are at least 30 years old.[6] To upgrade and/or replace just the State's transmission and distribution system to meet future energy demand is estimated to require more than $30 billion over the next ten years.[7] The scale of the State's transmission and distribution network, and the associated future investment need, is a reflection of a system designed to meet peak load demand that occurs only during a limited number of hours each year. To illustrate, the ratio of the average load in the State compared to the peak load is 55 percent.[8] For that reason, much of the State's energy system is underutilized most of the time. Energy storage can increase the efficiency and capacity factor of the States' energy grid by flattening peak loads, delay or avoid investments in expensive transmission and distribution assets, or increasing utilization of existing assets.

Changing climate is also expected to exacerbate existing infrastructure challenges. Extreme weather events, such as landslides, high winds, heavy precipitation, droughts, and wildfires, can inflict significant damage on the state's electricity generation, transmission, and distribution infrastructure. For example, Hurricane Sandy in 2012 left more than eight million customers without power.[9] Over longer timeframes, climate change is expected to decrease the efficiency of energy generation while increasing the demand for electricity, which may cause supply issues.[10] Energy storage can enhance the reliability and resilience of the grid. For example, deployment of energy storage within microgrids can allow critical facilities to continue operating during extreme weather events.[11]

Energy storage is also considered a critical need as the State strives to increase its reliance on renewable energy resources from approximately 24 percent in 2016 to 50 percent by 2030. As the share of renewable energy resources increases, energy storage can serve as a cost-effective mechanism to enable greater integration of intermittent renewable energy resources. Other states that have already achieved greater use of renewable energy resources, like California and Texas, have needed to curtail renewable resources due to over -generation and/or transmission

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[5] NYISO. 2018. 2018 Load & Capacity Data "Gold Book." Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2018-Load-Capacity-Data-Report-Gold-Book.pdf.

[6] NY State Energy Planning Board. 2015 New York State Energy Plan. Accessed on April 27, 2018 at: https://energyplan.ny.gov/.

[7] Ibid.

[8] Ibid.

[9] United States Government Accountability Office. Report to Congressional Requesters. Climate Change – Energy Infrastructure Risks and Adaptation Efforts. January 2014. Accessed on January 2, 2015 at: http://www.gao.gov/products/GAO-14-74.

[10] Ibid.

[11] NY-BEST. 2016. Energy Storage Roadmap for New York's Electric Grid. January. Albany, NY. Accessed on April 27, 2018 at: https://www.ny-best.org/sites/default/files/type-page/39090/attachments/NY-BEST%20Roadmap_2016_finalspreads.c.pdf.

constraints.[12] Energy storage can mitigate both these situations by storing excess generation or serving as congestion relief.

Energy Storage Roadmap Proposed Actions

Recognizing the multiple values of energy storage to the State energy system, Governor Cuomo announced a 1,500 MW energy storage goal for New York State by 2025 and directed the NYSDPS and NYSERDA to develop a roadmap to:

- Articulate a **path to deploy 1,500 MW** of energy storage by 2025;
- **Employ 30,000 New Yorkers** to establish the State as a home for this rapidly expanding clean technology 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; and
- Establish a secondary energy storage deployment **target for 2030**.

The Roadmap, includes an outline of market-supported policy, regulatory, and programmatic actions necessary to achieve the State's energy storage goals. Broadly, the policy, regulatory and programmatic actions are separated into seven categories and multiple sub-categories:

1. **Retail rate actions and utility programs.** Improving and modifying customer retail rates (delivery rates) and utility load management programs to send clearer price signals as to when peak reduction is most valuable to the system.
2. **Investor-owned utility (IOU) roles and business model.** Articulating the role and business model for IOUs to manage the full customer bill using assets such as storage including leveraging Non-Wires Alternatives (NWA) where third parties deploy assets that provide transmission and distribution relief to the utility, reduce capacity obligations on the utility or zone by reducing peak system load, and provide ancillary services to the wholesale market.
3. **Direct procurement.** Direct procurement approaches through utility NWAs, NYSERDA's Renewable Energy Certificates that can pair large scale renewables with energy storage, and through New York State leading by example through State procurement.
4. **Bridge incentives.** Recommending a market acceleration bridge incentive to accelerate the market learning curve and reduce costs. Staff recommends that an approximately $300 million bridge incentive, excluding any funding provided by Long Island Power Authority or Public Service Enterprise Group, be considered from existing approved funding sources. Staff estimates that this funding could build 500 MW or more of customer-sited (standalone or paired with on-site generation) and distribution/bulk sited storage.
5. **Cross-cutting actions.** Implementing a number of cross-cutting actions to reduce barriers including access to more granular system load data to target highest need locations on the

[12] Ibid.

electric system and moving toward more integrated transmission and distribution system planning.

6. **"Clean Peak" actions.** Enabling a cleaner peak through rate design, the market acceleration bridge incentive, REC procurements and developing a methodology for analyzing peaker plant operational and emission profiles on a unit-by-unit basis to determine best potential candidates for hybridization, repowering or replacement by storage.
7. **Wholesale market actions.** Presenting a number of actions to better enable storage participation in wholesale markets including dual market participation (providing distribution system and wholesale system services).

Budget and Funding

Under Governor Cuomo's January 2, 2018 proposal, the Governor proposed a commitment of at least $200 million from the New York Green Bank (NYGB) for storage-related investments to help drive down costs and to strategically deploy energy storage to where the grid needs it most. The Governor also directed NYSERDA to invest at least $60 million through storage pilots and activities to "reduce barriers to deploying energy storage, including permitting, customer acquisition, interconnection, and financing costs."[13] The Roadmap also indicates that bridge incentive funding is recommended to accelerate market adoption including, but not limited to, customer sited storage, distribution sited storage, and paired photovoltaic (PV) plus storage (either at a customer site or community distributed generation).[14]

1.3 PUBLIC BENEFITS OF ENERGY STORAGE ROADMAP

Consistent with 6 NYCRR §617.9(b)(5)(1), this section provides a concise description of the public benefits anticipated from the proposed actions described in **Section 1.2** for the Roadmap. The public benefits of pursuing the Roadmap should be considered in comparison to the cost of the "business as usual" scenario in which current programs are maintained and the electricity system develops in reasonably anticipated ways.

The overarching goal of the Roadmap is to accelerate the State energy storage market and increase the deployment of energy storage within the State's energy system. Greater deployment of energy storage and availability of such technologies would be expected to strengthen the benefits of REV and related initiatives like the CEF and the CES, as there will be greater certainty of the availability of value-added energy storage technologies. This deployment will make achieving the State's wider energy goals more likely, including but not limited to: making energy more affordable, increasing the amount of electricity generated by renewable energy resources, decreasing the State's dependence on fossil fuels and enabling customers to participate as active market participants.

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[13] Governor Cuomo Unveils 20th Proposal of 2018 State of the State: New York's Clean Energy Jobs and Climate Agenda. Accessed on April 27, 2018 at: https://www.governor.ny.gov/news/governor-cuomo-unveils-20th-proposal-2018-state-state-new-yorks-clean-energy-jobs-and-climate.

[14] NYSERDA/NYSDPS. 2018. New York State Energy Storage Roadmap and NYSDPS/NYSERDA Staff Recommendations.

If successful, a more robust energy storage market will contribute to a wide array of public benefits. **Exhibit 1-1** provides an example of the general public benefits that may accrue from greater deployment of energy storage.

EXHIBIT 1-1 SUMMARY OF POTENTIAL BENEFITS FOR THE ENERGY STORAGE ROADMAP

	PERSPECTIVE		
BENEFIT CATEGORY	RATE IMPACT MEASURES (RATES)	UTILITY COST (BILL)	SOCIETAL
ENERGY SYSTEM[15]			
Improved power quality and the reliable delivery of electricity to customers	✓	✓	✓
Improved stability and reliability of transmission and distribution systems	✓	✓	✓
Increased use of existing equipment, thereby deferring or eliminating costly upgrades	✓	✓	✓
Improved availability and increased market value of DER	✓	✓	
Increased use and improved value of renewable energy generation	✓	✓	✓
Cost reductions through capacity and transmission payment deferral	✓	✓	
PUBLIC HEALTH			
Increased use of renewable energy resources results in avoided emissions of GHG and criteria air pollutants.			✓
Increased air quality results in a reduction of state health care expenditures for treatment of asthma, acute bronchitis, and respiratory conditions.			✓
CLIMATE CHANGE			
Climate change is expected to increase air temperatures, in turn intensifying water cycles through increased evaporation and precipitation. Greater energy storage deployment can reduce the State's reliance on fossil fuel energy, aiding in the prevention of:[16]	✓	✓	✓
Increases in local flash and coastal flooding in the State.	✓	✓	✓
Increases in the frequency and intensity of extreme precipitation and extreme heat events in the State.	✓	✓	✓
Longer summer dry periods in the State, with lower summer flows in large rivers, lower groundwater tables, and higher river and in-stream water temperatures.	✓	✓	✓

[15] U.S. Department of Energy. Energy Storage. Office of Electricity Delivery & Energy Reliability. Accessed on April 27, 2018 at: https://www.energy.gov/oe/activities/technology-development/energy-storage.

[16] Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grahborn (Eds). 2011. Responding to Climate Change in New York State. Synthesis Report prepared for NYSERDA. Accessed on September 10, 2014 at: http://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/EMEP/climaid/ClimAID-synthesisreport.pdf.

BENEFIT CATEGORY	PERSPECTIVE		
	RATE IMPACT MEASURES (RATES)	UTILITY COST (BILL)	SOCIETAL
ECOSYSTEM SERVICES			
Land and water use impacts will fall relative to the business as usual scenario to the extent that greater energy storage deployment increases the use of renewable energy resources in lieu of investment in fossil fuel sources or expansion of the State's transmission and distribution system.			✓
ECONOMIC BENEFITS			
Increased manufacturing of renewable energy equipment.			✓
Jobs and revenue creation.			✓
Effects of spending throughout local economy.			✓
TECHNOLOGICAL INNOVATION			
Investment in the energy storage market spurred by the Proposed Action is expected to contribute to significant cost reductions for the underlying technology.	✓	✓	

1.4 LOCATION OF ACTION

The Roadmap, in conjunction with REV and CEF, is intended to change the ways in which energy is valued, distributed, managed, and used across the entire energy industry. As such, the location of the action is the entire State of New York. Subsequent chapters use the State of New York as the analytic study area.

1.5 RELATIONSHIPS TO OTHER PLANS AND PROGRAMS

The Roadmap is part of a broader suite of policies and initiatives known as REV, a comprehensive strategy to shift the State's energy market from one characterized by centralized, large and discrete, supply resources, to a market that values distributed renewable energy sources. In the order initiating the REV proceeding, the Commission identified six objectives for the REV initiative:

- Enhanced customer knowledge and tools that will support effective management of their total energy bill;
- Market animation and leverage of ratepayer contributions;
- System-wide efficiency;
- Fuel and resource diversity;
- System reliability and resiliency; and,
- Reduction of carbon emissions.

On a track parallel to the REV, the Commission initiated a process to update the State's portfolio of clean energy programs and explore opportunities for greater use of market-based mechanisms to support clean energy development. The result of this effort was the CEF consisting of four program portfolios, designed to collectively accelerate and expand investment in clean energy technologies:

- **Market Development** to reduce costs and accelerate customer demand for energy efficiency and other behind-the-meter clean energy solutions, and increase private investment. This portfolio will provide financial support, technical knowledge, data, and education to customers and service providers to accelerate demand for clean energy solutions and will train an advanced workforce able to fill new jobs in the sector. Under this portfolio NYSERDA has initiated market development efforts to reduce the soft costs of energy storage.[17]
- **NY-Sun** to provide long-term certainty to New York's growing solar market and to lower the costs for homeowners and businesses investing in solar power. This portfolio will make solar energy more affordable and accessible for residential and commercial customers, with a goal of bringing solar to 150,000 new homes and businesses by 2020.
- **NYGB** to partner with private financial institutions to accelerate and expand the availability of capital for clean energy projects. This portfolio will increase confidence in lending for clean technologies through a total investment of $1 billion.
- **Innovation and Research** to invest in cutting edge technologies that will meet increasing demand for clean energy. This portfolio will drive clean tech business growth across five key opportunity areas: smart grid technology, renewables and DERs, high performance buildings, transportation, and cleantech startup and innovation development. Under this portfolio NYSERDA has developed the *Clean Energy Fund Investment Plan: Renewables Optimization Chapter* which is aimed at reducing hardware costs (e.g., balance-of-system costs), and improving their efficiency, energy and power density, and thermal stability performance.[18]

To further accelerate the State's shift away from fossil fuels towards greater reliance on renewable energy resources, the State has initiated a series of additional efforts to further support such development, of which the following have potential for substantive interactions with the Roadmap:

- **Charge NY** is helping the State get ready to accommodate more than 30,000 plug-in electric vehicles (EVs) by 2018 and up to one million by 2025. To support these new EVs, up to 10,000 EV charging stations will be installed across the State by 2021.[19] To further support the EV market, in March 2017, Governor Cuomo launched a $70 million EV rebate and outreach initiative to encourage the growth of clean and non-polluting EV use in the State and promote the reduction of carbon emissions in the transportation

[17] NYSERDA. 2017. Clean Energy Fund Investment Plan: Renewables Optimization Chapter. Portfolio: Innovation & Research. Matter Number 16-00681, In the Matter of the Clean Energy Fund Investment Plan. Revised November 1.

[18] Ibid.

[19] NYSERDA. Electric Car Resources in New York State. Accessed on April 27, 2018 at: https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY.

sector. The "Drive Clean" rebates are available to all New York residents who buy eligible cars through participating new car dealers.[20]

- **NY Prize** is a $40 million program to help communities create microgrids - standalone energy systems that can operate independently in the event of a power outage.[21] As community-based microgrids often include energy storage, NY Prize is expected to result in new opportunities for energy storage technologies.
- **DER Roadmap** outlines a path for developing a series of market enhancements to open NYISO's wholesale marketplace to DER. DER is a resource, or a set of resources, typically located on an end-use customer's premises that can provide wholesale market services but are usually operated for the purpose of supplying the customer's electric load. Opportunities for DER participation are currently limited within NYISO's Energy, Ancillary Services, and Capacity markets.
- **Clean Energy Standard.** The Renewable Energy Standard (RES) is a program requiring utilities and energy suppliers (also referred to as load serving entities, or LSEs) to procure renewable energy credits (RECs), associated with new renewable energy generation resources, for their retail customers.[22] The present REC targets established by the RES is more than two times the level of large-scale renewable generation that was procured through the State's prior program, the Renewable Portfolio Standard (RPS).[23]
- **Offshore Wind Roadmap**.[24] In January 2017, Governor Cuomo proposed a commitment to develop up to 2,400 MW of offshore wind power by 2030. In 2018, Governor Cuomo called for at least 800 MW of offshore wind power to be procured between two solicitations in 2018 and 2019. To achieve the Governor's commitment, NYSERDA launched a process to consider offshore wind procurement options through a filing in January 2018 with the Commission.

[20] Governor Cuomo Launches $70 Million Electric Car Rebate and Outreach Initiative. March 21, 2017. Accessed on March 21, 2017 at: https://www.governor.ny.gov/news/governor-cuomo-launches-70-million-electric-car-rebate-and-outreach-initiative.

[21] NYSERDA. NY Prize. Powering a New Generation of Community Energy. 2014. Accessed on December 30, 2014 at: http://www.nyserda.ny.gov/All-Programs/Programs/NY-Prize.

[22] NYSERDA. Clean Energy Standard. Accessed on April 27, 2018 at: https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Standard.

[23] NYDPS. 2016. Clean Energy Standard Order. August 1. Accessed on April 27, 2018 at: http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7b44C5D5B8-14C3-4F32-8399-F5487D6D8FE8%7d.

[24] NYSERDA. New York State Offshore Wind. Accessed on April 27, 2018 at: https://www.nyserda.ny.gov/All%20Programs/Programs/Offshore%20Wind.

CHAPTER 2 | THE ELECTRIC INDUSTRY IN NEW YORK STATE

Consistent with New York Codes, Rules and Regulation (NYCRR) 6 NYCRR §617.9(b)(5)(ii) of New York's State Environmental Quality Review Act (SEQRA), this chapter provides baseline information on New York State's (the State's) current electric energy industry. The background information presented in this chapter is intended to assist with understanding the potential impacts of the proposed Energy Storage Roadmap (the Roadmap). **Chapter 3** provides information on the environmental setting, which serves as a baseline description of existing environmental conditions. Together, the information presented in **Chapter 2** and **Chapter 3** provides a baseline against which the impacts of changes in the energy industry from the Roadmap are evaluated and compared in **Chapter 5** through **Chapter 10**.

This chapter is organized into five sections, including:

- **Section 2.1** provides a short historical overview of the electric industry in the State;
- **Section 2.2** introduces the existing regulatory environment underlying the State's electricity industry;
- **Section 2.3** discusses historical trends in electricity demand;
- **Section 2.4** describes the present electricity system, including the State's generation, transmission, and distribution systems; and,
- **Section 2.5** discusses the current state of the energy storage market.

2.1 HISTORY OF THE ELECTRIC INDUSTRY

For most of its history, the basic design of the electric grid has remained essentially the same. Electricity is generated at central stations, transmitted long distances via high-voltage lines, then stepped down in voltage and delivered to customers through local distribution systems. The system was built to serve the instantaneous demand of customers, with a reserve margin to accommodate peak demand, plant outages and other contingencies. The generation of power was effectively a natural monopoly, under which utilities owned, operated, and coordinated power generation. Electric service was then "bundled" to retail customers in "franchise" areas through cost-based rates regulated by the New York Public Service Commission (the Commission).[25] In the 1990s, the State's electricity industry was dominated by seven large Investor-Owned Utilities (IOUs), including Central Hudson Gas & Electric Company (CHG&E), Consolidated Edison Company of New York, Inc. (Con Edison), Long Island Lighting Company (LILCO), New York

[25] Tierney, Susan. 2010. The New York Independent System Operator. A Ten Year Review. Analysis Group. Boston, Massachusetts. April 12, 2010. Accessed on May 2, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Other_Reports/Other_Reports/Tierney_-_Analysis_Group_-_NYISO_10-Year_Review_-_4-12-2010_FINAL.pdf.

State Electric & Gas Company (NYSEG), Niagara Mohawk Power Corporation (NIMO), Orange & Rockland Company (O&R), and Rochester Gas & Electric Company (RG&E). Each of these companies was vertically integrated, owning and operating power plants, transmission facilities, and distribution systems.

From the 1970s through the 1990s, a number of factors led to a restructuring of the vertically-integrated electric industry, including, but not limited to, the energy price shocks of the 1970s, cost overruns and safety issues with nuclear plants, and advancements in energy-related technologies. In response to these factors, the State, along with 13 other states, initiated efforts in the 1990s to restructure the electricity industry, with the goal of increasing market competition and improving the operation of electricity industries to improve energy delivery, reliability, and safety.[26]

Following the issuance of Order 96-12 in Case 94-E-0952 (the Competitive Opportunities Bypass proceeding) in 1996, the IOUs generally agreed, in individual proceedings, to divest, most of their generation assets.[27] While the IOUs retained the function of delivering energy (e.g., distribution) and a competitive wholesale market for electricity was developed, Energy Service Companies (ESCOs) were subsequently allowed to sell energy directly to retail energy consumers.[28] As a result State electricity consumers today can choose their energy supplier, an ESCO or their local IOU, both of which purchase electricity from generators who are mostly independent of the IOU.[29]

To facilitate the State's electricity restructuring and respond to the Federal Energy Regulatory Commission's (FERC) mandate that states provide fair and open access to state electrical grids, the New York Independent System Operator (NYISO) was created in 1999.[30] NYISO is a not-for-profit corporation governed by a ten member board of directors. Concurrent with its creation, NYISO assumed operational control of the State's bulk power transmission system and the dispatch of generation in 1999. In this manner, NYISO became the sole administrator for the State's wholesale electricity market.

In the wake of the 2003 blackout, which occurred across parts of the Midwest and the Northeast U.S. and Ontario, Canada, the U.S. Congress passed a number of major industry changes through the Energy Policy Act of 2005 (EPAct). Of particular relevance, the EPAct expanded FERC's authority to include ensuring the reliability of high voltage interstate transmission systems

[26] Borenstein, Severin and Bushnell, James. The U.S. Electricity Industry after 20 Years of Restructuring. Energy Institute at Haas, Revised May 2015. Accessed on May 2, 2018 at: https://ei.haas.berkeley.edu/research/papers/WP252.pdf.

[27] NYISO. 2014. Power Trends 2014: Evolution of the Grid. Accessed on May 2, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/ptrends_2014_final_jun2014_final.pdf.

[28] An ESCO is a company permitted by the New York Public Service Commission to offer electricity and/or natural gas supply to customers in New York State; ESCOs do not own or operate the distribution and transmission systems.

[29] NYSPSC. 2018. *About Power to Choose* – The NYS Public Service Commission's Consumer Web Site. Accessed on May 2, 2018 at: http://www3.dps.ny.gov/W/AskPSC.nsf/All/FF35A24303B7CDFF8525816000555A38?OpenDocument.

[29] NYISO. 2018. NYISO Website page "Who We Are: History." Accessed on May 2, 2018 at: https://home.nyiso.com/who-we-are/.

through mandatory reliability standards.[31] Under the EPAct, regional, state and local reliability standards must be as stringent as the federal standards, which are proposed by the North American Electric Reliability Corporation and adopted by FERC, as warranted. In New York State, reliability rules are established by several regulatory entities, including the New York State Reliability Council (NYSRC) and the Northeast Power Coordinating Council (NPCC), and are reviewed and adopted, as appropriate, by the Commission.

2.2 REGULATORY ENVIRONMENT

New York State's electricity industry is regulated by a collection of federal and state statutes and authorities. Authorized under the Federal Power Act (FPA) and major amendments thereafter, FERC regulates the transmission and wholesale sale of electricity (and of natural gas for resale) in interstate commerce. FERC also reviews proposals to build liquefied natural gas (LNG) terminals and interstate natural gas pipelines as well as licensing hydropower projects.[32]

Within the State, primary oversight of the electricity industry is maintained by the Commission. Founded in 1907, the Commission regulates the State's electric, gas, steam, telecommunications, and water utilities, and is charged by law with responsibility for setting just and reasonable rates and ensuring the provision of safe and adequate service by the utilities it regulates.[33]

Originally enacted on July 26, 1976, the New York Energy Law has been amended several times since 1976, expanding or revising authorized areas of scope. Of particular relevance is §6.104, which requires the State Energy Planning Board (the Board) to develop and adopt a state energy plan every four years, or more frequently if required. The Board initiated development of the State's first energy plan in March 2001 and since then has issued a state energy plan in 2002 and 2009. As discussed in **Chapter 1**, the 2015 New York State Energy Plan (2015 State Energy Plan) describes the coordination of agencies required to advance the State's goals, namely to:

- Generate 50 percent of the State's electricity from renewable resources by 2030;
- Reduce greenhouse gas emissions from 1990 levels by 40 percent by 2030; and
- Decrease energy consumption in buildings by 23 percent from 2012 levels by 2030.[34]

The 2015 State Energy Plan also incorporates progress made to date on implementation of Reforming the Energy Vision (REV) policies, including the creation of the Clean Energy Fund (CEF), and the launch of the NY Green Bank (NYGB). The plan is organized around the following long-term goals:

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[31] FERC. FERC & EPAct 2005 Meeting Milestones. Accessed on May 2, 2018 at: http://www.ferc.gov/legal/fed-sta/ferc-and-epact-2005.pdf.

[32] FERC. What FERC Does. Last Updated May 24, 2016. Accessed on May 2, 2018 at: http://www.ferc.gov/about/ferc-does.asp.

[33] New York State Energy Planning Board. 2012. New York State Transmission and Distribution Systems Reliability Study and Report. August. Accessed on May 2, 2018 at: http://nyssmartgrid.com/wp-content/uploads/2012/09/reliability-study.pdf.

[34] NYISO. 2015. 2015 New York State Energy Plan: The Energy to Lead. New York State Energy Planning Board. Accessed on May 2, 2018 at: https://energyplan.ny.gov/Plans/2015.aspx.

- Drive system-wide savings that benefit customers and encourage private investment in distributed clean energy solutions that help customers better manage their energy bill and reduce fuel costs.
- Animate clean energy markets through strategies to attract private sector capital investment, and support clean transportation alternatives, enabling the State to meet its aggressive environmental energy goals and transition to a clean energy economy.
- Complement and further other resiliency efforts by promoting the development of clean, local energy resources that strengthen and improve the reliability of the grid.
- Provide the State with the ability to operate its energy system more efficiently and at a lower cost, and enable utilities to chart a vibrant, but changing, future.
- Help communities disproportionately impacted by air pollution pursue a clean energy future.
- Guide the development and implementation of programs that will help fund and facilitate the clean transportation system of the future while maintaining existing infrastructure. Build an integrated energy network able to harness the combined benefits of the central grid with clean, locally generated power.[35]

The CEF, for example, is designed to reduce ratepayer collections, drive economic development, and accelerate the use of clean energy and energy innovation by reshaping the State's energy efficiency, clean energy, and energy innovation programs.[36] These efforts are organized into four "portfolios":

1) Market Development – reduce costs and accelerate customer demand for energy efficiency and other behind-the-meter clean energy solutions, and increase private investment.
2) NY-SUN – provide long-term certainty to the State's growing solar market and lower costs for homeowners and businesses investing in solar power.
3) NYGB – partner with private financial institutions to accelerate and expand availability of capital for clean energy projects.
4) Innovation and Research – invest in cutting-edge technologies that will meet increasing demand for clean energy.[37]

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[35] NYISO. 2015. *Overview* - The 2015 New York State Energy Plan: The Energy to Lead. Accessed on May 2, 20187 at: https://energyplan.ny.gov/Plans/2015.aspx.

[36] NYSERDA. 2018. Clean Energy Fund Website. Accessed on May 2, 2018 at: https://www.nyserda.ny.gov/About/Clean-Energy-Fund.

[37] NYSERDA. Reforming the Energy Vision: Clean Energy Fund, Fact Sheet. Accessed on May 2, 2018 at: file:///C:/Users/NScherer/Downloads/clean-energy-fund-fact-sheet.pdf.

2.3 TRENDS IN ELECTRICITY DEMAND

The U.S. Energy Information Administration (EIA) defines energy consumption as simply "the use of energy as a source of heat or power or as a raw material input to a manufacturing process."[38] Peak demand is one measure of consumption, defined as "the maximum load during a specified period of time."[39] Peak demand takes into account the rate of consumption, or the time period over which a certain amount of power is consumed. For example, 1 kilowatt-hour (kWh) of consumption could result from using one 100 Watt bulb for ten hours, or ten 100 Watt bulbs for one hour. While these represent the same level of energy consumption, the peak demand is different (i.e., 100 Watts versus 1,000 Watts), with the latter requiring ten times more system capacity. According to NYISO, peak demand, also known as peak load, is usually measured hourly. Peak demand is an important factor because reliability standards, such as reserve requirements, are based on projected peak demand.

U.S. electricity demand has been falling since 2010; electricity consumption was 16 percent lower in 2017 than it was in 2010.[40] Electricity consumption in the State has declined more dramatically over this period: electricity consumption in the State was 27 percent lower in 2017 than it was in 2010. While the year to year consumption has been variable, the overall trend is clear: electricity consumption in the State has been declining since 2001. For example, electricity consumption in the State in 2017 is almost half (46 percent lower) consumption in 2001. According to the EIA, in 2015, the State has the lowest total energy consumed per capita in the U.S., but the seventh highest average residential retail price of electricity (as of February 2018).[41,42]

Looking forward, however, U.S. energy consumption overall is projected to grow at 0.4 percent per year from 2018 to 2028. In contrast, overall energy consumption in the State is projected to continue to *decline* at 0.14 percent per year over the same time period.[43,44] Beyond 2028 for the State, forecasted overall demand grows modestly. Peak demand is also forecasted to decrease at an average annual rate of 0.13 percent from 2018 to 2028.

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[38] EIA. 2018. EIA Glossary. Accessed on May 2, 2018 at: http://www.eia.gov/tools/glossary/index.cfm?id=E.

[39] EIA. 2018. EIA Glossary. Accessed on May 2, 2018 at: http://www.eia.gov/tools/glossary/index.cfm?id=P. Also, NYISO indicates that peak demand, also known as peak load, is usually measured hourly. NYISO. 2018. 2018 Power Trends: New York's Dynamic Power Grid. Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2018-Power-Trends.pdf.

[40] EIA. 2018. Total Consumption (Btu) for all sectors. Accessed on May 2, 2018 at: https://www.eia.gov/electricity/data/browser.

[41] EIA. Rankings: Total Energy Consumed per Capita, 2015 (million Btu). Accessed on May 2, 2018 at: https://www.eia.gov/state/rankings/?sid=NY#/series/12.

[42] EIA. Rankings: Average Retail Price of Electricity to Residential Sector, January 2018 (cents/kWh). Accessed on May 2, 2018 at: https://www.eia.gov/state/rankings/?sid=NY#/series/31.

[43] EIA. 2018. Annual Energy Outlook 2018. Accessed on May 2, 2018 at: https://www.eia.gov/outlooks/aeo/.

[44] NYISO. 2018. 2018 Load & Capacity Data "Gold Book." Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2018-Load-Capacity-Data-Report-Gold-Book.pdf.

In addition to annual energy demand, which provides a measure of overall electricity consumption, it is important to consider annual peak demand, which measures the maximum amount of electricity a system is required to deliver. While peak demand represents only a small fraction of a year's overall power consumption, it is a significant system factor because reliability standards are based on projected peak demand.

As an example, when comparing 1998 to 2013, the new peak set in 2013 is nearly 5,800 megawatts (MW) higher. Within a span of six months in 2013, the State set two seasonal records for peak electric demand; an all-time record peak of 33,956 MW set during a summer heat wave in July 2013 and a record winter peak of 25,738 MW set during the extreme cold that accompanied the January 2014 "polar vortex."[45]

During both of these record setting demand events, the State's electric system maintained reliability without resorting to emergency measures that reduce or curtail electric service to customers; however, these events underscored the unique challenge associated with peak electricity demand. To meet peak demands under the State's current centralized generation system, the State utilizes a variety of mechanisms. For example to address the summer peak demand in 2013, the State used demand response programs and imported electricity from the Ontario and PJM Interconnection LLC (PJM) regions. To address the 2013/2014 winter record peak demand, the State imported natural gas from New England and began using oil for generation to relieve natural gas constraints, and as the relative cost of oil-fired generation fell below natural gas-fired generation.[46]

Following those record peak demand periods, peak demand has declined starting in 2017. In 2017, the annual peak was 7.4 percent below the peak in 2016.[47] In fact, for the first time, peak demand is forecasted to *decrease* at an annual average rate of 0.13 percent from 2018 to 2028.

Geographical Distribution of Electricity Demand

In 2017, NYISO introduced the concept of the State's "Tale of Two Grids" – describing the significant differences between electricity consumption and demand between upstate and downstate areas.[48] In 2017, downstate areas, defined as New York Control Area (NYCA) load zones H through K, represented almost half of the State's total electricity consumption. Additionally, 2017 peak summer demand in New York City and Long Island exceeded that of the rest of the State. Moreover, while upstate generates more renewable energy resources, transmission constraints limit the ability to supply more of this clean energy to downstate customers.

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[45] NYISO. 2018. 2018 Power Trends: New York's Dynamic Power Grid. Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2018-Power-Trends.pdf.

[46] NYISO. 2014. Power Trends 2014: Evolution of the Grid. Accessed on May 2, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/ptrends_2014_final_jun2014_final.pdf.

[47] NYISO. 2018. 2018 Power Trends: New York's Dynamic Power Grid. Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2018-Power-Trends.pdf.

[48] Ibid.

2.4 THE PRESENT ELECTRIC SYSTEM

This section provides information on each of the components of the electrical system in the State: generation, transmission and distribution.

- **Generation** consists of the many generating units scattered throughout the State and the associated facilities typically located at a generating station, such as step-up transformers, controls, generation leads, switch gear, emissions control technologies (for example, selective catalytic reduction technologies, flue-gas desulfurization technologies, fabric filers, electrostatic precipitators), etc.
- **Transmission** includes the facilities that transport electricity at high voltage levels from the generation facilities (including those located outside the state) to the distribution system. It includes the transmission (and the sub-transmission) wires, poles, cables, substations and switching stations, underground transmission equipment, etc.
- **Distribution** operates at lower voltage levels, carrying electricity delivered by the transmission system to customer end-users. It is primarily composed of distribution wires, cables, poles, substations, regulators, meters, and capacitor banks.

While some loads can be served directly from the generation facilities, and others served from the transmission system, for most services the entire system serves as an integrated unit.

Generation

This section provides an overview of the existing electricity generation system serving the State, including an overview of existing power plants and capacity, as well as planned generation projects and projected capacity. The section continues with a discussion of the State's generation system reliability and imports and exports.

Existing Power Plants and Capacity

Generators sell electricity to wholesale customers through bilateral contracts or the wholesale markets operated by NYISO.[49] Following electricity restructuring, the majority of former utility-owned generation capacity is now owned by more than two dozen independent power producers (IPP). In addition, the New York Power Authority (NYPA), the country's largest state public power organization, supplies up to one-quarter of the State's total electricity demand. NYPA operates 16 generating facilities, including two of the State's major hydroelectric facilities (the Niagara Power Project and the St. Lawrence-FDR Power Project), and over 1,400 circuit-miles of transmission lines.[50]

[49] DPS and Ecology and Environment Inc. 2013. Indian Point Contingency Plan Final Generic Environmental Impact Statement. Prepared for New York State Public Service Commission. July 2013. Accessed on May 2, 2018 at: http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B4FEE54FA-74C8-4954-B76F-ECDEEEC16266%7D.

[50] New York Power Authority. NYPA website, "About NYPA." Accessed on May 2, 2018 at: http://www.nypa.gov/about.html and http://www.nypa.gov/Generation/default.htm.

As of March 2018, there were more than 700 operational electric generating units in the State.[51]

Exhibit 2-1 details the State's power generation and capacity by fuel type. In 2017, over a third of the State's electric generation came from dual-fuel (gas and oil) facilities. Nuclear generation accounted for just under a third, and hydropower followed at 23 percent of total state generation. Wind facilities produced three percent of total electricity generation in 2017.[52] While fossil fuels are responsible for 66 percent of the State's generating capacity, they are only responsible for 39 percent of its production. On the other hand, nuclear accounts for 14 percent of the State's generating capacity and 32 percent of its production, and hydropower accounts for 11 percent of generating capacity, but 23 percent of its production.[53] Overall, 29 percent of energy generation for the State came from renewable sources in 2017, up from 25 percent in 2016.[54] In 2016, for the first time, the State obtained more than one million megawatt-hours (MWhs) of electricity from solar generation, and 84 percent of that power came from distributed sources such as rooftop solar panels.[55]

Various factors can affect the mix of fuels used to generate electricity. For example, renewable portfolio standards adopted by the Commission set specific targets for a portion of renewable energy sources, while policy goals or environmental regulations may require power plants burning fossil fuels to meet certain emissions standards by limiting production and/or installing pollution controls. Over the past decade, notable changes in the State's fuel mix include increases in generation fueled by natural gas and the emergence of wind-powered generation. In particular, the portion of the State's generating capacity from gas and dual-fuel (gas and oil) facilities grew from 47 percent in 2000 to 57 percent in 2017, while the segment of generating capability from power plants fueled solely by oil dropped from 11 percent in 2000 to six percent in 2017. As discussed earlier, the expansion of dual-fuel generation may be driven in part by the volatility of natural gas prices. In addition, dual-fuel plants play a role in meeting reliability requirements. During periods of high electricity usage, reliability rules require many of these plants to switch to burning oil. Outside of peak times, generators can choose to run on whichever fuel is less expensive.[56]

[51] NYISO. 2018. 2018 Load & Capacity Data "Gold Book." Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2018-Load-Capacity-Data-Report-Gold-Book.pdf.

[52] Ibid.

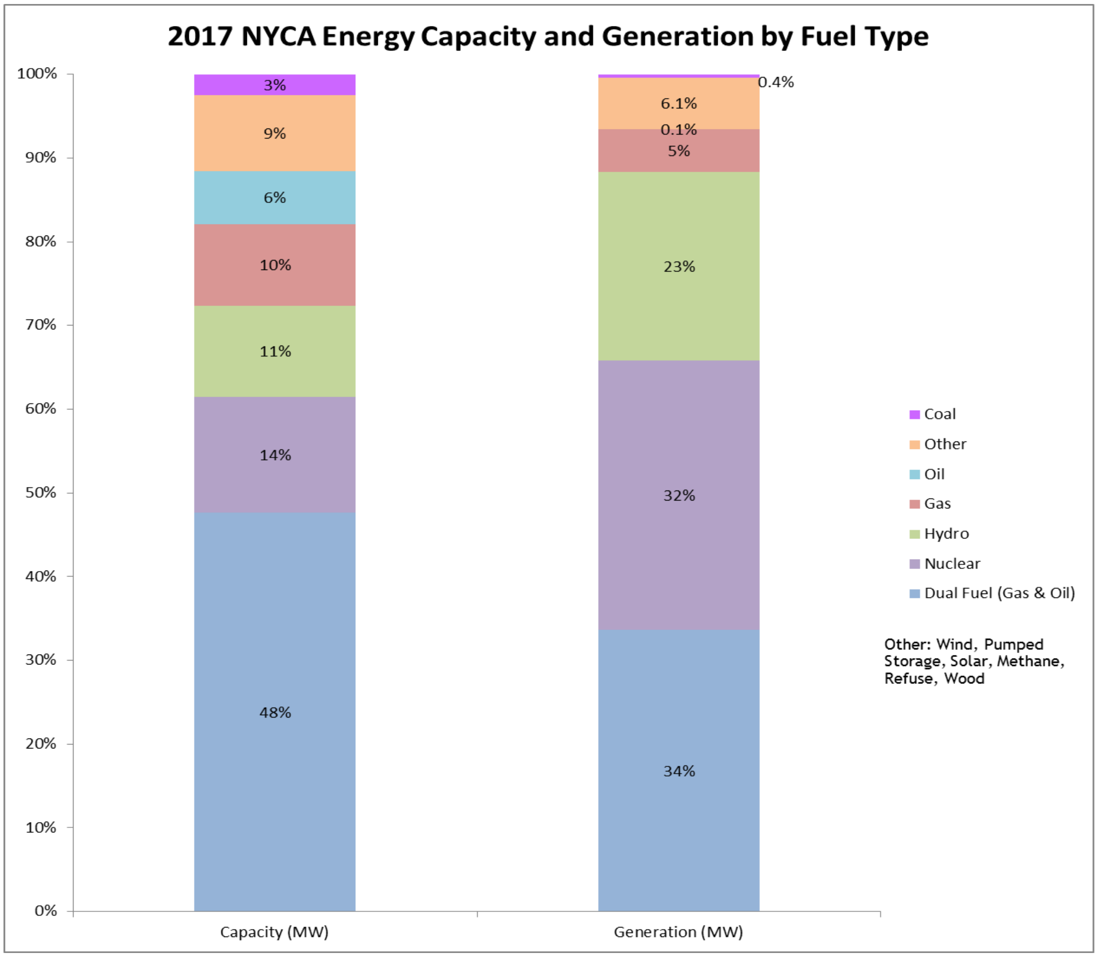
[53] Ibid.

[54] EIA. 2018. New York State Profile Overview. Accessed on May 2, 2018 at: https://www.eia.gov/state/?sid=NY

[55] EIA. 2018. State Profile and Energy Estimates: New York. Accessed on May 2, 2018 at: https://www.eia.gov/state/?sid=NY.

[56] NYISO. 2018. 2018 Power Trends: New York's Dynamic Power Grid. Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2018-Power-Trends.pdf.

EXHIBIT 2-1 NEW YORK STATE CAPACITY AND GENERATION BY FUEL TYPE[57]



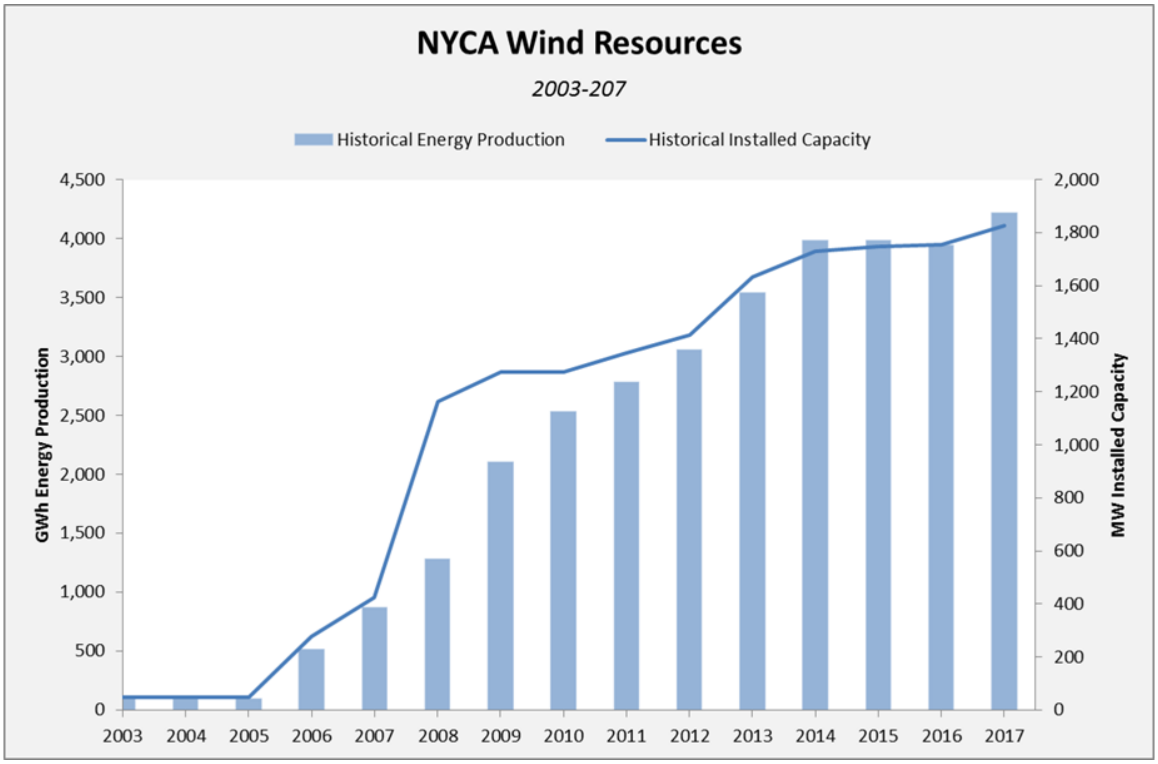
Note: Percentages represent 2018 NYCA summer capability and 2017 NYCA generation.

Virtually non-existent in 2000, wind power currently (2017) accounts for approximately five percent of the State's generating capability (**Exhibit 2-2**). In contrast, generation from power plants using coal declined from 11 percent in 2000 to three percent in 2017. Generation from nuclear power plants and hydroelectric facilities, however, have remained relatively constant since 2000, each accounting for approximately 14 and 15 percent of total capacity over the years, respectively.[58]

[57] NYISO. 2018. 2018 Load & Capacity Data "Gold Book." Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2018-Load-Capacity-Data-Report-Gold-Book.pdf.

[58] Ibid.

EXHIBIT 2-2 HISTORICAL WIND INSTALLED CAPACITY AND ENERGY PRODUCTION; 2003-2017[59]



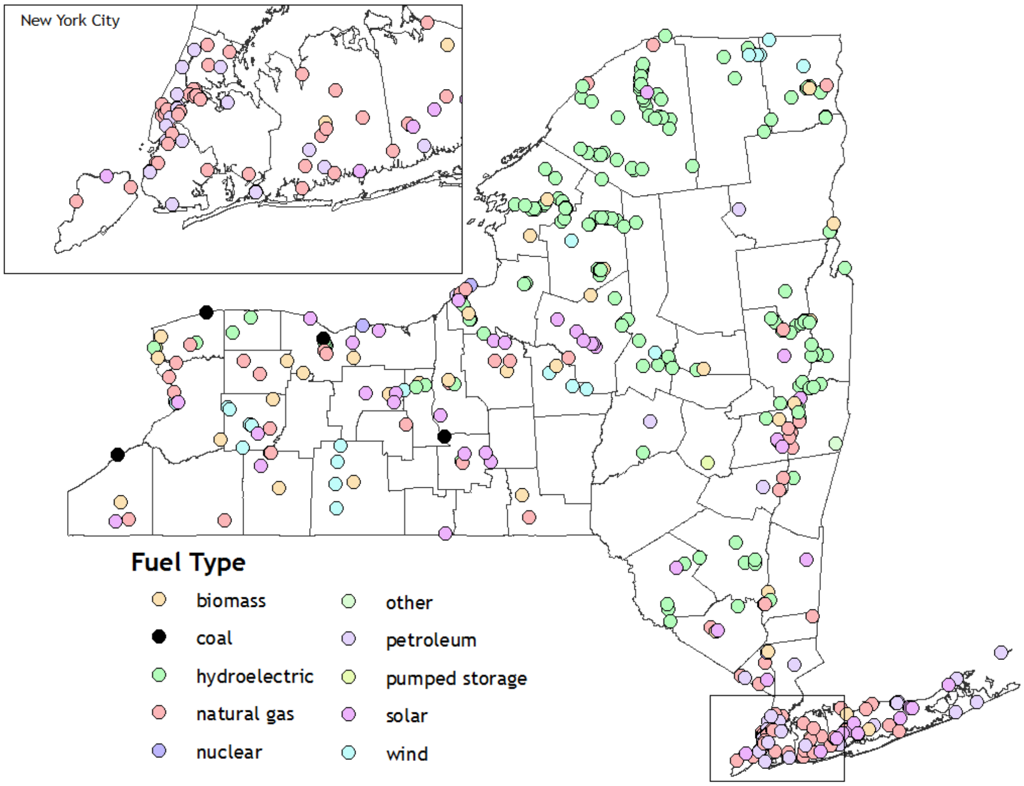
While the State has a relatively diverse mix of generation resources, supply is less diverse when viewed at the regional level (see **Exhibit 2-3**). For example, a majority of the State's electric demand is situated downstate, whereas most of the state's power supplies (and particularly the sources with historically lower operating costs, such as hydroelectricity and nuclear power) are located upstate; downstate uses 66 percent of the State's energy (70 percent of which comes from fossil fuels), but generates only 53 percent of the State's energy. This geographical variation in supply coupled with stringent air quality regulations, transmission limitations, and reliability standards means natural gas is used to meet the high levels of electricity demand generated in the downstate region (New York City and Long Island).[60,61]

[59] Ibid.

[60] NYISO. 2018. 2018 Power Trends: New York's Dynamic Power Grid. Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2018-Power-Trends.pdf.

[61] However, many of these units are also capable of using oil when necessary, which affords some level of fuel diversity and reliability benefits to the system.

EXHIBIT 2-3 LOCATION OF GENERATION BY FUEL TYPE, 2016-2017[62]

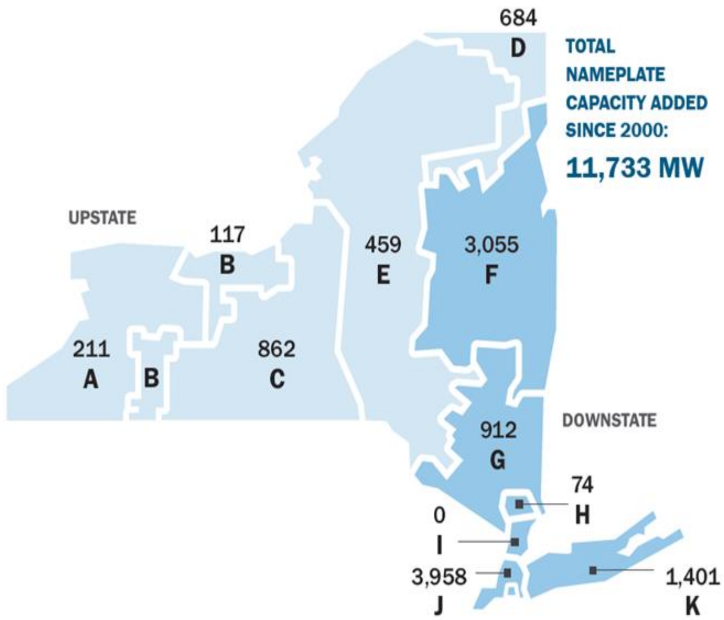


Since 2000, private power producers and public power authorities added more than 11,846 MW of generating capacity in the State (30 percent of the overall total generation capacity), compared to total retirements of nearly 7,000 MW (based on summer capability periods) over the same timeframe. Added generation primarily came from wind-powered and gas-fueled facilities, while retirements primarily came from the State's coal generation fleet. Over 80 percent of the new generation is located in New York City, Long Island, and in the Lower Hudson Valley – the regions of the State where power demand is greatest. Location-based pricing and regional capacity requirements of the State's wholesale electricity markets encourage investments in areas where the demand for electricity is highest.[63] **Exhibit 2-4** shows the distribution of new generation in the state since 2000.

[62] EIA. 2018. Power Plants. April 19. Accessed on May 7, 2018 at: https://www.eia.gov/maps/layer_info-m.php.

[63] NYISO. 2018. 2018 Power Trends: New York's Dynamic Power Grid. Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2018-Power-Trends.pdf.

EXHIBIT 2-4 NEW GENERATION IN NEW YORK STATE: 2000-2018[64]



The State's generation fleet is shifting as older facilities are retired and new renewable sources are developed. Nearly 60 percent of the generating capacity in the State is at least 30 years old. Steam turbines fueled by natural gas and/or oil have an average age of more than 40 years, while combined cycle units fueled by natural gas have an average age of little more than a decade.[65] The average of the State's hydropower facilities is over 50 years; however, NYPA recently modernized several major hydropower projects.[66] Renewable power projects such as wind and solar units are among the State's newest facilities. In January 2018, NYSERDA published its Offshore Wind Master Plan, a comprehensive roadmap to develop offshore wind capacity that would meet the State's goal of 2,400 MW of offshore wind energy generation by 2030, to supply Long Island and New York City (whose consumption accounts for 45 percent of the State's annual electricity use).[67] They also filed an Offshore Wind Policy Options Paper, which outlines the process for offshore wind procurement options, and addresses the options for addressing the

[64] Ibid.

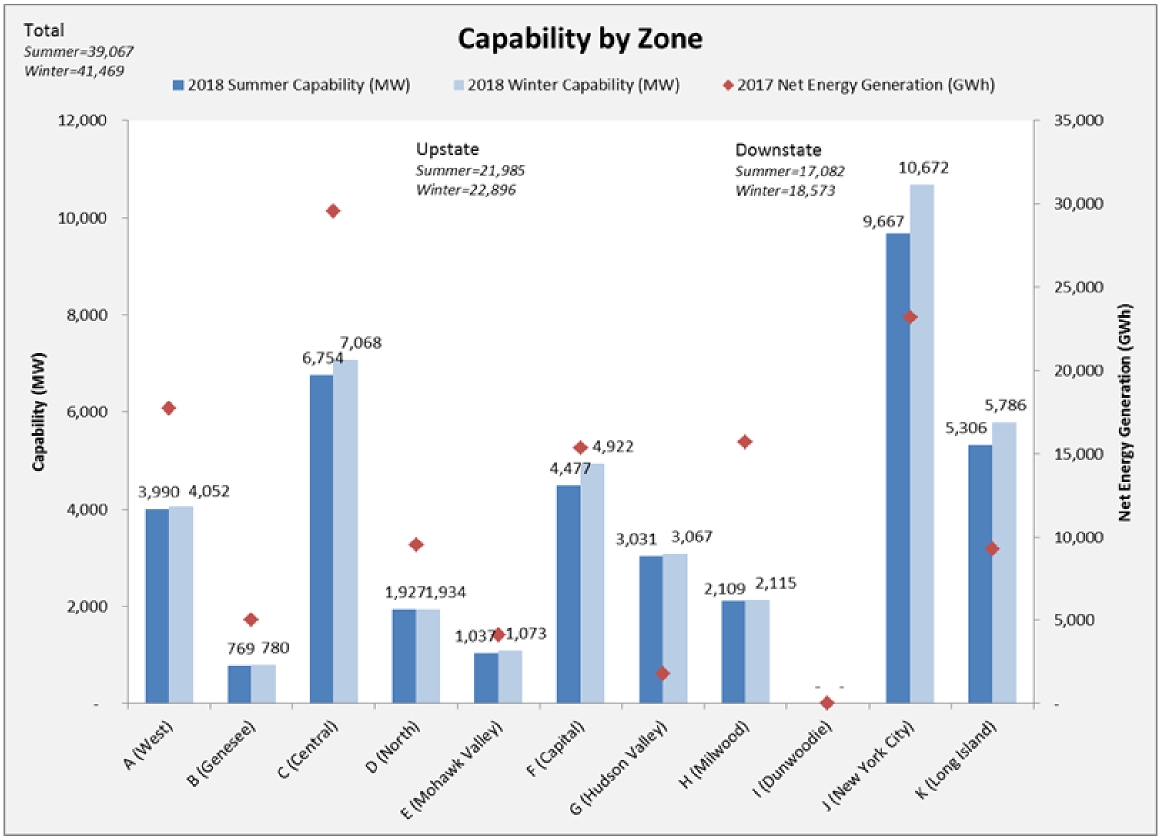
[65] Ibid.

[66] New York Power Authority. NYPA website, "NYPA Generating Facilities." Accessed on May 9, 2018 at: https://www.nypa.gov/power/generation/all-generating-facilities.

[67] NYSERDA. 2018. New York State Offshore Wind Master Plan: Charting a Course to 2,400 Megawatts of Offshore Wind Energy. NYSERDA Report 17-25. January 2018. Accessed on May 9, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Biomass-Solar-Wind/Master-Plan/Offshore-Wind-Policy-Options-Paper.pdf.

policy issues pertinent to the successful deployment of offshore wind at a level that meet's the State's goal.[68]

EXHIBIT 2-5 2018 INSTALLED GENERATION CAPACITY BY NYCA LOAD ZONE[69]



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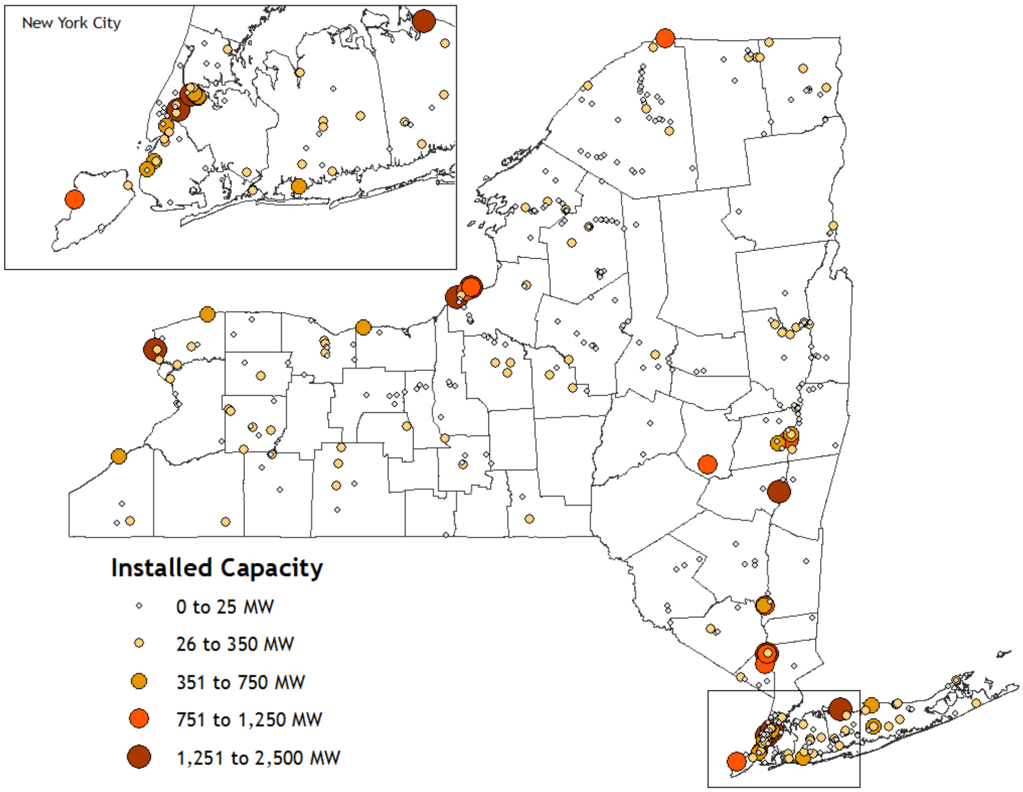
[68] Long Island-New York City Offshore Wind Policy Options Paper. January 29, 2018. Accessed on May 9, 2019 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Biomass-Solar-Wind/Master-Plan/Offshore-Wind-Master-Plan.pdf.

[69] Source: NYISO. 2018 Load & Capacity Data "Gold Book." April. p. 66-67. Accessed on May 2, 2018 at: http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2018-Load-Capacity-Data-Report-Gold-Book.pdf.

EXHIBIT 2-6 LOCATIONS OF GENERATING CAPACITY IN NEW YORK STATE[70]



Transmission System

More than 80 percent of the State's high-voltage transmission lines went into service before 1980; transmission infrastructure upgrades over the next 30 years could cost upwards of $25 billion.[71] NYISO recognizes the pressing need for new transmission investments in the State, both through new and upgraded transmission capacity. New and upgraded transmission facilities will help address congestion, deliver renewable power resources from upstate locations, and diversify the State's fuel sources. One of the key considerations is how to maximize the load served by renewable generation, primarily by increasing cross-state energy transfers (as much of the renewable generation is upstate and usage is downstate).

[70] ESRI Map Projection: WGS 1984 Mercator Auxiliary Sphere.

[71] NYISO. 2017. Power Trends: New York's Evolving Electric Grid. Accessed on May 2, 2018 at: https://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2017_Power_Trends.pdf.

Distribution System

Local distribution companies are statutorily responsible to "distribute" power from energy suppliers to the end user (i.e., the customer). Existing distribution systems serve approximately 7.8 million customers across the State.[72] Serving as the final step for most customers, the distribution system picks up where the transmission and sub-transmission systems leave off. Generally, electric distribution systems are designed for voltages from 34.5 kilovolts (kV) down to 2.4 kV, with direct services to customers typically at 120/208 volts. The most common service voltage for electric distribution systems in the State is 13 kV. Some customers are, however, able to take distribution service at higher voltage levels, in some cases even as high as transmission voltage levels. The State's distribution system includes both underground and overhead systems, with underground facilities generally found in newer installations and in highly congested areas such as New York City. There are over 300,000 miles of distribution lines throughout the State, of which slightly more than half are overhead.

Operation and Control

The vast majority of distribution systems in the State are operated and controlled by the six IOUs and the Long Island Power Authority (LIPA). For example, Con Edison's distribution system makes up a large percentage of the underground facilities in the State.[73] In addition to the six IOUs and LIPA, there are 49 municipal utilities and four rural electric cooperatives that own and operate their own distribution facilities, serving over 150,000 customers.[74] In most cases, the municipal utilities and cooperatives are connected to the larger utilities (e.g., NYPA or LIPA) and, therefore, have a relatively limited operating flexibility.[75] **Exhibit 2-7** illustrates the location of electric service territories and municipal utilities throughout the State.

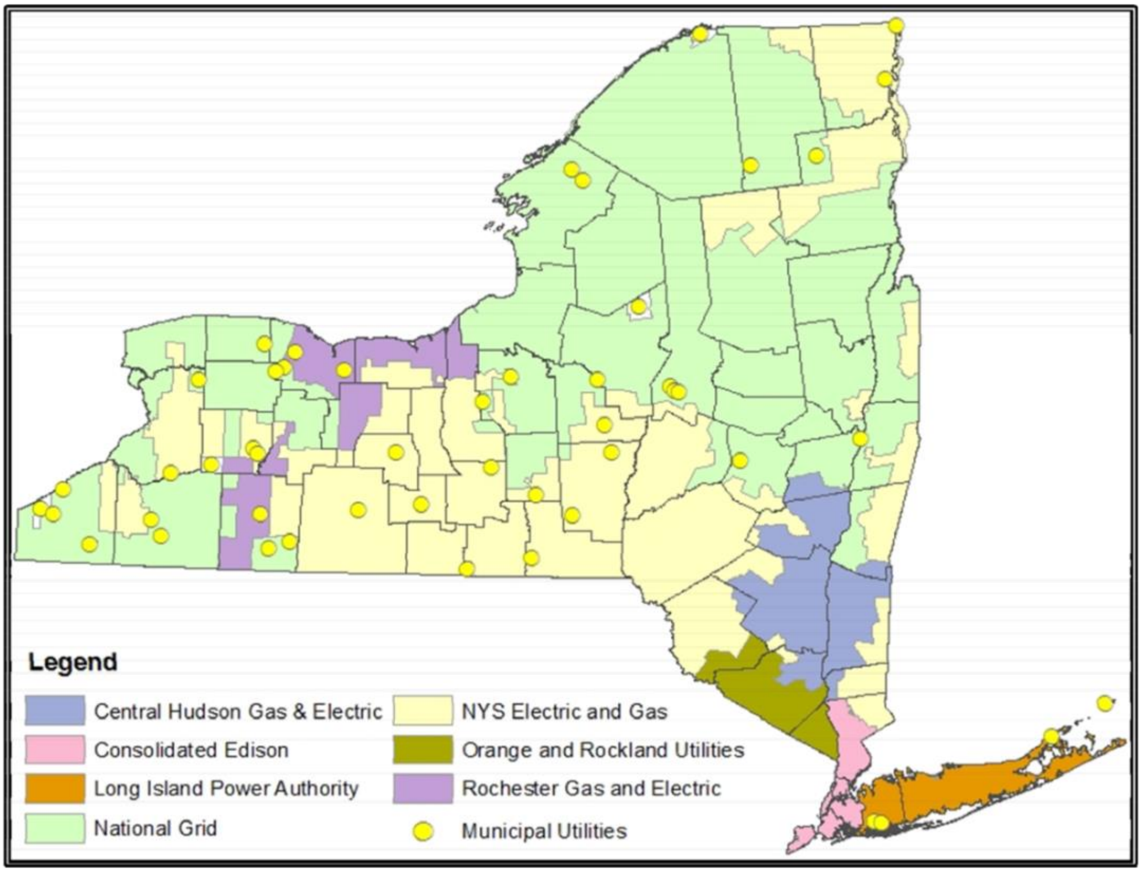
[72] NYSERDA; Department of Public Service. Interconnection of Distributed Generation in New York State: A Utility Readiness Assessment (Final Report). Report Number 15-28, September 2015. Accessed on May 2, 2018 at: http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/dcf68efca391ad6085257687006f396b/$FILE/83930296.pdf/EPRI%20Rpt%20-%20Interconnection%20of%20DG%20in%20NY%20State-complete%20-%20Sept%202015.pdf.

[73] New York State Energy Planning Board. 2012. New York State Transmission and Distribution Systems Reliability Study and Report. August. Page 14. Accessed on May 2, 2018 at: http://nyssmartgrid.com/wp-content/uploads/2012/09/reliability-study.pdf.

[74] DPS. Final Generic Environmental Impact Statement in Case 03-E-0188 Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard. Issued August 26, 2004. Accessed on May 2, 2018 at: http://www.dps.ny.gov/NY_RPS_FEIS_8-26-04.pdf.

[75] Ibid.

EXHIBIT 2-7 LOCATION OF ELECTRIC SERVICE TERRITORIES AND MUNICIPAL UTILITIES THROUGHOUT NEW YORK STATE[76]



Planning/Licensing of New Distribution Capacity

Local distribution companies are responsible for planning and licensing new distribution capacity/facilities. Licensing requirements for the siting of distribution facilities are normally governed by local jurisdictions and ordinances. The Commission requires the underground installation of new distribution facilities in residential subdivisions. The Commission also has rules governing the installation of small distributed generators to the distribution systems, referred to as Standardized Interconnection Requirements (SIRs).[77]

[76] New York State Energy Planning Board. 2012. New York State Transmission and Distribution Systems Reliability Study and Report. August. Page 14. Accessed on May 2, 2018 at: http://nyssmartgrid.com/wp-content/uploads/2012/09/reliability-study.pdf.

[77] NYPSC. 2017. New York State Standardized Interconnection Requirements and Application Process for New Distributed Generators 5 MW of Less Connected in Parallel with Utility Distribution Systems. August 2017. Accessed on May 2, 2018 at: http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/dcf68efca391ad6085257687006f396b/$FILE/August%202017%20SIR%20-Final.pdf.

The IOUs and municipal utilities and cooperatives are further responsible for all aspects of customer services, including but not necessarily limited to, safety, reliability, metering, billing, and complaints. With respect to distribution, the Commission regulates the IOUs and many of the municipal utilities.

As new generation is increasingly made up of distributed energy resources (DERs), careful consideration will be needed to effectively integrate such resources into the State's larger electricity system. The Commission recently issued updated guidance on interconnection requirements for new distributed generators connected in parallel with utility distribution systems.[78] Net metering for grid-connected distributed generation is available subject to technology, system and aggregate capacity limitations.[79]

2.6 CURRENT STATUS OF ENERGY STORAGE MARKET

This section discusses the energy storage market, focusing on the technology, regulatory environment, and market demand/capacity for energy storage in the State. Energy storage is a resource capable of receiving energy from the grid and storing it for later injection of electricity back to the grid regardless of where the resource is located on the electrical system.[80]

Energy storage is growing around the world and in the U.S. As of 2016, over 170 gigawatts (GW) of energy storage capacity have been installed around the world, including 32 GW in the U.S., and 1.5 GW in the State.[81] Projections estimate that the energy storage market in the U.S. will continue to grow; by 2022, the U.S. storage market is expected to be worth $3.2 billion, a tenfold increase from 2016.[82]

Energy Storage Technologies

Energy Storage Resources (ESRs) can retain power to redistribute back to the grid on demand. They can also withdraw electricity from the grid to alleviate excess supply, if needed. ESRs can be either "front of the meter" (FTM) or "behind the meter" (BTM).

ESRs have the potential to provide several benefits, including to:

- Help utilities balance supply and demand in a reliable and efficient manner due to their flexibility to consume or supply electricity.[83]

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[78] Ibid.

[79] For a summary of net metering in New York State, see: DOE. Database of State Incentives for Renewables and Efficiency (DSIRE). Accessed on May 2, 2018 at: http://programs.dsireusa.org/system/program?fromSir=0&state=NY.

[80] FERC. 2018. Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators, Final Rule, 18 CFR Part 35, 162 FERC ¶ 61,127, February 15, 2018. Accessed on May 2, 2018 at: https://www.ferc.gov/whats-new/comm-meet/2018/021518/E-1.pdf.

[81] U.S. DOE. DOE Global Energy Storage Database. Last updated August 16, 2016. Accessed on May 2, 2018 at: http://www.energystorageexchange.org/projects/data_visualization.

[82] Munsell, Mike. "US Energy Storage Market Experiences Largest Quarter Ever." Green Tech Media. June 6, 2017. Accessed on May 2, 2018 at: https://www.greentechmedia.com/articles/read/us-energy-storage-market-experiences-largest-quarter-ever#gs.xDhO=yI.

[83] Ibid.

- Optimize lower cost generation resources and prioritize renewable generation over fossil fuel plants, by adjusting usage for energy market conditions.[84]
- Assist in mitigating transmission congestion and smoothing out the production of intermittent renewables.[85]
- Provide ramp support to meet reliability requirements, particularly for renewable resources, whose generation is variable (e.g., solar generation in the evening).[86]
- Help meet installed reserve margins to account for unanticipated generator or transmission outages, and potentially decrease future demands for installed reserve margins. ESRs can also assist in meeting operating reserve requirements.
- Provide voltage support on transmission systems, when insufficient reactive power can cause system voltage to decline (and vice versa).[87]
- Provide additional resources for "black starts" – when the grid must be restarted in the event of a blackout.[88]
- Help manage system peaks by discharging during periods of high load.

Exhibit 2-8 below summarizes the current uses of energy storage projects in the State. The two largest number of energy storage projects in the state are currently offering the following services: electric energy time shift (storage of energy when prices are low and use of stored energy when prices are high) and electric bill management (reduce costs for electric service).

[84] Vernacchia, John. "A Brief History of Utility-Scale Energy Storage: How utilities are employing energy storage systems for grid support and renewable energy firming." *Renewable Energy World*. September 19, 2017. Accessed on May 2, 2018 at: https://www.renewableenergyworld.com/articles/print/volume-20/issue-5/features/energy-storage/a-brief-history-of-utility-scale-energy-storage.html.

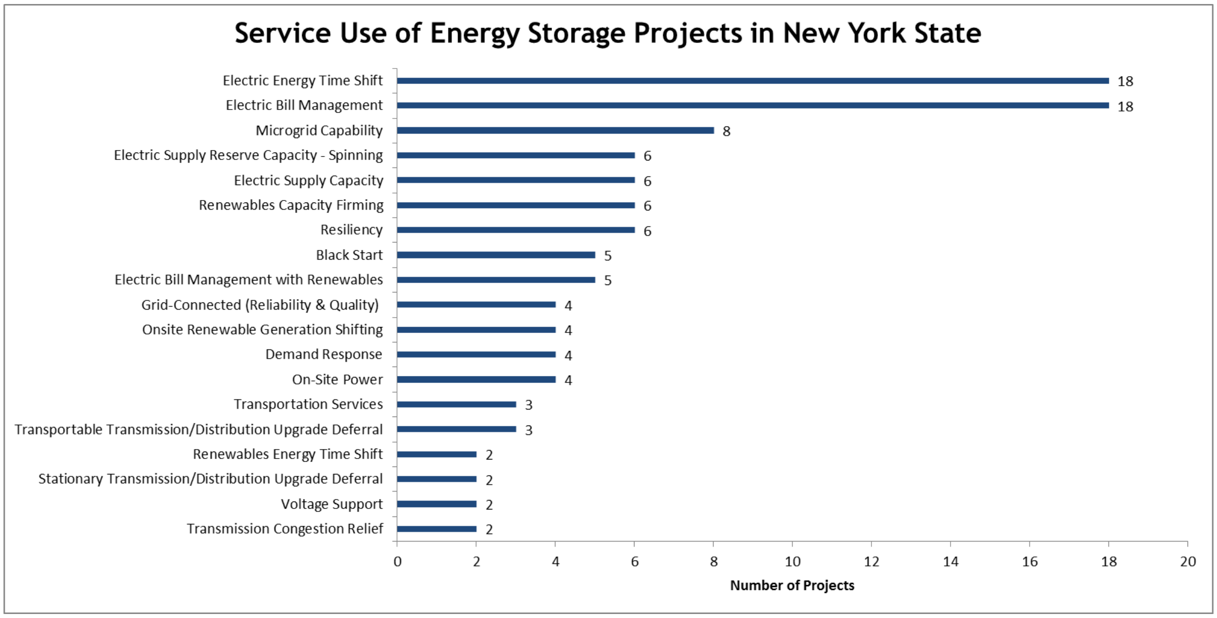
[85] NYISO. 2018. 2018 Power Trends: New York's Dynamic Power Grid. Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2018-Power-Trends.pdf.

[86] NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 2, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf.

[87] Ibid.

[88] Ibid.

EXHIBIT 2-8 SERVICE USE OF ENERGY STORAGE PROJECTS IN NEW YORK STATE; 2016[89]



There are four primary categories of energy storage:[90]

1. Chemical – batteries, flow batteries, fuel cells.
2. Electrical – superconductors.
3. Thermal – molten salt, ice storage.
4. Mechanical – pumped hydroelectric storage, compressed air energy storage (CAES).

Exhibit 2-9 below summarizes the storage types in each of these categories, including the capability of each type.

[89] U.S. DOE. DOE Global Energy Storage Database. Last updated August 16, 2016. Accessed on May 2, 2018 at: http://www.energystorageexchange.org/projects/data_visualization.

[90] NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 2, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf.

EXHIBIT 2-9 SUMMARY OF ENERGY STORAGE TECHNOLOGY TYPES

CATEGORY	STORAGE TYPE	DESCRIPTION	CURRENT NY CAPACITY (MW; AS OF 2018)	DAY-AHEAD MARKET	REAL-TIME MARKET	CAPACITY	VOLTAGE SUPPORT	RELIABILITY	OPERATING RESERVES
Chemical	Battery	Energy exchange between a chemical and an electrical state; e.g., lead-acid, sodium-sulfur, sodium-ion, sodium nickel chloride, nickel cadmium, nickel metal hydride, zinc-bromide.	55 MW	✓	✓	✓	✓	✓	✓
	Flow Battery	Batteries with liquid electrolytes separated by a membrane and can be instantly recharged if liquid electrolytes are exchanged.	--	✓	✓	✓	✓	✓	✓
	Fuel Cell	Converts hydrogen and oxygen into water and energy.	--	✓	✓	✓	✓	✓	✓
	Vehicle to Grid (V2G)	Electric vehicles serve as storage; aggregated EVs charge when prices are low and return electricity to the grid when prices are high.	--	✓	✓		✓	✓	✓
Electrical	Super-conductor	Two conductors separated by an insulated layer that has close to zero resistance when cooled below a critical temperature.	--				✓	✓	
Thermal	Molten Salt	Salt is circulated through a heat exchanger during the day, held in storage tanks at night, and dispatched back through heat exchanger to create super-heated steam which powers a turbine.	--	✓	✓	✓	✓	✓	✓
	Ice Storage	Make ice during off-peak night time hours, ice is melted during peak cooling day time hours.	5 MW	✓	✓	✓	✓	✓	✓
Mechanical	Pumped Hydro-electric Storage	Facility uses electricity to pump water from a lower reservoir to a higher reservoir. When prices are high, releases water to flow past a turbine to generate electricity.	1,400 MW	✓	✓	✓	✓	✓	✓

CATEGORY	STORAGE TYPE	DESCRIPTION	CURRENT NY CAPACITY (MW; AS OF 2018)	DAY-AHEAD MARKET	REAL-TIME MARKET	CAPACITY	VOLTAGE SUPPORT	RELIABILITY	OPERATING RESERVES
	Compressed Air Energy Storage (CAES)	Use electricity to compress air in a storage tank or cavern. As the air is released, it is expanded and heated to make a natural gas turbine more efficient.	9 MW	✓	✓	✓	✓	✓	✓
	Flywheel	Store and produce electricity as kinetic energy using a large spinning mass.	20 MW				✓	✓	
Note: 1) Includes announced, contracted, under construction, and operational projects.									

Sources:

NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 2, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf

Personal Communication, NYSERDA Staff. May 31, 2018.

Policy and Regulatory Environment for Energy Storage

As the market advances the technology of and demand for ESRs, regulatory authorities have had to adjust policies to address the needs of these resources. Policy changes in this arena in the State include:

- In 2009, the NYISO was the first of the Independent System Operators (ISO)/ Regional Transmission Operators (RTOs) to develop rules that allowed limited energy storage resources (LESR) to supply regulation service. The NYISO's innovative approach included a process where the LESR's state of charge is managed by the NYISO's real-time energy market software.[91]
- The State's REV Initiative encourages the incorporation of DERs into utility system planning processes.
- By December 2018, the Commission ordered that IOUs must have at least two energy storage projects attached to a distribution substation that offer at a minimum two distinct services (e.g., energy, regulation, or capacity).[92]
- On November 29, 2017, New York legislation instructed the Commission to create storage procurement targets for 2030.[93]
- Mayor de Blasio announced a New York City energy storage target of 100 MWh by 2020.[94]
- NYISO created a DER Roadmap, which presents its vision for: integrating DER into the NYISO's energy, ancillary services, and capacity markets; the alignment with the goals of REV; enhancing measurement and verification methodologies; aligning compensation with wholesale service performance; and focusing on wholesale market transactions.[95]
- Governor Cuomo's 2018 State of the State address called for a $200 million investment from the NYGB and a $60 million investment from NYSERDA to support the development and deployment of up to 1,500 MW of energy storage capacity by 2025.

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[91] NYISO. 2018. 2018 Power Trends: New York's Dynamic Power Grid. Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2018-Power-Trends.pdf.

[92] NYPSC. *Order on Distributed System Implementation Plan Filings,* State of New York Public Service Commission, 14-M-0101/ 16-M-0411, Mar. 9, 2017. Accessed on May 2, 2018 at: http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=16-M-0411.

[93] State of New York. Senate Bill S5190: Establishes the Energy Storage Deployment Program. November 29, 2017. Accessed on May 2, 2018 at: http://legislation.nysenate.gov/pdf/bills/2017/S5190.

[94] Patel, Sonal. "New York City Sets Ambitious Citywide Energy Storage Target." *Power*, Sept 29, 2016. Accessed on May 2, 2018 at: http://www.powermag.com/new-york-city-sets-ambitious-citywide-energy-storage-target/.

[95] NYISO. 2017. Distributed Energy Resources Roadmap for New York's Wholesale Electricity Markets. January 2017. Accessed on May 2, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/10/Distributed-Energy-Resources-Roadmap-DER.pdf.

The Governor also directed NYSERDA to develop a plan for the deployment of energy storage projects (the Roadmap).[96]

At the federal level, the FERC has enacted several rulings addressing energy storage, including:

- Order 755 (2011): Requires RTOs and ISOs to consider the response speed of resources used for frequency regulation resources (rather than only considering the capacity).[97]
- Order 784 (2013): Revises regulations to foster competition and transparency in ancillary services markets, to better account for and report transactions associated with the use of energy storage devices in public utility operations.[98]
- Order 841 (2018): Amended regulations under the FPA to remove barriers to the participation of electric storage resources in the capacity, energy, and ancillary service markets operated by RTOs and ISOs; Requires that RTOs and ISOs revise tariffs to establish a participation model consisting of market rules that, recognizing the physical and operational characteristics of electric storage resources, facilitates their participation in the RTO/ISO markets; requires they specify that the sale of electric energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets must be at the wholesale locational marginal price; and establishes a minimum size requirement of no greater than 0.1 MW.[99]
- Order 845 (2018): Revises the Large Generator Interconnection Procedures (LGIP) and the Large Generator Interconnection Agreement (LGIA), updating the definition of a generating facility to explicitly include electricity storage resources. It also revises interconnection rules and protocols for any generator larger than 20 MW, and allows for interconnection customers to request a level of interconnection service that is lower than the capacity of their generating facility.[100]

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[96] Governor Cuomo Unveils 20th Proposal of 2018 State of the State: New York's Clean Energy Jobs and Climate Agenda. Accessed on April 27, 2018 at: https://www.governor.ny.gov/news/governor-cuomo-unveils-20th-proposal-2018-state-state-new-yorks-clean-energy-jobs-and-climate.

[97] FERC. 2011. Frequency Regulation Compensation in the Organized Wholesale Power Markets. 137 FERC ¶ 61,064. 18 CFR Part 35. October 20, 2011. Accessed on May 2, 2018 at: https://www.ferc.gov/whats-new/comm-meet/2011/102011/E-28.pdf.

[98] FERC. 2013. Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies. 18 CFR Parts 35, 101, and 141. 144 FERC ¶ 61,056. Accessed on May 2, 2018 at: https://www.ferc.gov/whats-new/comm-meet/2013/071813/E-22.pdf.

[99] FERC. 2018. Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators. 18 CFR Part 35; 162 FERC ¶ 61,127. Issued February 15, 2018. Accessed on May 2, 2018 at: https://www.ferc.gov/whats-new/comm-meet/2018/021518/E-1.pdf.

[100] FERC. 2018. Reform of Generator Interconnection Procedures and Agreements. 18 CFR Part 37. 163 FERC ¶ 61,043. Accessed on May 31, 2018 at: https://www.ferc.gov/whats-new/comm-meet/2018/041918/E-2.pdf.

Market for Energy Storage

Storage resources can participate in NYISO-administered energy, ancillary services, and capacity markets in limited ways such as demand response programs. NYISO regulates two energy markets: the Day-Ahead Market (DAM) and the Real-Time Market (RTM). They also allow ESRs with 20 MW or less capacity to aggregate with other non-ESR DERs in order to facilitate wholesale market participation.[101]

Prior to 2014, market demand for energy storage was low, primarily as a result of high costs and insufficient renewable energy penetration. Since then, significant advances in the technologies available and a decline in their costs, supportive local and federal legislation, and cooperative ISOs/RTOs have increased the market for energy storage. In the U.S. overall, grid-supplied installed storage capacity increased 223 percent between 2014 and 2015, and distributed installed capacity increased 405 percent over the same period. In New York State, revenues from firms selling energy storage solutions and services increased from $598 million in 2012 to $908 million in 2015; employment in the sector increased from 2,990 jobs in 2012 to 4,340 jobs in 2015.[102] By 2030, projections estimate energy storage sales and services from NYS firms could generate $8.71 billion in global revenue and create 30,000 jobs in the State.[103,104,105]

NYISO's vision of the energy storage market in the State is presented in **Exhibit 2-10** below; distribution utilities would evolve into distributed system platforms, and consumers would become producers of electricity as well as consumers.

NYISO anticipates a new participation model to fully exploit the capabilities that new storage technologies can offer in terms of balancing system variability and supplying capacity during critical peak periods.[106] This participation model has three pillars:

1. Energy Storage Integration: creates a new ESR participation model that captures unique storage characteristics.

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[101] Ibid.

[102] EMI Consulting/IEc for NYSERDA. 2017. NYSERDA Energy Storage and NY-BEST Program: Market Characterization and Assessment. February 2017. Accessed on May 2, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/Program-Evaluation/2017ContractorReports/Energy-Storage-NY-BEST-Market-Characterization-Report.pdf.

[103] IEc for NYSERDA. 2016. The Energy Storage Industry in New York State: Recent Growth and Projections 2015 Update. October 2016. NYSERDA Contract 32883.

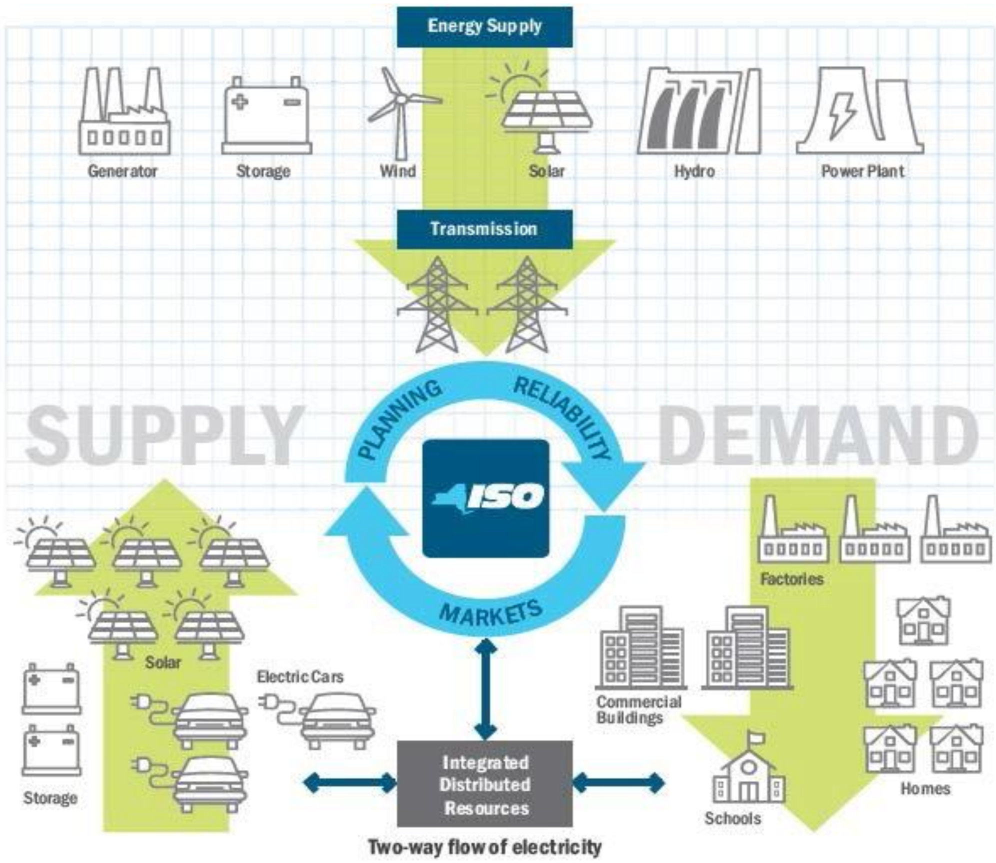
[104] New York State. 2018. Governor Cuomo Unveils 20th Proposal of 2018 State of the State: New York's Clean Energy Jobs and Climate Agenda. January 2, 2018. Accessed on May 18, 2018 at: https://www.governor.ny.gov/news/governor-cuomo-unveils-20th-proposal-2018-state-state-new-yorks-clean-energy-jobs-and-climate.

[105] In the baseline estimations (see Chapter 4), the analysis conservatively assume that these projected increases in energy storage capacity do not take place; in reality, some of these projected increases will have occurred absent the proposed action.

[106] NYISO. 2018. 2018 Power Trends: New York's Dynamic Power Grid. Accessed on May 4, 2018 at: http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2018-Power-Trends.pdf.

2. Energy Storage Optimization: utilizes ESR services more efficiently by taking into account the resource's energy constraints over the course of a day.
3. Renewable and Storage Aggregation: analyzes the pairing of ESRs with intermittent resources.[107]

EXHIBIT 2-10 NYISO VISION FOR FUTURE GRID STRUCTURE[108]



Overall, this chapter provided an overview of the historical overview of the electric industry in the State, the existing regulatory environment underlying the State's electric industry, historical trends in electricity demand, the present electrical system (including the State's generation, transmission, and distribution systems), and the current state of the energy storage market.

[107] NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 2, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf.

[108] NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 2, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf.

CHAPTER 3 | ENVIRONMENTAL SETTING

Consistent with New York Codes, Rules and Regulations (NYCRR) 6 NYCRR §617.9(b)(5)(ii) of New York's State Environmental Quality Review Act (SEQRA), this chapter provides an overview of the areas to be affected by the proposed action, defined under 6 NYCRR §617.2(l) as "the physical conditions that will be affected by [the] proposed action, including land, air, water, minerals, flora, fauna, noise, resources of agricultural, archeological, historic or aesthetic significance, existing patterns of population concentration, distribution or growth, existing community or neighborhood character, and human health." The environmental setting described in this chapter serves as a baseline of the existing environmental conditions against which **Chapter 5** through **Chapter 10** evaluate and compare the potential impacts of the Energy Storage Roadmap (the Roadmap). The areas potentially impacted by the proposed Roadmap actions include the entire State of New York (the State). However, since energy storage projects resulting from the Roadmap may be more highly concentrated in downstate areas in and around New York City, this chapter also discusses environmental factors specific to that area.

This chapter is organized into eleven sections consistent with the following environmental resource areas:

- **Section 3.1** provides a brief description of the State's physiography and geology;
- **Section 3.2** describes the different types of current land uses across the State, including open space and existing land uses associated with the electric industry;
- **Section 3.3** describes the State's oceans and estuaries, wetlands, drinking water, groundwater, water use, and the connection between energy and water resources;
- **Section 3.4** describes the State's plants and animals;
- **Section 3.5** summarizes climatic conditions such as temperature and precipitation, air quality, and climate change;
- **Section 3.6**, including the importance of those resources;
- **Section 3.7** covers solid and hazardous waste generation and management practices;
- **Section 3.8** summarizes potentially relevant public health issues such as ozone, particulate matter, and asthma;
- **Section 3.9** describes population in the State and the factors that contribute to the development and maintenance of community character;
- **Section 3.10** briefly describes the transportation modes and facilities found throughout the State; and

- **Section 3.11** provides an overview of the State's socioeconomic characteristics, including employment, income and wages, housing, municipal revenues and a description of low-income and minority populations that could be subject to disproportionate and adverse environmental impacts.

3.1 PHYSICAL GEOGRAPHY

New York State is the 27th largest state in the U.S. by size, covering more than 47,000 square miles (30.1 million acres),[109] including approximately 1,600 square miles (1.0 million acres) of inland water bodies.[110] The topography of the State is generally hilly or mountainous in all areas except Long Island and the relatively level areas adjacent to Lake Erie, Lake Ontario, and the St. Lawrence River. The highest topographic variations are found in the Catskill and Adirondack Mountains where elevations reach higher than 4,000 feet and variations between peaks and valleys of up to 2,500 feet. Approximately 40 percent of the State has an elevation of more than 1,000 feet above sea level. However, elevation on Manhattan does not exceed 265 feet above sea level and averages 33 feet above sea level.[111]

Geology

The State's electric industry is influenced by its geology. Geology determines the types and distribution of soils, water drainage, topography and ecosystems. In turn, these factors impact land use, development, and population distribution, thereby indirectly affecting the electric industry.

More directly, the buffering ability of bedrock geology, soils, and water can help limit the damage caused by acidic air pollutants released from sources such as electric generation, industrial activities, and transportation. The four types of geological features that provide pollution buffering in the State include: (1) shale and shale-sandstones, such as limestone; (2) granite; (3) sands and clays; and, (4) soils. The ability of certain geologic features to buffer air pollutants from surrounding soils and surface waters depends on the amount of calcium carbonate released by natural weather and erosion processes. Geologic features resistant to such processes, such as granite in the Adirondack Mountains and Hudson Highlands, provide minimal buffering capacity due, in part, to a lack of calcium carbonate.

Shale and shale-sandstones such as limestone provide the greatest buffering capacity. This bedrock dominates in the Appalachian Highlands, Hudson Valley, and the periphery of Tug Hill (in upstate New York).[112] Large areas of sandstone are found in narrow bands of bedrock along the northern edge of the Appalachian Highlands, the south shore of Lake Ontario, the St. Lawrence River plain, and the Catskill Mountains. Several long, narrow bands of limestone bedrock are also found in the periphery of the Adirondacks, and along the Lake Ontario plain, the St. Lawrence River plain, and the escarpment located south of the Mohawk River and west of the lower Hudson River. Large

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[109] U.S. Census Bureau. State & County Quick Facts – New York. Accessed on April 27, 2018 at: https://www.census.gov/quickfacts/fact/table/US,NY/PST045216.

[110] Cornell University. The Climate of New York. Accessed on April 27, 2018 at: http://archive.today/UGwJ.

[111] Ibid.

[112] For purposes of this GEIS, upstate New York is defined as areas that fall within NYCA Load Zones A-G and downstate as areas that fall within NYCA Load Zones H-K.

areas of limestone bedrock also occur at both the northern edge of the Hudson Highlands and along the Taconic Mountains. Although sands and clays erode rapidly, these geologic features, underlying most of Long Island, are primarily composed of silicates, which do not generate significant amounts of calcium carbonate and therefore provide little buffer to acidic pollution. New York City lies along the New York Bight, referring to the expanse of shallow ocean between the coast of New Jersey and Long Island.[113] New York City itself mainly comprises sedimentary formations of the Cretaceous, Tertiary, and Quaternary ages, situated primarily on the Atlantic Coastal Plain.[114]

3.2 LAND USE

Land use is generally defined as the management and/or modification of the natural environment (or land) to support human uses. Existing land uses are largely a function of local topography. For example, the highlands of eastern New York form natural barriers to transportation and settlement. As such, most New Yorkers live in the lowland areas in between, including the Lake Champlain and Hudson River Valleys, and south of the Hudson Highlands, where the topography slopes down to sea level in New York City and Long Island.

In addition to topography, land use is also influenced by such factors as proximity to developed areas and transportation networks, past uses of the land, and general societal and economic trends. The scope and scale of development across the State ranges from urban and suburban, to rural and natural areas. Because of topography, a variety of land uses are concentrated in a narrow corridor along the Hudson River. **Exhibit 3-1** provides an overview of major land uses across the State. As shown, more than half of the State is forest and woodland (56 percent), while approximately 21 percent is active farmland or cropland. Developed areas, which consist primarily of residential, commercial, and industrial land uses, comprise approximately nine percent of the State.

The majority of land in New York City is developed for residential, mixed use, commercial, institutional and industrial. However New York City’s system of parks and open spaces – in all five boroughs – covers 14 percent of the city, totaling approximately 29,000 acres.[115]

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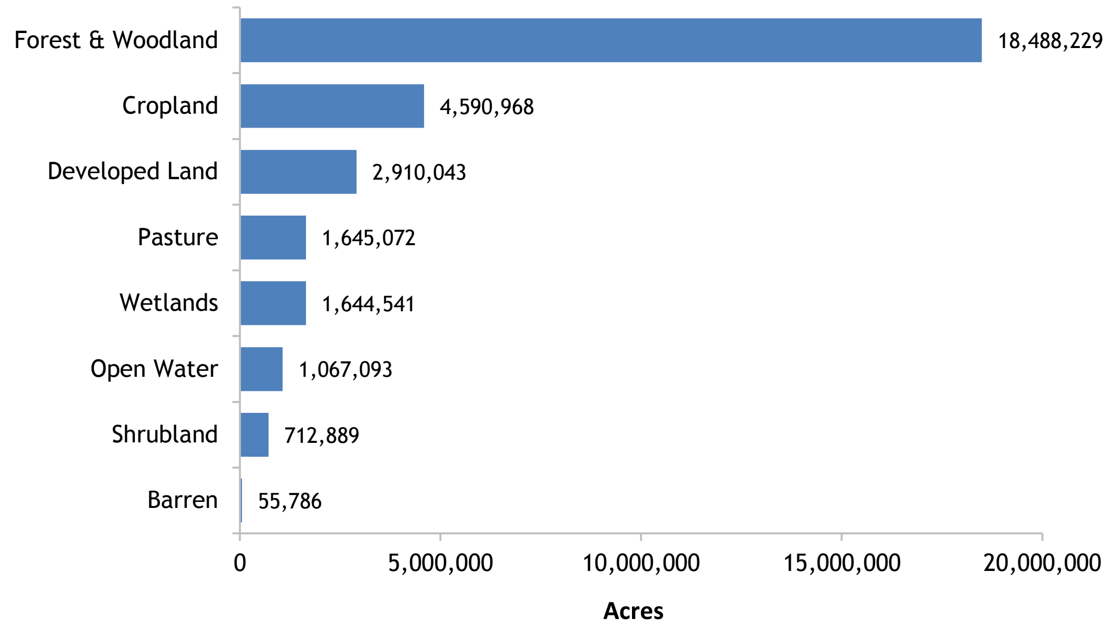
[113] USGS. 2003. Geology of the New York City Region. Accessed on May 3, 2018 at: https://3dparks.wr.usgs.gov/nyc/common/introduction.htm.

[114] Ibid.

[115] City of New York. 2013. A Stronger More Resilient New York: Chapter 11 Parks. Accessed on May 7, 2018 at: http://www.nyc.gov/html/sirr/downloads/pdf/final_report/Ch_11_Parks_FINAL_singles.pdf.

EXHIBIT 3-1 NEW YORK STATE LAND USE SUMMARY[116]



Local Land Use Planning

New York State constitutional "home rule" provisions mean that land use in the State is primarily controlled at the municipal level. All cities in the State and more than 70 percent of townships develop and adopt comprehensive land use plans, which address land use planning, conservation, zoning, and related regulatory requirements. Numerous statewide land use plans and resource management plans provide further guidance for local authorities on state-wide land use issues of importance (e.g., groundwater, coastal areas, etc.). Additionally local land use and planning laws will likely have implications for the siting of energy storage projects. For example, New York City's Department of City Planning pursues objectives related to neighborhood improvement, housing, economic development, resiliency and sustainability, land use reviews, and data and expertise. The City Planning Commission regularly holds hearings and votes on applications that relate to the use, development, and improvement of property that is subject to regulation by the City.

Open Space[117]

The definition of open space depends on the context. In a big city, a vacant lot or a small marsh can be open space. A small park or a narrow corridor for walking or bicycling is open space, though it may be surrounded by developed areas. Open space may be defined as an area of land or water that either remains in its natural state, free from intensive development for residential, commercial, industrial, or institutional use. Such spaces include agricultural and forest land, undeveloped coastal and estuarine lands, undeveloped scenic lands, public parks, and preserves.

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[116] National Agricultural Statistics Service Cropland Data Layer. 2017. Published crop-specific data layer. Accessed on May 7, 2018 at: https://nassgeodata.gmu.edu/CropScape/.

[117] NYSDEC. 2016. Final New York State Open Space Conservation Plan. December. Accessed on April 27, 2018. https://www.dec.ny.gov/lands/98720.html.

Waterways, water bodies, and wetlands are also important, especially those with public access, including the public shorelines and waters of two Great Lakes and other major lakes, major rivers, such as the Hudson River, and the Atlantic sea coast. Open space can be publicly or privately-owned. **Exhibit 3-2** displays a distribution of open space by ownership in the State. These spaces provide a variety of benefits to a State's economy, culture, environment and well-being of its residents.

The value of open space and parks is well-established. For example, one study documented $2.74 billion in added annual benefits from open space in Suffolk and Nassau counties on Long Island.[118] These benefits result from added tax revenues from increased land values near open space, reduction in governmental services on open space, recreation and tourism revenues, agricultural revenues, source water protection, storm water treatment, and pollution reduction, among other benefits.

EXHIBIT 3-2 SUMMARY OF PROTECTED AREAS IN NEW YORK STATE[119, 120]

OWNERSHIP	ACRES	PERCENT OF TOTAL
State Land	4,162,281	82%
Private Conservation Lands	433,462	9%
Federal Land	253,698	5%
Local Government	160,555	3%
Native American	87,442	2%
TOTAL	**5,097,438**	**100%**

Besides economic benefits, open space contributes to a greater quality of life for nearby residents, which also translates to added health benefits. Physical activity promotes health, and open space provides access to walking, riding, and hiking trails. In the largest study of its kind, a study in England examined mortality in 360,000 deaths from a population of 41 million people. The study showed that mortality was related to many factors, including income, but after correcting for such factors, access to open space was a significant factor contributing to lower mortality rates.[121]

New York State Open Space Conservation Program

The open space conservation program maintains broad public support throughout the State. This is a testament to the program's many environmental, health, and economic benefits. In addition to

[118] Trust for Public Land. 2010. The Economic Benefits and Fiscal Impact of Parks and Open Space in Nassau and Suffolk Counties, New York. A Report by The Trust for Public Land for the Long Island Community Foundation and the Rauch Foundation. Accessed on May 3, 2018 at: http://cloud.tpl.org/pubs/ccpe--nassau-county-park-benefits.pdf.

[119] While the Adirondacks Park is approximately six million acres, only 44.6 percent (or 2.6 million acres) of the park are State Conservation Lands. The remainder is private land, classified for use with varying levels of Adirondack Park Agency permitting and approval. For more information, see: Adirondack Park Agency. Adirondack Park Land Use Classification Statistics. March 20, 2018. Accessed on April 30, 2018 at: https://apa.ny.gov/gis/stats/colc201803.htm.

[120] Conservation Biology Institute. PAD-US 2.1 (CBI Edition) October 1, 2012. Accessed on April 30, 2018 at: https://databasin.org/datasets/5824df6d0e8a4adc88be16640053dd6a.

[121] Mitchell, R. and F. Popham. 2008. "Effect of exposure to natural environment on health inequalities: an observational population study." In The Lancet 372 (9650), pp. 1655-1660. (As cited in in Indian Point Contingency Plan Final Generic Environmental Impact Statement. July 2013).

outdoor recreational opportunities, goals of the open space conservation program include protecting plant and animal diversity to ensure viable ecosystems, protecting the drinking water supply and the water quality for aquatic ecosystems, improving the quality of life for the State's citizens, maintaining natural resource industries such as farming, forestry, fishing, and tourism, and combating global climate change and its potential effects.

To ensure citizen input into State land acquisition decisions, New York established a formal open space conservation program in 1990. New York State Department of Environmental Conservation (NYSDEC) and New York State Office of Parks Recreation & Historic Preservation (NYSOPRHP) developed a comprehensive statewide Open Space Conservation Plan that covers conservation actions, tools, and cooperation with other participating State agencies, including the Department of State (DOS), the Adirondack Park Agency, the Department of Agriculture & Markets (DAM), and the Department of Transportation (DOT). Updated every three years, a revision of the plan was released in December 2016. The revised plan addresses open space conservation activities within four critical priority areas: (1) promoting outdoor recreation; (2) addressing climate change; (3) ensuring clean water, air and land for a healthy public and vibrant economy; and (4) protecting, using and conserving our natural resources and cultural heritage.[122]

Electric Industry Land Uses

Transmission and distribution lines account for the majority of the electric industry's direct use of land in the State. The statewide transmission system spans more than 180,000 acres plus a supporting network consisting of more than 10,000 overhead circuit miles and 600 underground circuit miles.[123] In addition, thousands of additional miles of local distribution lines convey electric power from utilities to customers. New York City receives electricity from both in-city-generated and imported power sources.[124] Consolidated Edison Company of New York, Inc. (Con Edison), which provides electricity to the vast majority of New York City residential and business customers, utilizes more than 2,000 primary feeders and 55 area substations. The distribution system utilizes some 205,000 utility poles and 46,000 overhead transformers throughout the City, as well as a vast network of underground conduits, wires and cables.[125]

3.3 WATER RESOURCES

This section describes the State's water resources beginning with the State's oceans and estuaries, wetlands, drinking water, groundwater, and water use. This section ends with a brief discussion of the intersection of energy and water resources.

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[122] NYSDEC. 2016 Draft Open Space Conservation Plan. Accessed on April 30, 2018 at: https://www.dec.ny.gov/lands/98720.html.

[123] DPS. Final Generic Environmental Impact Statement in Case 03-E-0188 Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard. Issued August 26, 2004. Accessed on May 3, 2018 at: http://www.dps.ny.gov/NY_RPS_FEIS_8-26-04.pdf.

[124] NYCEDC. 2013. A Stronger, More Resilient New York. June. Accessed on May 3, 2018 at: https://www.nycedc.com/resource/stronger-more-resilient-new-york.

[125] Con Edison. Electric System. Accessed on May 3, 2018 at: http://legacyold.coned.com/newsroom/energysystems_electric.asp.

Oceans and Estuaries[126]

The southern part of the State sits on the shore of the Northern Atlantic Ocean. New York includes nearly 1.2 million acres of salt and brackish water in the marine and coastal areas, and more than 2,800 miles of shoreline. The ocean current coming up the shoreline mixes with freshwater rivers and streams that drain into the ocean around New York City and Long Island. The intersection between these two types of waters creates several distinct estuaries that flourish with marine life, including five estuaries that exhibit unique characteristics, namely the Long Island Sound, the Peconic Estuary, the Long Island South Shore Estuary Reserve, the New York/New Jersey Harbor, and the Hudson River Estuary. These areas are managed cooperatively by NYSDEC, the U.S. Environmental Protection Agency (EPA), other state agencies, and local municipalities.

Wetlands

Wetlands (swamps, marshes, bogs, and similar areas) are areas saturated by surface or ground water sufficient to support distinctive vegetation adapted for life in saturated soil conditions. There are many of different types of wetland, including marshes, hardwood, coniferous and shrub swamps, wet meadows, bogs, fens, and coastal marshes. Wetlands serve as natural habitat for a number of plant and animal species. Wetlands also provide a buffer for flooding and tidal erosion along the State's shoreline.

In the State, public protection is afforded to two main types of wetland: tidal wetlands surrounding Long Island, New York City, and the Hudson River South of the Governor Mario M. Cuomo Bridge; and freshwater wetlands found throughout the state. The U.S. Geological Survey (USGS) estimates the total acreage of wetlands at approximately 2.4 million acres (or eight percent of the state's total land area), including over two million acres of freshwater wetlands and 25,000 acres of tidal wetlands.[127]

Drinking Water

Over ninety percent of all New Yorkers receive water from public water supply systems.[128] Public water supply systems vary in size. Mid-sized, privately-owned water supply companies serve municipalities while the smallest systems include small stores in rural areas that serve customers water from their own wells. In total, there are over 9,300 public water supply systems in the State. The largest engineered water system in the nation belongs to New York City, whose system serves more than nine million people.[129]

As shown in **Exhibit 3-3**, the majority of the State's population is served by surface water. For example, the nine million people served by the New York City water system rely on surface water associated with New York City's large upstate reservoir and distribution system.

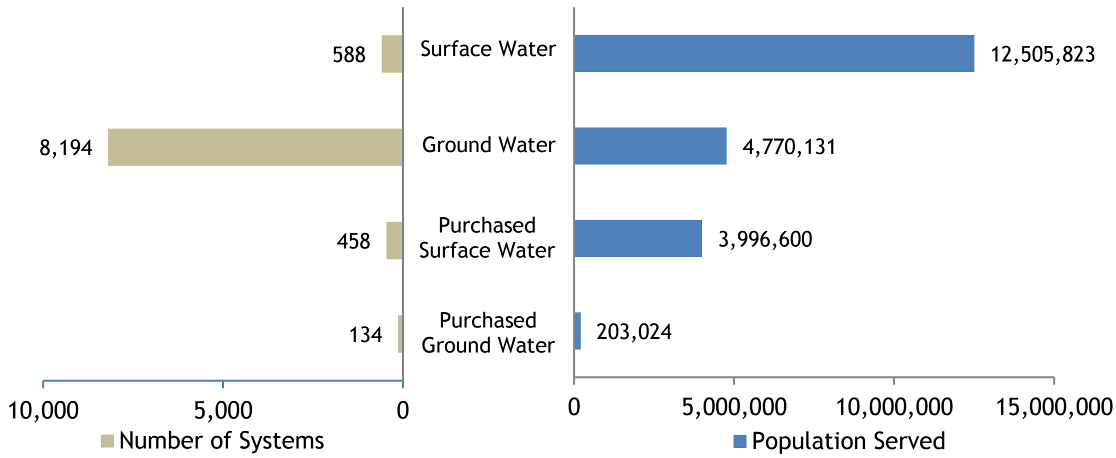
[126] NYSDEC. Oceans and Estuaries. Accessed on April 30, 2018 at: http://www.dec.ny.gov/lands/207.html.

[127] USGS. National Water Summary on Wetland Resources. State Summary Highlight. Water Supply Paper 2425. Accessed on April 30, 2018 at: http://water.usgs.gov/nwsum/WSP2425/state_highlights_summary.html.

[128] USGS. 2010. Water Use in the United States. Accessed on April 30, 2018 at: https://water.usgs.gov/watuse/data/2010/index.html.

[129] New York State Department of Health. Drinking Water Program: Facts and Figures. Accessed on April 30, 2018 at: https://www.health.ny.gov/environmental/water/drinking/facts_figures.htm.

EXHIBIT 3-3 SUMMARY OF NEW YORK DRINKING WATER SOURCES[130]



Groundwater

Groundwater – the water located beneath earth's surface in soil pore spaces and in the fractures of rock formations – occurs across all parts of the State. Approximately one-quarter of New Yorkers rely on groundwater as a source of potable water.[131] Unconsolidated sediments (e.g., sand and/or gravel deposits) function as the State's most productive aquifers. Groundwater in these aquifers occurs under water-table (unconfined) or artesian (confined) conditions. A number of municipalities, industries, and farms have built over many of these aquifers because they typically form flat areas that are suitable for development with an ample groundwater supply.[132] To enable better management of the State's groundwater resources, NYSDEC works with the USGS to map the State's groundwater resources. **Exhibit 3-4** shows the general location of the State's unconsolidated aquifers. The orange areas identify areas of primary aquifers – areas capable of yielding a great deal of groundwater and, therefore, are also the State's more heavily utilized aquifers. The grey areas show the remainder of the unconsolidated aquifers in the State. These aquifers are not as heavily utilized, but are capable of providing ten to 100 or more gallons per minute. Lastly, the pink area highlights the Long Island aquifer.[133]

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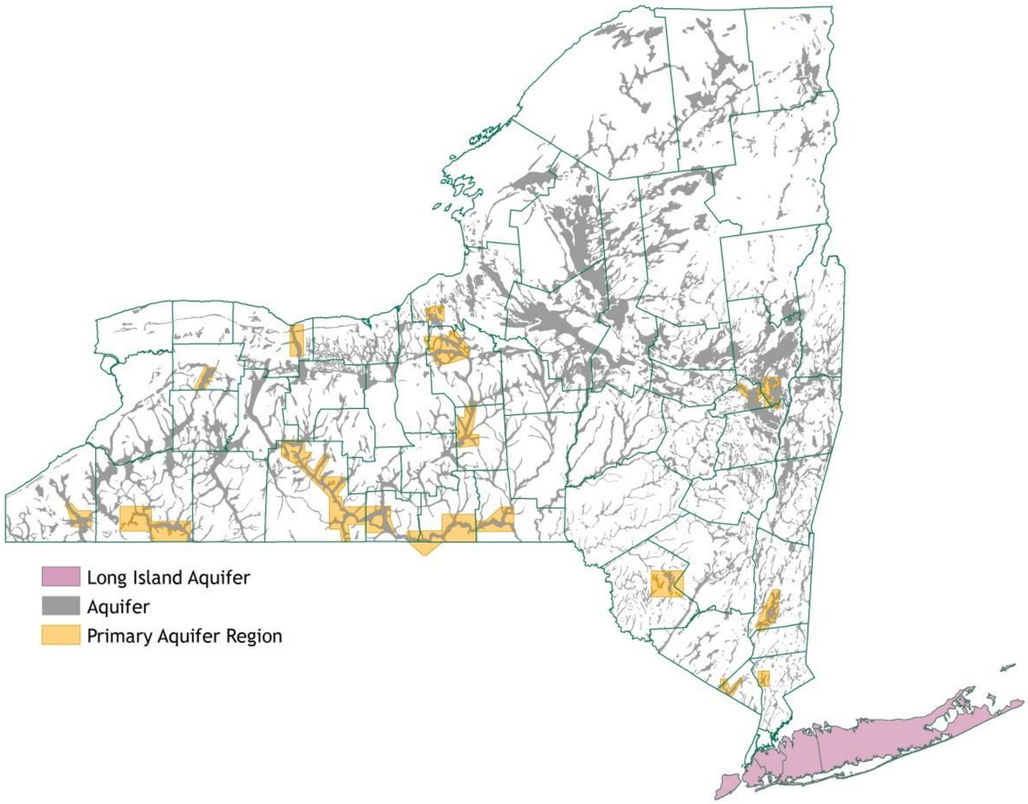
[130] New York State Department of Health. Drinking Water Program: Facts and Figures. Accessed on April 30, 2018 at: https://www.health.ny.gov/environmental/water/drinking/facts_figures.htm. The population count includes the population served by the New York City Water System, which includes a transient sub-population of approximately 2.8 million people.

[131] NYSDEC. Groundwater. Accessed on April 30, 2018 at: http://www.dec.ny.gov/lands/36064.html.

[132] NYSDEC. Groundwater Resource Mapping. Accessed on April 30, 2018 at: http://www.dec.ny.gov/lands/36118.html.

[133] NYSDEC. Groundwater. Accessed on April 30, 2018 at: http://www.dec.ny.gov/lands/36064.html.

EXHIBIT 3-4 UNCONSOLIDATED AQUIFERS IN NEW YORK STATE[134]



Water Use

In 2010, the most recent year for which complete data are available, USGS estimated annual water withdrawals in the State at approximately 10.6 billion gallons per day (bgd). Uses for such withdrawals include drinking water, irrigation, industrial, and thermoelectric power.[135] The vast majority (71 percent or 7.6 bgd) of the State's total annual withdrawals (10.6 bgd) are for thermoelectric power.[136]

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[134] NYSDEC. 2008. Groundwater. Accessed at: https://www.dec.ny.gov/lands/36119.html.

[135] USGS. 2010. Estimated Use of Water in the United States in 2010. Accessed on May 1, 2018 at: https://pubs.usgs.gov/circ/1405/pdf/circ1405.pdf.

[136] Ibid. USGS estimates that thermoelectric power in New York State withdraws 7.140 bgd of fresh surface water and 4.8 bgd of saline surface water.

New York City average water use in 2017 was estimated at 0.99 bgd.[137] New York City water use has experienced a consistent downward trend since 1979, when average daily usage was estimated at 1.5 bgd.[138]

Energy and Water Resources

Water is used in many forms of electric power generation to spin turbines directly (hydropower) or indirectly (steam-electric power) or for cooling generation equipment. Consequently, most of the State's electric power plants are located adjacent to major lakes, rivers, estuaries or coastal areas. The majority of the State's electric power is generated using water to cool steam used to spin turbines. Most plants built in the U.S. before 1970 operate with an open-loop (or once-through) cooling system.[139] In these systems, large volumes of water are withdrawn by the facility from an adjacent water body and returned to the source at a higher temperature. Both the extraction and return of water can result in environmental impacts. To minimize the adverse environmental impacts of such operations, Congress included Section 316(b) in the Clean Water Act (CWA) and New York State promulgated regulations (6 NYCRR part 704.5), which placed greater restrictions on once-through cooling systems to minimize the adverse environmental impacts of cooling water intake processes and identifies closed-cycle cooling systems as the best available technology.[140]

After 1970, cooling towers, or closed-loop systems became the more predominant cooling system for power generation. These systems operate by condensing generated turbine steam into hot water and then air-cooling the hot water in a tower – mechanically or by draft. The cooled water is collected and returned to the plant's boiler. Consumed water is evaporated in the cooling tower rather than being returned to the source watershed. Dry cooling mechanisms are also available and have been installed in several locations in the State over the last ten years. While water use and associated withdrawal and discharge impacts on waterbodies and associated ecosystem are reduced by dry-cooling systems, they require higher energy usage and are currently more expensive than wet cooling systems.

Thermoelectric water withdrawals in the State are significant, accounting for approximately 71 percent (or 7.6 bgd) of total water withdrawals in 2010. As of 2010, almost all thermoelectric water withdrawals were from surface water sources, of which approximately 64 percent were from saline surface waters and 36 percent from fresh surface waters.[141,142] Net power generation associated with thermoelectric-power water withdrawals totaled 77,900 gigawatt-hours (GWh) in

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[137] NYC Open Data. 2018. Water Consumption in New York City. May. Accessed on May 3, 2018 at: https://data.cityofnewyork.us/Environment/Water-Consumption-In-The-New-York-City/ia2d-e54m. The Open Data team is a partnership between the NYC Mayor's Office of Data Analytics (MODA) and the Department of Information Technology and Telecommunications (DOITT) to consolidate data from the state and city agencies of NYS. https://opendata.cityofnewyork.us/overview/.

[138] Ibid.

[139] EIA. 2004. Steam Electric Plant Operation and Design Report. EIA-767. Washington, DC.

[140] DOE. 2014. The Water-Energy Nexus: Challenges and Opportunities. June. Accessed on May 1, 2018 at: https://www.energy.gov /sites/prod/files/2014/07/f17/Water%20Energy%20Nexus%20Full%20Report%20July%202014.pdf.

[141] USGS estimates that 0.002 bgd of water withdrawals were from fresh ground waters in 2010.

[142] USGS. 2010. Estimated Use of Water in the United States in 2010. Accessed on May 1, 2018 at: https://pubs.usgs.gov/circ/1405/pdf/circ1405.pdf.

2010, the most recent year for which data are available. This translates to an average withdrawal rate of approximately 10.25 gallons of water to produce 1 kilowatt-hour (kWh) of energy.

3.4 SPECIES BIODIVERSITY

The biodiversity of the State includes all different species of animals, plants, fungi, microorganisms, and bacteria. The total number of species in the State is uncertain, but tens of thousands plants and animal species have been identified to date.[143] The New York Natural Heritage Program (NYNHP) maintains the most comprehensive database on the status and location of rare species and natural communities. The NYNHP currently monitors 179 natural community types, 802 rare plant species, and 466 rare animal species throughout the State, including molluscs, fish, insects, mammals, amphibians, reptiles, and birds.[144] Of protected animal species, 53 are state-listed as endangered, 37 are state-listed as threatened, and 58 are state-listed as species of special concern (i.e., any native species for which a welfare concern or risk of endangerment has been documented in the State).[145] Of the rare plant species, 349 are state-listed as endangered, 155 state-listed as threatened, 86 state-listed as rare, and 153 are state-listed as vulnerable.[146] According to the U.S. Fish and Wildlife Service (USFWS) ten federally-listed threatened and endangered plant species are present in the State. Of the ten federally-listed plant species, two species are endangered and eight species are threatened. According to the USFWS database, the State has 24 federally-listed threatened and endangered animal species, of which 18 species are endangered and six species are threatened.[147]

3.5 CLIMATE AND AIR QUALITY[148]

The climate of the State is broadly representative of the humid continental type, which prevails in the Northeast. Variation in climate across the State is driven by differences in latitude, topography, as well as proximity to large bodies of water. Due to its geographical position, the State is subject to a variety of air masses. Regional climate is driven by two countervailing air masses: cold air from the northern interior of the continent and humid air from the Gulf of Mexico and adjacent subtropical waters. The State is also affected by a third air mass flowing inland from the North Atlantic Ocean, which can produce cool, cloudy, and damp weather conditions. This maritime influence is particularly dominant in the southeastern portion of the State.

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[143] NYSDEC. Biodiversity & Species Conservation: Sustaining New York's Animals, Plants and Ecosystems. Accessed on May 14, 2018 at: http://www.dec.ny.gov/animals/279.html.

[144] NYSDEC. New York Natural Heritage Program. Accessed on May 14, 2018 at: http://www.dec.ny.gov/animals/29338.html.

[145] NYSDEC. Part 182: Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern; Incidental Take Permits. Accessed on May 14, 2018 at: https://www.dec.ny.gov/animals/7494.html.

[146] New York State. 6 CRR-NY 193.3. Protected native plants. Accessed on May 14, 2018 at: https://govt.westlaw.com/nycrr/Document/I21efe775c22211ddb7c8fb397c5bd26b?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=%28sc.Default%29.

[147] U.S. Fish and Wildlife Service. Federally Listed, Proposed, and Candidate Endangered and Threatened Species in New York. Accessed on May 14, 2018 at: https://www.fws.gov/northeast/nyfo/es/SELIST10-15-2015.pdf.

[148] National Climatic Data Center. The Climate of New York. Accessed on May 1, 2018 at: https://www.ncdc.noaa.gov/climatenormals/clim60/states/Clim_NY_01.pdf.

Moisture for precipitation is transported primarily from the Gulf of Mexico and Atlantic Ocean through circulation patterns and storm systems. Nearly all storm and frontal systems moving eastward across the continent pass through, or in close proximity to, the State. Storm systems that move northward along the Atlantic coast are of particular importance on the weather and climate of Long Island and the lower Hudson Valley. While statewide precipitation is distributed relatively evenly throughout the year (i.e., distinct dry or wet seasons are absent), the distribution of rainfall within the State varies based on local topography and proximity to the Great Lakes or Atlantic Ocean. Since 2000, New York City has experienced an average of 50.6 inches of precipitation annually.[149]

The State also receives an abundant amount of snowfall each year, the majority of which occurs in upstate New York. The State receives an average seasonal snowfall of approximately 40 inches or more, with average snowfall exceeding 70 inches in much (60 percent) of the State. Snowfall in New York City and Long Island are tempered significantly by the Atlantic Ocean, which reduces snow accumulation to approximately 25 to 35 inches per year.

The average annual mean temperature in New York City is 53.9°F.[150] The coldest year recorded in Central Park was in 1888 with an average annual temperature of 49.3°F – eight degrees cooler than the warmest year in 2012 which had average annual temperature of 57.3°F.[151] New York City temperatures of 90°F or higher often occur from late May to mid-September. Temperatures in urbanized areas of New York City can get even warmer due to the heat island effect, a term used to describe the increased air and structure temperatures in an urban area as opposed to noticeably lower temperatures in less developed setting.[152] The relative lack of trees and increased presence of dark materials such as cement results in increased solar energy absorption, leading to higher temperatures than would otherwise be found.[153] While climate change is discussed later in the chapter, the increased temperatures resulting from both the heat island effect and longer, hotter summers heightens the demand for electricity as City residents seek cooler temperatures through the use of air conditioning.[154]

[149] NOAA. 2018. Monthly & Annual Precipitation at Central Park. February. Accessed on May 2, 2018, at: https://www.weather.gov/media/okx/Climate/CentralPark/monthlyannualprecip.pdf.

[150] NOAA. 2018. Average Monthly & Annual Temperatures at Central Park. February. Accessed on May 3, 2018 at: https://www.weather.gov/media/okx/Climate/CentralPark/monthlyannualtemp.pdf.

[151] Ibid.

[152] NYSDEC. Heat Island Effects. Accessed on May 3, 2018 at: https://www.dec.ny.gov/lands/30344.html.

[153] Ibid.

[154] NYISO. 2017. Power Trends: New York's Evolving Electric Grid. Accessed on May 3, 2018 at: https://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/2017_Power_Trends.pdf.

Climate Change

Over the last century, the atmospheric concentrations of carbon dioxide and other heat-trapping greenhouse gases have rapidly increased. Combustion of fossil fuels (coal, oil, and natural gas) to generate energy is the greatest contributor to atmospheric carbon dioxide (CO_2) levels. Agricultural and other industrial processes also emit other greenhouse gases such as methane, nitrous oxide (NO_x) and halocarbons. Compared with other states, New York emits relatively low amounts of greenhouse gases (GHG) per capita (8.52 tons of carbon dioxide equivalent (CO_2e)[155] per New Yorker in 2015).[156] This is due to a smaller proportion of the State's electric energy needs met by coal-fired power plants, and also to the widespread use of public transportation in the State's larger cities.[157]

As the concentration of greenhouse gases increases, more heat is trapped in the atmosphere, which causes an increase in temperatures. Over the last century, the State has experienced rising annual average temperatures. The fastest increases in State average temperatures occurred over the last four decades (i.e., since 1970), with annual average temperatures rising approximately 2.4º F and winter warming exceeding 4.4º F.[158] By mid-century, the State's average annual temperatures are projected to rise up to 6º F compared to the 1971-2000 temperatures.[159]

Because CO_2 and other greenhouse gases remain in the atmosphere for decades or even centuries, climate change is expected to continue even in the face of declining emissions. In response, a number of initiatives and policies exist across the State public agencies and local communities to prepare for the significant risks that climate change poses to the State's communities and infrastructure. In 2015, New York City committed to reducing greenhouse gas emissions by 80 percent by 2050 in its OneNYC plan, and has since aligned itself with the goals of the Paris Agreement, a global effort aimed at preventing average temperatures from rising above 1.5º C.[160] In general, climate change is expected to make wet regions wetter and dry regions drier.[161] In the Northeast, rising air temperatures will intensify water cycles through increased evaporation and precipitation. In the State, more intense water cycles leads to water impacts such as increases in localized flash and coastal flooding, increases in the in the frequency and intensity of extreme

[155] To report the total impact multiple greenhouse gases may have on climate, these figures are given in terms of carbon dioxide equivalent (CO_2e). The carbon dioxide equivalent for a gas expresses its climate-changing ability as a multiple of that of carbon dioxide. CO_2e is derived by multiplying the tons of the gas by its associated global warming potential, a measure of energy that the gas absorbs relative to carbon dioxide. (Source: EPA. Glossary of Climate Change Terms. Accessed on May 7, 2018 at: https://19january2017snapshot.epa.gov/climatechange/glossary-climate-change-terms_.html.

[156] EIA. 2018. Energy-Related Carbon Dioxide Emissions by State, 2000-2015. January. Accessed on May 2, 2018 at: https://www.eia.gov/environment/emissions/state/analysis/.

[157] Ibid.

[158] NYSDEC. Climate Change in New York. Accessed on May 3, 2018 at: http://www.dec.ny.gov/energy/94702.html.

[159] Ibid.

[160] City of New York. OneNYC. Accessed on May 3, 2018 at: https://onenyc.cityofnewyork.us/plan/.

[161] Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

precipitation and extreme heat events, longer summer dry periods, lower summer flows in large rivers, lower groundwater tables, and higher river and in-stream water temperatures.[162,163]

Projections predict that sea level at the southern tip of Manhattan in New York City (aka The Battery) may rise between 0.6 and 1.8 feet by 2050 and between 1.9 and 6.3 feet by 2100, relative to sea levels in 2012.[164] **Exhibit 3-5** illustrates historical rates of sea level rise at this location in New York City.

Rising ocean temperatures also affect coastal areas of the State through an increase in severe coastal storms and rising sea level. These two factors can alter sensitive coastal areas, increase the risk of property damage and harm to coastal residents, decrease the diversity of coastal species, and move saltwater further north in the Hudson River – potentially contaminating water supplies in those areas. Extreme coastal floods are currently 50 percent more likely to occur in New York City as compared to 1900, and all coastal floods are more expansive due to higher sea levels.[165] Over 500,000 New Yorkers live within the 100-year coastal floodplain, and therefore face risks from severe storm events.[166] The impacts of climate changes are expected to increase the vulnerability of the affected residents, especially those populations at the greatest economic and social disadvantages.[167]

[162] Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grahborn (Eds). 2011. Responding to Climate Change in New York State. Synthesis Report prepared for NYSERDA. Accessed on May 3, 2018 at: http://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/EMEP/climaid/ClimAID-synthesis-report.pdf.

[163] Horton, R., D. Bader, C. Rosenzweig, A. DeGaetano, and W.Solecki. 2014. Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information. Supplemental Report prepared for NYSERDA. Accessed on May 3, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/ClimAID/2014-ClimAid-Report.pdf.

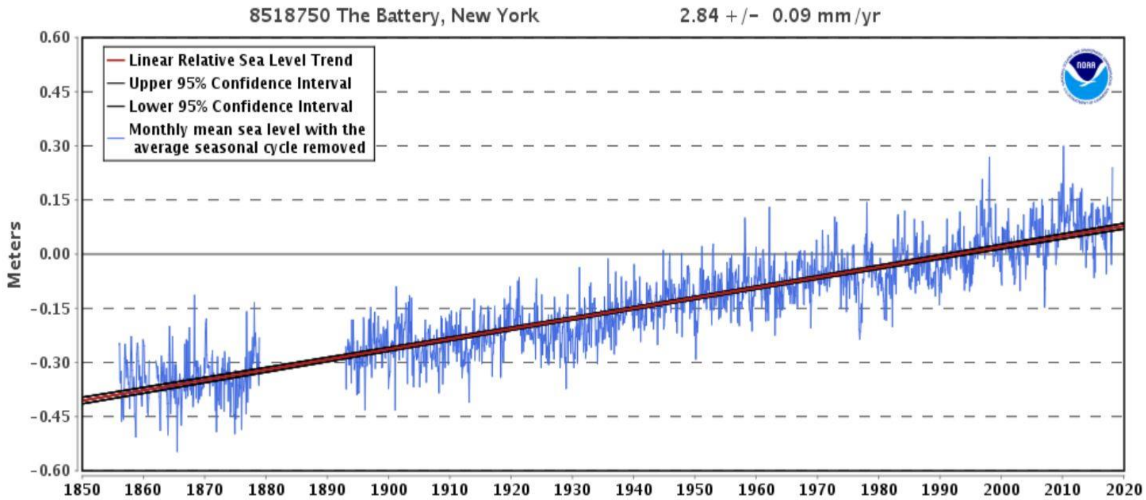
[164] Strauss, B., C. Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawaitz. 2014. New York and The Surging Sea. A Vulnerability Assessment with Projections for Sea Level Rise and Coastal Flood Risk. Updated April 2014. Accessed on May 7, 2018 at: http://sealevel.climatecentral.org/uploads/ssrf/NY-Report.pdf.

[165] IPCC Working Group 1 (2013). Summary for Policy Makers. Accessed on May 3, 2018 at: http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf.

[166] Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grahborn (Eds). 2011. Responding to Climate Change in New York State. Synthesis Report prepared for NYSERDA. Accessed on May 3, 2018 at: http://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/EMEP/climaid/ClimAID-synthesis-report.pdf.

[167] Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

EXHIBIT 3-5 OBSERVED SEA LEVEL IN NEW YORK CITY[168]



Changing climate is also expected to generate both immediate direct and long-term impacts on the State's energy infrastructure. Extreme weather events, such as landslides, high winds, heavy precipitation, droughts, and wildfires, can inflict significant damage on the State's electricity generation, transmission, and distribution infrastructure. For example, Hurricane Sandy in 2012 left more than eight million customers without power.[169] Most of New York City had power restored within a few days as transmission and distribution lines were repaired, but there were many neighborhoods that were without power for weeks.[170] Disruptions to city life extended well beyond the damaged infrastructure. Primary power was lost and backup generators failed in many hospitals, causing widespread emergency evacuations of over 6,500 patients; elevators did not function in high-rise buildings, and water pumps did not have power, which often resulted in taps higher than the seventh floor going dry.[171] When public transportation systems had to shut down due to lack of power, many residents were unable to commute to work. The estimated $19 billion in damages encompasses not only the direct damages to infrastructure, but also the unavoidable disruption to city life and commerce.[172]

[168] NOAA. Tides & Currents. Mean Sea Level Trend 8518750 The Battery, New York. Accessed on April 30, 2018 at: https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8518750.

[169] United States Government Accountability Office. Report to Congressional Requesters. Climate Change – Energy Infrastructure Risks and Adaptation Efforts. January 2014. Accessed on May 7, 2018 at: http://www.gao.gov/products/GAO-14-74.

[170] NYCEDC. 2013. A Stronger, More Resilient New York. June. Accessed on May 3, 2018 at: https://www.nycedc.com/resource/stronger-more-resilient-new-york.

[171] Ibid.

[172] Ibid.

Over longer timeframes, climate change is expected to decrease the efficiency of energy generation while increasing the demand for electricity, which may cause supply issues.[173] For example increased storm activity, higher temperatures and variable water availability can adversely affect natural gas and oil extraction, particularly in coastal areas. Warming temperatures can also adversely affect transmission efficiency and capacity. Renewable energy generation dependent on water resources, wind patterns, or solar radiation are also susceptible to changes in climate. **Exhibit 3-6** summarizes potentially negative impacts of climate change on different types of renewable energy resources and energy storage.

New Yorkers may also face public health risks as the ambient environment changes. In particular, researchers expect heat-related deaths to increase at a faster rate than cold-related deaths. Rising temperatures and increased emissions will exacerbate existing air quality issues. Increased smog, larger and more frequent wildfires, and a greater volume of pollens and molds will serve to aggravate cardiovascular and respiratory illnesses, including asthma.[174] In New York City between 2000 and 2006, there were an average of 638 heat-related deaths annually. A study by Columbia University estimates that the annual heat-related deaths in 2080 could be as low as 167, or as high as 3,331, depending on different scenarios of climate change adaptations and population growth.[175]

EXHIBIT 3-6 POTENTIALLY NEGATIVE IMPACTS OF CLIMATE CHANGE ON RENEWABLE ENERGY RESOURCES AND ENERGY STORAGE[176, 177]

TECHNOLOGY	POTENTIALLY NEGATIVE CLIMATE CHANGE EFFECT
Hydropower	• Changes in precipitation • Increased temperature and evaporation
Solar	• Changes in haze, humidity, dust • Warmer temperatures affect effectiveness of PV electricity generation • Concentrating Solar Power may be negatively affected by droughts
Wind	• Extreme weather • Wind variability caused by changing weather patterns
Energy Storage	• Potential to overheat

[173] United States Government Accountability Office. Report to Congressional Requesters. Climate Change – Energy Infrastructure Risks and Adaptation Efforts. January 2014. Accessed on May 7, 2018 at: http://www.gao.gov/products/GAO-14-74.

[174] Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

[175] Petkova EP, Vink JK, Horton RM, Gasparrini A, Bader DA, Francis JD, Kinney PL. 2017. Towards more comprehensive projections of urban heat-related mortality: estimates for New York City under multiple population, adaptation, and climate scenarios. Environ Health Perspect 125:47–55; Accessed on May 3, 2018 at: http://dx.doi.org/10.1289/EHP166.

[176] Rodrigues, A., Machado, D., and T. Dentinho. 2017. Electrical Storage Systems Feasibility; the Case of Terceira Island. July. MDPI. Accessed on May 3, 2018 at: http://www.mdpi.com/2071-1050/9/7/1276/pdf.

[177] United States Government Accountability Office. Report to Congressional Requesters. Climate Change – Energy Infrastructure Risks and Adaptation Efforts. January 2014. Accessed on May 3, 2018 at: http://www.gao.gov/products/GAO-14-74.

3.6 CULTURAL AND HISTORIC RESOURCES

The State is home to a diverse array of cultural, historic, and archaeological resources, spanning prehistory through the modern era with elements of both the natural and anthropogenic environments. This section summarizes the State's cultural and historic resources, including but not limited to, historic buildings, archaeological sites, burial grounds, Native American sacred sites, and other significant cultural resources.

National and State Registers of Historic Places

The National and State Registers of Historic Places (NRHP/SRHP) serve to document the historic significance of various buildings, sites, structures, objects (e.g., sculptures, statuary, etc.), and districts throughout the State. Eligibility for both registers is determined by the State Historic Preservation Office (SHPO), and is based on the property's age and level of historic significance, integrity, and context. The 5,000 SRHP/NRHP-listed places in the State feature approximately 90,000 contributing properties. In addition, SHPO has identified more than 30,000 properties as eligible for listing on the SRHP/NRHP. Although these NRHP-eligible properties are not formally nominated for listing, they receive the same protections and consideration as SRHP/NRHP-listed properties. SHPO has also developed the Cultural Resources Information System (CRIS), a web-based information system created to provide public access to the State's historic and cultural resource databases. It also includes over 1.5 million pages of digital images from NRHP documents to survey reports and archaeological inventory forms.[178]

The New York City Landmarks Preservation Commission is the authority delegated by SHPO to evaluate potential impacts on cultural and historic resources within New York City. The five boroughs together encompass over 36,000 landmark properties, including 1,405 individual landmarks, 120 interior landmarks, and 10 scenic landmarks. The majority of the protected properties are located in 141 historic districts and historic district extensions across the city.[179]

National Historic Landmarks

The National Historic Landmarks Program, administered by the National Park Service (NPS), recognizes 272 places within the State for their contribution to American history and culture.[180] Like the properties on the National and State Registers, National Historic Landmarks can include buildings, sites, objects, or districts; however, eligibility for the latter program requires a greater threshold of historic significance. National Historic Landmarks may include the following:

- Properties with the strongest association with a given historical event;
- The properties that best interpret the story of a given individual who played a significant role in the nation's history;

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[178] SHPO. CRIS: Overview. Accessed on May 3, 2018 at: https://cris.parks.ny.gov/CRISHELP/?context=60.

[179] NYCLPC. About LPC. Accessed on May 3, 2018 at: http://www1.nyc.gov/site/lpc/about/about-lpc.page.

[180] National Park Service, National Historic Landmarks Program (NPS NHPL). 2018. List of National Historic Landmarks. Accessed on May 7, 2018 at: https://www.nps.gov/nhl/find/statelists/ny/NY.pdf.

- Exceptional representations of a particular building or engineering technique or method, or building type; or
- Archaeological sites that may yield new and innovative information about the past.

National Historic Landmarks in the New York City area are numerous. Among these landmarks are the National Recreation Area, Gateway; National Monuments such as the African Burial Ground, Castle Clinton, and Governors Island; National Historic Sites such as the Home of Franklin D Roosevelt; and the National Parks of New York Harbor.[181]

Locally Designated Historic Sites

Many municipalities throughout the State also recognize buildings and sites that are historically significant. Local governments may also establish historic preservation committees, designate local landmarks, and grant protections for local historic and cultural resources identified in their communities. To date, the SHPO has approved the adoption of historic preservation ordinances by 74 local governments through its coordination of the federally-sponsored Certified Local Government Program.[182]

Archaeological Resources

Archaeological sites in the State include both prehistoric Native American sites, which date back as far back as 12,000 years ago through 1500 AD, and historic-period resources related to the settlement and development of the State since the arrival of European colonists and settlers. While the exact number of archaeological sites is unknown, SHPO records include approximately 18,000 archaeological sites, while New York State Museum's records (consolidated with the SHPO's files) identify approximately 12,000 sites. Of these, approximately 560 sites are listed on the NRHP, and the SHPO has identified an additional 1,100 sites as eligible for and therefore receiving protection under the NRHP.[183]

The New York City Landmarks Preservation Commission (LPC) established the Archaeology Department in 2002, which reviews any proposed subsurface work that falls under environmental review regulations or is a landmark as defined by the LPC or NPS.[184] In addition, the Archaeology Department supervises the subsequent archaeology and appropriate mitigation if important archaeological resources are discovered.[185] An Archaeological Repository of artifacts discovered

[181] NPS. Find A Park: New York. Accessed on May 3, 2018 at: https://www.nps.gov/state/ny/index.htm.

[182] SHPO. Certified Local Governments. Accessed on May 3, 2018 at: https://parks.ny.gov/shpo/certified-local-governments/.

[183] DPS and Ecology and Environment Inc. 2013. Indian Point Contingency Plan Final Generic Environmental Impact Statement. Prepared for New York State Public Service Commission. July 2013. Accessed on May 7, 2018 at: http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B1CFCC090-1E99-4A8C-BC0C-56764C8985AD%7D.

[184] NYCLPC. Departments: Archaeology. Accessed on May 3, 2018 at: https://www1.nyc.gov/site/lpc/about/archaeology.page.

[185] Ibid.

throughout the city is maintained by the Archaeology Department; 32 city-owned collections have uncovered almost a million artifacts.[186]

3.7 WASTE MANAGEMENT

In 2008, New York residents generated approximately 36.6 million tons of materials and waste, of which the majority was municipal solid waste (18.3 million tons, or 50 percent), followed by industrial waste (13.0 million tons, or 36 percent), with the remaining composed of Construction and Demolition (C&D) at ten percent, and biosolids at five percent.[187]

Electric utilities in the State generate approximately two million tons of solid waste per year as a by-product of conventional energy production and the burning of fossil fuels. Such production, primarily in coal-fired units, creates approximately two million tons per year of fly ash, bottom ash, and scrubber sludge as fuel generation waste. While some of the electric industry's solid waste is recycled, most is buried in landfills. In 2014, the State's ten Waste-to-Energy (WTE) facilities processed approximately four million tons of Municipal Solid Waste (MSW) and generated 2,236,188 megawatt-hours (MWh) of electricity, delivering approximately one percent of the electric power generated in the State.[188] These facilities also produced approximately 970,000 tons of non-hazardous combined ash (a combination of fly ash and bottom ash).

Rechargeable batteries can present a hazard to the environment when disposed; most contain toxic materials. In December 2010, the New York State Rechargeable Battery Recycling Act was signed into law, mandating that manufacturers of rechargeable batteries collect and safely recycle certain batteries at no cost to the consumers.[189] The law is only applicable to batteries weighing less than 25 pounds and includes: nickel-cadmium, sealed lead, nickel metal hydride, lithium ion, and any other similar type of dry cell battery capable of being recharged. The law also specifically excludes batteries used as the primary power source for a vehicle and batteries for storing electricity generated by an alternative power source (e.g., solar, or wind). In New York City alone, the New York Department of Sanitation estimates that in FY 2017 over 3.5 tons of rechargeable batteries were diverted from the landfill.[190]

[186] NYCLPC. 2018. List of the Collections. Accessed on May 3, 2018 at: http://archaeology.cityofnewyork.us/collection/list-of-the-collections.

[187] NYSDEC. 2010. Beyond Waste: A Sustainable Materials Management Strategy for New York State. Accessed on May 7, 2018 at: https://www.dec.ny.gov/docs/materials_minerals_pdf/frptbeyondwaste.pdf.

[188] NYSDEC. 2014 Municipal Waste Combustion Summary Report. Accessed on May 3, 2018 at: https://www.dec.ny.gov/chemical/40052.html.

[189] NYSDEC. Rechargeable Battery Recycling. Accessed on May 3, 2018 at: http://www.dec.ny.gov/chemical/72065.html.

[190] NYDS. New York City Municipal Refuse and Recycling Statistics: Fiscal Year 2017. Accessed on May 3, 2018 at: http://www1.nyc.gov/assets/dsny/docs/about_dsny-non-dsny-collections-FY2017.pdf.

3.8 PUBLIC HEALTH

Relevant public health issues include: asthma and air quality-related health concerns and exposure of the public to electric and magnetic fields (EMFs).

Air Pollutants

Fossil-fuel electric generating plants release criteria pollutants such as NO_x and sulfur dioxide (SO_2), as well as hazardous air pollutants such as mercury. Air quality in the State has continued to improve since the promulgation of federal and state, and municipal control requirements for stationary and area sources, complemented by on-going improvements in mobile source emissions and efficiency. For example, the average wintertime SO_2 levels in New York City declined by 68 percent between 2008 and 2014 as a result of legislation passed by the New York City Council in 2010.[191] While control technologies are required for new generating facilities, and the use of natural gas as a primary energy source (instead of oil or coal) has lowered emissions per kWh of generation, most of the largest individual emission sources in the State continue to be electricity generation plants. Most air quality control regions in the State are in attainment with national air quality standards, while ozone continues to be a priority for air quality planning purposes.[192] The counties that constitute the New York City are largely in attainment with all national air quality standards; the exceptions are Bronx and Queens Counties, which are both in moderate nonattainment for ozone standards.[193]

Ozone

Ozone can have an adverse effect on the human body. High ozone concentrations irritate nasal, throat, asthma, and bronchial tissues. Ozone attacks certain components of the body's defense system, raising concerns about the effects of ozone exposure on the human immune system. High concentrations of ozone can also harm forests, thereby altering wildlife habitats, lowering crop yields, and damaging materials such as rubber, plastics, synthetic fibers, dyes, and paints.[194]

Ozone formation occurs most commonly over cities with large numbers of industries, power plants, and vehicles. In large urban areas, ozone mixes with other pollutants to create smog. Smog reduces visibility and can irritate and inflame eye tissues. Generally, hot and dry weather fosters smog production.

Particulate Matter

Particulate matter (PM) is a generic term for a broad class of chemically and physically diverse substances that exist as discrete particles (liquid droplets or solids) over a wide range of sizes. PM is classified in terms of the particle's aerodynamic diameter. PM2.5 is particulate matter with an aerodynamic diameter of 2.5 microns or less. Elevated levels of PM2.5 in the atmosphere have been linked to serious health conditions in humans. Exposure to PM2.5 has been closely associated

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[191] New York City Air Quality Programs Reduce Harmful Air Pollutants. Accessed on May 3, 2018 at: https://www.healthypeople.gov/2020/healthy-people-in-action/story/new-york-city-air-quality-programs-reduce-harmful-air-pollutants.

[192] EPA. Green Book. Current Nonattainment Counties for All Criteria Pollutants. April 30, 2018. Accessed on May 3, 2018 at: https://www3.epa.gov/airquality/greenbook/ancl.html.

[193] Ibid. Moderate nonattainment for 8-Hour Ozone (2008 Standard) Classification means the area has a design value between 0.086 and 0.100 ppm.

[194] EPA. The Science of Ozone Depletion. Accessed on May 3, 2018 at: http://www.epa.gov/ozone/science

with increased hospital admissions and emergency room visits for heart and lung disease, increased incidence of respiratory disease, including asthma, decreased lung function and premature death. Sensitive groups that appear to be at greatest risk of such effects include the elderly, individuals with existing cardiopulmonary disease, and children. Reductions in the NO_x and SO_2 will in turn reduce the fine particulates formed from those emissions.

After several years of efforts to control pollution sources, the New York metropolitan area achieved compliance with EPA air quality standards for PM2.5, bringing the entire state into federal compliance in April 2014. Measurements showed that long-term PM2.5 concentrations in outdoor air went from 14 percent above the federal 24-hour standard in 2003 to 26 below in 2013.[195] All counties in the State have since been in attainment for PM2.5 air quality standards.[196]

Asthma[197]

Asthma is a chronic lung disease caused by restriction of the airways that can result from a variety of genetic and environmental factors. Chronic asthma is usually controllable with drugs that relax the constricted airways or block inflammation caused by allergens and irritants. Common triggers for acute attacks include, but are not necessarily limited to, tobacco smoke, dust mites, cockroach allergen, pets, molds, smoke, and outdoor air pollution, which may come from power plant emissions, and other chemical irritants.[198] Nationally, nearly one in 13 school-age children suffer from asthma. The incidence of childhood asthma, however, is rising more rapidly in preschool-aged children and children living in urban inner cities, where asthma rates are generally higher than in non-urban populations.[199] In 2011, the New York State Asthma Surveillance Summary Report indicated an average 10.2 percent of adults in New York City were affected by asthma.[200] Between 2003 and 2010 asthma rates among adults in New York City were consistently lower compared to adults in the rest of the state; however starting in 2011, the trend reversed.[201] Asthma rates among children in New York City follow a similar trend as adults. Between 2006 and 2010, an estimated 10.3 percent of children in New York City had asthma. Rates of asthma across the

[195] NYSDEC. 2014. New York Statewide Air Quality Now Meets Federal Standard. April. Accessed on May 3, 2018 at: http://www.dec.ny.gov/press/96759.html.

[196] EPA. 2018. New York Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants. April. Accessed on May 3, 2018 at: https://www3.epa.gov/airquality/greenbook/anayo_ny.html.

[197] New York State Department of Health. 2013. New York State Asthma Surveillance Summary Report. Public Health Information Group, Center for Community Health. October. Accessed on May 3, 2018 at: https://www.health.ny.gov/statistics/ny_asthma/pdf/2013_asthma_surveillance_summary_report.pdf.

[198] Centers for Disease Control and Prevention. Asthma webpage. Accessed on May 3, 2018 at: http://www.cdc.gov/asthma/faqs.htm.

[199] Ibid.

[200] New York State Department of Health. 2013. New York State Asthma Surveillance Summary Report. Public Health Information Group, Center for Community Health. October. Accessed on May 3, 2018 at: https://www.health.ny.gov/statistics/ny_asthma/pdf/2013_asthma_surveillance_summary_report.pdf.

[201] Ibid.

state are highest among Latino and black children, with 11.7 percent and 14.3 percent of children being affected, respectively.[202]

Electric and Magnetic Fields

EMFs are generated by all electric currents, including kitchen appliances and cellular telephones, as well as power transmission lines. The health effects of EMF and, specifically, extremely low frequency fields, which are generated when the direction of current flow in an alternating current (AC) line switches, have been studied since the 1970s. Although some studies have shown a correlation between exposures to magnetic fields and childhood leukemia, brain tumors, and breast cancer; because many other factors correlate with houses located in close proximity to transmission lines, a causal relationship between EMF exposure and cancer is unclear. The National Cancer Institute conducted a scientific review of the existing health literature investigating whether a link between EMF exposure and cancer exists. The review examines literature exploring a connection between EMFs and cancer in both children and adults, and in both cases, the review notes that no consistent evidence for a causal link between EMF exposure and cancers has been found. The European Commission Scientific Committee on Emerging and Newly Identified Health Risks, which reviewed electromagnetic fields in 2015 found a slight increased risk of childhood leukemia with daily exposures to low frequency fields; however, these findings are not supported by experimental studies.[203]

While there are no national or New York State standards for occupational exposures, the New York State Public Service Commission (the Commission) has established two electric field strength standards:

- **Opinion 78-13** (issued June 19, 1978) established a limit for electric fields at the edge of a right-of-way (ROW), at three feet above ground level to 1.6 kilovolts (kV) per meter for electric transmission lines.
- **Interim Policy guidelines** (issued on September 11, 1990) limit magnetic fields at the edge of an ROW at three feet above ground level to 200 milligauss (mG) for transmission lines.

In addition to public exposures, the Occupational Safety and Health Administration (OSHA) monitors and sets international and industrial guidelines for worker safety.[204]

Currently, urban populations are exposed to EMF in the home and workplace from appliances and power cables, many of which are belowground or shielded. Rural populations are also exposed, albeit at relatively low levels, from overhead transmission lines, in addition to exposure in the home and workplace. However, public exposure is many thousands of times less than worker exposures because EMF strength diminishes with the square root of the distance from a power line and the cube root of the distance from a point source. For example, a magnetic field measuring

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[202] Ibid.

[203] National Cancer Institute. 2016. Electromagnetic Fields and Cancer. May 27. Accessed on May 3, 2018 at: https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet#q6.

[204] U.S. Department of Labor, Occupational Safety and Health Administration. Safety and Health Topics: Extremely Low Frequency Radiation. Accessed on May 3, 2018 at: http://www.osha.gov/SLTC/elfradiation/.

57.5 mG immediately beside a 230 kV transmission line measures just 7.1 mG at a distance of 100 feet, and 1.8 mG at a distance of 200 feet.[205]

3.9 COMMUNITY CHARACTER

Community character is influenced in large part by shifts in population and regional economic patterns. A community's character is defined by a combination of elements, including local natural features, land uses, development patterns, population growth and density, and regional socioeconomic patterns.

Municipalities typically guide community character through comprehensive plans or master plans, implemented through local land use regulations, including zoning. Community character, as described by residents, however, is more difficult to define (or legislate), and is sometimes associated with more intangible community qualities such as demographics, population density open space, air quality, land use and neighborhood compositions, or traffic patterns.

Population[206]

New York is the fourth most populous state, behind California, Texas, and Florida.[207] The U.S. Census estimated the population of the State at 19,849,399 on July 1, 2017, a 2.4 percent increase from the state's 2010 population of 19,378,102.

The State is divided into 62 counties, 11 metropolitan statistical areas (MSAs) and five combined statistical areas (CSAs). Approximately 42.8 percent of the State's population resides within New York City with a 2016 population of approximately 8.5 million people; New York City is also the most populous metropolitan area in the U.S.[208, 209]

Population levels and density vary substantially across the State. The five counties within New York City – Bronx, Kings, New York, Queens, and Richmond – are home to approximately 8.5 million residents and feature a population density of 28,252 per square mile. By comparison, the remainder of the State contains 11.2 million residents at a density of 240 per square mile.[210] **Exhibit 3-7** illustrates the relative population densities across the State. Population density outside of the New York Metropolitan area exhibits an inverse relationship, as distance to the New York City metropolitan area increases, population densities are considerably lower and development less intense; attributes reflecting communities more rural in nature.

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[205] National Institute of Environmental Health Sciences. 2013. Electric and Magnetic Fields. May 26. Accessed on May 3, 2018 at: http://www.niehs.nih.gov/health/topics/agents/emf/.

[206] U.S. Census Bureau. State & County Quick Facts – New York. Accessed on May 7, 2018 at: https://www.census.gov/quickfacts/NY.

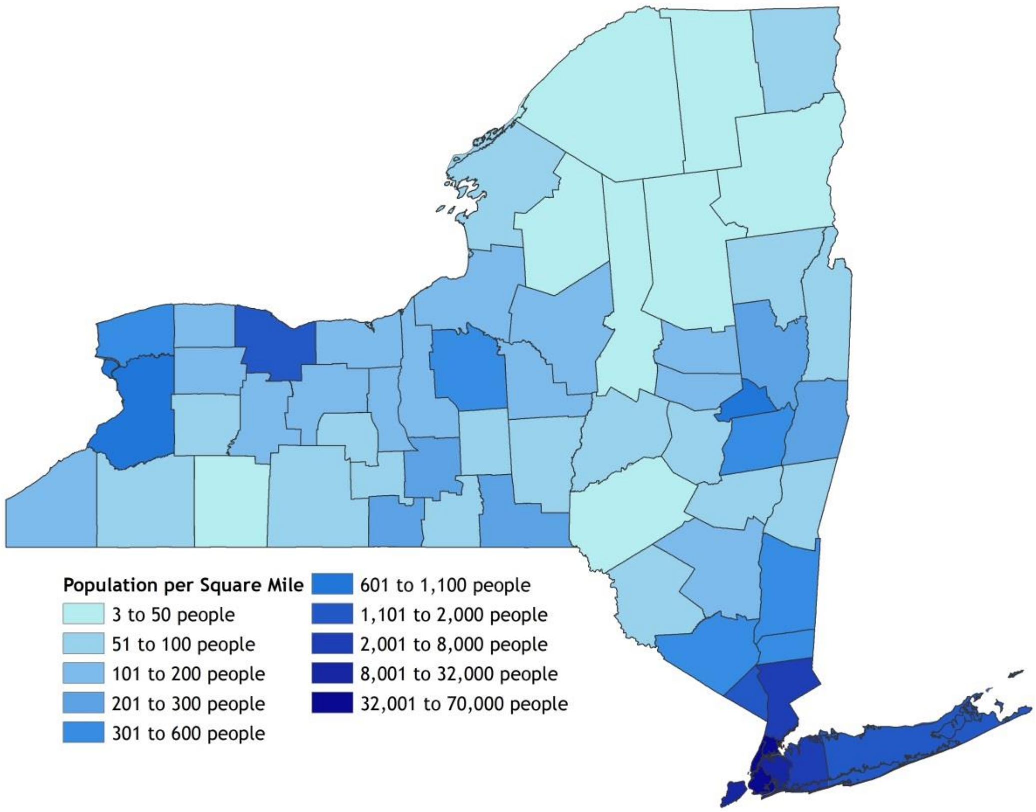
[207] U.S. Census Bureau. 2017. American Fact Finder. Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2017. 2017 Population Estimates. Accessed on May 3, 2018 at: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml.

[208] U.S. Census Bureau. 2016 American Community Survey 1-Year Estimates. Accessed on May 3, 2018 at: http://www1.nyc.gov/assets/planning/download/pdf/data-maps/nyc-population/acs/demo_2016acs1yr_nyc.pdf.

[209] U.S. Census Bureau. State & County Quick Facts – New York. Accessed on May 3, 2018 at: https://www.census.gov/quickfacts/fact/table/newyorkcitynewyork/PST045216

[210] New York State Department of Health. 2015. Vital Statistics of New York State 2015. Accessed on May 3, 2018 at: https://www.health.ny.gov/statistics/vital_statistics/2015/table02.htm.

EXHIBIT 3-7 NEW YORK STATE POPULATION DENSITY BY COUNTY[211]



While the State saw an overall increase in population between 2010 and 2015, much of that population growth is occurring in counties in and around New York City. Population in all ten counties in and around New York City increased in 2015 compared to 2010, whereas only 12 counties in the remaining upstate areas experienced growth.[212]

Community Types

While community character can sometimes appear relatively constant, it is always evolving due to shifting demographics, changes in the local and regional economy, and the passage of time. Regardless of size, development projects have the potential to affect community character over both the short- and long-term. Although often difficult for residents or visitors to define, elements of community character can be highly influential in individuals' decisions to migrate, start a business, or travel to a given location. These elements can work in either positive or negative ways, either attracting or deterring residents, businesses, or visitors. **Exhibit 3-8** summarizes the seven most common community types in the State.

[211] U.S. Census 2010.

[212] Ibid.

EXHIBIT 3-8 SUMMARY OF NEW YORK COMMUNITY TYPES[213]

COMMUNITY TYPE	COMMUNITY TYPE DESCRIPTION
Rural Agricultural	The dominant land use in this community type is agriculture, and farm structures/equipment, livestock, and open fields are significant components of this landscape. Rural residences are typically scattered along a network of country roads. The topography in this setting will vary from hilly to flat, with a mix of crops and pastureland, woodlots and hedgerows.
Rural Hamlet	The dominant feature in this community type is a cluster of residential structures in a largely rural setting. These areas may have a small commercial center that is usually located at an intersection of two rural roadways. Historic structures of varying significance are often present.
Village	These communities typically consist of a concentration of residential structures with a commercial business core. Historic structures and/or historic districts are often present. The structures may be of a vernacular material or style but typically include a mix of new and old architecture. Vegetation consists of large street trees, landscaped yards, and parks. The streets are often organized in a traditional grid pattern, and the more modern commercial and industrial facilities are typically located on the village periphery.
Suburban	Suburban residential areas consist of mostly residential structures along existing road frontage, as well as residential subdivisions with curvilinear roads and cul-de-sacs. These moderate-to high-density residential developments include larger yards and relatively modern homes of varying architectural styles and materials. Commercial portions of suburbs generally consist of strip development along a highway, including retail stores, automobile dealers, shopping centers, malls, and office- or light-industrial complexes; residential uses are limited. Suburban commercial character is typically dominated by highways, buildings, automobiles, and pavement (roads and parking lots). This type of setting usually surrounds a village or urban area; the surrounding landscape can vary from suburban residential, to farmland, to forested hills.
Urban	Urban residential settings are typically dominated by 2-to 4-story masonry apartment blocks and single family and multiple family homes, although some urban residential areas (e.g., portions of New York City) feature structures much larger than this. The streets are generally organized in a grid pattern and lined by narrow sidewalks and street trees. Urban commercial areas generally feature buildings that are at least two to four stories in height, with retail storefronts along the sidewalks and upper floors that are used as offices and apartments. Urban downtowns typically occur in the center of a city and are characterized by high-rise buildings and gridded street patterns. Both urban commercial and downtown areas usually feature gridded street patterns, which are busy with traffic, and frequently accommodate on-street parking. In general, views along urban streets are framed or screened by adjacent buildings, and vegetation is typically limited to street trees, planters, pocket parks, or larger public parks.

[213] Table source from Chapter 4.14 of the Indian Point Contingency Plan Draft Generic Environmental Impact Statement. DPS and Ecology and Environment Inc. 2013. Indian Point Contingency Plan Final Generic Environmental Impact Statement. Prepared for New York State Public Service Commission. July 2013. Accessed on May 7, 2018 at: http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B1CFCC090-1E99-4A8C-BC0C-56764C8985AD%7D.

COMMUNITY TYPE	COMMUNITY TYPE DESCRIPTION
Industrial	Industrial areas are dominated by an often haphazard mix of buildings and structures associated with manufacturing, warehousing, utility, and transportation-related activities. An industrial setting often occurs along the outskirts of urban and village areas. The topography is generally flat and vegetation is limited or nonexistent. Pedestrian activity is generally insignificant, as most activity typically occurs within the industrial facilities in such areas, although some industrial settings (typically older manufacturing districts) feature limited residential uses that may contribute a degree of community character.
Developed Shoreline	Along the State's coastlines (e.g., Long Island Sound, New York Harbor, and the Hudson River), open water is the dominant feature but is frequently interrupted by docks, piers, and/or boats. The shoreline may include natural beach or may be bulkheaded or otherwise structurally reinforced. A developed coastline will include ports, marinas, and shorefront commercial, residential, and recreational facilities. Along lakeshores other than those of the Great Lakes, the dominant natural feature is water, with surrounding hills and mountains typically in the background. However, the natural shoreline in these settings is interrupted by man-made features such as seasonal homes/camps, boathouses, and docks. The foreground that frames the water views includes both man-made and natural features.

3.10 TRANSPORTATION

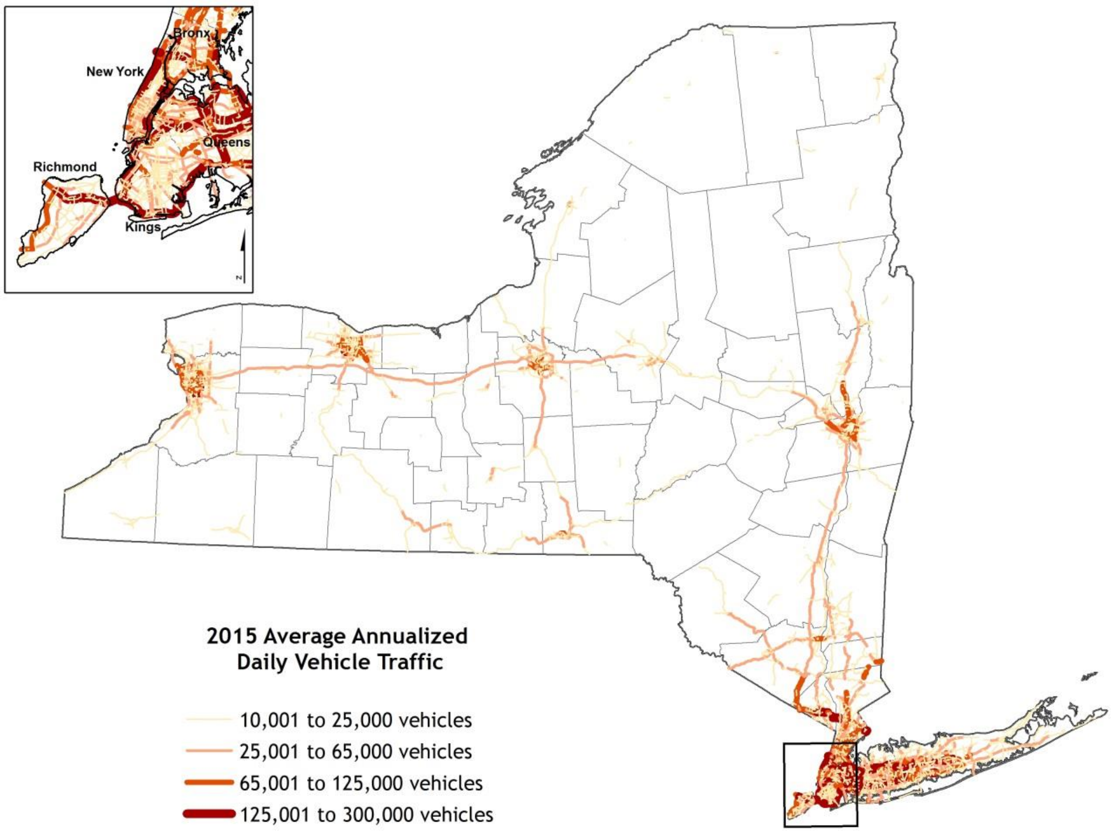
The transportation issues discussed in this chapter include roads and highways; transit and rail services; and plug-in electric vehicles.

Roads and Highways

New York's primary transportation network consists of the existing system of interstate highways, urban expressways, rural highways, and local streets. Ownership of the State's roads, highways, and, in particular, bridges, is a patchwork of federal, state, county, local, and private ownership. The New York State Thruway is maintained by the New York State Thruway Authority and Canal Corporation, whereas the remaining federal and state highways are under the jurisdiction of the DOT. While counties and municipalities are responsible for local roads and bridges, federal funds from the Federal Highway Administration (FHWA) are frequently relied upon for periodic repairs and routine maintenance. The State's inventory of bridges includes a number of state and local bridges that currently require rehabilitation or replacement due to age and higher traffic loads in excess of the bridges' constructed capacity.

Vehicular traffic between New York City and the rest of the state is a major area of focus. In particular, the Hudson Valley corridor, which funnels traffic to New York City, consist of New York State Routes 9 and 9A and several limited access highways, including the New York State Mainline Thruway (I-87), which crosses the Hudson at the Gov. Mario M. Cuomo Bridge and continues to I-278 in the Bronx, Sawmill River Parkway, Bronx River Parkway, Hutchinson River Parkway (I-678), and I-95. Highway capacity in these areas is generally insufficient, adversely affecting vehicular traffic in the southeastern part of the State. Insufficient highway capacity is further exacerbated from the State's ongoing efforts to repair, reconstruct, and maintain the State's aging roads and highways; the capacity for existing highways to bear extra loads for construction vehicles or fuel deliveries is varied and in some areas limited. **Exhibit 3-9** presents the 2015 average annualized daily vehicle traffic volumes for the State as-a-whole as well as a subset focused on the Greater New York City Area.

EXHIBIT 3-9 NEW YORK STATE TRAFFIC VOLUMES WITH FOCUS ON NEW YORK CITY



Transit and Rail Services

The Metropolitan Transportation Authority (MTA) is the largest transportation network in North America. The MTA owns and operates New York City's public transit network, including the subways, buses, and the Metro-North and Long Island commuter railroads. The MTA also maintains most of the bridges in and out of New York City.[214] Across its network, MTA serves a population of more than 15.3 million people who travel to, from, and thru New York City, Long Island and the southeastern portions of the State. The MTA estimates that its subways, buses, and railroads provide 2.6 billion trips each year – the equivalent of approximately one in every three users of mass transit in the U.S. and two-thirds of the nation's rail riders. MTA bridges and tunnels in 2017 carried a record 310 million vehicles– more than any bridge and tunnel authority in the nation.[215]

[214] New York Metropolitan Transportation Authority. The MTA Network. Accessed on May 4, 2018 at: http://web.mta.info/mta/network.htm.

[215] Ibid.

Established in 1921, the Port Authority of New York and New Jersey (Port Authority) operates a number of facilities and transportation systems that serve the New York and adjacent New Jersey area, including commuter rail service to and from Manhattan and New Jersey, marine terminals and ports, six tunnels and bridges, and the Port Authority Bus Terminal in Manhattan.[216]

The State also maintains an extensive system of rail lines for passengers and freight. Amtrak is the sole provider of intercity rail passenger service in the State, providing passenger service over rail lines owned by freight railroads. Amtrak links downstate with upstate cities, including Albany, Utica, Syracuse, Rochester, Buffalo, and many other intermediate points. The owners and operators of the State's freight corridors include CSX Transportation, Canadian Pacific Railway, and Norfolk Southern Railway.

3.11 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

The socioeconomic setting that may be affected by the approval of the Roadmap comprises several factors: employment levels; housing requirements; municipal revenues; and, electricity rates. Depending on the geographic footprint of energy storage and potential effects on electricity rates, environmental justice issues may also emerge.

General Demographics

New York City's long history as a principal point of entry into the U.S. serves as a source of ethnic and cultural diversity unique to the State. According to the U.S. Census, Caucasians make up the majority of the State's population in 2016 with 69.9 percent, followed by black or African Americans at 17.7 percent, Asians at 8.9 percent, and American Indians and Pacific Islanders each less than one percent. In addition, approximately 23 percent of the population is foreign-born. Socioeconomic conditions vary substantially across the state.[217]

Employment Characteristics[218]

In the State, approximately 9.5 million people were employed in non-farm positions in March 2018. This represents a 1.1 percent increase compared to March 2017.[219] According to the New York State Department of Labor, total private sector jobs (including construction) increased by 105,300 jobs during the same period, equivalent to a year-over-year growth rate of 1.3 percent. The large majority of the private sector job growth occurred in the downstate area; New York City experienced job growth at a rate of 1.6 percent. Comparatively in the upstate region, private sector jobs grew by 0.5 percent over the past year. Job growth in the upstate region occurred primarily in metro areas; counties outside metropolitan areas often experienced job loss over the last year. The

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[216] The Port Authority of New York and New Jersey. Overview of Facilities and Services. Accessed on May 4, 2018 at: http://www.panynj.gov/about/facilities-services.html.

[217] U.S. Census Bureau. 2017. Quick Facts: New York. Accessed on May 4, 2018 at: https://www.census.gov/quickfacts/fact/table/NY/RHI125216#viewtop.

[218] New York State Department of Labor. 2018. Press Release: Number of Nonfarm Jobs by Place of Work: New York State and Areas. April 19. Accessed on May 4, 2018 at: https://www.labor.ny.gov/stats/pressreleases/2018/Apr19_18prtbjd.pdf.

[219] New York State Department of Labor. Current Employment Statistics. Preliminary. Accessed on May 4, 2018 at: https://labor.ny.gov/stats/cesemp.asp.

prominent exceptions were Greene County and Seneca County, which increased 4.8 and 3.2 percent, respectively.

Income and Wage Characteristics[220]

The annual mean wage for all occupations in the State in 2017 was $60,100 in 2017, an increase of two percent from 2016. In 2017, the average median wage in counties in upstate New York was $29,989; the average median wage in counties of downstate New York during the same year was $40,056.[221,222]

Counties with the highest median household income include Nassau County ($118,959), Putnam County ($97,606), and Suffolk County ($90,128). In upstate New York, Saratoga County had the highest median household income in 2016 ($74,080). Counties with the lowest median household incomes in 2016 include Bronx County ($35,302), Chautauqua County ($43,211), and Cattaraugus County ($43,884).[223]

Exhibit 3-10 presents key economic characteristics for downstate New York.

EXHIBIT 3-10 SELECT INCOME AND WAGE CHARACTERISTICS OF DOWNSTATE NEW YORK STATE (2012-2016)

METRIC	DOWNSTATE NEW YORK COUNTIES[224]
Households	4,399,996
Homeownership rate	49.0%
Median home value	$508,863
Per capita income ($2016)	$38,391
Median household income	$71,704
Persons below poverty level	12.3%

[220] U.S. Bureau of Labor Statistics. Occupational Employment Statistics. Last updated March 30, 2018. Accessed on May 4, 2018 at: http://www.bls.gov/oes/tables.htm.

[221] A weighted average median household income was calculated for each region based on the number of households and median household income of each county in each region.

[222] Calculated using weights constructed from ACS 2016 household totals and median household income (2016 dollars) data. Source: U.S. Census Bureau. 2012-2016 American Community Survey 5-Year Estimates. Accessed on May 4, 2018 at: http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t&keepList=t.

[223] U.S. Census Bureau. 2012-2016 American Community Survey 5-Year Estimates. Accessed on May 4, 2018 at: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_DP03&src=pt.

[224] As defined earlier in this chapter, for the purposes of this generic environmental impact statement (GEIS), downstate New York counties include Bronx, Kings, Nassau, New York, Queens, Richmond, Suffolk, and Westchester.

Housing Characteristics

In 2016, the estimated housing vacancy rate in the State was 11.3 percent, a slight increase from 11.2 percent in 2015.[225] In 2016, 46.5 percent of housing units were single unit residences, while 27.1 percent of housing units were a part of structures containing two to 19 housing units, and 27.1 percent of housing units were a part of structures containing 20 or more housing units. Mobile homes account for 2.3 percent of all housing units.[226] In New York City, the 2017 vacancy rate was 3.63 percent, but varied a relatively large amount by borough. The Bronx had the lowest vacancy rate at just 2.71 percent; Manhattan had the highest, at 4.73 percent.[227]

The 2016 American Community Survey (ACS) estimated that 43.8 percent of renters in the State paid gross rent costs totaling 35.0 percent or more of household income.[228] In 2017, of 2,172,634 total rental units in New York City, approximately 1.0 million units (or 47 percent) were rent-regulated.[229]

According to the Federal Reserve Bank of New York, the housing boom and bust in the early part of the 2000s largely bypassed upstate New York, where construction activity is a relatively small part of the overall economy. As a result, home prices generally stabilized across upstate New York, with some parts even experiencing appreciation of home prices; for example, Buffalo, Rochester, and Syracuse all ranked in the top ten percent in terms of home price appreciation in 2009.[230]

Municipal Revenue

Real estate property taxes (RPT) are the primary source of revenue for the majority of cities, towns, and villages in the State. The RPT is levied in more than 4,700 taxing jurisdictions in the State, calculated based on the value of residential and non-residential real properties, with certain exceptions. Reliance on the RPT varies by type of government. In fiscal year 2016, counties across the State received 23.2 percent of their revenue from the RPT, cities received 26.1 percent, and school districts received 55.2 percent.[231] Across all local governments, RPT accounted for 44 percent of total revenues.

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[225] U.S. Census Bureau. 2012-2016 American Community Survey. Accessed on May 4, 2018 at: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_DP03&s.rc=pt.

[226] Ibid.

[227] New York City Rent Guidelines Board. 2018. 2018 Income and Affordability Study. April 5. Accessed on May 4, 2018 at: https://www1.nyc.gov/assets/rentguidelinesboard/pdf/ia18.pdf.

[228] U.S. Census Bureau. 2012-2016 American Community Survey. Accessed on May 4, 2018 at: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_DP03&s.rc=pt.

[229] New York City Rent Guidelines Board. 2018. 2018 Income and Affordability Study. April 5. Accessed on May 4, 2018 at: https://www1.nyc.gov/assets/rentguidelinesboard/pdf/ia18.pdf.

[230] Federal Reserve Bank of New York. 2010. “Bypassing the Bust: The Stability of Upstate New York’s Housing Markets during the Recession.” Accessed on May 7, 2018 at: http://www.newyorkfed.org/research/current_issues/ci16-3.pdf.

[231] Office of the NYS Comptroller, Division of Local Government and School Accountability. 2017. 2016 Annual Report on Local Governments. February. Accessed on May 4, 2018 at: http://www.osc.state.ny.us/localgov/annualreport/2017-annual-report.pdf.

In addition to the RPT, New York City is unique in its authority to levy several additional taxes, including personal and business income taxes. The City of Yonkers is also authorized to levy an individual income tax. Certain other local governments, including cities, counties, and school districts, are authorized to impose sales/use taxes, hotels and motel taxes, real estate transfer taxes, mortgage recording taxes and utility taxes.

Environmental Justice

The EPA defines environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Environmental justice efforts focus on improving the environment in communities, specifically minority and low-income communities, and addressing disproportionate adverse environmental impacts that may exist in those communities.

NYSDEC promulgated regulations at 6 NYCRR Part 487 for incorporating environmental justice consideration into proceedings before the New York State Board on Electric Generation and the Environment for determining whether to site major electric generating facilities pursuant to Article 10 of the Public Service Law.[232] For matters overseen by the NYSDEC, for example the NYSDECs environmental permit review process and NYSDECs application of the SEQRA, NYSDEC Commissioner Policy 29 on Environmental Justice and Permitting (CP-29) provides guidance to NYSDEC staff on environmental justice issues. Under CP-29, potential environmental justice areas are U.S. Census block groups of 250 to 500 households each that, in the 2000 census, had populations that met or exceeded at least one of the following statistical thresholds:

1. At least 51.1 percent of the population in an urban area reporting themselves to be members of minority groups; or
2. At least 33.8 percent of the population in a rural area reporting themselves to be members of minority groups; or
3. At least 23.59 percent of the population in an urban or rural area with household incomes below the federal poverty level.[233]

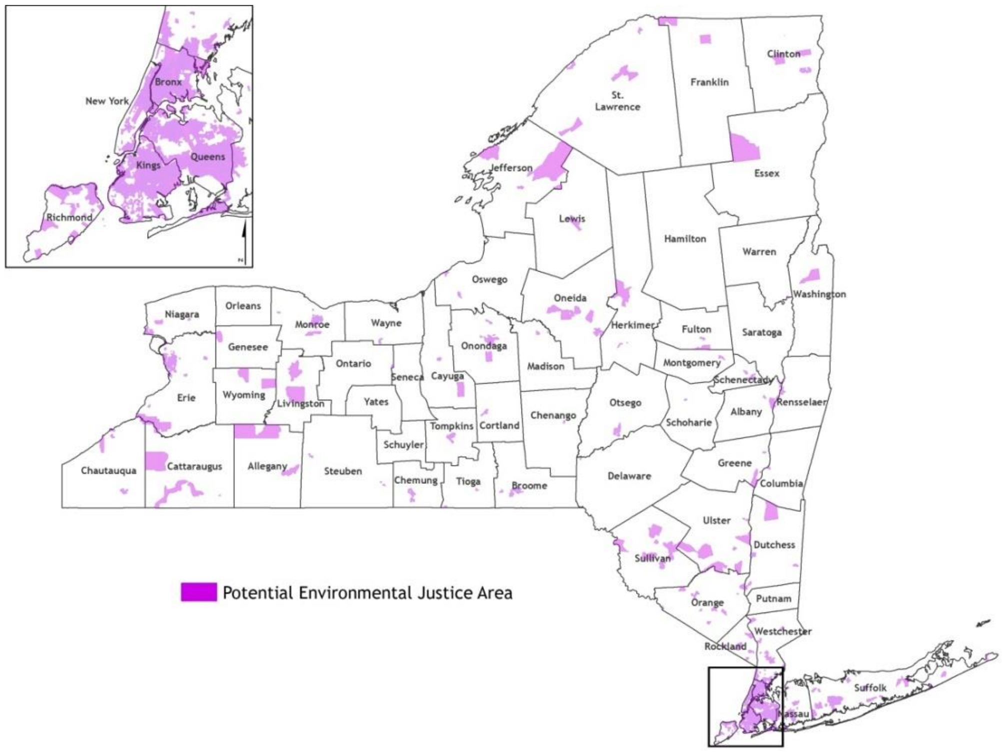
As shown in **Exhibit 3-11**, based on 2000 U.S. Census data, Potential Environmental Justice Areas (PEJAs) occur throughout the state, with an area of concentration in New York City. The 2000 Census PEJA is the most recent mapping available of New York's PEJAs.[234]

[232] NYSDEC. 2018. Environmental Justice. Accessed on May 7, 2018 at: http://www.dec.ny.gov/public/333.html.

[233] NYSDEC. 2018. Maps and Geospatial Information System (GIS) Tools for Environmental Justice. Accessed on May 7, 2018 at: https://www.dec.ny.gov/public/911.html.

[234] The 2010 Census does not provide the necessary information to define updated PEJAs. In addition, while more recent American Community Survey (ACS) data provides more recent information on median household income and the racial and ethnic population of New York State, additional data limitations preclude the use of this data for the purposes of developing updated PEJA maps. In particular, the 2000 Census represented a complete count of the population of New York, while the ACS represents only a sample subset.

EXHIBIT 3-11 NYSDEC DEFINED POTENTIAL ENVIRONMENTAL JUSTICE AREAS IN NEW YORK STATE – WITH FOCUS ON NEW YORK CITY[235]



Overall, this chapter provided an overview of the areas to be affected by the proposed action: the entire State of New York with a focus on downstate areas in and around New York City. Potentially affected environmental resource categories include physical geography, land use, water resources, species biodiversity, climate and air quality, cultural and historic resources, waste management, public health, community character, transportation, and socioeconomics and environmental justice.

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[235] NYSDEC. 2018. Maps and Geospatial Information System (GIS) Tools for Environmental Justice. Accessed on May 1, 2018 at: https://www.dec.ny.gov/public/911.html.

CHAPTER 4 | ALTERNATIVES CONSIDERED

Consistent with New York Codes, Rules and Regulations (NYCRR) 6 NYCRR §617.9(b)(5)(v) of New York's State Environmental Quality Review Act (SEQRA), this chapter characterizes the regulatory and market alternatives that could arise in response to the approval and implementation of the Energy Storage Roadmap (the Roadmap). The chapter is organized into two sections.

- **Section 4.1** describes the baseline or "no action" scenario developed as a point of reference for the comparison of alternatives. In addition, it identifies the alternatives as defined for purposes of this Generic Environmental Impact Statement (GEIS) and summarizes their characteristics.
- **Section 4.2** presents summary electrical system impacts data for the alternatives by type of energy storage resource. These results facilitate the discussion of broader environmental and socioeconomic impacts in subsequent chapters.

4.1 BASELINE AND ALTERNATIVES DEFINITION

Defining a baseline or "no action" condition is necessary to provide a common point of reference to which each of the alternatives considered can be compared. This baseline should represent the most likely state of resources, activities, markets, and behaviors that would exist absent any efforts to achieve or accomplish one of the alternatives. The Roadmap endeavors to stimulate energy storage development through a variety of regulatory and policy actions. Identifying this resulting increment of additional storage resources and summarizing the related operational and market outcomes is the focus of this chapter.

To support the Roadmap development, the New York State Energy Research and Development Authority (NYSERDA) and New York State Department of Public Service (NYSDPS) engaged consultants to model certain energy storage use-case scenarios. The scope of this exercise sought to determine the range of energy storage deployment that could result in net positive benefits to ratepayers while meeting electric system needs. These benefits include, among others, reduction in peak loads, transmission and distribution system upgrade deferral, emission reductions, ancillary services, and augmenting or replacing peaker generation capacity.[236]

The baseline condition assumed in the Acelerex Energy Storage Study incorporates the key system characteristics contemplated for the Reforming the Energy Vision (REV) and Clean Energy Standard (CES) by the year 2030. Specifically, it assumes net system load of 150,000 gigawatt-hours (GWh), which includes a 35,600 GWh reduction from energy efficiency improvements. This load is served by 75,000 GWh of renewable generation, including 43,300 GWh of existing renewable resources supplemented by 32,216 GWh of new capacity. The remaining 50 percent of

[236] Acerelex. *Forthcoming.* Energy Storage Study.

load is served by existing generation, while allowing for certain known plant retirements or additions. The model uses the New York Independent System Operator (NYISO) 2022 Power Flow Base Case as the representation for the transmission system. Finally, the modeling accounts for the 1,400 megawatts (MW) of pumped hydroelectric generation that already exists within the State.

The “alternative” case models the net impacts to the electrical system from developing additional storage above the baseline conditions. Specifically, it considers the deployment of 1,500 MW of capacity by 2025, plus a range of incremental capacity levels by 2030. The New York State Public Service Commission (the Commission) will determine the ultimate capacity target within the context of the Roadmap; however, based on the available modeling, energy storage levels up to 3,633 MW of incremental energy storage capacity were examined in meeting system needs. To reasonably capture the potential environmental impacts of 1,500 MW to 3,633 MW of incremental energy storage capacity, this assessment considers a modeling scenario that yields 2,795 MW of incremental storage capacity by 2030. This scenario was developed using a system optimization approach and given a set of market and system constraints which capped ancillary services storage participation at 25 percent of the market and total capacity value at 10 percent of the market and serves as an illustrative example of the full range of potential energy storage deployment by 2030 and associated environmental impacts.

The Acelerex Energy Storage Study is technology agnostic; it examines potential effects by duration of power supply. **Exhibit 4-1** presents the types of technologies that fall within each duration group. The model applies a cost curve for each technology group to assess overall deployment costs and to facilitate the simulation of broader electrical system effects.

EXHIBIT 4-1 ENERGY STORAGE TECHNOLOGIES DURATION AND REPRESENTATIVE TECHNOLOGIES

DURATION	REPRESENTATIVE TECHNOLOGIES
Long duration (6+ hours)	• Lithium-ion battery, Flow battery, Thermal storage, Emerging battery chemistries (e.g., metal-based), Pumped hydro, Compressed air storage
Medium Long duration (4 hours)	• Lithium-ion battery, Flow battery, Zinc-air battery, Zinc-bromine hybrid flow battery, Advanced lead acid battery, Sodium-sulfur (NaS) battery
Medium Short (2 hours)	• Lithium-ion battery, Valve-regulated lead-acid battery
Short (30 mins)	• Lithium-ion, Flywheel, Ultracapacitors

With these core inputs established, the Acelerex Energy Storage Study simulates impacts from additional energy storage. This simulation uses chronological dispatch approaches to: optimize generation and transmission outcomes; identify intertemporal constraints; forecast unit commitment, economic dispatch, and market clearing prices; and balance real-time generation and load. The results of the simulation capture a suite of impacts, representing net present values attributable to the full life cycle of incremental storage deployment. These impacts include:

- **Energy storage cost –** total cost of the deployed storage (capital and operations and maintenance (O&M));
- **Fixed O&M costs –** change in fixed O&M costs under the storage alternative;
- **Capacity value –** capacity market revenue attributable to storage deployment;
- **Distribution system effects –** investment deferral attributed to storage installed;
- **Total generation costs –** changes in variable costs including variable O&M and fuel;
- **Ancillary services value –** market revenue attributable to storage deployment; and
- **Emissions effects –** change in carbon dioxide (CO_2) emissions.[237]

The next section discusses the results of this simulation in the next section.

4.2 RESULTS

As shown in **Exhibit 4-2**, the 2,795 MW model results indicate that most additional capacity would come from long duration energy storage technology (1,447 MW), with more limited incremental capacity for short-term duration options. Total electric energy attributable to this level of energy storage equals 12,557 megawatt-hours (MWh).[238]

EXHIBIT 4-2 DISTRIBUTION OF ENERGY STORAGE DEPLOYMENT BY TECHNOLOGY TYPE[239]

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

Under this alternative, energy storage may displace other forms of generation resources. Specifically, the modeling indicates that, through 2030 – 2,202 MW of oil and natural gas generation capacity may be retired beyond reference case retirements. If the Commission determines a capacity target higher than 2,795 MW, additional displacement may occur. The model also indicates capacity prices would decline with additional energy storage deployment.

[237] The simulation does not include quantification of other potential emissions changes, including nitrogen oxides and sulfur dioxide. Later chapters qualitatively discuss these potential emissions changes and related impacts.

[238] It is important to distinguish these reported results from the “use case” studies presented in the energy storage roadmap report. The use cases focus on those value streams that could be potentially monetized in the near term (2019 to 2021 or the medium term (2022-2025). The modeling results presented here focus on the broader life cycle effects of ES installations, allowing for market and system adjustments and therefore yielding a broader assessment of value streams.

[239] If the Commission determines a capacity target higher than 2,795, MW and MWH values would increase across all duration categories, but would likely increase more for long- and medium-long energy storage technologies.

The model provides a rough indication of where incremental energy storage may be located, using a system optimization approach and given a set of market and system constraints (described above). In general, energy storage resources would be distributed across the state, but with the majority of deployments occurring in downstate regions. Specifically, the results indicate that approximately 57 percent of the new energy storage would be located in the New York (NYJ) and Long Island (NYK) zones, with the remaining 43 percent distributed across other zones. Note that the model provides only general location results and not site-specific information.

CHAPTER 5 | ENVIRONMENTAL IMPACTS OF PROPOSED ACTION

Consistent with New York Codes, Rules and Regulations (NYCRR) 6 NYCRR §617.10(a) of New York's State Environmental Quality Review Act (SEQRA), state and local agencies are required to assess the potential of their actions to change the use, appearance, or condition of the environment. Specifically, this chapter evaluates the impacts that could arise from actions taken in response to the approval and implementation of the Energy Storage Roadmap (the Roadmap). As previously discussed, the Roadmap is designed to increase the deployment and integration of energy storage technologies within New York State's (the State's) electrical grid. In considering how to implement the Roadmap, it is also necessary to assess the potential for energy storage technologies to directly or indirectly change (or impact) other aspects of the environment. In particular, such changes include those that may not be the primary goal of the State or local agency's proposed action, but nonetheless, could result in significant and/or adverse impacts on the environment.

Overall findings suggest that adverse direct environmental impacts of the Roadmap are likely to be minimal and a variety of mitigation measures exist to minimize such impacts. The Generic Environmental Impact Statement (GEIS) considers three types of energy storage technologies: batteries, thermal storage and flywheels. Risks exist across all three technology types, most notably: risk of soil and groundwater contamination due to improper disposal of battery-related waste, and public safety risks from the operation of batteries and flywheels. Section 5.2 provides a summary of the environmental impacts across the three technology types.

The analysis of environmental impacts is largely qualitative because the Roadmap is technology agnostic and as a result, the exact mix and location of energy storage technologies that will be implemented under the Roadmap is uncertain. Energy storage's flexibility, in terms of modularity, potential multi-use applications, and in some cases mobility, further complicates projecting the likely types, sizes, and application of energy storage into the future.

Finally, the qualitative assessment of environmental impacts is relatively insensitive to changes in the total amount of deployed energy storage in 2030 within the identified range, driven in part by storage's modularity.

5.1 FRAMEWORK FOR EVALUATING THE ENVIRONMENTAL IMPACTS OF THE ENERGY STORAGE ROADMAP

Consistent with the State's overarching clean energy strategies, the Roadmap is not designed to rely on one prescriptive pathway. Rather, the Roadmap seeks to use and leverage a range of mechanisms, tools, and approaches to achieve its objectives. The goal of the Roadmap will not be achieved by one or two large actions, but by numerous separate individual projects over several years. The Roadmap also does not prescribe the scope and scale of these transactions – that is, the Roadmap is technology agnostic in that it does not establish standards or targets for specific types of energy storage technologies. Instead, the Roadmap is focused on designing and establishing a framework and incentive structure that will drive new investment and activities in the energy storage market.

The extent to which each type of energy storage technology will be used (or activated) in response to the Roadmap is uncertain. However, based on the goals and actions of the Roadmap, discussion of environmental impacts considers three categories of energy storage technologies that would likely be deployed within the study period: batteries, thermal storage and flywheels. **Exhibit 5-1** below summarizes these three categories of energy storage and identifies types of appropriate applications.

EXHIBIT 5-1 TYPES OF BATTERY STORAGE TECHNOLOGIES

ENERGY STORAGE TECHNOLOGY TYPE	LONG (6+ HOURS)	MEDIUM LONG (4 HOURS)	MEDIUM SHORT (2 HOURS)	SHORT (30 MINS)
Batteries, including lithium-ion, flow, lead-acid, sodium, and other chemistries	✔	✔	✔	✔
Thermal Storage, including ice, chilled water, or dispatchable hot water heaters	✔	--	--	--
Flywheels	--	--	--	✔

Further, because the exact mix and location of energy storage technologies that will be implemented under the Roadmap is uncertain, the evaluation of environmental impacts in this chapter is largely qualitative. That is, a quantitative assessment of the potential environmental impacts would require site-specific information concerning those energy storage technologies and facilities that will be implemented in response to the Roadmap.[240] However, as discussed, such information is not available because the Roadmap does not prescribe the development of specific energy storage projects or facilities.

[240] Energy storage technologies can range in size; for example among battery technologies, lead acid batteries tend to have the highest total footprint. For a 500 kW/2,000 kWh battery lead acid batteries tend to be 1,976 ft^2, sodium sulfur 642 ft^2, and lithium-ion, the smallest at 367 ft^2. NYSERDA. 2014. Behind-the-Meter Battery Storage: Technical and Market Assessment. December. Accessed on May 24, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Electic-Power-Delivery/Behind-Meter-Battery-Storage.pdf.

The qualitative assessment presented in this chapter utilizes a broad definition of environmental impacts (impacts and effects are synonymous in this context), including the resource areas described in **Chapter 3**. The analysis focuses on two types of effects: direct and indirect. In promulgating regulations under the National Environmental Policy Act (NEPA) at 40 CFR §1508.8, the Council on Environmental Quality defines direct effects as those occurring at the same time and in the same place as the action itself; indirect effects are those occurring later in time and farther away, but which are still reasonably foreseeable.

Chapter Organization

The remainder of this chapter is organized in five parts:

- **Section 5.2** summarizes the analysis of the direct and near term environmental impacts of the three energy storage technology categories likely to be affected by the Roadmap;
- **Section 5.3** summarizes the analysis of the indirect, longer-term environmental impacts;
- **Section 5.4** considers the potential for the Roadmap programs to spur development of new technologies, yet unknown; and
- **Section 5.5** considers the potential cumulative impacts of the Roadmap when added to other past, present, and reasonably foreseeable future actions.

Measures to mitigate the environmental impacts identified in this chapter are presented in **Chapter 6**. The economic and social impacts of the Roadmap are discussed in **Chapter 9**.

5.2 DIRECT AND NEAR TERM EFFECTS

This section presents an analysis of the direct environmental effects of the Roadmap. The first part of this section discusses direct effects applicable across all types of energy storage technologies included in the Roadmap. It is possible, if not probable, that energy storage technologies will advance substantially by 2030, and that additional technologies will become technically and commercially viable during this time period. The net impact of other unanticipated technologies is, by its nature, unknown at this time; therefore, this analysis focuses on the three categories of energy storage technologies that would likely be deployed within the study period: batteries, thermal storage and flywheels. Subsequent sub-sections consider additional direct environmental impacts relevant to each type of energy storage technology. For example, the analysis considers the question: what are the potential environmental impacts of an increase in deployment of a specific energy storage technology? Examination of the indirect impacts of the Roadmap – impacts which occur later in time or further away – are considered in the subsequent **Section 5.3**.

Overall the energy storage technologies considered in this GEIS (i.e., battery storage; thermal storage; and flywheels) have relatively few direct environmental impacts and mitigation measures exist to address existing impacts. **Exhibit 5-2** on the following page summarizes direct environmental impacts by technology type. The following sections provide additional detail.

EXHIBIT 5-2 SUMMARY OF ENVIRONMENTAL IMPACTS BY ENERGY STORAGE TECHNOLOGY TYPE

ENERGY STORAGE TECHNOLOGY TYPE	BATTERIES	THERMAL STORAGE	FLYWHEELS
Land Use and Space Requirements	• Project footprint variable based on project size. Utility scale installations may require larger areas.	• Latent heat storage solutions require minimal additional space for water tanks.	• Project footprint minimal, and variable based on project size. Utility scale installations may require larger areas.
Water Resources	• Minimal siting-related risk during construction. • Risk at end-of-life without proper disposal.	• Minimal siting-related risk during construction. • Increase in demand for water resources to conduct and store energy.	• Minimal siting-related risk during construction.
Public Health	• Fire safety risk	--	• Potential equipment safety risk.
Climate change and air quality	• Some emissions from resource extraction and manufacturing. • Some emissions from transportation. • Minimal emissions from system operation.	• Minimal emissions from system operation; may be offset by reductions in overall consumption.	• Minimal emissions from system operation.
Waste Management	• Resource extraction. • End-of-life, recycling limitations.	--	• Long lifespan (20 years or more); little turnover waste. • Magnetic bearings must be replaced periodically.
Transportation	• Manufacturing and recycling facilities currently out-of-state.	--	--
Community Character	• Minimal - low noise and visual profile.	• Minimal - low noise and visual profile.	• Minimal - low noise and visual profile.
Socioeconomic	• Reduces the cost of renewable energy • Reduces peak demand	• Reduces peak demand	• Reduces the cost of renewable energy • Reduces peak demand

5.2.1 Impacts Across Energy Storage Technologies

This section discusses direct effects applicable across all types of energy storage technologies including potential impacts on land use, water resources, species biodiversity, climate and air quality, community character, and socioeconomics. Due to the largely modular nature of energy storage, it is not expected that these effects will vary across New York Independent System Operator (NYISO) zones in a significant way. Additional discussion of the indirect effects of the Roadmap is included in **Section 5.3**

Overall the energy storage technologies considered in this GEIS (i.e., battery storage; thermal storage; and flywheels) have a relatively small land use footprint and it generally increases as the size of a project increases. The development of utility-scale energy storage facilities may have site-specific impacts on land use.

Factors influencing the siting of utility-scale energy storage facilities are based on the intended use for the energy storage. For example, energy storage facilities intended to meet the needs of frequency regulation are best situated at the point of interconnection.[241] This would increase the amount of land dedicated to utility services directly adjacent to the substation. Energy storage intended to reduce the intermittency of electricity supply from renewable energy sources are typically co-sited with the renewable energy facility, in some cases expanding the footprint of the overall facility.[242] Large-scale storage facilities are likely to be based within areas already supporting commercial, industrial, or utility uses; or co-located with existing electric substation, switchyard locations or renewable energy-generating sites. For example the battery energy storage system associated with the Campo Verde Solar Project in California is located within the footprint of the existing solar project.[243] However, it is possible that construction of new energy storage facilities may result in the conversion of undeveloped lands to developed lands – although this is dependent on the site-specific characteristics of each facility.

Surface water resources may be potentially affected by the construction of an energy storage facility through storm water runoff if site-soils are disturbed during construction. The potential degree of environmental impact would depend on the size of the impacted area and the site's proximity to protected waters, among other site-specific factors.

Storage associated with intermittent generation sources (i.e., co-located with wind energy projects) may enable impact-reduction strategies for protection of vulnerable species (e.g., bats and birds) that are susceptible to operational impacts. For example, energy storage can enable the curtailment of wind turbine operation to avoid periods of peak wildlife activity in close proximity to wind

[241] Overton, Thomas, W. 2016. Practical Considerations for Siting Utility Scale Battery Projects. Power Magazine. May. Accessed on May 10, 2018 at: http://www.powermag.com/practical-considerations-siting-utility-scale-battery-projects/.

[242] NYSERDA. 2017. Clean Energy Fund Investment Plan: Renewables Optimization Chapter. Portfolio: Innovation & Research. Matter Number 16-00681, In the Matter of the Clean Energy Fund Investment Plan. Revised November 1.

[243] EGI. 2016. Final Supplemental Environmental Impact Report for the Campo Verde Battery Energy Storage System. December. Prepared for County of Imperial. Accessed on May 9, 2018 at: http://www.icpds.com/CMS/Media/SFEIR.pdf.

turbines (e.g., feeding or migratory passage). Energy storage is likely to play a role in curtailment considerations of both on-land and offshore wind generation developments.

When evaluating the environmental impacts of energy storage, such impacts are influenced by the efficiency of the technology and the original source of electricity. By design, a storage device outputs less energy than the charging input.[244] The overall emissions impacts to the grid are highly case-dependent. The energy loss between the electricity generator and an energy storage system increases with the distance between the two. Physically remote electricity generators have to account for the transmission losses by producing more electricity. As such, energy storage devices may result in increased electricity demand from the existing grid, which may result in greater emissions when considered on a standalone basis (e.g., not taking into account displacement of other forms of energy generation).[245] When energy storage technologies complement cleaner generation – as envisioned under the existing Reforming the Energy Vision (REV) framework – such technologies can contribute to lower levels of both local (i.e., criteria pollutants) and global (i.e., greenhouse gases (GHG)) emissions.[246] One of the goals of the Roadmap is specifically aimed at avoiding carbon dioxide (CO_2) emissions over the lifetime of storage assets, particularly as the amounts of renewable generation on the grid increase and curtailment becomes a more significant occurrence. On a large scale, the use of storage as part of a broader strategy to increase the responsiveness of demand will facilitate greater development of low-carbon energy generation. Where system efficiency is measured in terms of average heat rate, storage that complements low-carbon off-peak generation will reduce total carbon output.

The installation of energy storage systems is not likely to impact the community character of an area.[247] During the construction phase movement of heavy machinery may create noise pollution, which could potentially have a short-term impact on community character. However the operational phase of energy storage technologies is generally quiet. For example, batteries create minimal noise but some noise pollution from the cooling units that prevent the batteries from overheating could potentially have an impact on community character if not mitigated.[248] The efficiency of the cooling units can be increased (and therefore the noise impacts decreased) by focusing them directly on the battery racks as opposed to cooling the entire battery casing. This

[244] Denholm, P. et al. NREL. The Value of Energy Storage for Grid Applications. May 2013. Accessed on May 9, 2018 at: https://www.nrel.gov/docs/fy13osti/58465.pdf.

[245] Lin, Y., J. X. Johnson, J.L. Mathieu. 2016. Emissions impacts of using energy storage for power system reserves. Applied Energy 168 p. 444-456. Accessed on May 9, 2018 at: http://dx.doi.org/10.1016/j.apenergy.2016.01.061.

[246] Lin, Yashen, Jeremiah X. Johnson, and Johanna L. Mathieu. Emissions impacts of using energy storage for power system reserves. Applied Energy 168, p. 444-456.

[247] EGI. 2016. Final Supplemental Environmental Impact Report for the Campo Verde Battery Energy Storage System. December. Prepared for County of Imperial. Accessed on May 9, 2018 at: http://www.icpds.com/CMS/Media/SFEIR.pdf.

[248] Most battery technologies, including lithium-ion, risk overheating. Although researchers have designed lithium-ion batteries with a mechanism that prevents overheating, it is not yet in mass production. Humphries, M. Stanford invents lithium-ion battery that can't overheat. ExtremeTech. February 2. Accessed on May 24, 2018 at: https://www.extremetech.com/extreme/222290-stanford-invents-lithium-ion-battery-that-cant-overheat.

method of cooling can also use up to 70 percent less power for the cooling units.[249] For thermal storage, compared to a traditional chiller operation, thermal energy storage minimizes daytime noise pollution.[250] Thermal energy storage systems avoid "chiller vibration" and similar noise associated with traditional systems.[251] While flywheel storage systems generate operational noise, the noise levels are relatively low, compared to conventional technologies (e.g., cooling fans).[252] For example, the Stephentown New York flywheel facility (as shown in **Exhibit 5-3**) uses flywheels but the mechanisms taken to mitigate safety risks also work to reduce ambient noise levels.[253]

EXHIBIT 5-3 STEPHENTOWN FLYWHEEL STORAGE FACILITY

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[249] Ibid.

[250] CALMAC. Thermal Energy Storage is Key for Modern Building Designs. December 23, 2014. Accessed on May 22, 2018 at: http://www.calmac.com/energy-storage-articles-thermal-energy-storage-is-key-for-modern-building-designs

[251] Buildings.com "4 Benefits of Thermal Energy Storage." Accessed on May 2, 2018 at: https://www.buildings.com/buzz/buildings-buzz/entryid/282/4-benefits-of-thermal-energy-storage.

[252] Beacon Power. "Environmental Benefits." Accessed on May 22, 2018 at: http://beaconpower.com/environmental-benefits/.

[253] NY PSC. Case 09-E-0628 – Petition of Stephentown Regulation Services LLC for a Certificate of Public Convenience and Necessity for Authorization Pursuant to PSL 68 to Construct and Operate an Energy Storage Facility of Up to 20-megawatts and Related Facilities to be Located in the Town of Stephentown, Rensselaer County; Order Granting a Certificate of Public Convenience and Necessity, Approving Financing and, Providing for Lightened Regulation, Issued and Effective October 16, 2009.

Socioeconomic impacts of energy storage are generally similar across technologies with some exceptions for thermal energy storage which does not supply electricity to the grid. The cost of producing and supplying renewable energy such as wind and solar may be reduced through battery or flywheel energy storage.[254] For example, a cost model of the Maui Electric Company system found that employing battery storage systems is effective at lessening wind curtailment as well as the annual cost of power production.[255] The study found that replacing the diesel-fired power generation with wind generation provided some savings, but energy storage systems accounted for the majority of the savings due to increased operational efficiencies of the conventional units, such as the spinning reserve.[256] Batteries and flywheels can also recycle energy to the grid (receive excess energy and redistribute it to the grid when needed), leading to reductions in energy costs. Thermal energy storage systems do not supply electricity to the grid, but similar to other types of energy storage they reduce demand during peak hours. As a result of this reduction in peak demand, individuals' energy costs are often reduced. Utility charges are reduced from the overall reduction in usage during peak hours, but also from avoidance of demand charges. These demand charges are extra fees associated with usage during peak hours, and can be substantial (up to an 80 percent surcharge). In some cases, utilities run demand response programs, in which customers are compensated (or their bill is reduced) if they reduce their peak consumption. Thermal energy storage systems also decrease utility charges as they generate the stored energy when prices are low (i.e., at night).[257]

Specific to battery storage technologies: a study found that in the European Union, jobs directly or indirectly linked to the production of battery storage systems and their value chains are expected to be created in response to the growing demand for lithium-ion batteries. This is also expected to increase the market share of lithium-ion batteries.[258]

5.2.2 Battery Storage

Battery storage systems convert electricity into chemical energy for later release. This section focuses the discussion of impacts on lithium-ion batteries (due to their dominance in the State market – about 90 percent of the projects in development are lithium-ion) but also discusses other types of chemical storage technologies (e.g., flow, lead acid, sodium, and other chemistries).[259,260] Batteries do not create any significant, on-site direct environmental impacts, but like any industrial product, batteries can indirectly generate life-cycle environmental impacts during manufacturing, transportation, and end-of-life product disposal. Battery energy technologies may be composed of toxic materials; methods that exist for the collection and recycling of batteries can mitigate the

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[254] Ellison, J. Bhatnagar, D., and Karlson, B. for Sandia National Lab, Maui Energy Storage Study, December 2012. Accessed on May 22, 2018 at: http://www.sandia.gov/ess/publications/SAND2012-10314.pdf.

[255] Ibid.

[256] Ibid.

[257] CALMAC. Lower Cooling Costs. Accessed on May 22, 2018 at: http://www.calmac.com/lower-cooling-costs.

[258] Ibid.

[259] NYSERDA/DPS. 2018. New York State Energy Storage Roadmap and DPS/NYSERDA Staff Recommendations.

[260] NY-BEST Consortium. 2016. Energy Storage Roadmap for New York's Electric Grid. January. Accessed on May 9, 2018 at: https://www.ny-best.org/sites/default/files/type-page/39090/attachments/NY-BEST%20Roadmap_2016_finalspreads.c.pdf.

public and environmental health consequences associated with improper disposal. Due to the lack of deployment at scale, land requirement estimates for battery storage are limited but generally these deployments require minimal space. Battery storage in combination with renewable energy such as wind and solar may also reduce costs of supplying renewable energy and further the displacement of fossil-fuel based generation.

This section first provides an overview of battery storage technologies covered under the Roadmap; the current (and prospective near future) status of the technology market; and follows with a discussion of the direct environmental impacts of battery storage.

Technology Overview

A battery works by exchanging its energy between an electrical and a chemical state; **Exhibit 5-4** presents the types of battery storage technologies considered in this GEIS.

EXHIBIT 5-4 TYPES OF BATTERY STORAGE TECHNOLOGIES[261]

TYPE OF BATTERY STORAGE	DESCRIPTION
Lithium-ion battery	• Typically uses nonferrous metals and minerals such as lithium, cobalt, nickel, manganese, graphite, copper, and aluminum.[262] • Currently the dominant rechargeable battery on the market.
Sodium-sulfur (NaS) battery[263]	• Molten sodium acts as the anode and molten sulfur acts as the cathode. • The electrodes are separated by the electrolyte, solid sodium alumina, which allows only positively charged sodium-ions through.
Flow battery (e.g., zinc-bromine hybrid flow)	• Contains liquid electrolytes separated by a membrane. Recharges when the liquid electrolytes are exchanged.
Zinc-air battery	• Oxygen reacts with a carbon cathode to produce hydroxyl, which subsequently reacts with a zinc anode to generate electricity. • Difficult to recharge.[264]
Fuel cell	• An alternative chemical storage technology that converts hydrogen and oxygen into water and energy. While not technically a battery, a fuel cell has many similar features as a flow battery.

[261] NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 9, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf.

[262] Roskill Information Services. 2017. Raw Materials in Focus as Lithium-ion Battery Market Development Moves up a Gear. January 27. Accessed on May 17, 2018 at: https://www.prnewswire.com/news-releases/raw-materials-in-focus-as-lithium-ion-battery-market-development-moves-up-a-gear-611953095.html.

[263] Energy Storage Association. Sodium Sulfur (NaS) Batteries. Accessed on May 22, 2018 at: http://energystorage.org/energy-storage/technologies/sodium-sulfur-nas-batteries.

[264] Irving, M. 2017. Rechargeable zinc-air batteries zero in on lithium. August 14. Accessed on May 22, 2018 at: https://newatlas.com/rechargeable-zinc-air-batteries-catalyst/50899/.

Over the past two decades lithium-ion battery prices have been declining with steeper cost declines occurring within the last ten years. For example, in 2005, lithium-ion batteries demanded between $1,000- $1,500 per kilowatt-hour (kWh); by 2016 prices dropped to less than $500/kWh. As demand from multiple markets (e.g., consumer electronics, electric vehicles (EVs), and large-scale storage) continues to grow, prices are expected to continue declining.[265]

Within the State, battery storage is still a nascent market; only a small portion of the existing 1,460 MW of energy storage currently deployed in the State is battery storage.[266] As mentioned above, approximately 90 percent of the State's battery projects currently in development or permitting stages are lithium-ion (totaling 100 MW). One example of solar plus storage is the Marcus Garvey Apartments microgrid in Brooklyn, New York which has 300 kW of lithium-ion batteries housed in a 40-foot container and operating since June 2017.[267] Currently Consolidated Edison Company of New York, Inc. (Con Edison) is undertaking a Commercial Battery Storage demonstration project under the REV. This project aims to install 4.2 MW/4.4 megawatt-hours (MWh) of lithium-ion battery storage at four customer-sited facilities. In exchange for hosting the battery storage, customers will receive a payment.[268,269] Con Edison's other REV demonstration project, Storage on Demand, uses a transportable lithium-ion battery storage facility (two mobile battery trailers and a mobile electrical switchgear) that may be utilized by two parties at different times throughout the year.[270] As part of the NY Prize initiatives, four community microgrid projects in the State have made it to Stage 2 of the competition and utilize battery storage:

- Town of Huntington: 100 kilowatt (kW) flywheel and 2.8 MW fuel cell;
- Village of Freeport: 1 MW battery (type unknown);
- Sunnyside Yard (New York City): 1 MW zinc air battery and
- Buffalo-Niagara Medical Campus: three 50 kW lithium-ion batteries.[271]

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[265] NY-BEST Consortium. 2016. Energy Storage Roadmap for New York's Electric Grid. January. Accessed on May 9, 2018 at: https://www.ny-best.org/sites/default/files/type-page/39090/attachments/NY-BEST%20Roadmap_2016_finalspreads.c.pdf.

[266] NYSERDA/DPS. 2018. New York State Energy Storage Roadmap and DPS/NYSERDA Staff Recommendations.

[267] Clean Energy Group. 2018. Marcus Garvey Apartments. Accessed May 31, 2018 at: https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/marcus-garvey-apartments/.

[268] NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 9, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf.

[269] ConEdison. 2017. REV Demonstration Project Outline: Commercial Battery Storage, January 20. Accessed on May 9, 2018 at: http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B8B24C029-D9E5-4561-9630-88A208F6A880%7D.

[270] ConEdison. 2017. REV Demonstration Project Outline: Storage on Demand, February 27.

[271] NYSERDA. 2017. NY Prize Stage 2 Winners. Accessed on May 9, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Programs/NYPrize/ny-prize-stage-2-awarded-projects.pdf.

Electrified rail and subway system wayside storage is also an anticipated market for battery storage in the State.[272] Batteries commonly used for this type of storage include lithium-ion, electric double layer capacitors, and nickel capacitors.[273] This type of storage is used to capture and store dynamic braking energy for future use to aid in braking or accelerating.[274] It is currently common for rail and subway vehicles to use regenerative power, but that power is often converted to heat unless a second vehicle is nearby to use it for acceleration.[275] Data on the number of electrified rail and subway vehicles which utilize regenerative power across the U.S. are not available, but the New York State Energy Research and Development Authority (NYSERDA) estimates that approximately 39 percent of 11,000 heavy rail vehicles use regenerative power and are thus well suited for wayside storage.[276] The Washington Metropolitan Area Transit Authority is also developing capabilities for a battery storage system to store dynamic braking energy, and completed a demonstration project in 2015.[277]

Environmental Impact Overview

This section discusses the environmental impacts specific to battery storage technologies including land use, water resources, climate and air quality, waste management, public health, and transportation. Overall impacts are likely to be minimal and focused on waste management impacts which can be minimized through mitigation measures.

Land Use and Space Requirements

As discussed in the previous section, land use requirements for energy storage vary based on site-specific attributes but overall, land use requirements are relatively small. For example, a recent project in South Korea consolidated 2.4 MWh of battery storage within a 40 foot container – including the associated cooling system required to maintain a safe temperature for the batteries.[278] Of the battery storage technologies discussed, lithium-ion has a substantially smaller footprint; a 500 kW battery requires 367 square feet, which is almost half of the next smallest, sodium sulfur

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[272] NYSERDA/DPS. 2018. New York State Energy Storage Roadmap and DPS/NYSERDA Staff Recommendations.

[273] NYSERDA. 2013. Feasibility Study of On-Car Regenerative Braking System (RBS) for Electric Rail Applications. January 11. Report prepared by Dayton T. Brown, Inc. Accessed on May 24, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Transportation/feasibility-on-car-regenerative-electric-rail-applications.pdf.

[274] Rasul, Mohammad & Patel, A & Cole, Colin & Sun, Y & Spiryagin, Maksym & Godber, T & Hames, S. (2013). Train Motive Power Technologies: A Review on Existing and Emerging (Hybrid) Technologies. Accessed on May 10, 2018 at: https://www.researchgate.net/publication/308719679_Train_Motive_Power_Technologies_A_Review_on_Existing_and_Emerging_Hybrid_Technologies.

[275] NYSERDA. 2013. Feasibility Study of On-Car Regenerative Braking System (RBS) for Electric Rail Applications. January 11. Report prepared by Dayton T. Brown, Inc. Accessed on May 24, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Transportation/feasibility-on-car-regenerative-electric-rail-applications.pdf.

[276] Ibid.

[277] Federal Transit Administration. 2015. WMATA Energy Storage Demonstration Project. June. Report prepared by Washington Metropolitan Area Transit Authority. Accessed on May 24, 2018 at: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Report_No._0086.pdf.

[278] Overton, Thomas, W. 2016. Practical Considerations for Siting Utility Scale Battery Projects. Power Magazine. May. Accessed on May 10, 2018 at: http://www.powermag.com/practical-considerations-siting-utility-scale-battery-projects/.

at 642 square feet. Lead acid batteries have the largest footprint at 1,976 square feet for 500 kW.[279] Battery systems are heavy, and even the relatively lightweight technologies tend to exceed the standard safe weights for regular floors meaning they must be installed on concrete or otherwise reinforced floors.[280] It is possible to install battery storage systems in areas such as parking garages, storage rooms, and closets, assuming all code and cooling requirements are met.[281] Cooling systems are particularly important when batteries are sited in close proximity to each other; as such configurations are otherwise at greater risk of overheating.

Water Resources

Impacts of battery energy storage on water resources may occur at the battery's end-of-life. If lithium-ion batteries are handled improperly, lithium – which is highly flammable when it contacts water – could flow into surface water or leach into groundwater and cause combustion.[282] Other battery storage systems which do not contain lithium are much less combustible; the general fire risks associated with all batteries are discussed below in the Public Health sub-section below.[283] Proper disposal of lithium-ion batteries and recycling opportunities are discussed in the Waste Management sub-section below.

Climate and Air Quality

This section focuses on the direct effects on climate and air quality from the manufacturing of batteries. Overall, the manufacturing stage of lithium-ion batteries has a much larger direct impact on the climate and air quality than the other stages of their life cycle, due to GHG emissions from electricity used while manufacturing the batteries.[284] Manufacturing of lithium-ion batteries often occurs in countries in which fossil fuels are the main source of electricity.[285] Additionally lead acid and lithium-ion batteries have particularly large emission contributions during the manufacturing stage when compared to other battery storage technologies.[286] The top producers of lithium-ion batteries are in East Asia; this trend will likely continue as the demand for lithium-ion batteries

[279] NYSERDA. 2014. Behind-the-Meter Battery Storage: Technical and Market Assessment. December. Accessed on May 24, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Electic-Power-Delivery/Behind-Meter-Battery-Storage.pdf.

[280] Ibid.

[281] Ibid.

[282] Warren, C. 2016. EPRI Examines Environmental Aspects of Grid-Scale Battery Deployment. January 18. Accessed on May 8, 2018 at: http://eprijournal.com/ensuring-a-clean-grid-batteries-not-excluded/.

[283] NYSERDA. 2014. Behind-the-Meter Battery Storage: Technical and Market Assessment. December. Accessed on May 24, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Electic-Power-Delivery/Behind-Meter-Battery-Storage.pdf.

[284] Hiremath, M., Derendorf, K., and T. Vogt. 2015. Comparative Life Cycle Assessment of Battery Storage Systems for Stationary Applications. Accessed on May 21, 2018 at: http://pstorage-acs-6854636.s3.amazonaws.com/3808612/es504572q_si_001.pdf.

[285] Vandepaer, L., Cloutier, J., Amor, B. 2017. Environmental impacts of Lithium Metal Polymer and Lithium-ion stationary batteries. Renewable and Sustainable Energy Reviews 78 (2017) 46-60. Accessed on May 10, 2018 at: http://www.ourenergypolicy.org/wp-content/uploads/2017/05/1-s2.0-S1364032117305580-main.pdf.

[286] Oliveira, L., Messagie, M., Mertens, J., Laget, H., Coosemans, T., and J. Van Mierlo. 2015. Environmental performance of electricity storage systems for grid applications, a life cycle approach. June 10. Energy Conversion and Management 101 (2015) 326-335.

climbs.[287] The manufacturing of lithium-ion batteries does not occur in the State and beyond the manufacturing stage lithium-ion batteries have minimal direct impacts on GHG emissions.[288,289] Lithium-ion batteries have the highest efficiency of the battery storage technologies discussed, ranging between 85 and 98 percent. The lowest is nickel cadmium at 60 percent to 70 percent efficiency, and lead acid and sodium sulfur batteries both range between 70 to 80 percent efficiency.[290] Additional discussion of indirect changes in climate and air quality due to the Roadmap overall is included in **Section 5.3**.

Waste Management

Substantive environmental impacts due to battery-based energy storage could occur during the material extraction and end-of life disposal phases.[291,292] As discussed above, lithium-ion batteries typically use nonferrous metals and minerals including lithium, cobalt, nickel, manganese, graphite, copper, and aluminum.[293] Sourcing many of these metals and minerals requires intensive extractive processes that may cause local site-specific environmental impacts. None of the raw materials used in lithium-ion batteries are mined in the State.[294]

For a battery's end-of-life, improper disposal may cause land and groundwater pollution.[295] Lithium combined with water forms a flammable compound, posing environmental and human-health hazards if lithium-ion batteries are disposed of in typical landfills without end-of-life battery processing, which neutralizes the solvents in the battery, prior to disposal. The process involves cooling the battery to -325°F to deactivate the lithium, shredding the battery, and

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[287] The Economist. 2017. After electric cars, what more will it take for batteries to change the face of energy? August 12. Accessed on May 21, 2018 at: https://www.economist.com/briefing/2017/08/12/after-electric-cars-what-more-will-it-take-for-batteries-to-change-the-face-of-energy.

[288] Hiremath, M., Derendorf, K., and T. Vogt. 2015. Comparative Life Cycle Assessment of Battery Storage Systems for Stationary Applications. Accessed on May 21, 2018 at: http://pstorage-acs-6854636.s3.amazonaws.com/3808612/es504572q_si_001.pdf.

[289] Denholm, P.; Kulcinski, G.L. (2004). "Life Cycle Energy Requirements and Greenhouse Gas Emissions from Large Scale Energy Storage Systems." Energy Conversion and Management (45/13–14); pp. 2153–2172. (As cited in NREL Renewable Electricity Futures Study Volume 2, 2012).

[290] NYSERDA. 2014. Behind-the-Meter Battery Storage: Technical and Market Assessment. December. Accessed on May 24, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Electic-Power-Delivery/Behind-Meter-Battery-Storage.pdf.

[291] Ibid.

[292] Van den Bossche, P., Vergels, F., Van Mierlo, J., Matheys, J., and W. Van Autenboer. 2006. Assessment of the sustainability of battery technologies through the SUBAT project. J Power Sources 2006 162(2):913-9. Accessed on May 17, 2018 at: https://etecmc10.vub.ac.be/publications/2005VandenBossche216.pdf.

[293] Roskill Information Services. 2017. Raw Materials in Focus as Lithium-ion Battery Market Development Moves up a Gear. January 27. Accessed on May 17, 2018 at: https://www.prnewswire.com/news-releases/raw-materials-in-focus-as-lithium-ion-battery-market-development-moves-up-a-gear-611953095.html.

[294] NYSDEC. Mining in New York State. Accessed on May 24, 2018 at: http://www.dec.ny.gov/lands/5045.html.

[295] Gaustad, G. 2018. Lifecycles of Lithium-Ion Batteries: Understanding Impacts from Material Extraction to End of Life. March 14. Spring Bridge on International Frontiers of Engineering (2018) 48:1. Accessed on May 17, 2018 at: https://www.nae.edu/Publications/Bridge/180760/181102.aspx.

neutralizing the remaining solvents.[296] Once deconstructed, these parts are now relatively safe to be disposed of in a landfill, and at this point the battery's lithium salt can also be collected and refined to a lithium metal, which is typically used to produce new lithium-ion batteries.[297,298] This relatively simple process can limit the potential negative environmental impacts of battery disposal, and is a common process performed on consumer lithium-ion batteries used in electronics.[299, 300]

Recycling lithium-ion batteries may also limit negative environmental impacts, although several barriers exist including lack of (1) cost-effectiveness, (2) facilities, and (3) regulatory oversight. For example, in 2016, mined lithium was less expensive than recycled lithium.[301] Compared to a typical lead-acid battery, lithium-ion batteries' more heterogeneous chemistry requires labor-intensive or chemical reagent-intensive processes, which are rarely cost effective.[302,303] Recycling lead-acid batteries is heavily regulated which has resulted in well-established recycling processes. Due to the growing use of lithium-ion batteries, research and development into cost-effective lithium-ion recycling processes are ongoing. For example, an intermediate recycling process – currently used in Canada – has achieved promising results recycling lithium-ion batteries that have cobalt or nickel as the cathodes.[304] Another process, direct recycling, is able to extract almost all of the battery components to be recycled or potentially reused. While technological progress has been made, concern exists among manufacturers regarding the quality and performance of these recycled materials and consequently demand remains low.[305]

The expected lifetime of battery storage technologies varies and tends to range between three and 20 years, depending on the battery. The expected lifetime of a lead acid battery is three to five years, and lithium-ion and sodium sulfur batteries' expected lifetime is 10 to 15 years. The longest

[296] Aevitas. 2017. Battery Recycling. Accessed on May 22, 2018 at: http://www.aevitas.ca/battery-recycling.html.

[297] Ibid.

[298] MassDEP.2018. Guide: Safely Manage Hazardous Household Products. Accessed on May 22, 2018 at: https://www.mass.gov/guides/safely-manage-hazardous-household-products.

[299] Warren, C. 2016. EPRI Examines Environmental Aspects of Grid-Scale Battery Deployment. January 18. Accessed on May 8, 2018 at: http://eprijournal.com/ensuring-a-clean-grid-batteries-not-excluded/.

[300] Aevitas. 2017. Battery Recycling. Accessed on May 22, 2018 at: http://www.aevitas.ca/battery-recycling.html.

[301] Ibid.

[302] Ibid.

[303] Gaustad, G. 2018. Lifecycles of Lithium-Ion Batteries: Understanding Impacts from Material Extraction to End of Life. March 14. Spring Bridge on International Frontiers of Engineering (2018) 48:1. Accessed on May 17, 2018 at: https://www.nae.edu/Publications/Bridge/180760/181102.aspx.

[304] Gaines, L. 2014. The future of automotive lithium-ion battery recycling: Charting a sustainable course. November 15. Sustainable Materials and Technologies 1-2 (2014) 2-7. Accessed on May 10, 2018 at: https://www.sciencedirect.com/science/article/pii/S2214993714000037.

[305] Ibid.

expected lifetime is 15 to 20 years for nickel cadmium batteries.[306] The need for disposal technologies therefore varies based on the battery.

As most utility-scale lithium-ion batteries have not yet reached their end of life, there are relatively few companies within the U.S. that recycle lithium-ion batteries, and presently none of them recycle utility-scale lithium-ion batteries.[307,308,309] Call2Recycle, the organization responsible for collecting and recycling lithium-ion batteries 25 pounds or less in the State currently sends the batteries to a facility in Canada for processing.[310] More companies are likely to enter the lithium-ion recycling market due to the increase in number of spent electric vehicle batteries. As the existing stock utility-scale lithium-ion batteries approaches decommissioning (approximately mid-2020s) effective processes are expected to be in place to cost-effectively recycle, reuse or otherwise decommission spent lithium-ion batteries.[311] To the extent that the Roadmap results in an increase in the use of lithium-ion batteries as part of electrified rail and subway system wayside storage, near-term environmental impacts associated with spent lithium-ion batteries may occur. Lithium-ion batteries in such applications have a limited lifecycle under the extreme charging and discharging conditions that occur during regenerative braking, meaning frequent replacement may be necessary.[312] As such, these batteries may reach their end-of-life prior to the development of established battery recycling facilities, potentially resulting in environmental impacts.

Current New York State regulations require lithium-ion battery recycling (Article 27, Title 18 of the ECL) but this regulation is intended to address smaller batteries weighing fewer than 25 pounds commonly used in personal electronic devices, and therefore would not be applicable to many utility-scale operations that use batteries weighing greater than 25 pounds.[313] Utility-scale lithium-ion batteries may fall under regulations governing hazardous waste 6 CRR-NY Part 374-3, Universal Waste Rule if they exhibit characteristics of a hazardous waste (e.g., ignitability,

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[306] NYSERDA. 2014. Behind-the-Meter Battery Storage: Technical and Market Assessment. December. Accessed on May 24, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Electic-Power-Delivery/Behind-Meter-Battery-Storage.pdf.

[307] Bohlsen, M. 2018. A Look at the Lithium-Ion Battery Recycling Industry and Companies. January 23. Accessed on May 22, 2018 at: https://seekingalpha.com/article/4139266-look-lithium-ion-battery-recycling-industry-companies?page=2.

[308] Gaines, L. 2014. The future of automotive lithium-ion battery recycling: Charting a sustainable course. November 15. Sustainable Materials and Technologies 1-2 (2014) 2-7. Accessed on May 10, 2018 at: https://www.sciencedirect.com/science/article/pii/S2214993714000037.

[309] These companies include American Manganese, Apple, Green Technology Solutions, Inc., and Johnson Matthey.

[310] Rechargeable Battery Recycling Corporation (RBRC). 2011. Call2Recycle. A Rechargeable Battery Collection and Recycling Plan for the State of New York. Submitted to the New York State Department of Environmental Conservation. March 7.

[311] Warren, C. 2016. EPRI Examines Environmental Aspects of Grid-Scale Battery Deployment. January 18. Accessed on May 8, 2018 at: http://eprijournal.com/ensuring-a-clean-grid-batteries-not-excluded/.

[312] Rasul, Mohammad & Patel, A & Cole, Colin & Sun, Y & Spiryagin, Maksym & Godber, T & Hames, S. (2013). Train Motive Power Technologies: A Review on Existing and Emerging (Hybrid) Technologies. Accessed on May 10, 2018 at: https://www.researchgate.net/publication/308719679_Train_Motive_Power_Technologies_A_Review_on_Existing_and_Emerging_Hybrid_Technologies.

[313] NYSDEC. Rechargeable Battery Recycling. Accessed on May 17, 2018 at: https://www.dec.ny.gov/chemical/72065.html.

corrosively, reactivity, or toxicity). The regulatory status of utility-scale lithium ion batteries in the State is currently unclear but they likely fall under 6 CRR-NY Part 374. Increased regulation – or clarification of existing regulations – for utility-scale batteries may provide the additional demand for lithium-ion recycling facilities and reduce potential environmental impacts of battery-based energy storage.

Repurposing which often involves refurbishing batteries for use in another application may also limit potential environmental impacts.[314] The Amsterdam ArenA in the Netherlands is repurposing 280 former Nissan LEAF batteries to provide 4 MW of storage capacity and 4 MW of back-up power to the arena and surrounding neighborhood.[315,316] Current restrictions in the U.S. limit the repurposing of EV batteries, although Underwriters Labs has developed Standard 1974 to govern battery repurposing, but potential exists to develop second-life uses for rechargeable batteries.[317]

Public Health

This section discusses public health impacts directly attributable to battery storage including fire and toxicity risks. The potential for the battery to melt, leak, combust, or explode exists, generally as a result of damage due to inadequate cooling, ventilation, unsafe activity, or seismic activity.[318] Notably, documented incidences of utility-scale battery fires are rare, as of 2016, only two renewable energy generation plus energy storage facilities had reported a fire.[319] There currently exists a lack of consensus in the State on accepted fire safety standards for all battery storage technologies, particularly lithium-ion batteries and especially with regards to the appropriate course of action in the event of a lithium-ion battery fire.[320] Independent lab testing conducted by DNV GL on behalf of NYSERDA and Con Edison in 2017 has removed ambiguity surrounding

[314] Gaustad, G. 2018. Lifecycles of Lithium-Ion Batteries: Understanding Impacts from Material Extraction to End of Life. March 14. Spring Bridge on International Frontiers of Engineering (2018) 48:1. Accessed on May 17, 2018 at: https://www.nae.edu/Publications/Bridge/180760/181102.aspx.

[315] Vernacchia, J. 2017. A Brief History of Utility-Scale Energy Storage. September 19.

[316] Johan Cruuf Arena. 2016. Amsterdam ArenA More Energy Efficient with Battery Storage. November 30. Accessed on May 10, 2018 at: http://www.johancruijffarena.nl/default-showon-page/amsterdam-arena-more-energy-efficient-with-battery-storage-.htm.

[317] Gaustad, G. 2018. Lifecycles of Lithium-Ion Batteries: Understanding Impacts from Material Extraction to End of Life. March 14. Spring Bridge on International Frontiers of Engineering (2018) 48:1. Accessed on May 17, 2018 at: https://www.nae.edu/Publications/Bridge/180760/181102.aspx.

[318] NYSERDA. 2014. Behind-the-Meter Battery Storage: Technical and Market Assessment. December. Accessed on May 24, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Electic-Power-Delivery/Behind-Meter-Battery-Storage.pdf.

[319] Blum, A.F., Long, R.T. 2016. Hazard Assessment of Lithium Ion Battery Energy Storage Systems, Final Report. Prepared for the National Fire Protection Association. February. Accessed on May 31, 2018 at: https://www.nfpa.org/-/media/Files/News-and-Research/Resources/Research-Foundation/Research-Foundation-reports/Other-research-topics/RFFireHazardAssessmentLithiumIonBattery.ashx?la=en.

[320] Maloney, P. 2017. Fire safety issues dog battery storage growth in New York City, slowing deployment. March 21. Accessed on May 24, 2018 at: https://www.utilitydive.com/news/fire-safety-issues-dog-battery-storage-growth-in-new-york-city-slowing-dep/438290/.

best methods to confront a lithium-ion battery fire including the use of water as the currently preferred extinguishing method.[321]

Many types of battery storage technologies contain toxic and hazardous chemicals that can cause damage when exposed to humans. When exposure occurs it is generally because the battery has been damaged or tampered with, therefore the risk can be reduced following instructions from the manufacturer.[322] Vandepaer et al. (2017) found in an impact assessment across 1,500 environmental flows sectioned into four damage categories that for 6 MWh lithium-ion batteries, there are no significant public health impacts during the use phase and maintenance.[323]

Transportation

As stated above, the majority of lithium-ion batteries are manufactured in East Asia. The closest utility-scale lithium-ion battery manufacturer to New York is in Canada.[324] Transportation will play a significant role in enabling the State to obtain battery storage systems. This may lead to a minor increase in greenhouse gas emissions and traffic congestion on major roads. At the battery's end-of-life – due to lack of processing and recycling facilities in the State – lithium-ion batteries currently must be transported out of the State which may also lead to a minimal increase in greenhouse gas emissions and traffic congestion on major roads.

5.2.3 Thermal Storage

Thermal storage technology harnesses the energy that is created during heat exchanges. There are two primary methods to accomplish this: sensible heat storage and latent heat storage. Sensible heat storage uses a medium to exchange heat without the use of phase changes or chemical changes; it involves storing thermal energy by heating or cooling a liquid or solid storage medium such as water, sand, molten salts, rocks, etc. For example, pumping heated or cooled water into aquifers or manmade boreholes, or circling water around an insulated pit filled with gravel.[325] Latent heat storage involves phase changes (e.g., from a solid state into a liquid state); for example, using electricity when prices are low to create ice that is later used to cool a building.[326]

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321 DNV GL, 2017. Considerations for ESS Fire Safety. Accessed on May 31, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Energy-Storage/20170118-ConEd-NYSERDA-Battery-Testing-Report.pdf.

322 NYSERDA. 2014. Behind-the-Meter Battery Storage: Technical and Market Assessment. December. Accessed on May 24, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Electic-Power-Delivery/Behind-Meter-Battery-Storage.pdf.

323 Vandepaer, L., Cloutier, J., Amor, B. 2017. Environmental impacts of Lithium Metal Polymer and Lithium-ion stationary batteries. Renewable and Sustainable Energy Reviews 78 (2017) 46-60. Accessed on May 10, 2018 at: http://www.ourenergypolicy.org/wp-content/uploads/2017/05/1-s2.0-S1364032117305580-main.pdf.

324 Colthorpe, A. 2018. LG Chem, Samsung SDI at top of Navigant's grid-scale Li0ion leaderboard. February 22. Accessed on May 22, 2018 at: https://www.energy-storage.news/news/lg-chem-samsung-sdi-at-top-of-navigants-grid-scale-li-ion-leaderboard.

325 ETSAP/IRENA. Thermal Energy Storage. Energy Technology System Analysis Programme (ETSAP) and International Renewable Energy Agency (IRENA). *Technology-Policy Brief E17;* January 2013. Accessed on May 10, 2018 at: https://iea-etsap.org/E-TechDS/HIGHLIGHTS%20PDF/E17IR%20ThEnergy%20Stor_AH_Jan2013_final_GSOK%201.pdf.

326 NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 9, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf.

Thermal energy storage systems can be either centralized (e.g., district heating or cooling systems) or distributed systems (e.g., domestic and commercial buildings). Thermal storage is different from battery storage in that it generally cannot contribute energy to the grid; its primary purpose is to reduce demand on the grid during peak periods.[327]

There are several varieties of sensible and latent heat storage. For example, sensible heat storage includes solid material storage (molten sand, rock, silica/magnesia fire bricks, reinforced concrete, granite, aluminum, cast iron/steel) and liquid storage (water, oils, ethanol, propane, butane, isotunaol, isopentanol, octane). Water tank storage through grid-interactive thermal storage (GETS) is the most common form of sensible heat storage. Other storage options include underground storage, borehole storage, packed-bed storage, aquifer storage, and cavern/pit storage.[328] GETS systems add bi-directional control to electric resistance water heaters, which allows the utility or third party aggregator to control them as a flexible energy storage device.[329]

Latent heat storage includes ice storage, chilled water storage, warm storage (for heating plants), hot storage (for solar cooling and heating), and passive heating/cooling through integration in building materials (e.g., incorporation of paraffin wax into gypsum walls or plaster that cool and solidify by night and melt during the day, thus cooling the walls – the most common materials used are paraffins, hydrated salts, and fatty acids).[330]

Another emerging thermal energy storage application is thermo-chemical storage technology. This application involves using chemical reactions to store and release energy. Thermo-chemical materials are charged (i.e., heat is applied), resulting in a reaction that produces separate products that can easily be separated and stored until they are mixed again, which releases energy.[331] These technologies are promising; however they are for the most part under development and demonstration.[332]

This section focuses the discussion on impacts of the following three types of thermal storage: ice, chilled water, and GETS; these technologies are expected to represent the majority of thermal energy storage technologies deployed (in terms of MW capacity), as outlined in the Roadmap.[333] Thermal energy storage technologies can vary in terms of their size and resulting environmental impacts, however in general their footprint, resources demanded, and environmental impacts are

[327] PG&E. Thermal Energy Storage Strategies for Commercial HVAC Systems. *Application Note: An In-Depth Examination of an Energy Efficiency Technology.* Revised 4/25/97. Accessed on May 22, 2018 at: https://www.pge.com/includes/docs/pdfs/about/edusafety/training/pec/inforesource/thrmstor.pdf.

[328] Sarbu, Ioan. A Comprehensive Review of Thermal Energy Storage. *Sustainability*. 2018; Vol. 10, No. 191. http://www.mdpi.com/2071-1050/10/1/191/pdf.

[329] Podorson, David. Grid Interactive Water Heaters – How Water Heaters Have Evolved Into a Grid Scale Energy Storage Medium. ACEEE Summer Study on Energy Efficiency in Buildings. 2016. Accessed on May 24, 2018 at: https://aceee.org/files/proceedings/2016/data/papers/6_336.pdf.

[330] Sarbu, Ioan. A Comprehensive Review of Thermal Energy Storage. *Sustainability*. 2018; Vol. 10, No. 191. Accessed on May 24, 2018 at: http://www.mdpi.com/2071-1050/10/1/191/pdf.

[331] Ibid.

[332] Christensen, J.M. et al. Chemical Energy Storage. *DTU International Energy Report 2013.* Accessed on May 24, 2018 at: http://orbit.dtu.dk/files/60269108/DTU_International_Energy_Report_2013.pdf.

[333] NYSERDA/DPS. 2018. New York State Energy Storage Roadmap and DPS/NYSERDA Staff Recommendations.

minimal. Additional space may be needed to water tank installation in latent heat storage technologies, and minimal additional electric power is needed to operate the technologies. There is an increase in demand for water resources for these technologies; for latent storage technologies these are a one-time demand, for sensible storage technologies this demand is continuous.

The remainder of this section provides an overview of these three technologies; the current (and prospective near future) status of the technology market; and discusses the direct environmental impacts of thermal storage in more detail.

Technology Overview

There are several types of thermal storage; **Exhibit 5-5** summarizes the three types of thermal storage considered in the GEIS: ice, chilled water, and GETS.

EXHIBIT 5-5 TYPES OF THERMAL STORAGE TECHNOLOGIES

TYPE OF THERMAL STORAGE		DESCRIPTION
Latent Heat Storage[334,335]	Ice Storage	• During off-peak hours, water surrounding a heat exchanger is frozen. • During peak hours, the ice is used to augment or offset electric chiller cooling through ice harvesting, external melt ice-on-coil, internal melt ice-on-coil, encapsulated ice, or ice slurry. • In some cases, a chemical agent is used to accelerate the freezing process (e.g., ethylene or propylene glycol).
	Chilled Water	• Water is chilled with conventional chillers during off-peak hours. • During peak hours, chilled water is pumped out and used for cooling. • Warm water replaces the cooled water and the process is repeated.
Sensible Heat Storage[336]	Grid-Interactive Thermal Storage (GETS)	• Integration of intelligent and real time control signals with enhanced electric thermal storage water heaters. • Electricity is stored as heat in dense ceramic bricks inside the heater or as heated water. • Energy is stored during off-peak hours and used during peak hours.

[334] ETSAP/IRENA. Thermal Energy Storage. Energy Technology System Analysis Programme (ETSAP) and International Renewable Energy Agency (IRENA). *Technology-Policy Brief E17*; January 2013. Accessed on May 10, 2018 at: https://iea-etsap.org/E-TechDS/HIGHLIGHTS%20PDF/E17IR%20ThEnergy%20Stor_AH_Jan2013_final_GSOK%201.pdf.

[335] CALMAC. How Thermal Energy Storage Works. Accessed on May 22, 2018 at: http://www.calmac.com/how-energy-storage-works.

[336] Steffes, P.E. "Grid-Interactive Electric Thermal Storage (GETS) Space & Water Heating.: 'Smart' domestics Space and Water Heaters provide affordable energy storage and grid control for ancillary value, renewable integration and other grid optimization." EnergyStorage.org. SC12011-Rev-4. Accessed on May 10, 2018 at: http://energystorage.org/system/files/attachments/gets_white_paper_space_water_htg_sc2011.pdf.

Latent heat storage technologies (ice and chilled water) are generally more costly to operate than sensible heat storage technologies (GETS), primarily as a result of the energy required for the high number and frequency of cycles needed to freeze or chill water. In general, chilled systems are more cost-effective than ice systems, as they require less space and energy to produce. Conversely, sensible heat storage systems are relatively inexpensive to operate; however, they require large volumes of water because of the low energy density of the process.[337] Latent heat systems typically have a capacity of 50-150 kWh per ton (kWh/t; and power of 0.001-10.0 MW), while sensible heat systems typically have a capacity of 10-50 kWh/t (and power of 0.001-1.0 MW).[338] In New York, there is currently approximately 55 MW of ice or chilled water thermal storage installations.[339]

In total, there are 4.025 MW of installed thermal storage projects in the State. In addition, there is a $5 million, 1.5-2 MW/6-8 MWh project planned by Con Edison and Axiom that will freeze salt water[340] in onsite tanks for refrigeration in grocery stores in Brooklyn and Queens.[341]

Data are not available on the exact number of GETS water heaters installed in the state; however, it is estimated that there are over 53.6 million electric water heaters in the U.S., which *could* be used as a GETS system.[342] Looking forward, there is evidence that interest in using water heaters as GETS systems is growing; the current market potential for this application is estimated at $3.6 billion (less than one percent of the U.S.'s annual electricity expenditures). A 2017 report estimates that between 40 and 60 percent of current electric demand in the U.S. for water heating could be reduced by using GETS systems – customer and grid savings include avoided generation capacity, avoided transmission and distribution capacity, energy arbitrage, and ancillary services in the wholesale market.[343]

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[337] IRENA. 2013. Thermal Energy Storage: Technology Brief. IEA-ETSAP and IRENA Technology Brief E17, January 2013. Accessed on May 10, 2018 at: https://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20E17%20Thermal%20Energy%20Storage.pdf.

[338] Sarbu, Ioan. A Comprehensive Review of Thermal Energy Storage. *Sustainability*. 2018; Vol. 10, No. 191. Accessed on May 24, 2018 at: http://www.mdpi.com/2071-1050/10/1/191/pdf.

[339] Personal Communication, NYSERDA Staff. May 31, 2018.

[340] Salt water can be used for thermal storage by supersaturating the salt solution (by cooling to temperatures below normal crystallization temperatures), which stores heat which can then be released when it is heated to its equilibrium state. Barrett, P.F. Thermal Energy Storage in Supersaturated Salt Solutions. *Materials Chemistry and Physics,* Vol. 10, Issue 1. January 1984, pp. 39-49.

[341] NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 9, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf.

[342] U.S. EIA. Residential Energy Consumption Survey (RECS). Table HC8.1 Water Heating in U.S. Homes by Housing Unit Type, 2015. February 2017. Accessed on May 22, 2018 at: https://www.eia.gov/consumption/residential/data/2015/hc/php/hc8.1.php.

[343] Trabish, Herman K. "Utilities in hot water: Realizing the benefits of grid-integrated water heaters." UtilityDive.com. June 20, 2017. Accessed on May 10, 2018 at: https://www.utilitydive.com/news/utilities-in-hot-water-realizing-the-benefits-of-grid-integrated-water-hea/445241/

Environmental Impact Overview

This section discusses the direct environmental impacts of thermal storage technologies including land use and space requirements, water resources, and climate and air quality. Overall impacts from thermal storage are likely to be minimal and focused on water resource impacts which may be minimized through mitigation efforts.

Land Use and Space Requirements

As discussed in the previous section, land use requirements for energy storage are relatively small, including the requirements for thermal energy storage technologies. Thermal energy storage is primarily used in buildings and in industrial processes. Therefore, installations occur "on site;" additional land is not required beyond the footprint of the existing building.[344] For example, GETS systems are generally used for domestic applications;[345] therefore, their space requirement is minimal. Water tanks associated with latent heat storage solutions, however, may increase the amount of space required for installation. For example, one manufacturer of chilled water tanks describes its systems reaching heights of 30 meters (or 100 feet) and tanks with a capacity of 42 million gallons.[346] However, for most buildings, a footprint of a quarter of one percent of a building's air conditioned square footage is necessary to offset up to 30 percent of a building's peak cooling load using thermal storage technology. Installation of thermal energy technologies is highly flexible; systems can be installed on rooftops, inside buildings, outside buildings, underground, or partially buried.[347]

Water Resources

The primary environmental impact of thermal storage options is an increase in demand for water resources to conduct and store energy. For example, for chilled water storage systems, the typical storage volume for chilled water is approximately 10.7 cubic feet per ton-hour of cooling.[348] This translates to a requirement of almost 400,000 gallons of water for 5,000 ton-hours of cooling. Ice storage typically requires about 1.5 cubic feet of ice per ton-hour of cooling. This translates to a requirement of over 54,000 gallons of water for 5,000 ton-hours of cooling.[349] Although specific cooling requirements vary between buildings, a typical commercial installation of thermal energy

[344] Sarbu, Ioan. A Comprehensive Review of Thermal Energy Storage. *Sustainability*. 2018; Vol. 10, No. 191. Accessed on May 24, 2018 at: http://www.mdpi.com/2071-1050/10/1/191/pdf.

[345] They can be used in commercial applications; however, even in commercial settings they are relatively small systems to install.

[346] DN Tanks. Chilled Water Thermal Energy Storage Tank Overview. Accessed on May 22, 2018 at: https://www.districtenergy.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=6bd75989-da56-5cdb-e335-b53d2e97bfd1.

[347] CALMAC. Thermal Energy Storage is Key for Modern Building Designs. December 23, 2014. Accessed on May 22, 2018 at: http://www.calmac.com/energy-storage-articles-thermal-energy-storage-is-key-for-modern-building-designs.

[348] PG&E. Thermal Energy Storage Strategies for Commercial HVAC Systems. *Application Note: An In-Depth Examination of an Energy Efficiency Technology.* Revised 4/25/97. Accessed on May 22, 2018 at: https://www.pge.com/includes/docs/pdfs/about/edusafety/training/pec/inforesource/thrmstor.pdf.

[349] Chilled Water TES – an Alternative to Static Ice. July 7, 2015. Accessed on May 22, 2018 at: http://www.fefpa.org/post_conf_handouts/Summer2015/Chilled%20Water%20Storage%20in%20Collier%20County%20Schools%20FEFPA%20Summer%202015.pdf.

storage systems requires 5,000 to 10,000 ton-hours of cooling per year.[350] Therefore, a typical commercial building will need 400,000 to 800,000 gallons of water for a chilled water system and 54,000 to 108,000 gallons for an ice storage system. However, once these systems are filled with water, the systems recycle that water continuously. In other words, the water cycles from the chilled or frozen state back to warm water, and the process repeats. As a result, this water demand is a one-time need. The average large commercial building (over 200,000 square feet) in the U.S. consumes 12.6 million gallons of water per year.[351] Therefore, the average chilled water system will require 3.2 to 6.3 percent of average annual water consumption for chilled water systems and 0.4 to 0.8 percent of average annual water consumption for ice storage systems – as a one-time demand.

As noted above, sensible heat systems tend to require larger volumes of water than latent heat systems because of the low energy density of the process; sensible systems have three times lower energy density than latent heat storage systems.[352] In addition, the water used in a GETS systems is not recycled – it is cycled through the system as it used and replaced.

Climate and Air Quality

Thermal storage technologies require energy to operate: electricity is used to chill, freeze, or heat water. The production of the electricity needed to power these systems can result in the production of greenhouse gases. In some cases, the net effect of the addition of thermal energy storage on electricity consumption is positive (consumption increases), in some cases it is negative (consumption decreases). For example, thermal energy storage technologies are not 100 percent efficient – they lose energy during their charge-discharge processes. Efficiency, measured as the ratio of the energy provided to the user to the energy needed to charge to storage system (accounting for energy loss during the storage period and the charging/discharging cycle) ranges from 50 to 90 percent.[353] However, they also provide peak demand reduction, load shifting, and buffering of the intermittent output of renewable energy resources. Although the individual storage technology may increase energy consumption at its connection point to the grid, these services can contribute to improvements in the efficiency of the grid as a whole. For example, in a recent study of the Dallas-Fort Worth metro area, researchers found that using thermal energy storage to shift daytime cooling load to nighttime cooling storage reduced annual, system-wide primary fuel consumption by 17.6 MWh for each MWh of installed thermal storage capacity.[354] Another study conducted by the California Energy Commission found that source energy savings from thermal

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[350] Ibid.

[351] U.S. EIA. 2012 Commercial Buildings Energy Consumption Survey: Water Consumption in Large Buildings Summary. February 9, 2017. Accessed on May 24, 2018 at: https://www.eia.gov/consumption/commercial/reports/2012/water/.

[352] IRENA. 2013. Thermal Energy Storage: Technology Brief. IEA-ETSAP and IRENA Technology Brief E17, January 2013. Accessed on May 10, 2018 at: https://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20E17%20Thermal%20Energy%20Storage.pdf.

[353] Ibid.

[354] Deetjen, Thomas A, Reimers, Andrew, and Webber, Michael E. Can storage reduce electricity consumption? A general equation for the grid-wide efficiency impact of using cooling thermal energy storage for load shifting. *Environmental Research Letters*. Vol 13, 2018. Accessed on May 24, 2018 at: http://iopscience.iop.org/article/10.1088/1748-9326/aa9f06/pdf.

energy storage technologies range from 20 to 43 percent for commercial buildings in California.[355] The net effect on the production of greenhouse gas emissions from the installation of energy storage technologies cannot be estimated at this time.

Additional discussion of indirect changes in climate and air quality due to the Roadmap overall is included in **Section 5.3**.

5.2.4 Flywheels

Flywheels store and produce electricity as kinetic energy using a large spinning mass.[356] Electric energy is used as an input, and then a rotor spins in a nearly frictionless enclosure, storing the energy. When short-term backup power is required, the inertia allows the rotor to continue spinning and the resulting kinetic energy is converted to electricity. Flywheels generally take few materials and space to install, and they require low maintenance and have long lives.

This section provides an overview of flywheel technology covered under the Roadmap; the current (and prospective near future) status of the technology market; and discusses the direct environmental impacts of flywheels in more detail.

Technology Overview

Energy storage systems using flywheel technology are based on the kinetic transfer of energy. Electric energy is used to generate energy by accelerating a rotating mass using a motor generator. The energy generated is stored in the rotating mass and discharged by drawing down the kinetic energy using the same motor generator. The spinning mass operates in a nearly frictionless enclosure; inertia allows the mass to continually spin and convert the resulting kinetic energy to electricity during peak hours, or when power fluctuates or is lost. The two most common applications of flywheels are for uninterruptible power supplies (UPS) and power quality management. Flywheel systems can also absorb excess power from the grid, and recycle it back when needed. They can also be installed at both transmission and distribution levels, or used in individual applications in grid isolated approaches.[357] Multiple flywheels can be connected, meaning that users can incrementally expand their storage options.[358]

[355] CEC. 1996. Source Energy and Environmental Impacts of Thermal Energy Storage. February 1996. Accessed on May 10, 2018 at: http://www.pcmproducts.net/files/500_95_005_tes_report.pdf.

[356] NYISO. 2017. The State of Storage: Energy Storage Resources in New York's Wholesale Electricity Markets. December 2017. Accessed on May 9, 2018 at: https://home.nyiso.com/wp-content/uploads/2017/12/State_of_Storage_Report_Final_1Dec2017.pdf.

[357] Amiryar, Mustafa E.; Pullen, Keith R. A Review of Flywheel Energy Storage System Technologies and Their Applications. *Applied Sciences*. Vol. 7, No. 286. 2017. Accessed on May 22, 2018 at: https://www.mdpi.com/2076-3417/7/3/286/pdf.

[358] Beacon Power. "Technology." Accessed on May 22, 2018 at: http://beaconpower.com/technology/.

Flywheel technologies require little maintenance, and consequently have relatively long lifespans (often more than 20 years);[359] newer configurations can produce more than 175,000 full depth of discharge cycles.[360] They also do not require significant space to operate, due to their high energy density and compact size (although they do require a solid base to be anchored to because of the gyroscopic effect of the rotations, especially during discharge). For example, when compared to battery storage options, flywheels require, on average, less floor space than an equivalent capacity battery or capacitator system by about four to one.[361] As a result, flywheels are generally desirable where space is at a premium. In general, flywheels are not suitable for longer-duration capacity needs to the bulk grid, as they store energy for shorter durations than needed for large scale applications.[362] Flywheels can also be recharged relatively quickly (sometimes as quickly as two minutes). Because flywheels are unaffected by temperature changes, they do not need cooling like batteries or thermal energy storage options.[363]

There are currently three flywheel storage facilities in the U.S.:

- 1 MW facility in Ohio (installed in 2008),
- 1 MW facility in Massachusetts (installed in 2009), and
- 20 MW facility in Stephentown New York (installed in 2011).[364]

The New York facility provides approximately 10 percent of the regulation market capacity and over 30 percent of the area control error correction.[365] There are also over 400 flywheels in commercial operation, providing power capacity of over 88 MW across the U.S.[366,367] At this time, all installed flywheels have a power capacity of 20 MW or less. There are currently three 20 MW facilities in the U.S.: the facility in New York, another in California, and one more in

[359] Amiryar, Mustafa E.; Pullen, Keith R. A Review of Flywheel Energy Storage System Technologies and Their Applications. *Applied Sciences*. Vol. 7, No. 286. 2017. Accessed on May 22, 2018 at: https://www.mdpi.com/2076-3417/7/3/286/pdf.

[360] ESA. "Flywheels" Web Page. Accessed on May 10, 2018 at: http://energystorage.org/energy-storage/technologies/flywheels.

[361] Bezner, Steven D. "Everything You Wanted to Know About Energy Storage But Were Afraid To Ask." *Traction Power*. 8 – Technical Forums. Accessed on May 10, 2018 at: http://www.apta.com/mc/rail/previous/2010/Papers/Everything-You-Wanted-To-Know-About-Energy-Storage-But-Were-Afraid-To-Ask.pdf.

[362] Singh, Joshua N.R. "Energy Storage via Flywheel Technology." Accessed on May 10, 2018 at: https://ziang.binghamton.edu/node/26.

[363] Electrical Review. "Flywheel UPS – the pros and cons." October 9, 2012. Accessed on May 10, 2018 at: https://www.electricalreview.co.uk/features/advertorials/8834-flywheel-ups-the-pros-and-cons.

[364] Denholm, P.; Fernandez, S.J.; Hall, D.G.; Mai, T.; Tegan, S. 2012. "Energy Storage Technologies." Chapter 12. National Renewable Energy Laboratory. Renewable Electricity Futures Study, Vol. 2. Accessed on May 10, 2018 at: https://digital.library.unt.edu/ark:/67531/metadc844059/m2/1/high_res_d/1046903.pdf.

[365] Beacon Power. "Operating Plants." Accessed on May 22, 2018 at: http://beaconpower.com/operating-plants/.

[366] Ibid.

[367] U.S. DOE. Global Energy Storage Database. Office of Electricity Delivery & Energy Reliability. Accessed on May 22, 2018 at: www.energystorageexchange.org.

Pennsylvania; the remaining facilities have a capacity of 8 MW or less.[368] Typical capacities range from 3 kWh to 133 kWh.[369]

Environmental Overview

This section discussions the environmental impacts specific to flywheel storage technologies including land use and space requirements, climate and air quality, waste management, and public health. Overall, flywheels have negligible environmental impacts.[370]

Land Use and Space Requirements

As discussed in the previous section, land use requirements for energy storage are relatively small, including the requirements for flywheel storage technologies. Flywheel energy storage is primarily used in buildings and in industrial processes; therefore, installations occur “on site;” additional land is not generally required beyond the footprint of the existing building.[371] Flywheels are designed to be modular – each module is a stand-alone unit, and modules can be fit together with others to build an energy storage system of any size (from 100 kW to multi-MW).[372] The modular configuration minimizes the size of the footprint needed, and provides flexibility to place the modules in places that maximize their use of space. As noted above, the footprint of flywheel storage systems is relatively small (compared to battery storage options, for example). For example, Beacon Power’s flywheels (who installed and operate the three 20 MW facilities in the U.S.) are 49 inches high and 27 inches in diameter. Depending on the specific site, more than 20 MW of power capacity can be installed in one acre or space; they are also capable of being installed underground.[373,374]

Climate and Air Quality

Flywheel energy storage requires electricity to operate: electricity is used to generate the kinetic energy that is stored in the flywheel. They also require standby power to keep the flywheel rotating.[375] The production of the electricity needed to power these systems can result in the production of greenhouse gases. The power capacity of flywheels can vary; Beacon Power’s flywheels require 480 volt alternative current (AC) power to produce up to 160 kW of power, and

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[368] Ibid.

[369] Castelvecchi, D. 2007. Spinning into control. Science News. 171:312-313.

[370] ESA. “Flywheels” Web Page. Accessed on May 10, 2018 at: http://energystorage.org/energy-storage/technologies/flywheels.

[371] Amiryar, Mustafa E.; Pullen, Keith R. A Review of Flywheel Energy Storage System Technologies and Their Applications. *Applied Sciences*. Vol. 7, No. 286. 2017. Accessed on May 22, 2018 at: https://www.mdpi.com/2076-3417/7/3/286/pdf.

[372] Individual units are designed to be operated independently, even when combined with other units.

[373] Beacon Power. Modular Design. Accessed on May 24, 2018 at: http://beaconpower.com/modular-design/.

[374] Beacon Power. Product Specification: BHE-6. Accessed on May 24, 2018 at: http://istochnik-13.narod.ru/head/eab/flywheel6.pdf.

[375] Bezner, Steven D. “Everything You Wanted to Know About Energy Storage But Were Afraid To Ask.” *Traction Power*. 8 - Technical Forums. Accessed on May 10, 2018 at: http://www.apta.com/mc/rail/previous/2010/Papers/Everything-You-Wanted-To-Know-About-Energy-Storage-But-Were-Afraid-To-Ask.pdf.

take two and a half hours or less and 4 kW of input power to fully recharge.[376,377] Additional discussion of climate and air quality impacts of the Roadmap overall is included in **Section 5.3**.

Waste Management

As noted above, flywheels have a long lifespan (20 years or more), meaning there is little turnover waste to manage. They are generally made of inert or benign materials that when discarded have little environmental impact, and require no hazardous chemicals to operate. The only component that requires periodic replacement is the magnetic bearings that are used to minimize the friction of the rotating mass, reduce wear, and to facilitate extended use at high speeds. To ensure optimal performance, the magnetic bearings need to be replaced periodically, which means the old bearings are discarded.[378] These bearings, however, are made from metals and ferrous objects (e.g., iron),[379] which can be recycled.[380]

Public Health

There is a potential safety risk associated with flywheel technologies. If the flywheel is overcharged (i.e., loaded with more energy than its components can handle), this can result in an "explosive-like" event. To minimize this risk, security walls (or housing) are often used and systems are mounted carefully.[381] In addition, care must be taken in design and installation to ensure that the tensile strength (i.e., strength of the rotor material) is operated within a suitable safety margin (to keep the stress of the rotor below the strength of the rotor material).[382]

5.3 INDIRECT EFFECTS

The core policy outcomes of the Roadmap complement the State's broader clean energy policies: identify and implement policy, regulatory, and programmatic actions to support energy storage deployment in the State. Taken together, these outcomes are designed to increase system reliability and resiliency, reduce energy-related carbon emissions and lower the overall costs of power across all sectors of the economy. Such changes in the State's energy industry will evolve over long periods of time in response to numerous separate individual initiatives. Therefore, in aggregate, the

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[376] Beacon Power. Power Electronics. Accessed on May 24, 2018 at: http://beaconpower.com/power-electronics/.

[377] Beacon Power. Product Specification: BHE-6. Accessed on May 24, 2018 at: http://istochnik-13.narod.ru/head/eab/flywheel6.pdf.

[378] Amiryar, Mustafa E.; Pullen, Keith R. A Review of Flywheel Energy Storage System Technologies and Their Applications. *Applied Sciences*. Vol. 7, No. 286. 2017. Accessed on May 22, 2018 at: https://www.mdpi.com/2076-3417/7/3/286/pdf.

[379] Calnetix Technologies. General Explanation of How Magnetic Bearings Work. September 2013. Accessed on May 22, 2018 at: https://www.calnetix.com/sites/default/files/CALNETIX_HOW_MAGNETIC_BEARINGS_WORK.pdf.

[380] Bureau of International Recycling. "Ferrous Materials." Accessed on May 22, 2018 at: http://www.bir.org/industry/ferrous-metals/.

[381] Advantage Environment. Energy Storage with Flywheel Technology. December 4, 2011. Accessed on May 22, 2018 at: http://advantage-environment.com/future/energy-storage-with-flywheel-technology/.

[382] Amiryar, Mustafa E.; Pullen, Keith R. A Review of Flywheel Energy Storage System Technologies and Their Applications. *Applied Sciences*. Vol. 7, No. 286. 2017. Accessed on May 22, 2018 at: https://www.mdpi.com/2076-3417/7/3/286/pdf.

energy storage technologies discussed in this chapter serve and generate one common long-term, indirect effect: reducing the use of energy generated from fossil fuels.

The environmental impact of a reduction in the use of fossil-fuel based energy generation on the human environment is generally positive, but will occur over longer time horizons. For example, by reducing energy consumption, energy storage technologies may avoid some degree of the adverse environmental impacts associated with fossil fuel-based energy generation. The extent to which energy storage avoids adverse impacts and generates benefits, however, is complex. A variety of factors influence potential outcomes, including the mechanism by which energy consumption is reduced, the location on the grid at which changes in energy consumption occur, and the current mix of fuel sources used in generation. The “dirtier” the fuels used for generation, the greater the potential benefits from energy storage technologies and complementary clean energy technologies, programs, and resources energy storage. Adverse impacts avoided may also change over time, reflecting the dynamic nature of the electric grid and the energy market itself. That is, adverse impacts over the next three to five years may differ from adverse impacts avoided in ten to 15 years.

Energy storage technologies improve the reliability and stability of the grid, particularly when paired with intermittent renewable generation. The costs of producing and supplying renewable energies can be reduced when flywheel or battery energy storage technologies are employed. This can be achieved by increasing the operational efficiencies of conventional units, for example. These technologies can supply electricity to the grid to meet demand, and can withdraw electricity from the grid to alleviate excess supply. This ability helps enable other clean energy technologies, programs, and resources to achieve greater impacts on the electric grid in terms of stability, resilience, and efficiency. These technologies can also reduce peak demand, which lowers the costs of energy through usage reduction and avoidance of demand charges. In this capacity, energy storage technologies may be considered as a form of mitigation, providing a means by which the environmental impacts of other technologies and processes can be avoided. For example, energy storage can enable the curtailment of wind turbine operation to avoid periods of peak wildlife activity in close proximity to wind turbines (e.g., feeding or migratory passage). Energy storage is likely to play a role in curtailment considerations of both on-land and offshore wind generation developments.

In aggregate, the greatest indirect environmental impacts of the Roadmap stem from reductions in the generation of energy from fossil fuel power plants. Such plants are the second largest source of emissions, and most concentrated source, accounting for approximately 16 percent of all GHG emissions in the State.[383] The following section provides a summary of the potential environmental benefits indirectly generated by increases in the penetration of energy storage technologies discussed in this chapter.

[383] NYSERDA. 2015. New York State Greenhouse Gas Inventory and Forecast: Inventory 1990-2011 and Forecast 2012-2030. Final Report. Revised June 2015. Accessed on May 10, 2018 at: https://energyplan.ny.gov/-/media/Files/EDPPP/Energy-Prices/Energy-Statistics/2015-greenhouse-gas-inventory.pdf.

Criteria Air Pollutants

Fossil fuel electric generation is a major source of criteria air pollutants, including CO_2, carbon monoxide (CO), and heavy metals. The release of sulfur dioxide (SO_2) and nitrous oxides (NO_x) from fossil fuel generated power plants, also leads to the formation of particulate matter (PM2.5), ozone, and other acidic compounds. Mercury (Hg) compounds are another pollutant from fossil fuel energy generation, particularly from coal-powered plants.[384] Criteria air pollutants are particularly important factors influencing local and regional air quality. These pollutants can negatively affect air quality, visibility, and public health.

It is likely that storage deployed and utilized during peak periods due to the Roadmap will result in reduced operation of the least efficient and highest emitting plants, and will correspondingly reduce total SO_2 and NO_x emissions.[385] However, the net effect criteria air pollutants in certain localities are uncertain. **Chapter 6** includes discussion of measures to mitigate such impacts.

Greenhouse Gases

A key long-term outcome of the Roadmap is to support the REV's goals of reducing GHG emissions from 1990 levels by 40 percent by 2030 (in combination with the 2015 New York State Energy Plan); in 2015, the state had decreased GHG emissions by 12 percent (of 1990 levels).[386,387] In the State, electric generation emitted 31.3 million tons of carbon dioxide equivalent gas (CO_2e) in 2016.[388] As discussed in **Chapter 3**, GHG such as CO_2 contribute to the global trend of rising average temperatures, changes in precipitation patterns and rising sea levels. As temperatures continue to rise and climate change further intensifies, the negative impacts of climate change on the State's residents, economy, and natural ecosystems will also increase.[389] Actions (like those proposed in the Roadmap) that stem the further rise of atmospheric GHG levels and prepare the State for the impact of climate change can reduce the magnitude of such impact both within the State and globally. The Acelerex Energy Storage Study provides an illustrative example of the impact of deploying 2,795 MW by 2030, estimated to achieve a reduction of 1.97 million metric tons (MMT) of CO_2e by 2030.[390]

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[384] EIA. Electricity Explained: Electricity and the Environment. Accessed on May 10, 2018 at: https://www.eia.gov/energyexplained/index.php?page=electricity_environment.

[385] The Acelerex study did not consider local reliability or minimum oil burn requirements, both of which may impact the total quantified emissions of SOx and NOx.

[386] NYISO. 2015. 2015 New York State Energy Plan: The Energy to Lead. New York State Energy Planning Board. Accessed on May 2, 2018 at: https://energyplan.ny.gov/Plans/2015.aspx.

[387] New York State Energy Planning Board. The Energy to Lead: 2015 New York State Energy Plan. Accessed on May 24, 2018 at: https://energyplan.ny.gov/-/media/nysenergyplan/2015-state-energy-plan.pdf.

[388] EIA. 2016. New York Electricity Profile 2016. Accessed on May 10, 2018 at: https://www.eia.gov/electricity/state/newyork/.

[389] Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grahborn (Eds). 2011. Responding to Climate Change in New York State. Synthesis Report prepared for NYSERDA. November 2011. Accessed on May 10, 2018 at: https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/EMEP/climaid/ClimAID-Report.pdf.

[390] Acerelex. *Forthcoming.* Energy Storage Study.

Public Health

Emissions from fossil fuel-based electric generation can negatively affect human health. Exposure to ozone can aggravate lung diseases including asthma, emphysema, and chronic bronchitis, as well as increase the risk of premature mortality from heart or lung disease. Health effects from PM2.5 include aggravated asthma, irregular heartbeat, decreased lung function, nonfatal heart attacks, and premature mortality in those with heart or lung disease.[391] NO_x can increase the risk of respiratory diseases and exacerbate existing respiratory symptoms, especially in children, elderly, and the poor. Individuals with asthma may experience aggravated symptoms when exposed to NO_x.[392] Additionally, exposure to NO_x can cause irreversible structural changes to the lungs. One study estimated health impacts from fossil fuel energy sources at $362 to $886 billion in economic value annually, based on premature mortality, workdays missed, and direct costs to the U.S. healthcare system resulting from PM2.5, NO_x, and SO_2.[393] The same study estimated that the economic value of negative health impacts was equal to approximately $0.14 to $0.31 per kWh.[394] These costs may be even higher if GHG emissions are included.[395] Increased deployment of energy storage is expected to contribute to further reductions in such air emissions and the related costs.

Water, Land and Ecological Resources

Avoided fossil fuel and nuclear generation should also reduce water demand and improve the health of aquatic ecosystems. Both coal combustion in power plants and nuclear plants use significant quantities of water for producing steam and cooling.[396] For natural gas combustion, boilers and combined cycle systems also require water for cooling processes.[397] If process or cooling water comes from a surface water source, water intake structures are required to withdraw the necessary water for the plant's operation. Such intake structures can stress or directly take aquatic organisms held against or passed through intake screens.[398]

Coal-fired generation, natural gas boilers, and natural gas combined cycle systems all release wastewater with excess heat and hazardous chemicals during plant operation. Thermal water

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[391] EPA. Particulate Matter (PM) Pollution: What are the harmful effects of PM? Accessed on May 10, 2018 at: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#effects.

[392] EPA. Nitrogen Dioxide (NO_2) Pollution: What are the harmful effects of NO_2? Accessed on May 10, 2018 at: https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects.

[393] Machol, Ben and Rizk, Sarah. 2013. "Economic Value of U.S. Fossil Fuel Electricity Health Impacts." Environment International. February 2013. Volume 52. Pp 75-80.

[394] Gerdes, Justin. Forbes.com. How Much Do Health Impacts From Fossil Fuel Electricity Cost The U.S. Economy. April 8, 2013. Accessed on September 26, 2014 at: https://www.forbes.com/sites/justingerdes/2013/04/08/how-much-do-health-impacts-from-fossil-fuel-electricity-cost-the-u-s-economy/#34b3aaffc679.

[395] Ibid.

[396] Kenny, J.F., Barber, N.L., Hutson, S.S., Linsey, K.S., Lovelace, J.K., and Maupin, M.A., 2009, Estimated use of water in the United States in 2005: U.S. Geological Survey Circular 1344, 52 p. Accessed on May 10, 2018 at: http://pubs.usgs.gov/circ/1344/.

[397] Union of Concerned Scientists. "How it Works: Water for Natural Gas." Accessed on May 10, 2018 at: https://www.ucsusa.org/clean-energy/energy-water-use/water-energy-electricity-natural-gas#.WvU59u-Uv0M.

[398] NYSDEC. Aquatic Habitat Protection. Accessed on May 10, 2018 at: http://www.dec.ny.gov/animals/32847.html.

discharges elevate water temperatures, which can harm organisms, destroy or degrade habitat, or form barriers to existing migratory routes. Hazardous substances in wastewater can impair water quality, as can deposition of acidic air pollutants (i.e., acid rain).[399]

Coal combustion in traditional legacy baseload generating plants generates significant amounts of solid waste. Much of this waste is disposed of in abandoned mines or landfills, potentially allowing pollutants to leach to ground or surface water. Soil contaminated by pollutant deposition near coal-fired power plants can require years to recover.[400] Acid rain due to emissions of NO_X and SO_2 also impairs the growth of and causes death in trees.[401] Greater adoption of energy storage will contribute to incremental reductions in these types of resource impacts.

Aesthetic, Visual, Cultural, and Historical Resources

Reduced emissions of NO_X and SO_2 and associated reductions in particulate matter due to avoided fossil fuel use would also improve visual and cultural resources in the State.[402] Fine particles are the primary cause of reduced visibility in some areas in the U.S., including national parks and wilderness areas. Reduced particle pollution will also help to protect stonework, including culturally important monuments, from staining and other damage.[403]

5.4 OTHER UNANTICIPATED TECHNOLOGIES

As the Roadmap is further developed, and implemented over a 12-year time frame (2018-2030), it may spur innovation and the development of currently unanticipated clean energy technologies. As the Roadmap will establish an energy storage deployment target for 2030, it is possible, if not probable, that energy storage technologies will advance substantially by 2030. Evidence suggests that the energy storage industry is evolving quickly. It is possible that the increased focus and support of the State on this sector will lead to the development and commercialization of new energy storage technologies or applications thereof. In addition, it is possible that increased levels of demand for large scale renewable energy will spur innovation and the development of currently unanticipated technologies. For example, while it is not technically or financially feasible to currently employ thermal energy storage through chemical reactions, substantial research and development efforts are underway to advance this technology.[404] In addition, superconducting magnetic energy storage or hydrogen energy storage technologies may become commercially viable during the time frame of the Roadmap. As technology changes and new technologies are developed, there is potential for unforeseen environmental impacts. Depending on the type of

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[399] Manjuntha, S.G., Bobade, K.B, Kudale, M.D. "Pre-Cooling Technique for a Thermal Discharge from the Coastal Thermal Power Plant." *Procedia Engineering*, Vol. 116, 2015, pp. 358-365.

[400] EIA. "Coal Explained: Coal and the Environment." Accessed on May 10, 2018 at: https://www.eia.gov/energyexplained/?page=coal_environment.

[401] EPA. "Acid Rain. Effects of Acid Rain." Accessed on May 10, 2018 at: http://www.epa.gov/acidrain/effects/forests.html.

[402] Ibid.

[403] EPA. Particulate Matter (PM) Pollution. Health and Environmental Effects of Particulate Matter (PM). Accessed on May 10, 2018 at: https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm.

[404] IRENA. 2013. Thermal Energy Storage: Technology Brief. IEA-ETSAP and IRENA Technology Brief E17, January 2013. Accessed on May 10, 2018 at: https://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20E17%20Thermal%20Energy%20Storage.pdf.

technology, it is possible that construction activities or operation and maintenance of the technology could create environmental impacts. To the extent that any new technologies displace fossil fuel electricity generation, or lower electricity consumption, such technologies could also generate positive environmental impacts. The net impact of other unanticipated technologies is, by its nature, unknown at this time.

5.5 CUMULATIVE IMPACTS

SEQRA Section 617.9(b)(5)(iii)(a) requires agencies to consider the "reasonably related short-term and long-term impacts, *cumulative impacts*, and other associated environmental impacts" of actions on the environment and existing natural resources. SEQRA does not expressly define "cumulative impacts;" however, it is useful to note that NEPA regulations at 40 CFR §1508.7 define cumulative impacts as the impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions.

Several court cases in the late 1980s and early 1990s provide additional direction on the appropriate approach for assessing cumulative impacts. Of particular relevance, *North Fork Environmental Council, Inc. v. Janoski* (196 AD2d 590 (2d Dept. 1993)) holds that: "in evaluating the potential environmental effect of a project before it, the lead agency must consider cumulative impacts of other simultaneous or subsequent actions which are included in any long-range plan of which the action under consideration is a part."

In this case, the Roadmap is part of and related to several, other, ongoing, state energy initiatives, including, but not necessarily limited to: (1) the REV (Case 14-M-0101); (2) the Clean Energy Fund (CEF; Case 14-M-0094); (3) the Large-Scale Renewable Program and a Clean Energy Standard enabling the Renewable Energy Standard (RES; Case 15-E-0302); (4) the New York Green Bank (NYGB; Case 13-M-0412); (5) the NY-Sun Initiative; (6) the 2015 New York State Energy Plan; (7) NY Prize; (8) Charge NY; (9) the Distributed Energy Resources (DER) Roadmap; (10) the Offshore Wind Roadmap; and (11) other energy-related technology and market development programs.

In addition to State-level clean energy initiatives, a number of energy-related efforts at the federal level may interact with the Roadmap. **Exhibit 5-6** summarizes the past, present and reasonably foreseeable future actions that are likely to interact with the Roadmap.

By considering cumulative impacts, the intent of SEQRA is to identify actions that may be insignificant by themselves, but which can degrade environmental resources over time when considered together. These considerations of potential cumulative effects include:

- The Roadmap is anticipated to engender overall positive environmental and social impacts, primarily by improving grid resiliency, reducing the State's CO_2 emissions, and promoting jobs growth.
- Certain cumulative negative impacts (e.g., potentially hazardous waste generation from battery storage facilities), however, may constrain the overall positive impacts of the Roadmap. As discussed further in **Chapter 6**, a number of regulations, policies, and best practices serve as measures that will mitigate adverse impacts that may arise from activities undertaken in response to the Roadmap.

- In general, the state and pre-2017 federal policies and initiatives identified in this section are designed to reduce the adverse economic, social, and environmental impacts of fossil fuel energy resources by increasing the use of clean energy resources and technologies. However, recent federal policies and actions including Executive Order 13783 and the proposed repeal of the Clean Power Plan introduce new uncertainty regarding the future landscape of fossil fuel-based energy resources.
- Cumulative site-specific impacts of the Roadmap are not known at this time and are beyond the scope of this GEIS. This GEIS provides a generic description of the potential environmental impacts of the Roadmap on land and water resources, agriculture, cultural and aesthetic resources, and other individually relevant impacts. Appropriate federal, state, and local permitting and environmental review processes will identify, evaluate, and mitigate potential site-specific impacts.

EXHIBIT 5-6 SUMMARY OF PAST, PRESENT AND REASONABLY FORESEEABLE FUTURE ACTIONS THAT INTERACT WITH THE PROPOSED ENERGY STORAGE ROADMAP

	PAST	PRESENT/NEAR-TERM
STATE/REGIONAL	• Office Petroleum Overcharge Restitution Fund • 1988 System Benefit Charge • New York Energy $mart Program • Electricity Restructuring • Revenue Decoupling • Energy Efficiency Portfolio Standards (EEPS) • Renewable Portfolio Standard (RPS) • Climate Action Council • NY Energy Highway	• New York State Energy Plan • Regional Greenhouse Gas Initiative (RGGI) • Executive Order 24 (Goals and Climate Action Plan) • Technology and Market Development Programs • NY-Sun Initiative • Green Bank • Climate Smart Communities • Transportation and Climate Initiative • ReCharge NY • Charge NY • Five Cities Energy Program • Build Smart NY • Cleaner Greener Communities
FEDERAL	• Energy Policy Act (1992, 2005, 2007) • Kyoto Protocol • Energy Independence and Security Act of 2007 • Emergency Economic Stabilization Act of 2008 • Production, Investment ,and Advanced Energy Manufacturing Tax Credits	• CAA Section 111(d) Clean Power Plan (*proposed elimination*) • EPA Greenhouse Gas Reporting Rule • Renewable Fuel Standard (RFS) • EPA Energy Star • Executive Order 13783: Promoting Energy Independence and Economic Growth

CHAPTER 6 | REGULATORY FRAMEWORK AND MITIGATION OF POTENTIAL ADVERSE IMPACTS

Consistent with New York Codes, Rules and Regulations (NYCRR) 6 NYCRR §§617.9(b)(5)(iv) and 617.11(d)(5) of New York's State Environmental Quality Review Act (SEQRA), this chapter describes the variety of measures available to minimize or avoid, to the maximum extent practicable (incorporating all practicable mitigation measures), potentially adverse environmental impacts that may result from energy storage activities that may be implemented under the Energy Storage Roadmap (the Roadmap). Specifically, this chapter discusses mitigation in two parts:

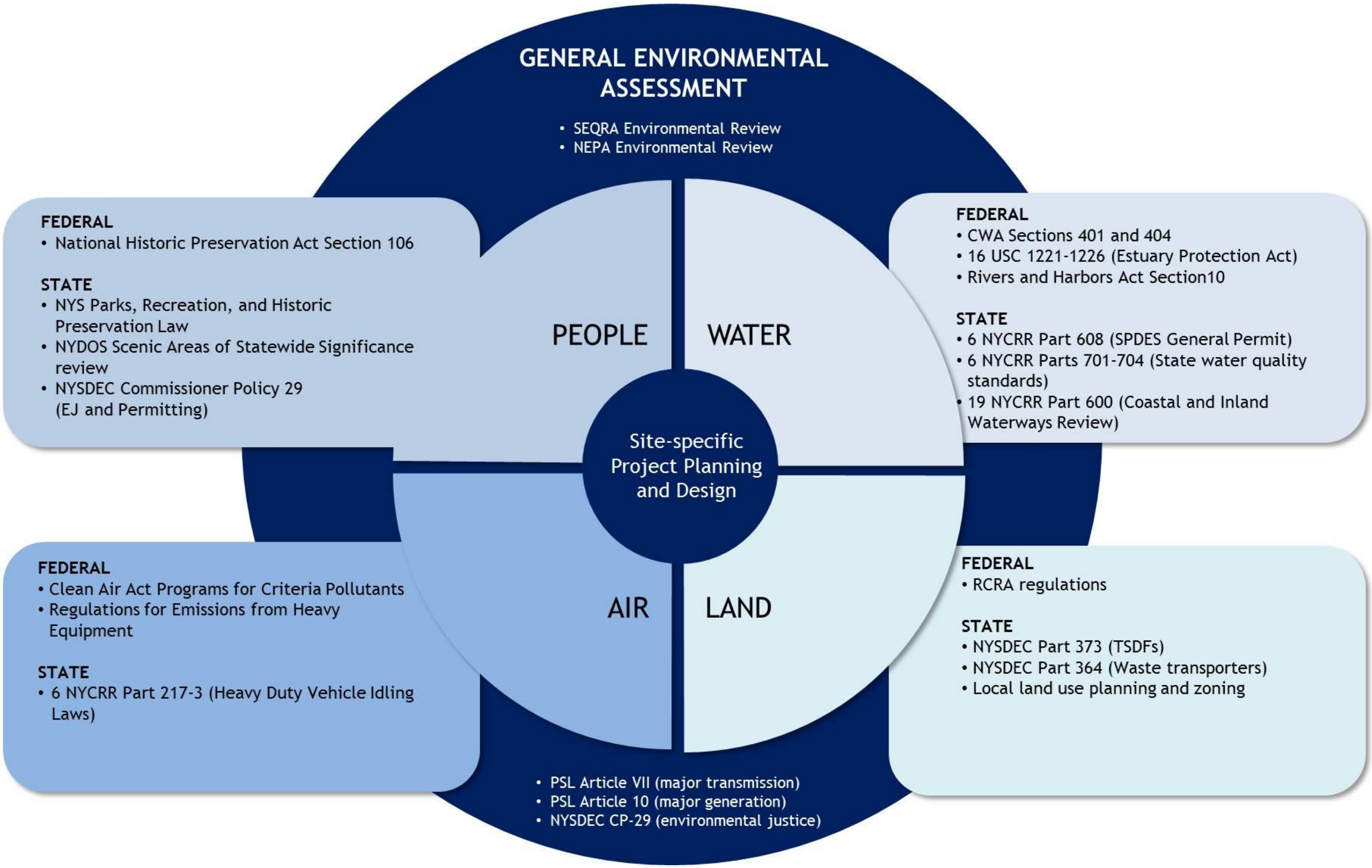
- **Section 6.1** introduces key federal and state regulations that may apply to energy storage activities during construction, operation, and closure of a specific project, and
- **Section 6.2** provides an overview of site-specific project design and planning which serves as a primary mitigation measure for many site-specific issues.

This chapter is not intended to provide an exhaustive list of potentially applicable regulations or mitigation measures, but rather a general overview of the key regulations and means by which adverse environmental impacts may be mitigated for a specific project or groups of similar projects.

6.1 POTENTIALLY APPLICABLE FEDERAL AND STATE REGULATIONS

The backdrop for New York's buildout of energy storage is compliance with existing federal and state regulations, which are designed specifically to protect human health and the environment from activities that could otherwise result in significant and/or adverse impacts. The following sections briefly discuss potentially applicable federal and state regulations for key resource areas that may be affected by Roadmap activities. On the following page, **Exhibit 6-1** summarizes potentially applicable permits and regulations, by resource area and type of review. Compliance with these laws will establish regulated environmental conditions, upon which any site specific mitigation measures, if needed, can be implemented.

EXHIBIT 6-1 SUMMARY OF POTENTIALLY APPLICABLE REGULATIONS



Air Resources

A number of federal and state regulations address air pollution, including hazardous air pollutants that may occur as the result of constructing energy storage facilities. This section provides an overview of the key regulations designed to mitigate, control and reduce air pollutants.

The primary federal statute governing air quality and air pollution is the Clean Air Act (CAA).[405] Air quality is defined by ambient air concentrations of specific pollutants that the U.S. Environmental Protection Agency (EPA) has identified as potentially harmful to public health and the environment.[406] Specifically, EPA has defined primary (and in some cases secondary) standards for six "criteria" pollutants, including: (1) particulate matter (PM10 and PM2.5); (2) carbon monoxide (CO); (3) sulfur dioxide (SO_2); (4) nitrogen dioxide (NO_2); (5) lead (Pb); and, (6) ozone. National primary ambient air quality standards define levels of air quality that EPA has determined necessary to provide an adequate margin of safety to protect public health, including the health of sensitive populations such as children and the elderly. National secondary ambient air quality standards define levels necessary to protect the public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Areas that do not meet National Ambient Air Quality Standards (NAAQS) – as set forth in the CAA – for specific criteria pollutants are designated as being in "nonattainment" for specific criteria pollutant standard(s). For some criteria pollutants, nonattainment status is further defined by the extent to which the applicable standard is exceeded. For example, there are five classifications of ozone nonattainment status (marginal, moderate, serious, severe, and extreme) and two classifications of carbon dioxide (CO_2) and PM10 nonattainment status (moderate and serious). The remaining criteria pollutants have designations of either attainment, nonattainment, or unclassifiable. Areas re-designated from nonattainment to attainment are commonly referred to as maintenance areas. These areas are in attainment but subject to an EPA-approved maintenance plan for a specific pollutant, to ensure continued compliance with the standard. Most air quality control regions in the State are in attainment with NAAQS. However, as of 2018 two regions are designated 8-hour ozone (2008) NAAQS nonattainment areas— the upstate county of Chautauqua and downstate counties including Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Suffolk, and Westchester.[407] All of the State is considered part of the Ozone Transport Region (OTR) and is required at a minimum to implement measures required in moderate ozone nonattainment for areas.

Construction of energy storage facilities may involve the use of heavy construction equipment such as excavators, forklifts, or on-site generators. EPA regulates emissions from heavy equipment through 40 CFR Part 1048 and 40 CFR Part 1039. Further, the State's ECL 6 NYCRR, Subpart 217-3 addresses heavy duty vehicles that may be traveling to, or working on an energy storage construction site by prohibiting idling for more than five minutes at a time. This idling restriction is aimed at reducing the air pollution, noise, and fuel use.

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[405] 42 U.S.C. 7401 et seq., amended in 1977 and 1990.

[406] The surrounding atmosphere, usually the outside air, as it exists around people, plants and structures.

[407] EPA. Greenbook. Nonattainment Status for Each County by Year for Criteria Pollutants as of July 02, 2014. Accessed on May 8, 2018 at: https://www3.epa.gov/airquality/greenbook/anayo_ny.html.

Water Resources

The following section discusses key federal and state regulations that may mitigate impacts to water resources from activities implemented under the Roadmap.

The primary federal statute governing water quality and water resources is the Clean Water Act (CWA). Any new infrastructure, including infrastructure associated with development of energy storage, that either crosses or occurs near navigable water may trigger federal review and permitting requirements under the CWA.[408] Projects for which construction occurs near navigable waters, or could otherwise obstruct or alter navigable waters must obtain a permit from the U.S. Army Corps of Engineers (USACE) under Section 10 of the River and Harbors Act. As part of such processes, project developers are required to propose and implement measures to avoid impacts to wetlands, streams, and other regulated water resources in accordance with the environmental criteria from CWA Section 404(b)(1). In cases where impacts are unavoidable, 33 CFR Parts 325 and 332 and 40 CFR Part 230 govern the framework under which developers may be able to compensate for (or offset) permanent impacts. EPA and USACE require compensatory mitigation to replace the loss of wetland, stream, and other aquatic resource functions from unavoidable impacts, which is usually accomplished through prior restoration or enhancement projects ("mitigation banks"), fee payments, or new restoration, establishment, enhancement, or preservation activities required in the permitting process.

Under CWA Section 401, projects applying for any federal licenses or permits must obtain New York State certification that any discharges into navigable waters will comply with New York State water quality standards. In most cases, the New York State Department of Environmental Conservation (NYSDEC) reviews and issues state certifications.

Regulations at the state level provide further protection for the State's water resources. For example, energy storage projects whose activities disturb stream banks, impound water, require the construction (or reconstruction or repair) of docks or mooring, or excavate and fill navigable waters or wetlands are required to obtain permits from NYSDEC under 6 NYCRR Part 608. Activities occurring in coastal areas are overseen by the State's Coastal and Inland Waterways Program, which is responsible for implementing the Federal Coastal Zone Management Act (FCZMA) and state-level coastal regulations under 19 NYCRR Part 600. While neither program requires permits or licenses for activities occurring in coastal areas, proposed activities must be consistent with the state's coastal policies that guide the appropriate use and protection of the State's coasts and waterways. An assessment of the potential impacts of such activities is required as part of project planning. Such assessments are designed to support economic development, but in a manner that avoids or minimizes, to the extent possible, loss or degradation of the unique natural and cultural resources that exist along the State's coastline. These include marine resources and wildlife, open space, shoreline erosion, and scenic beauty through the consideration of Significant Costal Fish and Wildlife Habitats and Scenic Areas of Statewide Significance designations.

In some cases, federal and state regulations work cooperatively to protect water resources. In particular, some federal programs require permittees to maintain compliance with applicable state

[408] CWA Section 404(f) provides exemptions for some activities associated with ongoing farming, ranching, and forestry activities that do not represent new uses of water that result in flow reduction.

regulations. One example is a key state regulatory program: the New York State Pollutant Discharge Elimination System (SPDES). This program, established under Article 17 of the ECL, is authorized by EPA for the control of wastewater and stormwater discharges in accordance with the CWA. Broader in scope than the CWA, New York's SPDES program controls point source discharges to both surface water and groundwater, including, for example, Concentrated Animal Feeding Operations (CAFOs). SPDES permits are required for any activity discharging wastewater into surface water or ground water.[409]

Waste Management

Energy storage projects may generate hazardous waste during construction or decommissioning processes and regular facility use. The manufacture and use of battery energy storage technologies may also involve generation and disposal of federal- and state-regulated wastes. The primary federal waste management regulation is the Resource Conservation and Recovery Act (RCRA), which regulates the transport and management of solid and hazardous wastes. EPA delegated authority to the State to implement and enforce hazardous waste regulations under RCRA. Through Part 373 permits, NYSDEC ensures that environmentally protective design and operational standards are maintained at facilities that treat, store or dispose of hazardous waste materials.[410] Anyone that transports regulated waste on the roads of the State, if the waste originates or is disposed in the state, must have a New York State Part 364 waste transporter permit.[411]

Public Service Law

New York State's PSL authorizes the New York State Department of Public Service (NYSDPS) and the New York State Public Service Commission (the Commission) with primary missions to ensure safe and reliable access to utility services including electricity, gas, steam, telecommunications, and water, at just and reasonable rates, while protecting the natural environment. By the authority granted through the PSL, the Commission also seeks to stimulate innovation, infrastructure investment, consumer awareness, and competitive markets in utility provision, including electric utilities. Energy storage facilities are considered in regulatory provisions of the PSL and its implementing regulations including PSL Articles 4, 7 and 10, which discuss requirements for electricity transmission and generation facility siting. Each article and its applicability to the Roadmap are discussed below.

Article 4, Certificate of Public Convenience and Necessity (CPCN), requires electric corporations to obtain permission and approval of the Commission prior to construction of an electric plant. The Commission has determined that standalone energy storage facilities up to 80 megawatt (MW) capacity are "alternate energy production facilities" (PSL §2(b)) that are not "electric plant[s]" (PSL §12) and therefore not subject to PSL §68.

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[409] SPDES permits are not required for a facility whose treatment system discharges less than 1,000 gallons/day and does not contain any industrial or other non-sewage waste streams. Those systems, such as a septic system, may still require local approval.

[410] NYSDEC. Hazardous Waste Management. Accessed on May 8, 2018 at: http://www.dec.ny.gov/chemical/8486.html.

[411] NYSDEC. Waste Transporters. Accessed on May 8, 2018 at: https://www.dec.ny.gov/chemical/8483.html.

Article 7, Siting of Major Utility Transmission Facilities, requires review of siting, construction, and operation of major electricity transmission facilities. Specifically, this article requires project developers to obtain a Certificate of Environmental Compatibility and Public Need from the Commission before a new facility may be constructed. In instances when controversial issues arise, a formal evidentiary hearing where evidence and testimony are presented may be required. Major electric transmission facilities include systems greater than 125 kilovolt (kV) and extend a distance of one mile or longer, or of 100 kV or more and less than 125 kV, extending a distance of ten miles or more. Applicants for such major facilities must publish notice of the proposed construction, and discuss in the application any environmental impact studies and consideration of alternate routes. Transmission lines that intersect the boundaries of a critical environmental area also require a specific environmental review. Article 7 does not impose the same requirements on small electric or distribution lines, substation additions, or simple upgrades; these minor projects may require local permits as well as selected state approvals under other statutes and regulations.

Commission Article 10, Siting of Major Electric Generating Facilities, establishes a regulatory framework for the New York State Board on Electric Generation Siting and the Environment (Siting Board) to review (and approve or deny) a Certificate of Environmental Compatibility and Public Need for a proposed new generating facility or repowered or modified major electric generating facility with a nameplate generating capacity of 25 MW or more (i.e., major electric generating facility). The Siting Board has determined that standalone energy storage facilities not associated with development of new electric generating facilities are not considered "major electric generating facilities" and thus not subject to siting provisions of Article 10.[412] However, in some cases where energy storage facilities are paired with proposed major electric generating facilities, energy storage components are considered "ancillary features" and may be subject to siting requirements of Article 10 as such. Article 10 requires review of environmental and public health impacts, environmental justice issues, and public safety. Facilities not subject to Article 10 would be subject to other relevant permitting and review procedures, including provisions of SEQRA as appropriate to specific project parameters.

General Environmental Review Requirements

Under the National Environmental Policy Act (NEPA), federal agencies must consider environmental impacts when making permitting decisions. When a project may have significant potential impacts, agencies must also prepare an environmental impact statement (EIS) that discusses the significant environmental impacts and reasonable alternatives that would avoid or mitigate such adverse impacts. Thus, projects requiring other federal approvals may also trigger review under NEPA, such as wind plus energy storage projects involving federal agency authority over federal lands or federal waters (e.g., offshore wind facilities).

Similarly, SEQRA requires an environmental review for an action that is directly undertaken, *funded,* approved or permitted by state or local government agencies. SEQRA requires the

[412] New York State Public Service Commission. Case 13-F-0287 – Petition of AES Energy, Storage, LLC for a Declaratory Ruling that Battery-Based Energy Storage Facilities are not Subject to Article 10 of the PSL; DECLARATORY RULING ON APPLICABILITY OF ARTICLE 10 OF THE PSL TO BATTERY-BASED ENERGY STORAGE FACILITIES Issued and Effective January 24, 2014.

sponsoring or approving governmental authority to identify and avoid or minimize any significant or adverse environmental impacts generated by the proposed action. That agency may avail itself of mitigation measures if actions cannot otherwise be avoided or minimized, and under 6 NYCRR §617.11(d)(5), must present a findings statement certifying that all other reasonable alternatives have been considered. After completing an initial environmental assessment, the lead agency determines the significance of an action's environmental impacts and then decides whether a full EIS and/or public hearing are required.

Accordingly, any projects under the Roadmap requiring federal, state, or local approvals, including those below the 25 MW threshold defined in Article 10, may trigger further environmental review under SEQRA or NEPA.[413] For example, in New York, the environmental impacts of a proposed utility-scale solar plus energy storage project must go through siting approvals from local government, which would trigger further environmental review. Residential rooftop solar plus small-scale energy storage generally only require county-level permits.

Minor sources of pollutants that do not exceed thresholds under other statutes (this includes most energy storage projects covered in the Roadmap) may be permitted under SEQRA administrative procedures that serve to coordinate impact assessments, permits and local requirements. For example, minor sources seeking permits in the jurisdiction of New York City are permitted under joint or coordinated SEQRA and City Environmental Quality Review (CEQR) requirements.

As discussed in **Chapter 1** (SEQRA and Description of the Proposed Action), the Governor signed the Community Risk and Resiliency Act (CRRA) into law on September 22, 2014. This new legal framework will require local and state funding and permitting decisions to consider risks from climate change and extreme weather impacts, such as storm surges and flooding, for proposed projects.

Environmental Justice

Environmental justice (EJ) communities, characterized by low-income and minority residents, have historically been overburdened by a high density of air pollution sources, particularly those associated with transportation and energy. To minimize disproportionate environmental impacts on EJ communities, community involvement is required as part of energy siting and permitting review processes and in the development of transportation projects. 6 NYCRR Part 487 establishes a regulatory framework for incorporating EJ issues into proceedings before the Siting Board for determining whether to approve a major electric power plant pursuant to Article 10 of the Commission.[414]

NYSDEC Commissioner Policy 29 on Environmental Justice and Permitting (CP-29) provides further direction to NYSDEC staff on screening projects for possible EJ issues. When NYSDEC staff receives an application under SEQRA, NYSDEC conducts a preliminary screen to identify: (1) whether the proposed action is in or near a potential environmental justice area (PEJA), and

[413] "Type II" actions listed in statewide and agency SEQR regulations do not require review, as they have been specifically determined not to have a significant adverse impact on the environment. As details of future activities under Energy Storage Roadmap are not known at this time, it is possible that the type, small size, or location of certain energy storage projects may not trigger any discretionary environmental review process (i.e., a generator proposed at a site already zoned to allow such generation).

[414] NYSDEC. 2018. Environmental Justice. Accessed on May 8, 2018 at: http://www.dec.ny.gov/public/333.html.

(2) whether potential adverse impacts are likely. Depending on the outcome of the screening, NYSDEC may provide additional guidance to the applicant to address identified EJ concerns. Such guidance may include the development of an enhanced public participation plan, or provisions for an analysis to ensure that impacts do not disproportionately affect PEJAs.

Consultation with the local community during the project planning and siting is an essential part of any successful development project. Engaging in an open dialogue with affected communities can help developers understand and proactively address community concerns. Greater transparency and active participation of community leaders can strengthen relationships between affected communities and project developers.

Additional Regulations

The discussion above summarizes the main regulations that may serve to mitigate environmental impacts from potential energy storage projects in the State. **Exhibit 6-2** provides a more extensive list of potentially applicable regulations, permits, and review. Site-specific characteristics and project-specific details will ultimately determine the regulations that will apply to each potential development.

EXHIBIT 6-2 POTENTIALLY APPLICABLE REGULATIONS, PERMITS, AND REVIEW PROCESSES

RESOURCE AREA	LEVEL	REGULATION, PERMIT, OR REVIEW	RELEVANT LAWS AND STATUTORY AUTHORITY
Air	Federal	CAA Programs for Criteria Pollutants	USC 7401-7671; PL 91-604, 41 (CAA); PL 101-549 (CAA Amendments)
	Federal	Regulations for Emissions from Heavy Equipment	40 CFR Part 1048; 40 CFR Part 1039
	State	Heavy Duty Vehicle Idling Laws	6 NYCRR Part 217-3
Water	Federal	CWA Section 404 Permit (discharge of dredged or fill material)	CWA Section 404
	Federal	Estuary Protection Act	16 USC 1221-1226 (PL 90-454)
	Federal	Clean Water Act DA permits	33 CFR Part 323, CWA Section 303 (30 USC. 1344)
	Federal	Rivers and Harbors Act Section 10 permit	33 CFR Part 322, 33 USC. 403.
	State	NYSDEC State Water Quality Certification	CWA Section 401 (PL-95-217)
	State	SPDES General Permit	6 NYCRR Part 608, CWA Section 402 (PL-95-217)
	State	New York State water quality standards	6 NYCRR Parts 701-704
	State	NY Coastal and Inland Waterways Program Consistency Review	Federal Coastal Zone Management Act, 19 NYCRR Part 600 (New York Waterfront Revitalization and Coastal Resources Act)
	State	NYDOS Coastal Assessment Form	16 USC 1456; NY
	State	NYSDEC Tidal Wetlands Act permits	6 NYCRR Part 661, ECL Article 25
	State	NYSDEC Freshwater Wetlands Act permits	6 NYCRR Part 663, ECL Sections 3 -0301 and 24-0301)
	State	NYSDEC Coastal Erosion Management permits	6 NYCRR Part 505, ECL 3-0301, 34-0108
	State	NYSDEC Protection of Waters Permit	ECL Article 15, Title 5
	State	NYSDOS Flooding and Erosion Hazard Policies	19 NYCRR Part 600.5(g), Policies 12 and 15
Land	Federal	Federal Land Management and Policy Act	PL 94-579
	Federal	Resource Conservation and Recovery Act	42 USC Section 6901
	State	NYSDEC Regulations for Hazardous Waste Treatment, Storage and Disposal Facilities	ECL, Section 27-09000 6 NYCRR, Part 373
	State	NYSDEC Regulations for Waste Transport	6 NYCRR, Part 364

RESOURCE AREA	LEVEL	REGULATION, PERMIT, OR REVIEW	RELEVANT LAWS AND STATUTORY AUTHORITY
	Local	Local Land Use Planning and Zoning	Various
People	Federal	Flood Insurance Act	42 USC Sections 4001-4127
	State	NYDOS Scenic Areas and Statewide Significance Review	19 NYCRR Part 602.5
	State	NYS Parks, Recreation, and Historic Preservation Law	ECL Section 45.0101
	State	NYSDOT special use permit (oversized vehicles on state highways)	NYS Vehicle and Traffic Law Title 3 Article 10 Title 5 Article 21-C Section 52
	State	New York State Office of Parks, Recreation and Historic Preservation. NYSOPRHP	PL 89-665 (National Historic Preservation Act Section 106)
	Local	Local Noise and Nuisance Ordinances	Various
General Environmental Assessment	Federal	NEPA Environmental Review	PL 91-190
	State	SEQRA Environmental Review	6 NYCRR Part 617
	State	Certificate of Public Convenience and Necessity	NYS PSL Article 4, Section 68
	State	PSL Article 7 (major transmission lines >125 KV)	NYS PSL Article 7
	State	PSL Article 10 (major electric generating facilities >25 MW)	NYS PSL Article 10
	State	Environmental Justice and Permitting	6 NYCRR Part 487; NYSDEC CP-29
	Regional and Local	Regional and Local Zoning, Permitting, and Review Requirements	Various

6.2 SITE-SPECIFIC MITIGATION AND BEST MANAGEMENT PRACTICES

The Roadmap may result in actions that fall outside the scope of existing federal, state and local regulatory review, permitting and licensing programs. In such cases, proper project planning, design and siting, and application of best management practices during all project phases will serve to mitigate environmental impacts not addressed by existing regulatory programs. This section discusses general best practices with regards to project siting, design, and operation.

Appropriate project planning and siting have the ability to avoid or minimize many environmental impacts. For example, proper siting considerations should avoid placing structures in sensitive resources such as mature forests, wetlands and other important wildlife or critical environmental areas. Early consultation with the appropriate resource protection agency should take place to develop plans to protect resources such as soils, streams and wetlands, agricultural lands, and cultural, archeological or scenic resources. In instances where siting of energy storage may require facilities near population centers and residential development, adhering to appropriate setbacks from houses, property lines, roads, and other structures will help to avoid or minimize operational noise and visual concerns. Projects and associated transmission and distribution infrastructure can also reduce visual impacts by using existing transmission corridors, minimizing clearing, incorporating vegetative screening, and using low profile structures. Additionally, projects can use appropriately colored transmission towers, non-reflective finishes, vegetative screens, and context-sensitive architectural treatments to address site-specific impacts. Pre- and post-construction studies can be used to monitor for potential operational impacts on ecological resources, and communities.

During the design phase, project planners should consider a project's compatibility with local land use and zoning ordinances, comprehensive plans, and the character of the host community. Project planners should also consider incorporating inherent project elements that can reduce environmental impact during operation.

Project planning and design can also consider upstream and downstream impacts. Battery storage technologies produce potentially hazardous waste at end-of-life; identifying a facility for recycling the batteries prior to project commencement can ensure proper disposal and reduce waste impacts.

Projects should also employ Best Management Practices (BMPs) throughout project construction and operation. In addition to consultation with relevant resource agencies, project planners should engage with local communities to develop BMPs that are appropriate and compatible with the local land use context. During construction, projects should limit construction activity at specific times (e.g., rush hour, daytime hours) or specific seasons/months to reduce impacts on noise, vegetation, sensitive habitats, and/or seasonal recreational activities. Reducing slopes near wetland areas will minimize grading effects and protect aquatic habitat. Utilizing existing access roads when possible and locating new roads along field edges can help to avoid impacts on agricultural and natural resources. Post-construction re-vegetation of disturbed areas with native species can speed recovery and reduce the potential for long-term impacts on plants and animals. Other practices can minimize impacts from dust associated with construction activities, including: using a truck wash station at the project fence line; periodic spraying of haul roads with water; or street cleaning to control dirt and dust on public roadways, depending on local site conditions. Following EPA's Clean Air Non-road Diesel Emissions Rule will reduce the sulfur content of diesel fuel used during construction activities. To reduce light pollution at night, projects can minimize illumination during facility operations. Designating an environmental monitor during construction can further help ensure compliance with all permit requirements and environmental protection commitments.

During the operations stage of energy storage facilities, integration of energy storage technologies into the electricity grid may potentially increase overall grid CO_2 emissions.[415] To mitigate this effect (and potentially obtain a net reduction in CO_2 emissions) energy storage facilities may employ operational patterns that reduce overall grid CO_2 emissions while minimizing operational costs.[416]

[415] Further discussed in **Chapter 5**.

[416] Arciniegas, Laura M. and Eric Hittinger. 2018. Tradeoffs between revenue and emissions in energy storage operation. *Energy* 143, p 1-11. Accessed on May 8, 2018 at: https://doi.org/10.1016/j.energy.2017.10.123.

CHAPTER 7 | UNAVOIDABLE ADVERSE IMPACTS

Consistent with New York Codes, Rules and Regulations (NYCRR) 6 NYCRR §617.9(b)(5)(iii)(b) of New York's State Environmental Quality Review Act (SEQRA) requires an analysis of unavoidable adverse impacts. Unavoidable adverse impacts are impacts that, if the Proposed Action is implemented, cannot be avoided or adequately mitigated. **Chapter 5** discusses the potential impacts that may result from implementation of the Energy Storage Roadmap (the Roadmap). The purpose of the Generic Environmental Impact Statement (GEIS) is not to evaluate specific energy storage projects and their site-specific impacts. As previously discussed, significant environmental impacts could result from individual but as yet unidentified projects implemented in the future pursuant to the Roadmap. However, the review presented in **Chapter 5** does not identify any unavoidable environmental impact of a type that cannot be mitigated through one or more of the techniques discussed in **Chapter 6** (Regulatory Framework and Mitigation of Potential Adverse Impacts). Unavoidable impacts of the "no action" alternative (i.e., where New York's energy industry continues to develop along its existing market and regulatory pathways and the Roadmap is not implemented) are discussed in **Chapter 1** and **Chapter 4**.

CHAPTER 8 | IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Consistent with New York Codes, Rules and Regulations (NYCRR) 6 NYCRR §§617.9(b)(5)(iii)(c) of New York's State Environmental Quality Review Act (SEQRA), this chapter discusses irreversible and irretrievable commitments of resources associated with the proposed action. Approval of the Energy Storage Roadmap (the Roadmap) would not, in itself, result in irreversible or irretrievable commitment of resources because no particular energy storage project, project site, or regulatory modification will be approved or endorsed by approval of the action. The construction of new energy storage projects in the future in response to the Roadmap may raise such concerns, but these will be identified in site-specific environmental analyses and avoided or minimized in accordance with SEQRA and other applicable laws and regulations (as discussed in **Chapter 6**). The principal commitment of resources for the construction and operation of energy storage projects is described in **Chapter 5** (Environmental Impacts of Proposed Action). However, actual impacts and resource commitments are currently and will remain unknown until specific projects are proposed.

CHAPTER 9 | GROWTH-INDUCING ASPECTS AND SOCIOECONOMIC IMPACTS

Consistent with New York Codes, Rules and Regulations (NYCRR) 6 NYCRR §617.9(b)(5)(iii)(d) of New York's State Environmental Quality Review Act (SEQRA), this chapter discusses the potential growth-inducing aspects and socioeconomic impacts of the proposed Energy Storage Roadmap (the Roadmap). Specifically, the chapter proceeds through the following sections:

- **Section 9.1:** introduces the analytic framework for the analysis of growth-inducing aspects and socioeconomic impacts of the Roadmap;
- **Section 9.2:** discusses the potential benefits of actions proposed in the Roadmap;
- **Section 9.3:** outlines the program costs associated with energy storage deployment;
- **Section 9.4:** compares the costs and benefits associated with Roadmap actions;
- **Section 9.5:** discusses the impacts of Roadmap actions on employment;
- **Section 9.6:** discusses the impacts of Roadmap actions on growth and community character;
- **Section 9.7**: identifies potential environmental justice impacts associated with actions proposed in the Roadmap.

9.1 ANALYTIC FRAMEWORK

This chapter provides qualitative information on the types of changes expected to occur from implementation of the Roadmap and the potential resulting growth-inducing aspects and socioeconomic impacts associated with those changes. As previously discussed, the exact mix of energy storage technologies that will be implemented under the Roadmap has some uncertainty, although the general direction is known. As such, this review is being conducted generically based on what is reasonably foreseeable.

Project-specific impacts analysis will be required only when specific actions are proposed that trigger applicable federal, state, or local approval processes and that exceed thresholds that trigger site-specific environmental impact reviews. No specific projects resulting from the Roadmap have yet been proposed. This chapter, therefore, does not attempt to predict or speculate on the possible impacts of project-specific actions but focuses instead on qualitative descriptions of overall potential growth-inducing aspects and socioeconomic impacts.

9.2 POTENTIAL BENEFITS

There is broad consensus that energy storage is a critical resource for enabling the vision of a cleaner, more resilient and affordable energy system in New York State (the State). The goal of the Roadmap is to define a path for the State's energy storage market that will ensure resources focus on the most critical barriers that can be realistically addressed and in turn, cost-effectively speed the deployment of energy storage technologies in ways that are viable, replicable and scalable. The Roadmap is intended to foster and optimize the conditions that will maximize the value of energy storage within the State's electricity system. **Exhibit 9-1** summarizes the overall potential benefits of the Roadmap.

EXHIBIT 9-1 SUMMARY OF POTENTIAL BENEFITS FOR THE ENERGY STORAGE ROADMAP

BENEFIT CATEGORY	PERSPECTIVE		
	RATE IMPACT MEASURES (RATES)	UTILITY COST (BILL)	SOCIETAL
ENERGY SYSTEM[417]			
Improved power quality and the reliable delivery of electricity to customers	✓	✓	✓
Improved stability and reliability of transmission and distribution systems	✓	✓	✓
Increased use of existing equipment, thereby deferring or eliminating costly upgrades	✓	✓	✓
Improved availability and increased market value of distributed energy resources	✓	✓	
Increased use and improved value of renewable energy generation	✓	✓	✓
Cost reductions through capacity and transmission payment deferral	✓	✓	
PUBLIC HEALTH			
Increased use of renewable energy resources results in avoided emissions of GHG and criteria air pollutants.			✓
Increased air quality results in a reduction of state health care expenditures for treatment of asthma, acute bronchitis, and respiratory conditions.			✓
CLIMATE CHANGE			
Climate change is expected to increase air temperatures, in turn intensifying water cycles through increased evaporation and precipitation. Greater energy storage deployment can reduce the State's reliance on fossil fuel energy, aiding in the prevention of: [418]	✓	✓	✓
Increases in local flash and coastal flooding in the State.	✓	✓	✓
Increases in the frequency and intensity of extreme precipitation and extreme heat events in the State.	✓	✓	✓

[417] U.S. Department of Energy. Energy Storage. Office of Electricity Delivery & Energy Reliability. Accessed on April 27, 2018 at: https://www.energy.gov/oe/activities/technology-development/energy-storage.

[418] Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grahborn (Eds). 2011. Responding to Climate Change in New York State. Synthesis Report prepared for NYSERDA. Accessed on September 10, 2014 at: http://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/EMEP/climaid/ClimAID-synthesisreport.pdf.

BENEFIT CATEGORY	PERSPECTIVE		
	RATE IMPACT MEASURES (RATES)	UTILITY COST (BILL)	SOCIETAL
Longer summer dry periods in the State, with lower summer flows in large rivers, lower groundwater tables, and higher river and in-stream water temperatures.	✓	✓	✓
ECOSYSTEM SERVICES			
Land and water use impacts will fall relative to the business as usual scenario to the extent that greater energy storage deployment increases the use of renewable energy resources in lieu of investment in fossil fuel sources or expansion of the State's transmission and distribution system.			✓
ECONOMIC BENEFITS			
Increased manufacturing of renewable energy equipment.			✓
Jobs and revenue creation.			✓
Effects of spending throughout local economy.			✓
TECHNOLOGICAL INNOVATION			
Investment in the energy storage market spurred by the Proposed Action is expected to contribute to significant cost reductions for the underlying technology.	✓	✓	

Energy storage provides a number of different services at all levels of the electricity system. The Roadmap identifies four such services of greatest value to State ratepayers:

- Meeting capacity (reliability) requirements;
- Providing distribution system relief (load reduction during critical periods);
- Reducing the cost caused by peak electric periods; and
- Integrating large-scale wind and solar generating facilities so they provide electricity when and where it's most needed.

The Acelerex Energy Storage Study monetizes the benefits of greater deployment and integration of energy storage into the electrical grid across several categories:

(1) Capacity, for example by shaving peak loads and reducing demand charges and avoiding interconnection upgrades;

(2) Distribution system savings, for example storage can be used to avoid or delay capital investment in aging, undersized or underutilized assets by providing local capacity and load relief, and relieving transmission congestion;

(3) Generation cost savings, for example by minimizing or avoiding the need to activate costly back-up fossil fuel-based generation or develop new central generation (e.g., black start capability and replacing redundant generation sources) or reducing the cost of renewable generation by avoiding curtailment due to over-generation or transmission constraints (including time-shifting supply and renewable firming);

(4) Ancillary services include short-term (e.g., minutes or up to one to two hours) grid applications, such as frequency regulation, spinning and non-spinning reserves, and ramping; and

(5) Fixed operation and maintenance (FOM) cost savings.[419]

To illustrate the range of benefits associated with accelerated deployment of between 1,500 and 3,633 MW of energy storage by 2030, Acelerex monetizes the benefits of deploying 2,795 megawatts (MW) of energy storage by 2030 across these five categories at approximately $3.09 billion; the majority stemming from distribution system savings.

These energy system benefits in turn generate additional benefits, which can be broadly organized into three categories:

- **Economic benefits**, directly generated through energy cost savings and indirectly through the creation of jobs, additional spending in the economy, increased productivity, reduced physical damage during extreme weather events, and/or redistributed resources for more productive economic uses.
- **Environmental benefits** generated by the reduction in fossil-fuel based generation. As discussed in **Chapter 5.3**, the energy storage roadmap is part of a statewide strategy intended to shift generation from fossil fuels to low-carbon resources. As the fossil fuel-based generation decreases, the associated adverse impacts to air, water, land and ecological resources. Of these benefits, reductions in greenhouse gas (GHG) emissions are especially important to mitigate the adverse impacts of climate change. To illustrate the potential impact of accelerated energy storage deployment, Acelerex monetized the benefits from avoided carbon dioxide (CO_2) emissions of deploying 2,795 MW of energy storage by 2030 at $44 million (2017 dollars, seven percent discount rate).
- **Public Health benefits** stem directly from environmental benefits, the most significant being a reduction in criteria air pollutants from reduction in fossil fuel-based generation, which can cause multiple adverse human health impacts.

Although these benefit categories are listed individually, it is important to recognize that these benefits are naturally intertwined with one another; feedback loops between and across benefit categories further increase the potential realized benefits of greater energy storage deployment. For example, reductions in adverse human health impacts related to lower emissions of criteria air pollutants will in turn generate economic benefits by avoiding premature death and increasing worker productivity from fewer respiratory illnesses.

[419] NY-BEST Consortium. 2016. Energy Storage Roadmap for New York's Electric Grid. January. Accessed on May 9, 2018 at: https://www.ny-best.org/sites/default/files/type-page/39090/attachments/NY-BEST%20Roadmap_2016_finalspreads.c.pdf.

9.3 PROGRAM COSTS

The principal cost categories associated with energy storage deployment include:

(1) Initial design and planning costs, including the cost of a project's initial design, as well as costs associated with obtaining building and development permits, securing financing, marketing the project, and other planning costs;

(2) Capital investments, include the cost to purchase and install the selected energy storage technology; and

(3) Operation and maintenance (O&M) costs, including the cost of labor, fuel, and the cost of material replaced as part of scheduled and unscheduled maintenance.

As an illustrative example of the cost of greater energy deployment between 1500 MW and 3,633 MW, Acelerex estimates the total costs of deploying 2,795 MW of energy storage by 2030 at approximately $1.9 billion (2017 dollars, assuming a seven percent discount rate).

9.4 COMPARISON OF COSTS AND BENEFITS

As an illustrative example of the positive net benefits possible from greater energy deployment between 1500 MW and 3,633 MW, Acelerex estimates the positive net benefits resulting from the deployment of 2,795 MW of energy storage by 2030 of approximately $1.2 billion (**Exhibit 9-2**). These results reflect lifetime benefits, based on an estimated ten-year asset life.

EXHIBIT 9-2 ILLUSTRAITVE EXAMPLE OF THE ESTIMATED BENEFITS AND COSTS OF GREATER ENERGY DEPLOYMENT THROUGH THE ENERGY STORAGE ROADMAP[420]

2030 (2,795 MW, 12,557 MWH)	
Model Benefits	**NPV in 2017 M$**
Ancillary Services	$140
Capacity Value	$732
Distribution Savings	$1,410
Fixed Operations and Maintenance	$214
Generation Cost Savings	$550
Avoided CO_2	$44 (1.97 MMT)
Benefit	$3,090
Costs	$1,902
Net Benefits	**$1,188**

9.5 IMPACTS ON EMPLOYMENT

In order to achieve the aggressive goals established by the Reforming the Energy Vision (REV), the State requires a robust supply of trained clean energy workers. Accordingly, job creation is a key objective of the Roadmap, as well as the 2015 New York State Energy Plan, REV and other statewide clean energy initiatives. Notably, per the New York State Energy Research and Development Authority's (NYSERDA's) 2017 New York Clean Energy Industry Report, between the last quarters of 2015 and 2016, clean energy employment grew by 3.4 percent

[420] Acelerex. NYSERDA Energy Storage Study Results. Powerpoint Briefing. May 2018.

compared to the statewide average of 1.9 percent.[421] The report further notes that the clean energy sector, as of 2016, employs more workers than both the biotech and agriculture industries combined. In 2016, NYSERDA estimates statewide employment in the clean energy sector at 146,000 jobs, of which energy efficiency accounts for the majority with 110,000 workers (or 75 percent). In the energy storage sector, NYSERDA estimates 1,144 workers in 2016.[422]

By establishing a statewide deployment mandate and directing greater resources to the energy storage sector, the Roadmap is expected to increase the number of energy storage jobs in the State than otherwise would exist based on current conditions in the energy storage market (e.g., continuing declines in the cost of storage and increasing demand due to greater deployment of renewable energy and smart grid technologies). To estimate the potential magnitude of the incremental job growth created by the Roadmap, this generic environmental impact statement (GEIS) develops an estimate of the number of jobs created per MW of storage capacity based on:

- Baseline (i.e., pre- Roadmap) projections of the amount of storage capacity installed in the State from 2020-2030; and
- Baseline projections of revenues and employment associated with the State energy storage industry from 2020-2030.

The below sections describe this approach in more detail.

In 2016, NYSERDA released estimates of the growth of the State's energy storage industry. Specifically, this study relies on readily available estimates of revenues and employment associated with energy storage market activities for the entire world, North America, and the U.S. and then scales this estimate to the State based on a series of validated assumptions and parameters. Based on this methodology, the baseline (i.e., pre- Roadmap) energy storage industry in the State is expected to generate 4,870 MW of storage capacity by the year 2030. In the same study, NYSERDA estimated the size and growth of the State energy storage industry in terms of revenues and employment, focusing on the employment in research, engineering, and manufacturing.[423] Using extrapolated estimates of revenues per employee and productivity gains, NYSERDA estimated the creation of approximately 3.1 to 3.6 jobs in research, engineering, and manufacturing for each $1 million in energy storage market revenue, with the job creation rate falling over time as the industry reaches greater maturity.

Combining these two data sets, this GEIS estimates the number of jobs created in research, engineering, and manufacturing per MW of storage capacity. As shown in **Exhibit 9-3**, this

[421] NYSERDA. 2017 New York Clean Energy Industry Report. Available online at: https://www.nyserda.ny.gov/About/Publications/2017%20New%20York%20Clean%20Energy%20Industry%20Report.

[422] *Ibid*. This employment number is slightly lower compared to the storage employment data produced in 2016 in NYSERDA's Energy Storage Industry in New York State report due primarily to the inclusion in this report of "traditional" markets such as forklifts, medical devices, lead-acid batteries, or military applications. The Energy Storage Industry report includes 650 grid storage jobs for emerging electricity storage markets in addition to 724 battery transportation jobs. Together, these two subsectors account for 1,374 workers, which is close to the NYSERDA Clean Energy Industry report which estimated 1,412 workers in grid modernization and storage. The remaining 2,560 workers from the Energy Storage Industry report are in traditional markets, which are not included in the Clean Energy Industry Report.

[423] This study did not consider employment in industry support service, such as installation and marketing/customer acquisition; these types of support jobs are discussed separately beginning on page 9-8.

EXHIBIT 9-3 DERIVATION OF JOBS PER MW OF ENERGY STORAGE CAPACITY PARAMETER

ID	PARAMETER	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
A	Baseline Projected Energy Storage Capacity	667	1,085	1,351	1,712	2,147	2,664	2,993	3,355	3,769	4,262	4,870
B	Baseline Projected Energy Storage Revenues ($M)*	$914	$1,383	$1,643	$1,959	$2,325	$2,715	$2,973	$3,257	$3,580	$3,955	$4,400
C	$M of Revenue per MW of Capacity *(B/A)*	$1.4	$1.3	$1.2	$1.1	$1.1	$1.0	$1.0	$1.0	$0.9	$0.9	$0.9
D	Jobs per $M of Revenue	3.6	3.5	3.4	3.3	3.3	3.2	3.2	3.2	3.1	3.1	3.1
E	Jobs per MW of Capacity (D * C)	4.9	4.4	4.1	3.8	3.5	3.3	3.2	3.1	3.0	2.9	2.8

* Does not incorporate revenue from commercial energy storage using ice-based or UPS technologies as these are not covered.

methodology estimates between 2.8 and 4.9 jobs created in research, engineering, and manufacturing per MW of installed capacity, depending on the year. Applying this parameter, the cumulative incremental employment impacts associated with the deployment of 2,795 MW of energy storage capacity through 2030 in the State is approximately 10,200 jobs in research, engineering, and manufacturing, or approximately 930 jobs per year across the ten-year study period.[424] This translates to an approximate job growth of between 5,500 and 13,300 jobs in research, engineering and manufacturing with an energy storage deployment range of 1,500 MW to 3,633 MW, respectively, by 2030.

The focus of the 2016 NYSERDA study, however, was on activities associated with developing and producing energy storage technologies, including jobs in research, engineering, and manufacturing. This study did not consider revenue or employment impacts associated with transitory support activities, such as installation and marketing/customer acquisition.[425] To estimate the growth in energy storage support jobs, this GEIS relies on the data developed as part of NYSERDA's 2017 New York Clean Energy Industry Report. According to this report, transitory support jobs, not included in the NYSERDA's 2016 study of the energy storage industry, represents approximately 55.9 percent of the all jobs in the energy storage industry (**Exhibit 9-4**). The values in **Exhibit 9-4** suggest that for each energy storage manufacturing and research/development job, there are an additional 1.3 energy storage jobs primarily engaged in installation, sales, and other transitory support activities (i.e., 55.9 percent divided by 44.1 percent). Accordingly, the additional transitory employment impacts associated with industry support jobs for the deployment of 2,795 MW by 2030 is approximately 12,400 jobs, or approximately 1,200 support jobs per year across the ten-year study period. This translates to an approximate job growth of between 7,100 and 17,200 industry support jobs associated with an energy storage deployment range of 1,500 MW to 3,633 MW, respectively, by 2030.

EXHIBIT 9-4 BREAKDOWN OF ENERGY STORAGE JOBS IN NEW YORK STATE BY NAICS CODE, 2016

Description	NAICS Code	% of Total Energy Storage Employment, 2016
Installation	236	29.9%
Installation	237	12.2%
Manufacturing	32-33	27.9%
Wholesale Trade	42	11.8%
Professional Services	52-54	16.2%
Other Services	81	2.0%

[424] This estimate is based on the key assumption that manufacturing and research/development jobs associated with energy storage jobs are proportional to installation jobs associated with energy storage; this estimate reflects only manufacturing and research/development jobs associated with energy storage. Installation and marketing/customer acquisition jobs associated with energy storage are separately estimated.

[425] The extent to which support activities associated with energy storage technology, i.e., installation and sales, will result in permanent jobs is unclear. There is insufficient information to determine whether the pace of energy storage installation and sales activities will persist to a sufficient extent to render such jobs permanent. As a conservative assumption, this analysis assumes that such jobs are transitory, i.e., demand for these services may diminish over time as the bulk of energy storage installation and sales activities are completed.

Description	NAICS Code	% of Total Energy Storage Employment, 2016
Proportion of Jobs in Technology Development and Production	32-33, 52-54	44.1%
Proportion of Supporting Jobs	236, 237, 42, 81	55.9%

When added to the estimated job growth associated with technology development and production, the total potential employment impact associated with deployment of 2,795 MW of energy storage capacity through 2030 in the State is approximately 2,000 jobs per year, including 930 jobs in technology development and production and 1,200 transitory jobs engaged in installation and marketing/customer acquisition. This translates to an approximate annual job growth of between 1,100 and 2,700 jobs per year associated with an energy storage deployment range of 1,500 MW to 3,633 MW, respectively, by 2030.

9.7 ENVIRONMENTAL JUSTICE IMPACTS

Actions taken in response to the Roadmap may occur in environmental justice (EJ) communities and may have the potential to affect low-income and minority populations within these communities. Regulations at 6 NYCRR Part 487 establish a framework for evaluating the potential EJ issues associated with siting a major electric generating facility (as defined by PSL Article 10). EJ issues are also addressed on a case-by-case basis as part of the New York State Department of Environmental Conservation's (NYSDEC's) environmental permit review process as well as its application of SEQRA. In 2003, NYSDEC issued Commissioner Policy 29 (CP-29), which defines EJ as:

> "…the fair treatment and meaningful involvement of all people regardless of race, color, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policy. Fair treatment means that no group of people, including a racial, ethnic or socio economic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local and tribal programs and policies."[426]

CP-29 specifies the process for analyzing environmental justice impacts in the context of SEQRA. When NYSDEC is the lead agency in a SEQRA review, NYSDEC staff will first conduct a preliminary screen to identify whether a proposed action(s) is in or near a Potential Environmental Justice Area (PEJA). If the screening indicates that the proposed action(s) occurs in or near a PEJA, the EIS will then need to identify and evaluate the additional burden of any significant adverse impact on the PEJA.[427] The detail and depth of analysis will vary depending on the project. In addition, if the proposed action occurs in or near a PEJA, the permit applicant must

[426] NYSDEC. 2014. Environmental Justice Policy Commissioner Policy 29. Accessed on August 29, 2014 at: http://www.dec.ny.gov/regulations/36951.html.

[427] If NYSDEC is not the lead agency, CP-29 directs that the lead agency implement the same process "to the extent permitted by law."

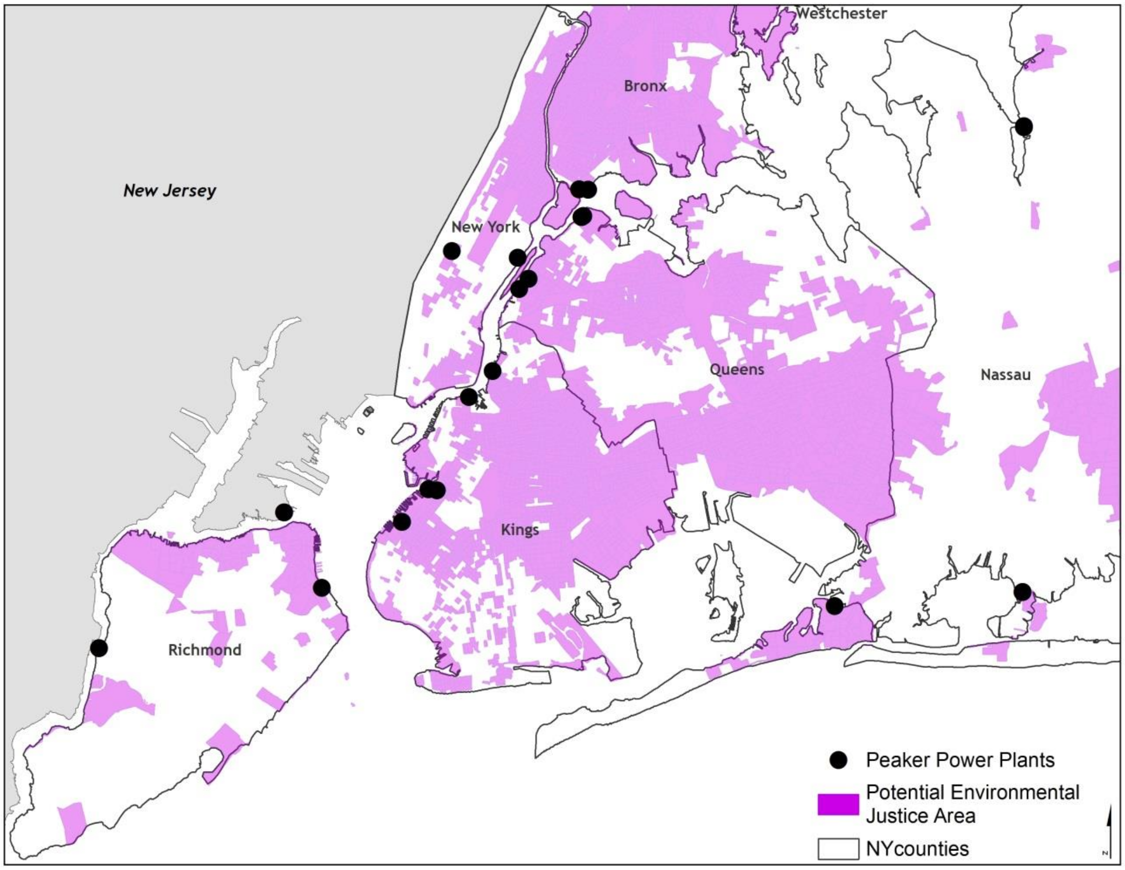
create and implement a plan for public participation. If the EIS includes an evaluation of additional burdens on a PEJA, public hearings will also be conducted.

While the Roadmap does not result in the approval of any specific projects, as discussed in **Chapter 1** – one of the Roadmap proposed actions is intended to investigate the opportunity to replace peaker plants, primarily located in the heavily populated downstate region, with energy storage facilities. These downstate peaker plants are only activated during extreme weather events, but produce twice the carbon emissions per unit of energy generated compared to fossil-fuel plants of similar capacity– emitting sulfur oxides (SO_x), nitrous oxides (NO_x), and particulate matter (PM), and contributing to ground-level ozone which causes asthma and other health impacts.[428] Potential replacement of the peaker plants is expected to reduce both the overall and site-specific environmental impacts associated with fossil fuel-based energy generation. **Exhibit 9-5** displays the location of peaker plants in the greater New York City area overlaid with the NYSDEC defined PEJA areas. Krieger et al. (2016) provide a framework for siting energy storage and demand response for the purpose of realizing greater environmental and health benefits.[429] While the Acelerex study was not able to accurately model the precise SO_x and NO_x emissions, it is likely that energy storage deployed and utilized during peak periods will result in reduced operation of the least efficient and highest emitting plants, and will correspondingly reduce total SO_x and NO_x emissions. o the extent that energy storage is used to replace (or accelerate the replacement of) peaker plants in potential environmental justice areas in the State, negative impacts would decrease for these vulnerable communities.

[428] NYSERDA/DPS. 2018. New York State Energy Storage Roadmap and DPS/NYSERDA Staff Recommendations.

[429] Krieger, Elena M., Joan A. Casey, and Seth B.C. Shonkoff. 2016. A framework for siting and dispatch of emerging energy resources to realize environmental and health benefits: Case study on peaker power plant displacement. Energy Policy 96, p. 30-313.

EXHIBIT 9-5 LOCATION OF PEAKER POWER PLANTS AND POTENTIAL ENVIRONMENTAL JUSTICE AREAS IN THE GREATER NEW YORK CITY AREA.



CHAPTER 10 | EFFECTS ON ENERGY CONSUMPTION

Consistent with New York Codes, Rules and Regulations (NYCRR) 6 NYCRR §617.9(b)(5)(iii)(e) of New York's State Environmental Quality Review Act (SEQRA), this chapter considers the potential impacts of the Energy Storage Roadmap (the Roadmap) on the use and conservation of energy. The Roadmap seeks to facilitate the deployment of additional energy storage in New York State (the State). This Generic Environmental Impact Statement (GEIS) considers the impacts resulting from a range of incremental energy storage of approximately 1,500 to 3,633 megawatts (MW) in capacity, focusing on a scenario of 2,795 MW to illustrate the full range of potential impacts that may arise from the Energy Storage Roadmap.

As discussed in prior chapters, penetration and adoption of energy storage could affect the electrical system in a number ways, at the generation, transmission, and distribution levels. In particular, expansion of energy storage may facilitate the deployment of renewable generation resources and relieve system pressures during periods of peak demand. These potential changes to the structure of the electrical system are not expected to directly affect the amount of electricity used or the amount of energy conserved in the State; rather, energy storage is expected to change how this demand is met.

To the extent energy storage does not change net retail prices in a material way, the Roadmap is not expected to indirectly affect the amount of energy consumed or conserved in the State.

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