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New York Power Authority

Small Clean Power Plant Adaptation Study

Study conducted by E3 and GE on behalf of the New York Power Authority, in consultation with the PEAK Coalition and Strategen Consulting

April 2022

About the Study

This report was produced by Energy and Environmental Economics, Inc. (E3) in a collaboration with General Electric Energy Consulting (GEEC). The study was sponsored by the New York Power Authority (NYPA), in consultation with the PEAK Coalition. The PEAK Coalition was also supported by independent advisory services from Strategen Consulting.

Representatives from E3, GEEC, NYPA, PEAK Coalition, and Strategen met on a weekly basis over the course of the study in "technical working group" sessions to review input assumptions, methodology, and findings. The report reflects the research, analysis, and conclusions of the E3 and GEEC teams, with input and perspective provided by NYPA, the PEAK Coalition, and Strategen.

Technical Working Group

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Executive Summary

This report was commissioned by the New York Power Authority (NYPA), the largest state public power organization in the United States, in consultation with the PEAK Coalition. In 2020, NYPA released its VISION2030 ten-year strategic plan, which among other notable commitments, sets a goal of achieving full decarbonization of NYPA generation assets by 2035, five years ahead of the targets set forth in New York State's Climate Act. This study focuses on NYPA's simple cycle combustion turbine units located in New York City, referred to as the "Small Clean Power Plants" (SCPPs), which comprise just over 400 megawatts of capacity.

The SCPPs are located in environmental justice communities across New York City, including two sites in the Bronx, two sites in Brooklyn, one site in Queens, and one in Staten Island. In 2020, NYPA entered into a Memorandum of Understanding (MOU) with the PEAK Coalition, a group of five leading environmental justice and clean energy interests, to (1) collaborate about opportunities to support NYS energy storage, climate and air pollution goals and (2) evaluate the potential to replace NYPA's existing peaker units, augment and otherwise install renewable and battery storage systems at NYPA's New York City sites and surrounding communities consistent with New York Independent System Operator (NYISO) reliability requirements, New York State's Climate Act requirements, and NYPA's VISION2030 plan.

Summary of Key Findings	
Key Finding #1	As NY adds renewable, storage, and transmission resources to meet the goals of the Climate Act, fossil generation in New York City is projected to decline significantly.
Key Finding #2	Under a more ambitious view of decarbonization in New York City, there may be opportunities to further displace higher-emitting fossil generation, which would lead to significant reductions in local NOx emissions.
Key Finding #3	Based on historical output levels, the frequency and duration of SCPP run-times would make full replacement with battery storage impossible; however, by 2030, the run-times of the SCPPs have declined in both frequency and duration, which would allow for the possibility of full replacement with 4-hour battery storage at each individual plant.
Key Finding #4	As electrification loads increase and New York shifts to a 100% decarbonized system, a system-wide reliability need is expected, which requires energy resources with capabilities for longer dispatch durations.
Key Finding #5	Given site characteristics and battery density assumptions, each individual SCPP site presents opportunities for adaptation strategies, including full or near-full replacement with battery storage by 2030.

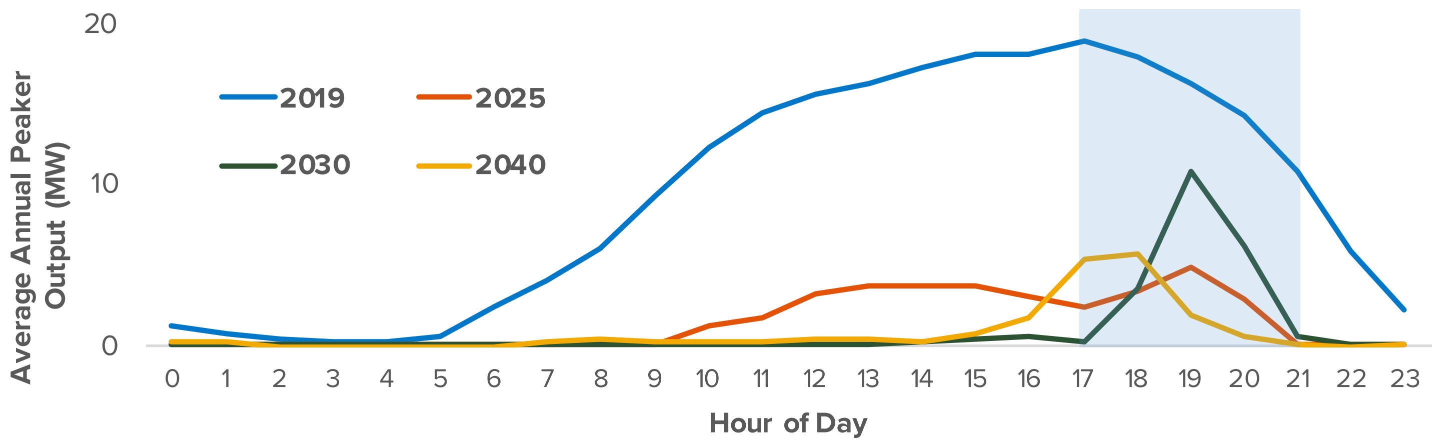
This study addresses the second goal outlined in the MOU through a detailed assessment of adaptation strategies at NYPA's SCPP sites, including full replacement with battery storage and an interim hybridization solution. Recognizing the importance of capturing the details of the New York electricity system and the contributions of NYPA's Small Clean Power Plants towards system needs in New York City, the analytical framework for this study relied on nodal production cost modeling[1] to assess the impacts of the Climate Act on the electric system, coupled with detailed storage operational and financial modeling to examine potential opportunities for battery storage at the SCPP sites. Reliability analysis and cost impacts to ratepayers are outside the scope of this study, but will be an essential part of the implementation plan moving forward.

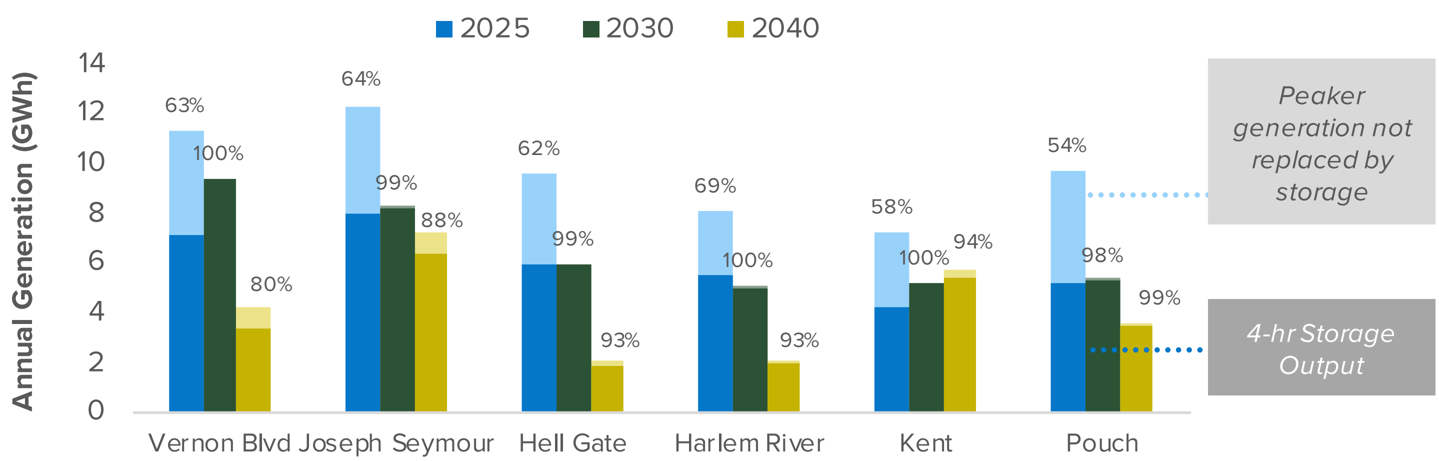
The analysis explored different strategies to decarbonize the SCPP sites as New York's electricity mix evolves to meet the State's clean energy and climate targets. The key findings of the study are highlighted in the table above.

NYPA's SCPPs, built in 2001, are among the most efficient peaker units in New York City ("Zone J" according to the NYISO zonal classification), and the units have historically been used to alleviate local transmission constraints. In 2019, the SCPPs were frequently called on to operate for long durations (i.e., >8 hours) that would have made replacement with battery storage very challenging. For example, even though the annual capacity factor at Seymour was 12%, there were 56 days in the year (almost entirely during the summer) when the plant ran at its full output for 8 hours or more. The long duration of historical 2019 SCPP outputs would have rendered full replacement with currently available battery storage technologies infeasible during that year.

This study modeled a Climate Act-compliant "Base Case" to assess changes in the New York electricity system and corresponding changes to the operations of NYPA's SCPPs, as New York State achieves its Clean Energy Standard target of having 70 percent of electricity consumed in New York come from renewable generation by 2030. Over the next

1 Production cost modeling simulates an hourly forecast of the electricity market, to minimize costs while adhering to all operating constraints. Nodes represent electrical substations or busbars where generators, customers (loads) or transmission lines interconnect to the rest of the transmission system, and nodal modeling simulates flows between each node in the transmission system.





decade, New York is projected to add significant amounts of renewables and storage to meet its Clean Energy Standard requirements, including investments in offshore wind and storage resources in New York City and new transmission projects to increase the delivery of clean energy into the city. As a result of these investments, the modeling of the New York system in GE-MAPS indicates that **fossil generation in New York City is projected to decline by over 20 percent relative to 2019 levels by 2030.**

In the Base Case modeling, consistent with the overall trajectory of fossil generation in New York City, the SCPP operations decline significantly over the next decade relative to the historical operations observed over the past decade. Importantly, the reductions in SCPP operations result in changes not only to the number of days that the SCPPs are running, but also to the duration over which the SCPPs are needed during those days. By 2030, the duration of SCPP output decreases dramatically to 2-3 hours, and is paired with sharper ramping requirements to meet the desired output. The combination of shorter dispatch durations and faster ramping requirements to meet future grid needs, improve the ability for battery storage to be able to replace projected SCPP dispatch obligations. **By 2030, due to the decrease in both frequency and duration of SCPP run-times, full replacement with 4-hour storage becomes feasible for each site, when examined individually.**

In order to examine an alternative vision for decarbonization in New York City, Strategen Consulting, in collaboration with the PEAK Coalition, developed an "Alternative Scenario" for resource deployment by 2030. The Alternative Scenario adopts a more ambitious view of possible additional actions towards decarbonization in New York City, such as more proactive retirement of privately owned fossil fueled power plants and accelerated growth in locally-sited resources, including storage and distributed solar. Modeling of the Alternative Scenario highlighted that **the addition of more locally-sited solar plus storage would further reduce utilization of higher-emitting fossil assets during peak hours, leading to significant benefits in the form of reductions in local particulate emissions in New York City.**

In addition to operational feasibility, the study also examined the initial physical feasibility of battery replacement, as the SCPP sites are all located in physically constrained areas of New York City on small plots of land. The primary implementation strategies considered were full replacement with battery storage and site hybridization (peaker plus storage). Several of NYPA's SCPPs are sited in or near communities that have been disproportionately impacted by air pollution, such as the South Bronx and Sunset Park. Based on review of site characteristics as well as density assumptions, each individual SCPP site presents opportunities for adaptation strategies, including full or near-full, replacement with battery storage by 2030. Seymour and Hell Gate were prioritized for a more detailed examination.

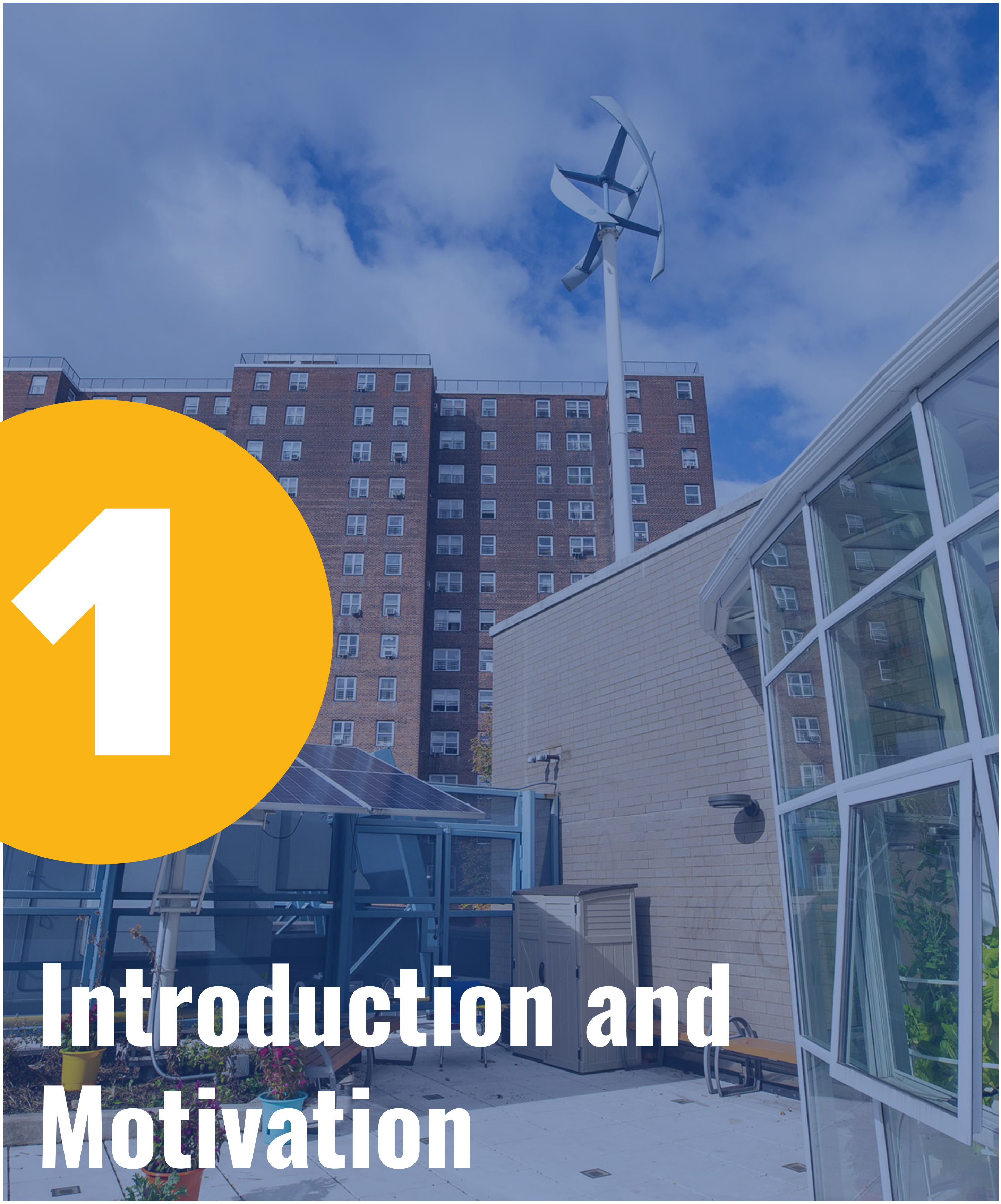
The study team performed an assessment of the impacts that Seymour replacement and Hell Gate hybridization would have on the rest of the NYISO system. By charging during low-price times or when renewables might otherwise be curtailed, and discharging during times of high prices to displace less-efficient, higher-emitting fossil generation, the analysis finds that replacement and hybridization strategies at individual sites achieves additional reductions of both system-wide greenhouse gas emissions and local NO_x pollution, beyond the direct reductions at the SCPP site itself. However, modeling of simultaneous replacement of all of the SCPPs with storage (i.e. "stacked" replacement) in 2035, finds that local congestion could lead to a 3.7% uptick in New York City NO_x emissions, relative to a case without retirement or replacement of the SCPPs. This would be the result of locally sited, less-efficient, and higher-emitting fossil generation taking the place of the SCPP's dispatch. However, with targeted deployment of local transmission upgrades or additional local clean energy resources, it is possible these impacts could be reduced or eliminated entirely, especially by 2040 when cleaner, zero-emissions generation is expected to be on the system. This initial assessment demonstrates the need for a thoughtful and carefully planned transition away from dependence on SCPPs in order to avoid any unintended emissions increases in the near term.

The findings of this study provide a promising path forward for the decarbonization of NYPA's SCPP sites, suggesting that storage replacement at individual sites will become operationally feasible as the resource mix evolves to meet New York's 70x30 goals. Concrete actions will be implemented:

ACTION: Continue Ongoing Stakeholder Engagement: NYPA is committed to continuing to engage with the community stakeholders to ensure that the SCPPs located in disadvantaged communities are prioritized for adaptation.

ACTION: Undertake Initial Reliability Analysis: NYPA will facilitate the necessary reliability assessments to advance towards the VISION2030 goal of decarbonization by 2035.

ACTION: Develop Strategic Roadmap: NYPA will develop a working roadmap for the organization's near-term strategy for its SCPPs by the end of 2022, in alignment with VISION2030.



1 Introduction and Motivation

1. Introduction and Motivation

As more jurisdictions across the United States adopt power sector decarbonization targets, states and utilities are considering how emissions reductions can be accelerated in environmental justice communities, where residents have continually borne the worst impacts of pollution. In New York, several studies have focused on the potential to offset or fully displace the emissions from "peaker" plants, so named because they operate mostly during periods of peak electricity demand. This analysis examines the potential to replace peakers by modeling not just the units' historical operations, but also their projected operations over time as New York's resource mix evolves to meet the State's aggressive climate goals.

This report was commissioned by the New York Power Authority (NYPA), the largest state public power organization in the United States. NYPA provides approximately 25 percent of New York's annual electricity generation, and owns and operates generation assets across New York State, including hydroelectric generation facilities, hydroelectric pumped storage facilities, dual fuel (gas/oil) combined cycle units, and gas-fired combustion turbines. The large majority (over 80 percent) of NYPA's generation is provided by its large hydroelectric facilities in northern and western New York, as well as small hydropower facilities across the state. NYPA's combined cycle and combustion turbines are located in New York City ("Zone J" according to the NYISO zonal classification) and Long Island and contribute the remainder of NYPA's generation.

In 2019, New York State passed the Climate Leadership and Community Protection Act (Climate Act), considered to be one of the most ambitious climate laws in the world.[2] The Climate Act requires that the New York economy becomes carbon-neutral by 2050, including an interim target to achieve a zero-emissions power system by 2040.[3] Governor Kathy Hochul, in her 2022 State of the State address, reaffirmed New York's commitment to renewable development that directly supplants dirty, fossil fuel power plants, especially in communities that have historically been subjected to the negative health effects of fossil fuel-based electric generation.[4]

In 2020, NYPA released its VISION2030 plan which, among other notable commitments, sets a goal of achieving full decarbonization of its generation assets by 2035, five years ahead of the requirements of the Climate Act. This study focuses on NYPA's simple cycle combustion turbine units located in New York City, referred to as the "Small Clean Power Plants" (SCPPs), which comprise just over 400 megawatts of capacity.[5] The units were built in 2001 in response to an urgent system need, and have since provided local reliability and resiliency benefits, in addition to energy in times of high demand. To meet its VISION2030 goals, NYPA must transition its SCPPs to carbon-free technologies by 2035. This analysis examines options to install clean energy technologies at the SCPP sites, with a focus on the capability of battery storage to provide similar operational services as the SCPPs.

> The PEAK Coalition includes UPROSE, the New York City Environmental Justice Alliance, Clean Energy Group, the POINT CDC, and New York Lawyers for the Public Interest.

The SCPPs are located in environmental justice communities across New York City, including two sites in the Bronx, two sites in Brooklyn, one site in Queens, and one in Staten Island. In 2020, NYPA entered into a Memorandum of Understanding

2 See, e.g., https://www.nytimes.com/2019/06/18/nyregion/greenhouse-gases-ny.html.

3 The Climate Act Draft Scoping Plan tasks the Department of Public Service and the Department of Environmental Conservation with defining which resources are eligible to contribute to a "zero-emissions" power system as required by the Climate Act. See p. 178: https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan.

4 2022 State of the State address, Governor Kathy Hochul, https://www.governor.ny.gov/sites/default/files/2022-01/2022StateoftheStateBook.pdf

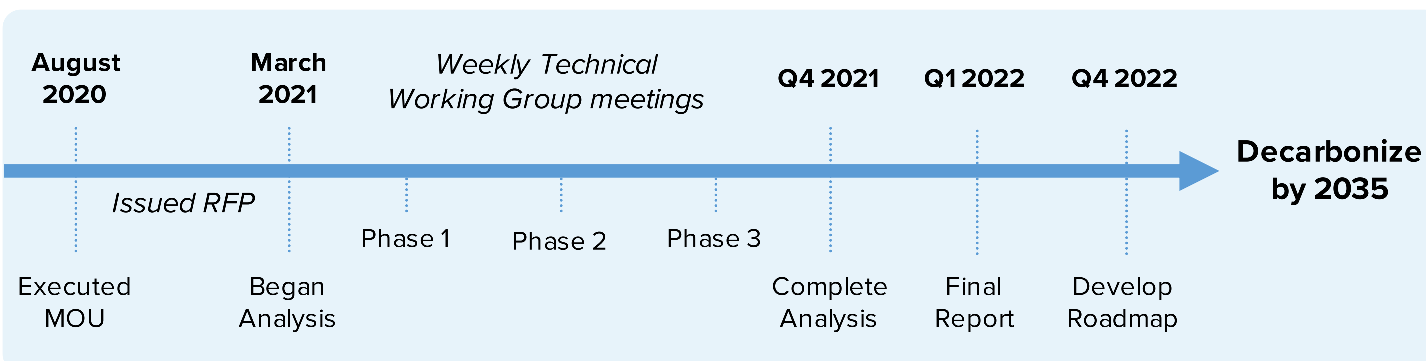
5 While this study is focused on NYPA's units, there are also actions being taken to replace peakers with battery storage elsewhere in New York City; see, for example, https://www.spglobal.com/platts/en/market-insights/latest-news/natural-gas/121721-eastern-generation-shutting-oil-fired-power-in-new-york-city-adding-battery-storage.

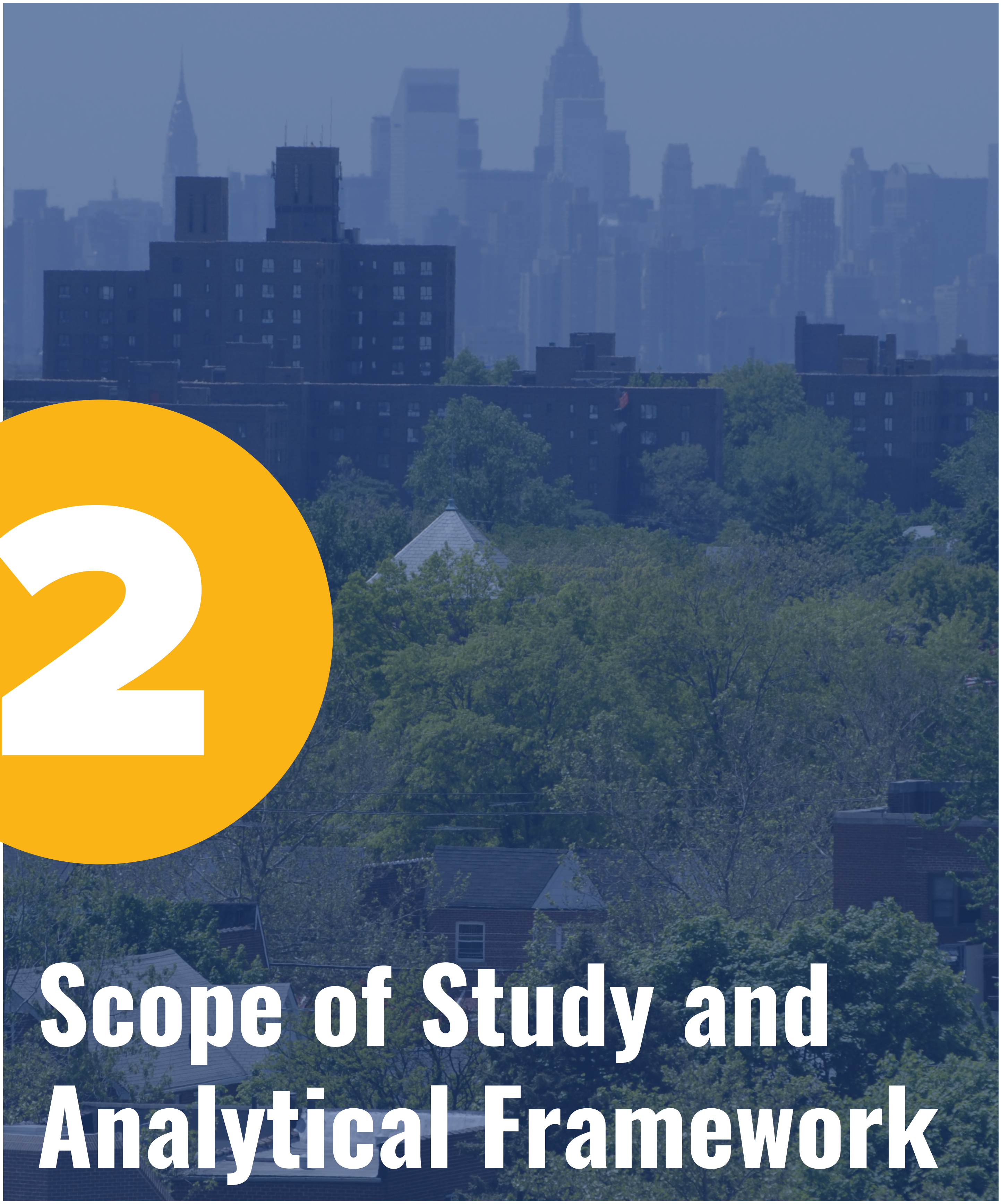
(MOU) with the PEAK Coalition, a group of five leading environmental justice and clean energy interests, outlining an agreement to: (1) collaborate about opportunities to support NYS energy storage, climate and air pollution goals and (2) evaluate the potential to replace NYPA's existing peaker units, augment and otherwise install renewable and battery storage systems at NYPA's New York City sites and surrounding communities consistent with New York Independent System Operator (NYISO) Reliability requirements. The agreement was a first-of-its-kind commitment between a utility and environmental justice stakeholders.

To support the second goal of the MOU, NYPA commissioned Energy and Environmental Economics, Inc. (E3) and General Electric Energy Consulting (GEEC) (collectively, the "study team") to perform the modeling and analysis for the study, and also contracted with Strategen Consulting to provide independent support to the PEAK Coalition. As part of this engagement, a technical working group with representatives from each of the above-mentioned parties was formed which met on a near-weekly basis to discuss input assumptions, methodology, and initial findings.

This study represents the culmination of a year-long effort by NYPA, in consultation with the PEAK Coalition, to perform a detailed assessment of adaptation strategies at each of the SCPP sites, including full replacement with battery storage and an interim hybridization (peaker plus storage) solution. At the same time, it is important to note that this study represents one step in the process of decarbonization by 2035. As outlined in Figure 1 and elaborated on in the Recommendations and Next Steps section, this report will inform the development of NYPA's strategic roadmap, which will provide actionable steps that NYPA plans to take in the near term, as well as high-level, long-term plans for full decarbonization by 2035.

Figure 1: Study Timeline





2

Scope of Study and Analytical Framework

2. Scope of Study and Analytical Framework

The core scope of this study is to examine the potential to replace, augment, and otherwise install renewable and battery storage systems at NYPA's SCPP sites in New York City. The scope includes the identification of high potential sites and configurations, as well as an examination of potential replacement and hybridization (i.e. peaker plus storage) configurations. More broadly, the objective of this work is to: 1) identify a near-term path forward for NYPA and to lay a foundation for strategies that accelerate the development of renewables and/or battery storage in New York City, 2) is consistent with the State's Climate Act requirements, and 3) is consistent with NYPA's VISION2030 plan.

A three-pronged analytical framework was developed that recognized the importance of capturing the detailed operations of the New York electricity system and the contributions of NYPA's Small Clean Power Plants towards system needs in New York City.
The analytical framework consists of the following modeling tools:

+ **GE-MAPS** | GE-MAPS is GE's nodal production cost model that simulates the operations of the NYISO system at a high level of geographic and unit-specific granularity, capturing flows and constraints on individual transmission lines.

+ **RESTORE** | RESTORE is E3's storage optimization model, which can be used to assess the hourly dispatch of battery storage replacement or hybridization configurations in comparison to the operation of the SCPPs.

The analysis builds off a growing body of literature that has examined opportunities to replace peaker power plants with battery storage, including a number of studies conducted specifically for New York City plants.[6,7,8] However, the analysis conducted in this study represents a first-of-its-kind approach to examining storage replacement opportunities as the

6 E3, prepared for NYSERDA and DPS, The Potential for Energy Storage to Repower or Replace Peaking Units in New York State, July 2019, https://www.ethree.com/wp-content/uploads/2019/08/E3_The_Potential_for_Energy_Storage_to_Repower_or_Replace_Peaking_Units_in_New_York_State_July_2019.pdf.

7 Strategen, prepared for NY-BEST, Long Island Fossil Peaker Replacement Study, October 2020, https://www.strategen.com/strategen-blog/long-island-fossil-peaker-replacement-study.

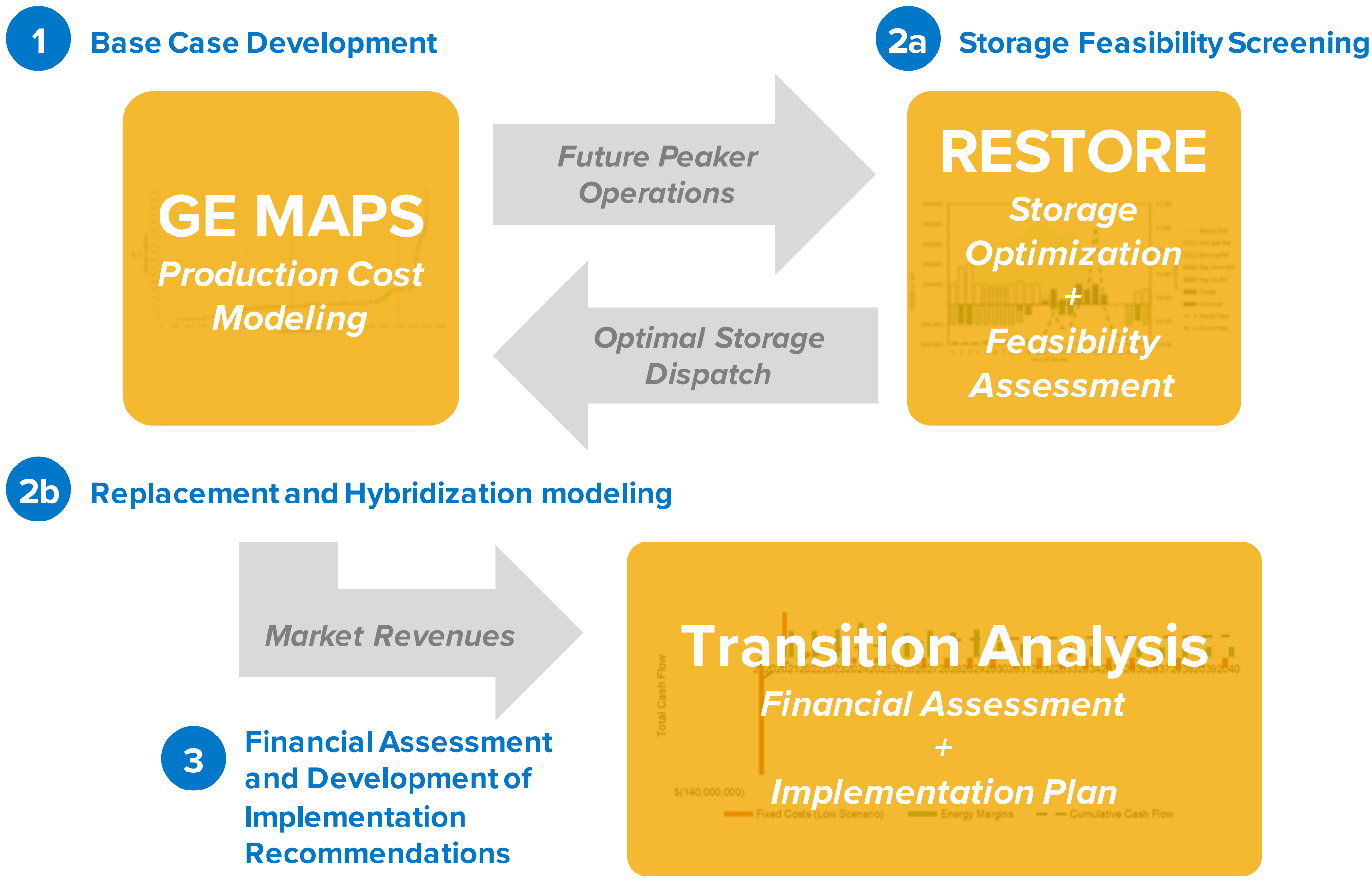
8 Form Energy, Solving the Clean Energy and Climate Justice Puzzle, July 2020, https://formenergy.com/wp-content/uploads/2020/08/Form_Energy_NYGasReplaceWhitePaper_V2.pdf.

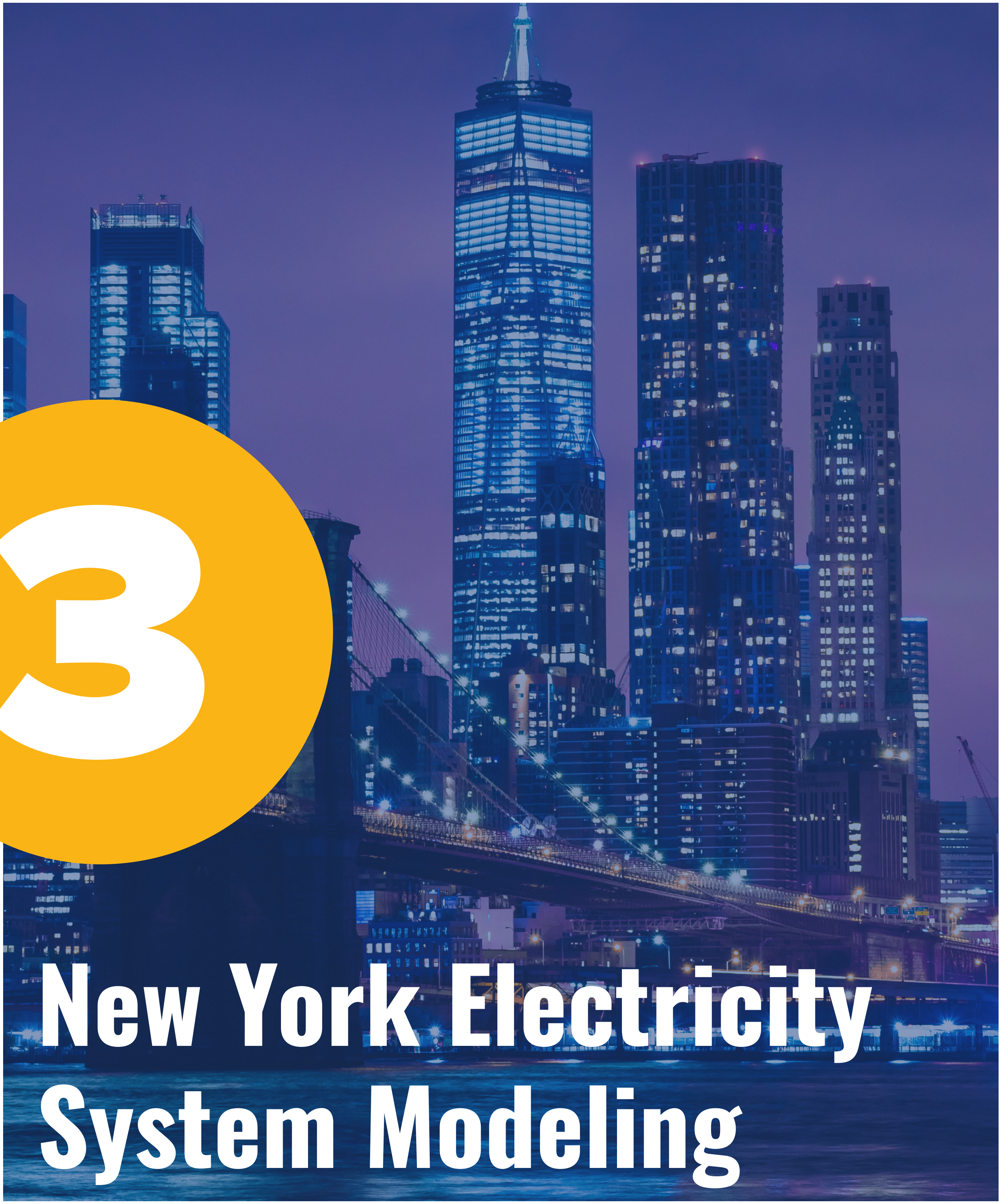
system evolves over time to meet the requirements of New York State's Climate Act. The analysis undertaken in this work was conducted in three phases, described below.

In Phase 1, GE-MAPS was used to develop an assessment of the impacts of the Climate Act requirements on the electric system. The Phase 1 modeling included both an examination of the impacts of the Climate Act's economy-wide goals on the magnitude and timing of loads, driven by the electrification of the transportation and buildings sector, as well as an assessment of changes to the resource mix in Zone J and across the NYISO system to meet the State's 70x30 and 100x40 goals.

The Phase 2 work included a detailed assessment of the feasibility of adaptation strategies at the SCPP sites, by examining the operations of the SCPPs over time and assessing the ability of battery storage to replace part or all of their output on an hourly basis. Lastly, the Phase 3 work contained a financial analysis of the adaptation strategies and an examination of different implementation options. The key objectives of each phase of work and the linkages between each phase are shown in Figure 2.

Figure 2: Overview of Analytical Framework





3

New York Electricity System Modeling

3. New York Electricity System Modeling

In order to examine changes to the New York electricity system as a result of the Climate Act, GE-MAPS was used to model a “Base Case”, which consisted of production cost modeling of the electricity system in 5-year increments between 2025 and 2040. The Base Case is intended to capture key changes to the operations of the New York grid over time as the State advances towards meeting its Climate Act requirements. To capture an additional trajectory of the New York electricity system, the modeling also examined a scenario with more aggressive deployment of behind-the-meter solar and battery storage in New York City (the “Alternative Scenario”), described in Section 3.7. Additionally, there have been several recent clean energy developments that are not included in the Base Case modeling, and their potential impacts are discussed qualitatively in Section 3.8.

Passed in 2019, the New York Climate Act contains several major requirements for both the New York State economy and the New York power grid. The Climate Act requires the State to reduce direct greenhouse gas (GHG) emissions by 85% below 1990 levels and to achieve carbon neutrality (on a net emissions basis) by 2050. In addition to these statewide targets for the entire New York economy, the Climate Act also includes specific electric sector-specific and technology-specific requirements. The electric sector is required to achieve a 70% Clean Energy Standard by 2030 and a 100% zero-emissions target by 2040, coupled with technology carve-outs to add 6 gigawatts (GW) of distributed solar by 2025; 3 GW of battery storage by 2030; and 9 GW of offshore wind by 2035. The key targets and timeline of the Climate Act requirements are shown in Figure 3, including modeling representations of interim progress.

Figure 3: Modeled Progress Towards Climate Act Requirements

2025

- 6 GW distributed solar PV
- 185 TBtu of on-site energy savings
- *1.8 GW offshore wind*
- *Recent wind and solar CES procurements*

2030

- 70% clean energy statewide
- 3 GW battery storage
- *1.3 GW Tier 4 renewables into NYC*
- *Modeled 6 GW offshore wind to reflect progress towards 2035*

2035

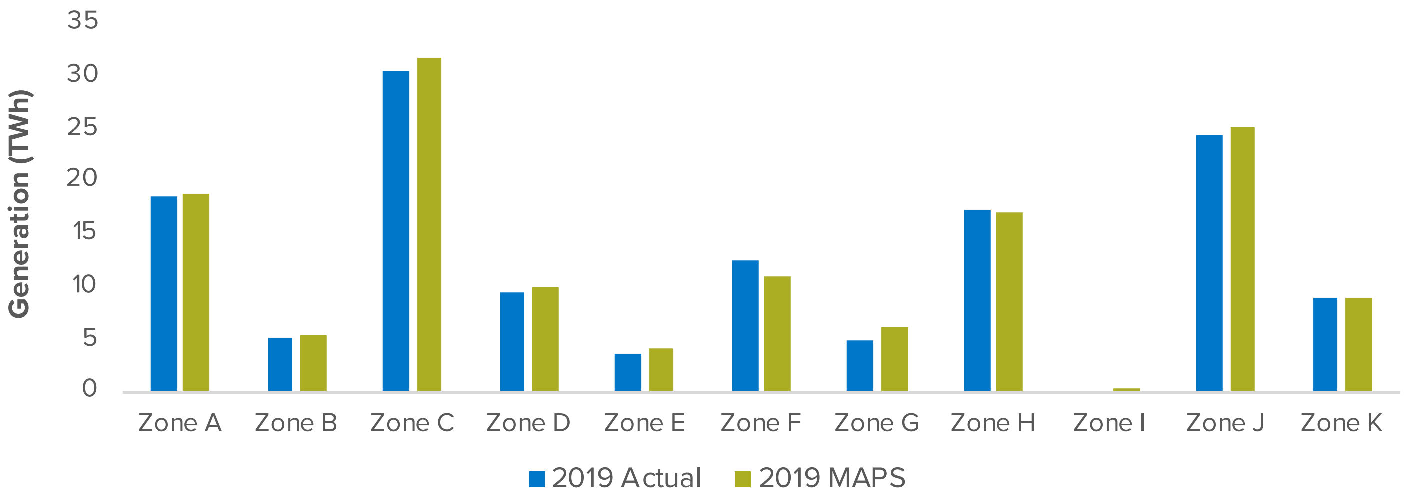
- 9 GW offshore wind
- Full decarbonization of NYPA portfolio
- *Modeled 75% clean energy by 2035 to reflect progress towards 2040*

2040

- 100% zero-emissions electricity
- *Modeled as ~80% renewable electricity*
- *Modeled 12 GW of offshore wind*

Items in italics represent modeled progress towards Climate Act targets.

Figure 4: Generation by NYISO Zone



3.1. Base Case Objectives

The Base Case models the impacts of the Climate Act using GE-MAPS, and is intended to assess a policy-compliant future and the impacts that changes to both customer loads and generation resources will have on the operations of NYPA's Small Clean Power Plants. However, the Base Case represents one possible pathway to meeting the Climate Act goals and serves as a reference against which the impacts of additional NYPA action, such as SCPP site adaptation, can be measured. By definition, the Base Case includes projections of resource changes outside of NYPA's control, including decisions made by other generation owners.

The Base Case analysis includes changes to the timing and magnitude of demand as a result of the electrification of transportation and buildings at a pace necessary to meet the Climate Act economy-wide goals. It also includes significant changes to the resource mix in NY and models additions necessary to meet the electric sector goals. However, it is important to recognize that the Base Case represents one possible pathway to meeting the Climate Act goals building on the existing literature, and should not be interpreted as a comprehensive vision – from either NYPA or PEAK Coalition – of what the clean energy transition in New York City should look like. An additional possible view of the future state of the electricity grid in New York City is modeled in the "Alternative Scenario".

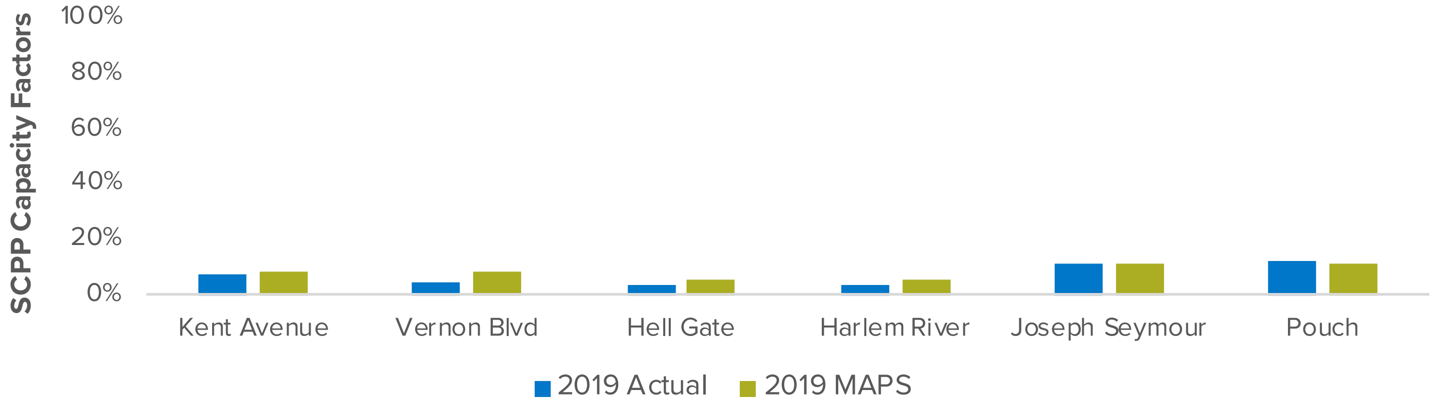
3.2. Benchmarking

As an initial step in modeling the New York system, a benchmarking analysis was performed to ensure that the generating units and transmission constraints in GE-MAPS were consistent with how the New York Independent System Operator (NYISO) system is operated. This effort builds on a longstanding collaboration between NYPA and GEEC and leverages an existing database with incremental adjustments performed to reflect recent changes, such as the NYISO's 2021 Load & Capacity Data "Gold Book".[9]

The GE-MAPS model was then run using historical load and fuel cost data to assess alignment with modeling results and real-world system operations. As shown in Figure 4 and Figure 5, the model closely mirrors the total generation by zone, and specifically for the SCPPs.

9 NYISO, 2021 Load and Capacity Data: Gold Book, April 2021, https://www.nyiso.com/documents/20142/2226333/2021-Gold-Book-Final-Public.pdf/b08606d7-db88-c04b-b260-ab35c300ed64.

Figure 5: SCPP Capacity Factors



3.3. Load Forecast

Multiple analyses have found that the electrification of the buildings and transportation sectors, coupled with growth in generation from zero-carbon electricity sources, is expected to be a key pillar in New York's efforts to decarbonize its economy.[10,11,12] The pace, scale, and timing of electrification will depend on a number of factors, including the availability and complementary usage of low-carbon fuels; however, electrification-driven load growth is expected to be a significant contributor to electric system demand over the next several decades.

The load forecasts developed for the Climate Leadership and Community Protection Act in the NYISO's 2021 Gold Book were used to inform the Base Case analysis, which provides an indication of changes in the magnitude of loads by NYISO zone over the forecast period.[13] As building heating demand and electric vehicle charging loads are added to the system, the timing of loads will change significantly. To assess changes in the timing of electric sector demand, the study team applied a load shape developed for NYSERDA's Deep Decarbonization Pathways report[14] to the NYISO Gold Book forecast.

Table 1: Statewide Load Forecast modeled in GE-MAPS Base Case

Statewide Load Forecast				
	2025	**2030**	**2035**	**2040**
Summer Peak (MW)	31,815	29,786	33,354	37,522
Winter Peak (MW)	23,413	26,002	31,804	38,111
Annual Energy (GWh)	151,793	161,601	189,677	221,444

In NYSERDA's 2020 Deep Decarbonization Pathways analysis, the scenarios incorporated several key strategies to manage the impacts of electrification, including the adoption of a diverse mix of heat pump technologies, deep investments in energy efficiency and efficient building shells, and implementation of workplace charging infrastructure, all of which serve to partially mitigate the "peak heat" challenge of electrification.[15] Meeting peak demand and maintaining resource adequacy over the forecast period would be more challenging without such investments embedded in the underlying load shape used for this study.

10 E3, prepared for NYSERDA, Pathways to Deep Decarbonization in New York State, June 2020, https://climate.ny.gov/CAC-Meetings-and-Materials
11 E3, prepared for NYSERDA, Integration Analysis Technical Supplement to the Draft Scoping Plan (Appendix G), December 2021, https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan.
12 Itron, prepared for NYISO, New York ISO Climate Change Impact Study, Phase I: Long-Term Load Impact, December 2019, https://www.nyiso.com/documents/20142/10773574/NYISO-Climate-Impact-Study-Phase1-Report.pdf.
13 NYISO, 2021 Load and Capacity Data: Gold Book, April 2021, https://www.nyiso.com/documents/20142/2226333/2021-Gold-Book-Final-Public.pdf/b08606d7-db88-c04b-b260-ab35c300ed64.
14 E3, prepared for NYSERDA, Pathways to Deep Decarbonization in New York State, June 2020, https://climate.ny.gov/CAC-Meetings-and-Materials.
15 "Peak heat" refers to the peak electricity demand that would occur during the winter as a result of the electrification of building space heating needs.

Table 2: Resource Mix to Meet 70x30 Target

Total Resources to Meet 70 x 30 (MW)					
Zone	Onshore Wind	Utility-Scale Solar	Tier 4	Offshore Wind	Storage
A	1,910	2,811			251
B	310	287			43
C	1,869	1,852			301
D	940				12
E	1,255	908			47
F		2,295			242
G		1,364			419
H					279
I					128
J			1,310	4,000	772
K		152		2,000	999
Total	**6,284**	**9,669**	**1,310**	**6,000**	**3,493**

3.4. Resource Portfolios

New York must rapidly accelerate the build-out of wind and solar resources in order to meet the 70x30 and 100x40 requirements while also continuing to meet increases in system demand driven by electrification. Multiple studies have performed a detailed examination of the resource portfolios that could contribute to meeting the State's electric sector targets. Capacity expansion modeling was outside of the scope of this study; instead, the analysis relied on a review of existing studies with targeted adjustment based on feedback from NYPA and its stakeholders.

To account for New York's transition to a decarbonized power sector, the resource portfolios utilized in the modeling reflect an expansion of onshore and offshore wind, utility-scale and distributed solar, and battery storage. New York's existing zero-carbon resources, such as the upstate nuclear and hydropower facilities, are assumed to remain online throughout the 2025-2040 period examined. The primary source utilized to develop the assumed resource mix to meet the State's 70x30 goals was the NYISO CARIS Report,[16] complemented by analysis from the NYSERDA Power Grid Study,[17] and adjusted for differences between modeling frameworks (e.g. different levels of curtailment in GE-MAPS led to a different resource mix necessary to meet the 70% target). The 2030 Base Case resource mix modeled for this study is shown in Table 2.

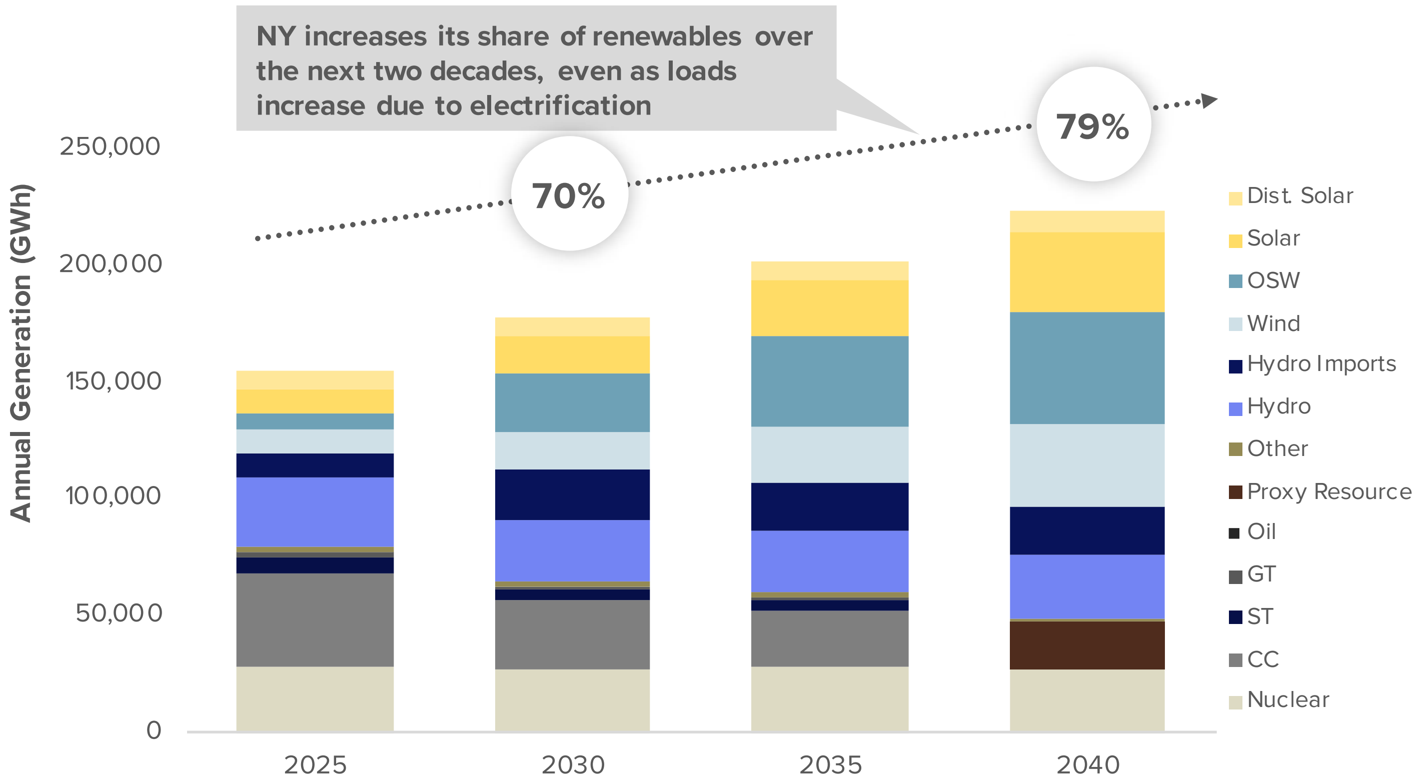
Aside from the currently planned retirements of peaker capacity for compliance with the Department of Environmental Conservation NO_x rule, no thermal generation was retired in the model between 2025-2039[18]. In 2040, the New York power system must be powered entirely be zero-emissions resources in order to meet the requirements of the Climate Act. **For the purposes of this modeling, it is assumed that an amount of firm zero-emissions capacity, equivalent to existing thermal capacity, is online and available to maintain system reliability; this generic proxy zero-carbon resource could be met by a number of emerging technologies that have not yet been deployed at commercial scale.**

16 NYISO, 2019 CARIS Report, July 2020, https://www.nyiso.com/documents/20142/2226108/2019-CARIS-Phase1-Report-Final.pdf.

17 Siemens Power Technologies, Inc. prepared for NYSERDA, New York Power Grid Study Appendix E: Zero-Emissions Electric Grid in New York by 2040, January 2021, https://www.nyserda.ny.gov/About/Publications/New-York-Power-Grid-Study.

18 The SCPPs are currently in compliance with the NO_x rule.

Figure 6: Base Case Generation Mix



Note: In 2040, nuclear generation and generation from zero-emissions firm resources ("Proxy Resources") provide the remainder of the state's generation to meet the 100% zero-emissions requirement of the Climate Act.

3.5. Caveats on System Reliability

Analysis of system reliability was outside this study's scope, but will be a necessary and essential step before implementation can proceed. The modeling was performed in GE-MAPS and included nodal production cost modeling for a single representative weather year, but did not examine the local, zonal, or system-wide reliability of the system over a broader range of future conditions (e.g. by performing loss-of-load probability modeling). Capacity expansion modeling or resource adequacy analysis was not performed for this study. However, more detailed reliability assessments must be pursued before retirement or replacement decisions can be made. NYPA will coordinate with the local Transmission Owner and NYISO to examine system and local reliability needs.

3.6. Generation Mix Results

KEY FINDING #1

The analysis finds that the additions of renewables and battery storage to meet the State's 70x30 and 100x40 requirements leads to substantial reductions in fossil generation, including reductions in output from fossil generation units both statewide and in New York City. The evolution of the State's generation mix, as modeled in the Base Case, is illustrated in Figure 6.

The increase in transfer capacity between upstate and downstate New York via the AC Transmission projects[19] help ensure that the expansion of wind and solar resources in upstate and western New York can contribute to reducing fossil generation in New York City. The interconnection of new offshore wind projects directly into Zone J, as well as a transmission project bringing hydropower from Hydro-Quebec into

19 NYISO, AC Transmission Public Policy Transmission Plan, April 2019, https://www.nyiso.com/documents/20142/5990681/AC-Transmission-Public-Policy-Transmission-Plan-2019-04-08.pdf.

Zone J under Tier 4 of the Clean Energy Standard, also play a role in delivering reductions in GHG emissions and local pollution in New York City.[20] As described in more detail in Section 3.8, the addition of the Clean Path NY transmission project under the Tier 4 solicitation would further improve deliverability of renewables to New York City. Battery storage built in New York City can help shift renewable output to peak times to displace the least-efficient and highest-emitting units. **The Base Case modeling projects that, as a result of the additions of renewables, storage, and new transmission infrastructure, fossil generation in New York City will decline by more than 20 percent relative to 2019 levels.**

3.7 Alternative Scenario

In order to examine an alternative, more expansive vision for decarbonization in New York City, an Alternative Scenario was developed by Strategen Consulting, in collaboration with the PEAK Coalition.[21] Whereas the Base Case models a policy-compliant future that represents one possible pathway to meet the Climate Act requirements, the Alternative Scenario serves as a reference to measure the energy and emissions related impacts of possible additional actions towards decarbonization in New York City, such as more proactive retirement of privately owned fossil fuel power plants and accelerated growth in locally sited resources, including storage and distributed solar.

The Alternative Scenario prioritized:

+ Reduced reliance on and dispatch of fossil assets in NYC;
+ Acceleration of the attainment of the State's clean energy goals; and
+ Increased deployment of community-sited resources.

To enable these key goals, Strategen and PEAK developed a trajectory of resource changes in New York City between now and 2040. An assessment of the feasibility of implementation of the Alternative Scenario was outside the scope of this study. The focus of this analysis was on comparison to the Base Case in 2030, and the following changes were modeled:

+ Retirement of 4.2 GW of fossil capacity by 2030, focused on the oldest and least used peaking fossil capacity (combustion turbines and steam turbines[22] in Zone J (NYC);
+ Addition of 4.2 GW of battery storage in Zone J by 2030, including 1.9 GW of 8-hour storage
+ Addition of 2.1 GW of distributed solar deployment in Zone J by 2030

The key changes in assumptions relative to the Base Case are shown in Table 3. GE-MAPS was utilized to assess the changes to electricity system operations in the Alternative Scenario relative to the Base Case in 2030.

Table 3: Comparison of Zone J Resource Changes in Base Case and Alternative Scenario

Alternative Scenario Assumptions (2030)		
Zone J Resources	Base Cases	Alternative Scenario
Distributed Solar Capacity	627	2133
Battery Storage Capacity	772	4219
Retired Fossil Capacity[23]	629	4219

The results of the comparison between the Alternative Scenario and the Base Case highlights that the addition of more locally-sited resources would further reduce utilization of peaker units in New York City, which would significantly reduce local NO_x emissions impacting nearby disadvantaged communities. The retirement of 4.2 GW of the oldest and least used peaking fossil capacity assets by 2030, which produce an outsized portion of local criteria air

20 "Tier 4" refers to a resource tier of the Clean Energy Standard for projects that deliver clean energy directly into New York City. For more information on Tier 4 projects, see: https://www.nyserda.ny.gov/All-Programs/Clean-Energy-Standard/Renewable-Generators-and-Developers/Tier-Four.

21 It should be noted that neither NYPA nor its consultants, E3 and GE Energy Consulting, vetted the technical or implementation feasibility of the assumptions underlying the alternative scenario. This modeling exercise is intended solely as an indicative exercise and should not be interpreted as an endorsement of the underlying assumptions by NYPA or its consultants.

22 The Alternative Scenario excluded changes to combined cycle (CCGT) power plants (often newer, more efficient units that run at higher capacity factors over the course of the year).

23 In the Base Case, there are several units that are seasonally offline in order to comply with NO_x regulations. Those units are not included in the retirement total here. In the Alternative Scenario, all of those units are assumed to retire.

Figure 7: Changes in Zone J in Alternative Scenario Relative to Base Case

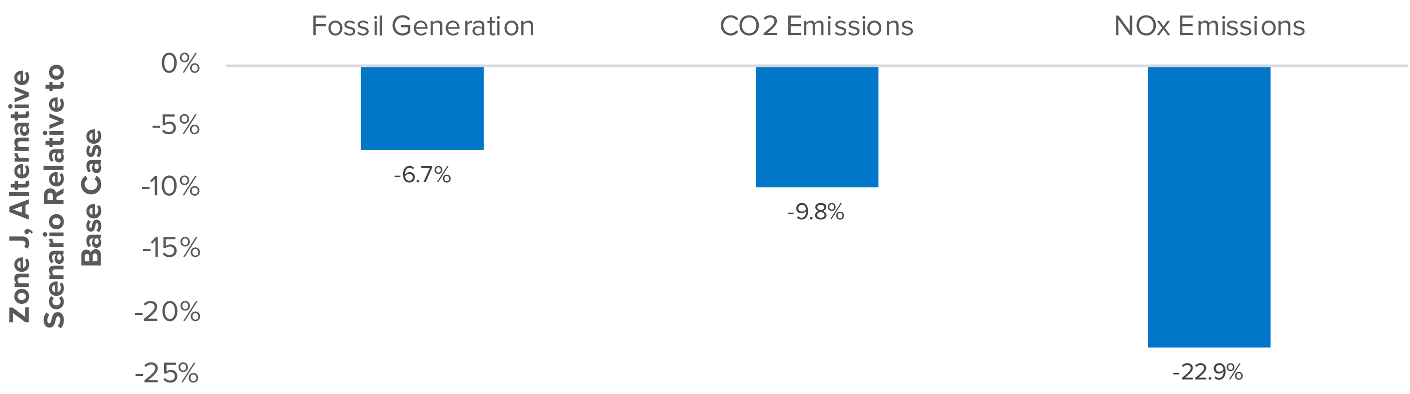
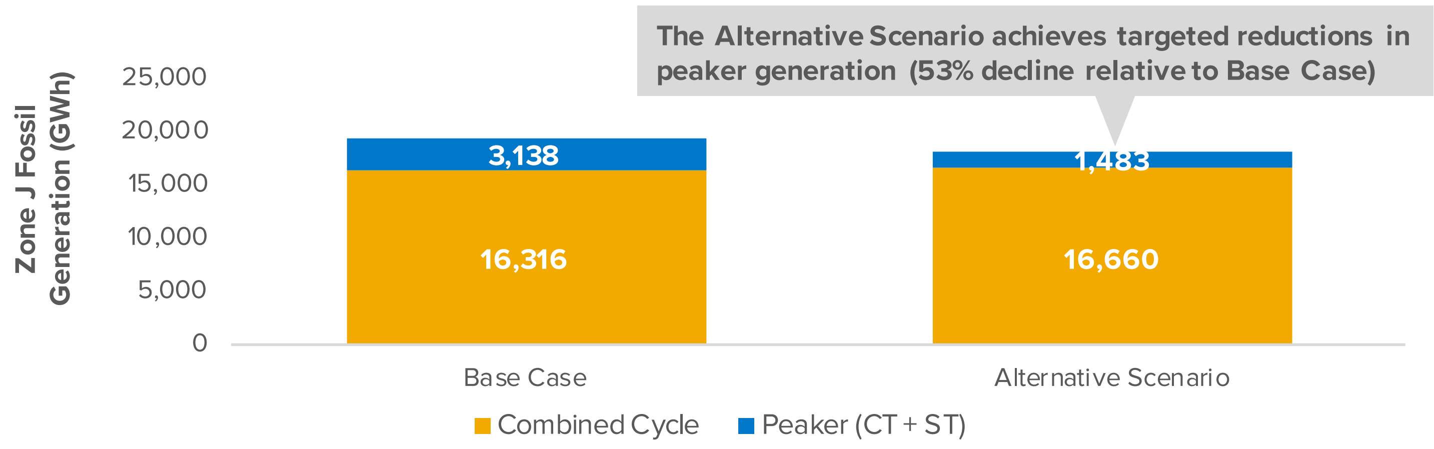


Figure 8: Impacts on Fossil Generation by Unit Type



pollutants,[24] coupled with the addition of local solar plus storage resources, resulted in a significant reduction in Zone J NO_x emissions.

KEY FINDING #2

The Alternative Scenario resulted in an approximately 7% reduction in total fossil fuel generation, 10% reduction in CO_2 emissions, and 23% reduction in NO_x emissions as compared to the Base Case in 2030 (Figure 7). **Notably, reductions in local particulate emissions are substantially larger than the reductions in fossil generation and carbon emissions, due to the fact that many of these aging fossil assets produce a disproportionate share of NO_x emissions in New York City.**

The changes modeled in the Alternative Scenario were focused on achieving targeted reductions in generation from combustion turbine and steam turbine units, both through retirement of several of these units and through the addition of local clean energy resources to help further displace peaker outputs. The addition of 1.5 GW of distributed solar in New York City (relative to the Base Case) produced 1,670 GWh of additional clean energy in 2030, and battery storage helps to shift the solar output later in the day to times of peak demand and high energy prices, when high-emitting peaking units are often on the margin.[25] The additional solar and storage resources included in the Alternative Scenario supported the reduction of 1,300 GWh of energy

24 In the Base Case in 2030, peaker units provided 16% of fossil generation in New York City, but contributed 55% of NO_x emissions.

25 The term "on the margin" indicates that a unit or set of units is the highest-cost resource being used to meet energy demand in that hour, and thus any additional output from other resources (e.g. solar) during that hour would also likely lead to direct reductions in the output of the marginal resources. When a unit is on the margin, it sets the clearing price for energy in that hour; if increases in output from other resources (or alternatively, reductions in demand) are sufficient to eliminate the need for that unit altogether, this would also lead to lower energy prices in that hour.

from fossil fuel power plants, with almost all of the reductions achieved at peaker units. As shown in Figure 8, the Alternative Scenario resulted in a 53% reduction in generation from combustion turbines and steam turbines in Zone J, as well as a 50% and 43% reductions in CO_2 and NO_X emissions, respectively, from these units relative to the Base Case in 2030.

The addition of 4.2 GW of storage on the system in the Alternative Scenario also helps to improve renewable integration, both in Zone J and across the broader region. The addition of significant energy storage resources located in New York City help facilitate increased imports into Zone J during the morning and early afternoon, because the batteries are able to charge during times of high solar output (both from local solar and upstate utility-scale resources), and then discharge during peak periods to reduce output from fossil generators. During non-summer months, the storage fleet often cycled twice a day, indicating the important role storage plays in the Alternative Scenario in helping to balance renewables and shifting output to help displace fossil generation. As a result of this intraday balancing provided by battery storage, renewable curtailment is also lower in the Alternative Scenario: curtailment in Zone J is reduced from 978 GWh in the Base Case to 734 GWh in the Alternative Scenario, representing a ~25% reduction in curtailment, and in the broader modeled region, curtailment was reduced from 5,711 GWh to 4,898 GWh in 2030, representing a ~15% reduction in curtailment.

3.8 Recent Clean Energy Developments

As New York continues to advance implementation of its clean energy policy objectives, there have been several recent clean energy developments after the modeling for this study was performed, including:

+ Selection of two transmission projects under the Clean Energy Standard Tier 4 solicitation[26]
+ Increase in distributed solar target to 10 GW by 2030[27] (from 6 GW by 2025)
+ Increase in storage target to 6 GW by 2030[28] (from 3 GW by 2030)

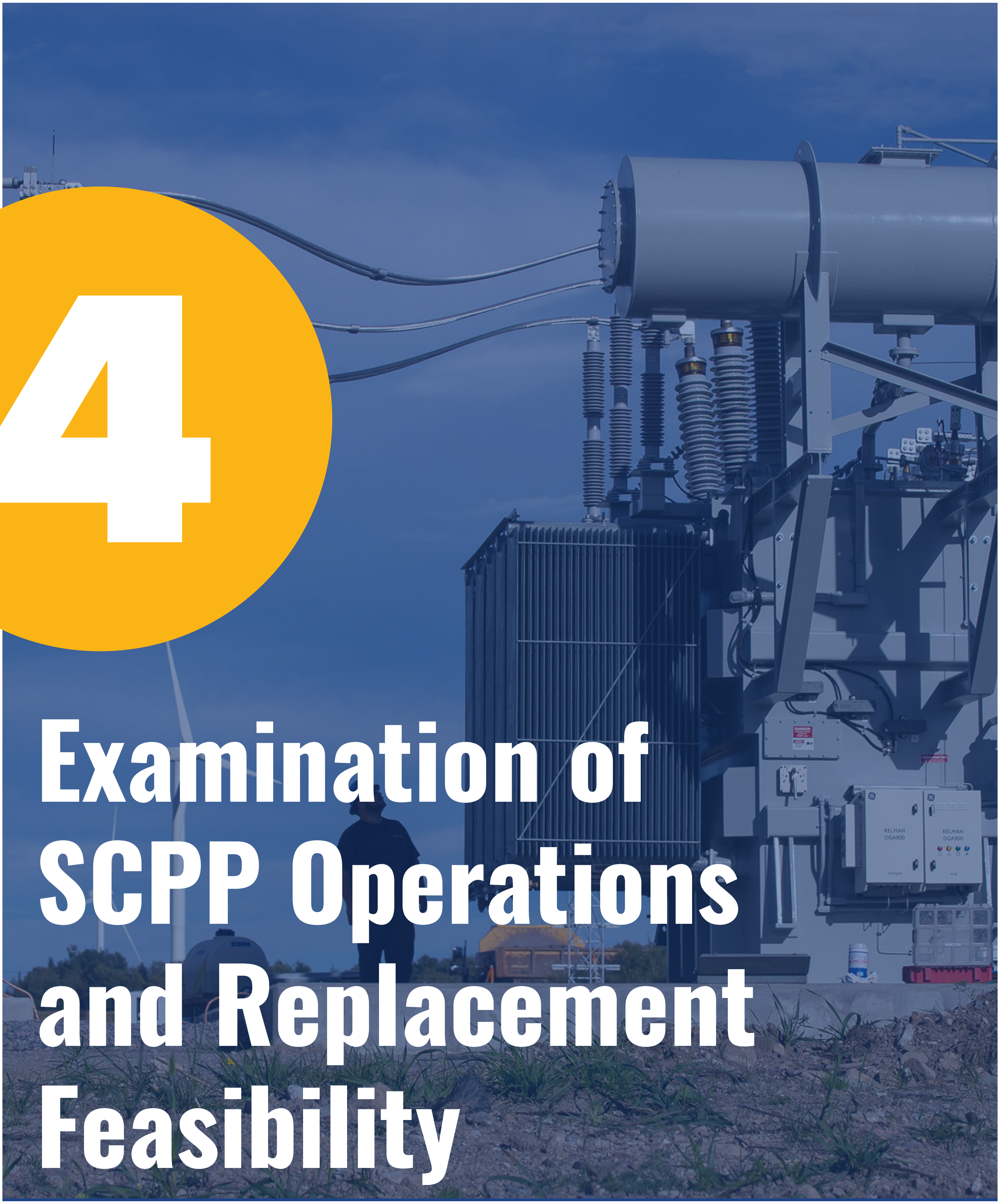
Each of these developments will increase the amount of clean energy in New York State and New York City, relative to what was modeled in the Base Case. The Base Case modeling did, however, include a proxy Tier 4 line delivering hydropower from Hydro-Quebec to Zone J (modeled at 1310 MW). The addition of the Clean Path line bringing wind and solar power from upstate New York to Zone J is projected to lead to additional reductions in fossil generation in New York City beyond what was modeled.[29] The addition of incremental distributed solar and storage will also increase utilization of and reliance on clean, non-emitting resources. It is expected that these recent developments would strengthen the operational feasibility of the adaptation strategies discussed in Section 4. These specific developments are expected to reduce reliance on fossil assets in New York City, including the SCPPs, and are also expected to increase the viability of SCPP replacement with battery storage.

26 In September 2021, Governor Hochul announced the selection of two transmission projects under Tier 4 of the Clean Energy Standard: Champlain Hudson Power Express, connecting Hydro-Quebec to New York City; and Clean Path New York, connecting upstate New York to New York City. In November 2021, finalized contracts for both projects were announced. For more information, see: https://www.nyserda.ny.gov/About/Newsroom/2021-Announcements/2021-11-30-Clean-Path-NY-Champlain-Hudson-Power-Express-Renewable-Energy.

27 In September 2021, Governor Hochul announced the expansion of the NY-Sun program with a goal of achieving at least 10 GW of solar energy by 2030. For more information, see: https://www.governor.ny.gov/news/governor-hochul-announces-expanded-ny-sun-program-achieve-least-10-gigawatts-solar-energy-2030.

28 In January 2021, in the State of the State address, Governor Hochul announced an increased battery storage target of at least 6 GW of storage by 2030. For more information, see: 2022StateoftheStateBook.pdf (ny.gov)

29 NYSERDA analysis projects that the Clean Path line will lead to 49 million metric tons of carbon reductions between 2025 and 2040, relative to a Reference Case without the line. For more details, see:
NYSERDA, “Tier 4 Petition, Appendix C: Cost Analysis”, November 2021, available at: https://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?Mattercaseno=15-E-0302



4

Examination of SCPP Operations and Replacement Feasibility

4. Examination of SCPP Operations and Replacement Feasibility

The Base Case modeling provides a detailed examination of changes occurring across the New York electricity system, including the changes in the operations of the SCPPs. The GE-MAPS modeling can be used to assess the direct impacts that the increases in renewables and storage across New York – and especially the additions of offshore wind, Tier 4 renewables, and storage into Zone J – will have on the utilization of the SCPPs.

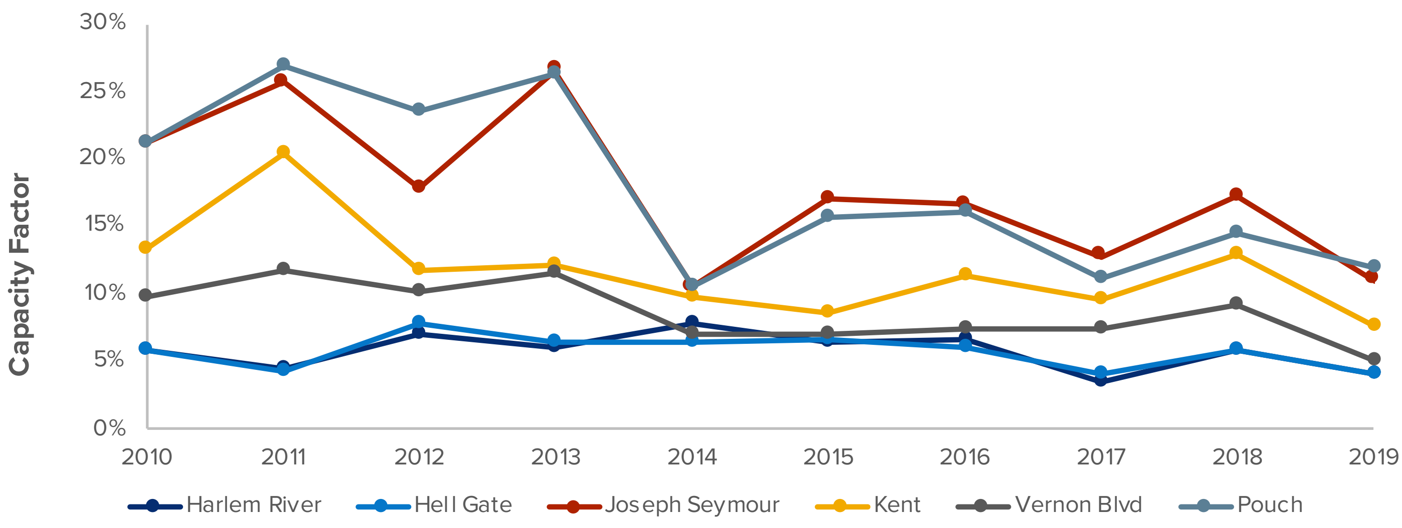
Leveraging the dispatch results from GE-MAPS, E3's storage optimization model, RESTORE, was used to assess the ability of battery storage to fully or partially replace each SCPP on an hourly basis.[30] For this analysis, storage was dispatched in order to maximize the replacement of SCPP output, based on the hourly SCPP operational data and subject to constraints on the duration of the storage configuration. It is important to note that no constraints on the timing of storage charging were placed with respect to local reliability, congestion, or load pockets. The storage was sized to the SCPP nameplate capacity and modeled for 4-hour and 8-hour durations, in order to assess the percentage of SCPP output that could be replaced under each configuration.[31]

4.1. Historical SCPP Operations and Feasibility Assessment

The SCPPs are among the most efficient peaker units in Zone J. In addition, the units were placed in their locations in part to alleviate local congestion and increase reliability and resiliency. As a result of their historically constrained locations coupled with their relatively low marginal costs, the SCPPs have historically run more compared to less efficient peakers; however, SCPP outputs are still relatively low compared to base load units such as combined cycles. In 2019, NYPA's units collectively ran at an average capacity factor of 7%, while other peakers in Zone J ran at an average capacity factor of just 0.6%; combined-cycle units ran at an average capacity factor of 64%.[32]

Over the past decade, the outputs of SCPPs have declined considerably, with Seymour and Pouch operating at above a 10% capacity factor in 2019

Figure 9: Historical Annual SCPP Operations

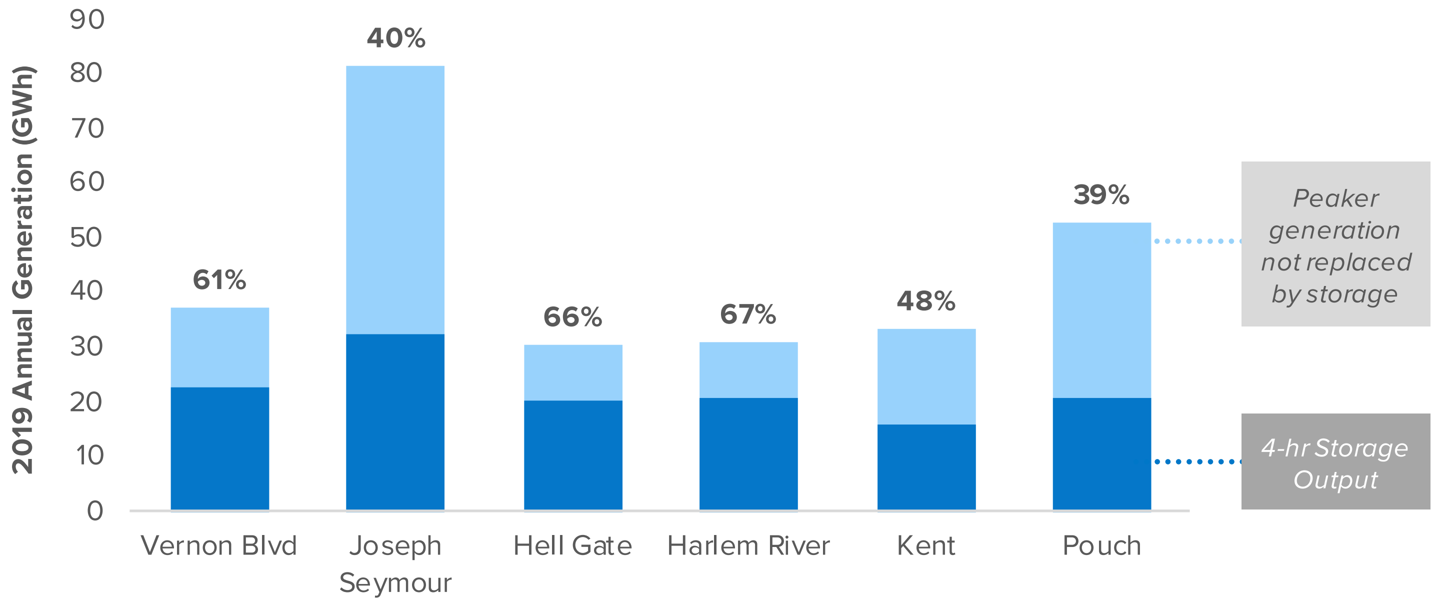


30 RESTORE uses a mixed integer linear programming (MILP) algorithm to simulate the optimal or profit maximizing operation of energy storage given its size and performance characteristics, accessible revenue streams, market in which it is expected to operate, and corresponding market price forecasts.

31 All configurations were assumed to have a roundtrip efficiency of 87%, parasitic losses of 0.5% state of charge per hour, and limit of 365 cycles per year.

32 E3 analysis of NYISO 2019 Gold Book data. Here, the analysis of other peakers in Zone J refers specifically to combustion turbines.

Figure 10: Feasibility of 4-hour Storage Replacement at SCPP Sites based on 2019 Operations



and the rest of the units falling within the range of 4-10%, as shown in Figure 9. Although annual capacity factors were lower than historical highs, the units still often ran for prolonged periods, especially during the summer months. For example, Seymour had an annual capacity factor or 12% in 2019, but ran at full output for 8 or more hours on 56 days of the year, the large majority of which were during the summer.

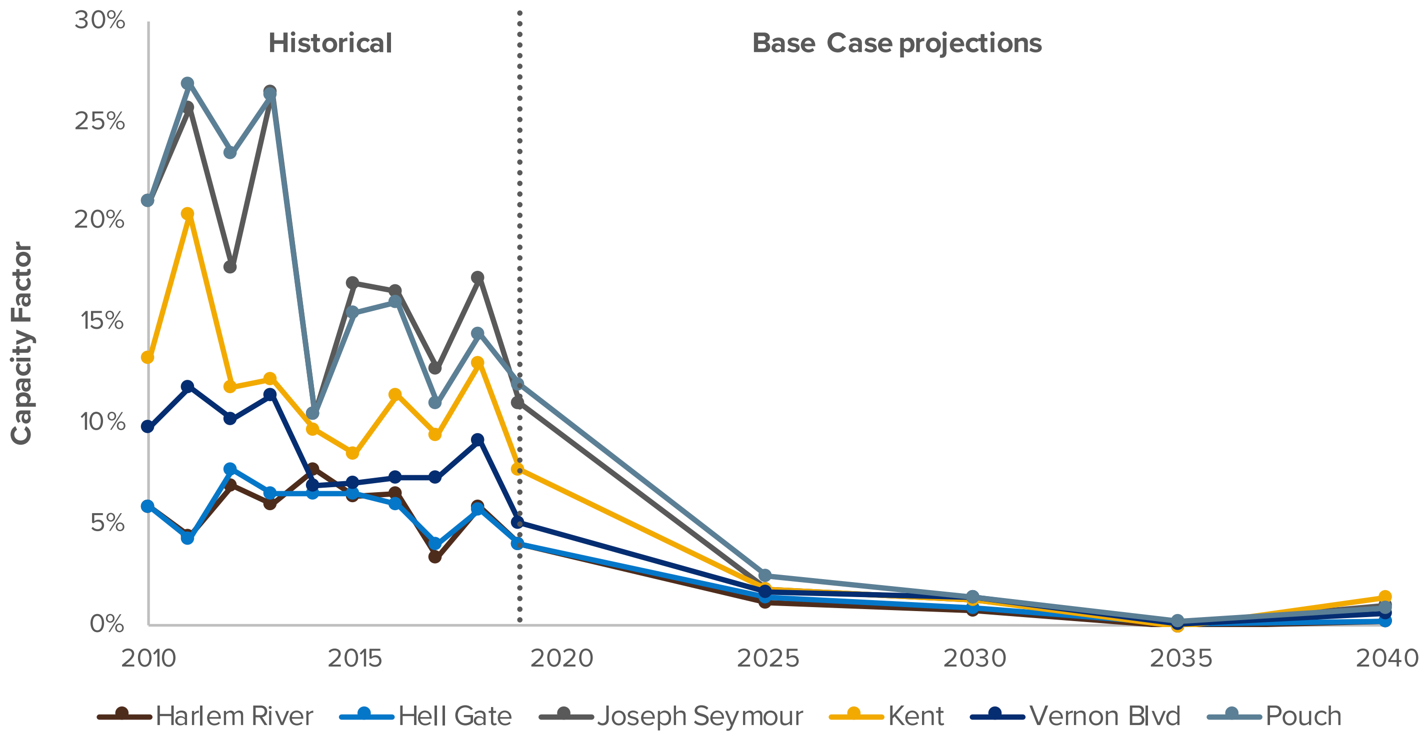
In order to benchmark the ability of battery storage to replace part or all of the peaker output on an hourly basis, the study first examined the historical operations of the SCPPs in 2019. While 2019 represented a historically low output year for the SCPPs, they were still frequently called on to operate for large portions of the day, making replacement with battery storage very challenging. The long duration of historical 2019 SCPP outputs render full replacement with battery storage infeasible. Storage sized to the nameplate SCPP capacity, with a 4-hour duration would only be able to replace 39-67% of annual SCPP output based on 2019 operations, depending on the site (see Figure 10).

4.2 Base Case SCPP Operations and Feasibility Assessment

KEY FINDING #3

The SCPP operations modeled in the Base Case for future years decline significantly from the historical SCPP operations observed over the past decade. In the near term, reductions in SCPP output in 2025 are driven by additions of offshore wind as well as increased transfer capacity into the New York City area as a result of the AC Transmission projects. In the longer term, SCPP outputs are further reduced by 2030 with the addition of a proxy Tier 4 line delivering hydropower from Hydro-Quebec to Zone J, continued deployment of battery storage in New York City to contribute to the State's 3 GW storage target by 2030, and the continued build-out of offshore wind projects on a path to reaching the State's 9 GW target by 2035.

Figure 11: Base Case Annual SCPP Operations



Importantly, the reductions in SCPP operations result in changes not only to the number of days that the SCPPs are running, but also to the time periods over which the SCPPs are needed during those days. By 2030, SCPP output duration decreases dramatically to 2-3 hours with sharper ramping required to meet system needs over a short period of time. Shorter duration outputs in future operations result in a higher likelihood that battery storage will be able to replace a higher portion of the SCPP. **By 2030, due to the decrease in both frequency and duration of SCPP run-times, full replacement with 4-hour storage becomes feasible for all sites**, as shown in Figure 13. However, it is important to note that replacement feasibility will depend on the timing of other resources coming onto the system as well as the reliability needs; if planned projects are delayed between 2025 and 2030 then the timing of replacement may also need to be adjusted.

KEY FINDING #4

Multiple analyses have demonstrated that, as electrification loads increase and the State reaches its 100x40 goals, there will be days when firm capacity in NY is needed for extended periods, even at very high renewable penetrations; for example during the winter there may be times of high demands from electrified heating loads coupled with multi-day periods of low renewable output.[33,34,35]

33 E3, prepared for NYSERDA, Integration Analysis Technical Supplement to the Draft Scoping Plan (Appendix G), December 2021, https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan.

34 Analysis Group, prepared for NYISO, Climate Change Impact Phase II: An Assessment of Climate Change Impacts on Power System Reliability in New York State, September 2020, https://www.nyiso.com/documents/20142/15125528/02%20Climate%20Change%20Impact%20and%20Resilience%20Study%20Phase%202.pdf/89647ae3-6005-70f5-03c0-d4ed33623ce4.

35 NYISO, Comprehensive Reliability Plan 2021-2030, December 2021, https://www.nyiso.com/documents/20142/2248481/2021-2030-Comprehensive-Reliability-Plan.pdf/.

Figure 12: Average Hourly SCPP Operations

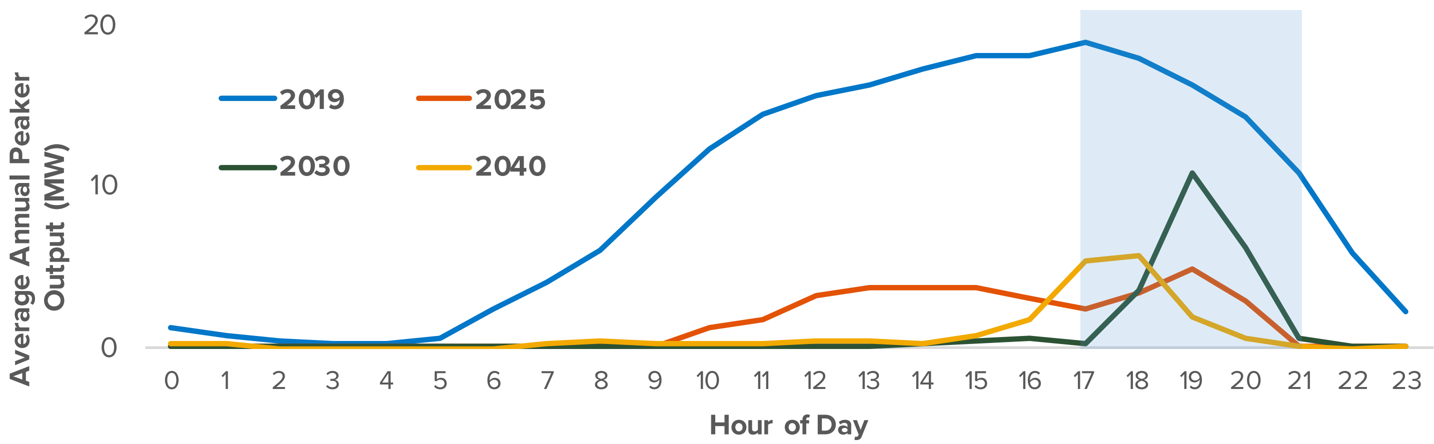
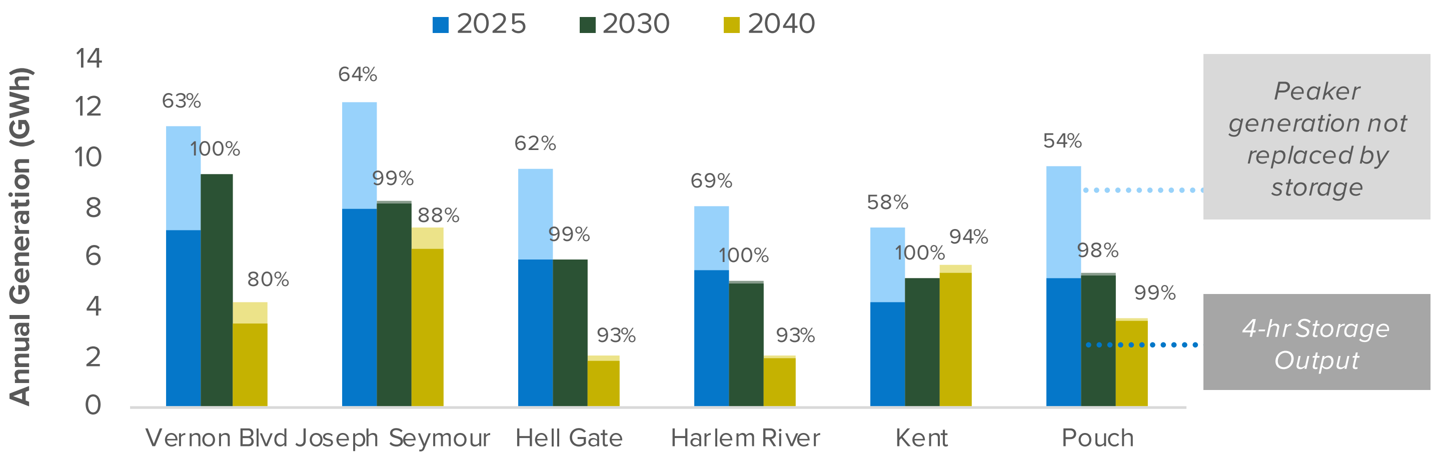
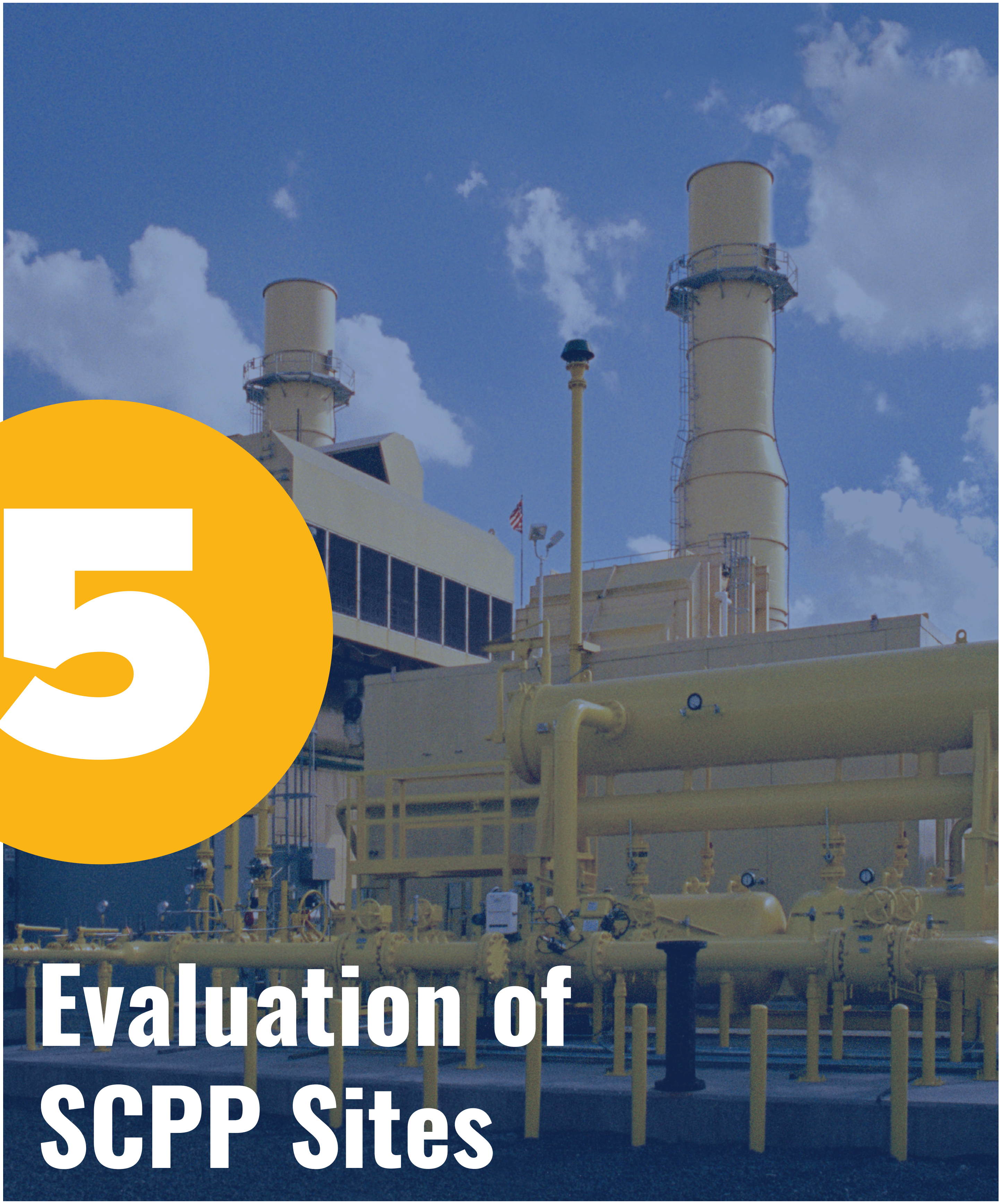


Figure 13: Feasibility of Storage Replacement at SCPP Sites based on Base Case Operations



In the 2040 Base Case modeling, the SCPPs run for extended periods on some days which cannot fully be met by 4-hour storage; these periods will require longer duration resources or firm capacity solutions. An evaluation of system needs over time will be considered in the strategic roadmap.



5

Evaluation of SCPP Sites

5. Evaluation of SCPP Sites

The SCPPs are located throughout New York City (see Figure 14), with two sites located in the Bronx, one site in Queens, two in Brooklyn, and one in Staten Island – an additional site located in Long Island was not included as part of this analysis. In order to assess site adaptation strategies, the study considered the practical realities of implementation based on the characteristics of each site (e.g. available land). Additionally, based on discussions with the PEAK Coalition, this study identified and prioritized sites where near-term implementation would provide the highest impacts for the surrounding communities.

5.1. Site Characteristics

In order to develop a successful implementation plan, it is important that the strategies under consideration reflect the physical realities at each site. The SCPP sites are all located in electrically constrained areas of New York City on small plots of land. Due to the relatively low power density of renewable technologies and the small land area available, renewable development at SCPP sites was not considered feasible and was excluded from this analysis.[36] The ability of NYPA to support the development of off-site renewable energy elsewhere was beyond the scope of this study.

NYPA conducted a preliminary assessment of each site in order to examine the available land area and study site adaptation strategies and opportunities for implementation. The primary strategies considered

Figure 14: Locations of NYPA's Small Clean Power Plants

36 Opportunities for NYPA to enable its customers to deploy community solar are discussed in the Next Steps section. For more information on renewable development in New York City, see: NREL, Expanding Community Shared Solar in NYC: Analysis of Barriers and Policy Pathways, February 2019, https://www.nrel.gov/docs/fy19osti/72186.pdf.

Table 4: Overview of SCPP Site Characteristics

Site Name	Borough	SCPP Capacity	Total Land Area
Harlem River Yards*	Bronx	79.9 MW	1.8 acres
Hell Gate*	Bronx	79.9 MW	2.6 acres
Kent (AKA North 1st)	Brooklyn	47 MW	1.4 acres
Vernon Boulevard	Queens	79.9 MW	3.2 acres
Joseph J. Seymour* (AKA Gowanus)	Brooklyn	79.9 MW	1.7 acres
Pouch Terminal	Staten Island	47 MW	1.1 acres

***Identified as a high priority for adaptation due to site characteristics and its location in disadvantaged communities.**

were full replacement with battery storage and hybridization with battery storage. Under a full replacement strategy, battery storage would be installed to match the output of the peaker (e.g. 47 MW or 80 MW), and configurations of different durations were assessed. Under a hybridization strategy (e.g. peaker plus 10 MW of battery storage per unit, e.g. 20 MW of storage at an 80 MW SCPP site), battery storage would be installed to supplement the output of the site and to help reduce peaker output, while the peaker remains online as well in the interim.

A review of recent battery storage projects in New York City and other constrained urban areas indicated that storage projects can have a density ranging between 23 to 30 MW per acre, or up to 40 MW per acre under certain conditions.[37, 38] At most SCPP sites, the existing site area would support full, or close to full, replacement of the peaker capacity within the existing site area by 2030. Hybrid configurations are more challenging because they involve the installation of storage capacity in addition to the existing SCPP units; therefore, there needs to be unused space at the site, adjacent space available, or waterfront access to facilitate barge units. The density achievable by battery storage will vary over time, and will be considered during implementation at each site.

5.2. Overview of Surrounding Communities

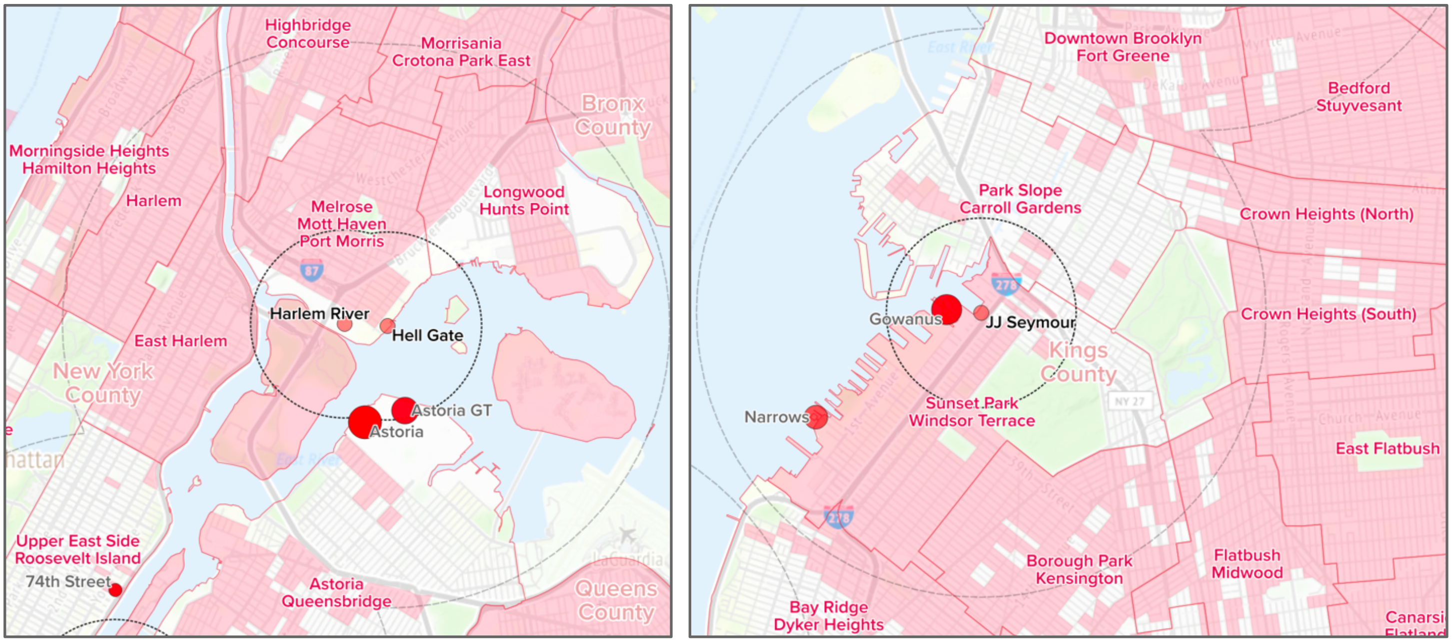
Several of the SCPPs are sited in or near communities that have been disproportionately impacted by air pollution, including from transportation, industry, power generation, and other sources. Additionally, communities in the South Bronx and Sunset Park have experienced significantly higher than average death rates from COVID-19.[39]

37 E3 reviewed several recent energy storage projects to assess a typical project density (for an entire site, not just the storage container): of 23-30 MW/acre. The projects reviewed were: East River ESS: https://edc.nyc/sites/default/files/2020-07/NYCIDA-Public-Hearing-Supplemental-Notice-July-2020.pdf; Escondido: https://www.greentechmedia.com/articles/read/aliso-canyon-emergency-batteries-officially-up-and-running-from-tesla-green; and Morro Bay: https://ieefa.org/vistra-proposes-600mw-battery-storage-project-in-california/.

38 Recent projects in other jurisdictions suggest a higher storage density may be feasible in some cases; for example, PG&E's Moss Landing project has a density of ~40 MW/acre. NYPA will continue to evaluate feasible densities in New York City on an ongoing basis. On one hand, constraints in urban areas may require an increased footprint due to separation distance requirements, limited ability for vertical "stacking" due to fire code considerations, etc. On the other hand, developers are actively pursuing opportunities to increase the density of storage capacity within constrained / expensive lease areas. For more details on Moss Landing project, see: https://files.ceqanet.opr.ca.gov/252916-2/attachment/cFUVBHWibQn3_v8ftWmvzuzHh6VmXSw2dEyjl_mbtKXtVQ6dRXrrX15nLYCLZUf_-SrEvpUR8xMo35Ap0

39 See: https://www.nytimes.com/interactive/2020/nyregion/new-york-city-coronavirus-cases.html.

Figure 15: SCPP Locations in Disadvantaged Communities



Hell Gate and Harlem River are located next to each other in the South Bronx, impacting historically disadvantaged communities such as Harlem, East Harlem, Melrose, Mott Haven, Longwood and Hunts Point. As of the last census, 36,200 New Yorkers live within 1-mile of these units, where 96% are part of a minority group and 70% live in low-income households. The area within 3-miles of the generation sites hosts about 675,400 people, 81% are minorities and 49% are low-income, and includes 17 New York City Housing Authority developments within that radius.[40]

As demonstrated in the Base Case and Alternative Scenario, the retirement of fossil fuel resources results in significant reduction of local pollutants, which leads to health improvements in currently affected communities. This provides an opportunity for replacement options and can catalyze the development of community-sited cleaner generation or storage resources in surrounding neighborhoods.

5.3. Near-term Adaptation Strategies

KEY FINDING #5

Each SCPP site was found to present opportunities for adaptation strategies. Based on review of site characteristics and density assumptions, as well as discussion of priority sites for near-term implementation from an environmental justice perspective, Seymour and Hell Gate were determined to be good candidates for a more detailed examination of adaptation strategies. The configurations to be modeled – hybridization at Hell Gate and full replacement at Seymour – are intended as proxies for the remaining SCPP sites as applicable, and are the subject of additional analysis as described in the next section.

40 Strategen Consulting analysis of census data.

6 Impacts of Site Adaptation

6. Impacts of Site Adaptation

Based on the review of the SCPP adaptation strategies, the prioritized configurations – hybridization at Hell Gate and replacement at Seymour – were analyzed further using RESTORE and GE-MAPS. The takeaways from this detailed analysis will be used, as applicable, for the remaining SCPP sites as well, and will be used to assist in the development of a plan for implementation.

As a first step in the modeling process, RESTORE was utilized to assess the revenue-optimizing operations of battery storage installed at the Seymour and Hell Gate sites, when responding to projected price signals under the Base Case. Then, the storage charging and discharging profiles were input into GE-MAPS, with either removal of or adjustment to the SCPP output accordingly. Production cost modeling was then re-run in GE-MAPS to assess the impacts of the adaptation strategies on operations and emissions of the remaining SCPPs and the rest of the Zone J system.

6.1. Emissions Impacts

The SCPP units, built in 2001, have a high efficiency and low NO_x emissions rate relative to other peaker units in New York City. As a result of their high efficiency and low costs, the SCPPs are low in the "dispatch stack" in Zone J; they are more expensive than combined cycle facilities but are less expensive than most of the remaining generating units. As a result, if the SCPPs were simply removed from today's system without replacement, there would be an increase in CO_2 and NO_x emissions, as more expensive, higher-emitting units would be called on to replace the power that would otherwise have been provided by the SCPPs. It is therefore important the retirement or replacement of the SCPPs be managed carefully in order to avoid an unintended increase in local emissions in the near term.

For modeling of the full replacement of the Seymour units with battery storage, the analysis finds that the addition of the storage at the site is able to replace the expected output of the SCPP without leading to any corresponding increases at other NYPA SCPP sites. Additionally, by charging during low-price times when efficient generation is on the margin or

Figure 16: Impacts of Seymour Replacement on Regional CO_2 Emissions in 2030

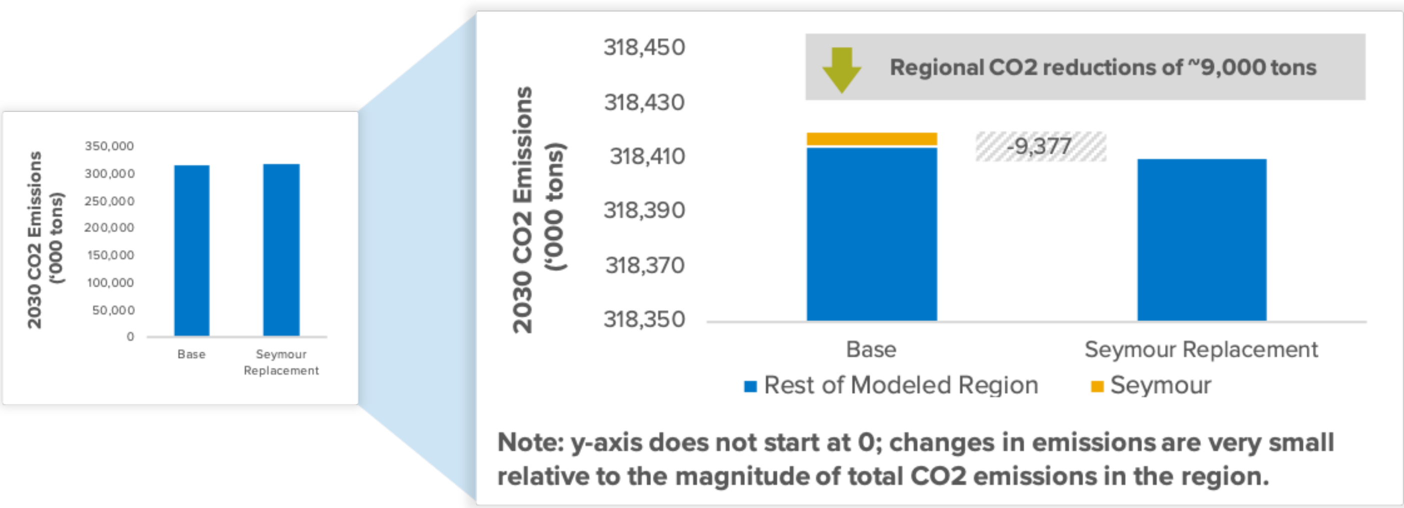


Figure 17: Impacts of Seymour Replacement on Local NOx Emissions in 2030

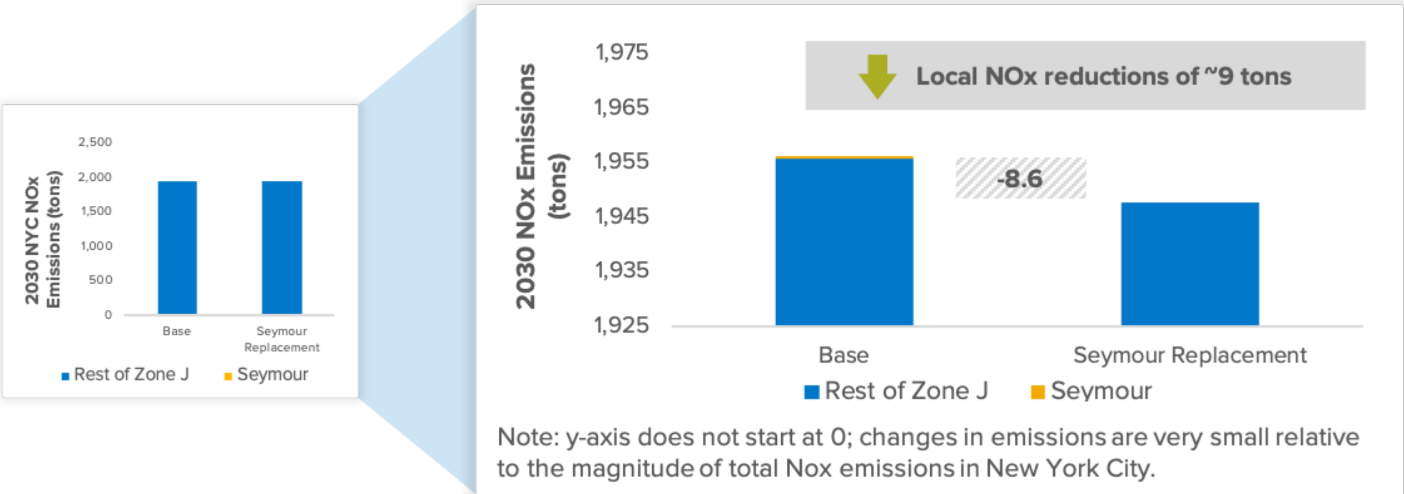


Table 5: Projected Emissions Impacts of Site Adaptation Strategies

Emissions Category	Base Case	Seymour Replacement	Hell Gate Hybridization
Regional (4 Pool) CO_2 Emissions ('000 tons)	318,420	318,410	318,397
Local (Zone J) NO_x Emissions (tons)	1,956	1,948	1,945
SCPP CO_2 Emissions (tons)	**24,803**	**19,587**	**24,022**
Harlem River Yard	3,212	3,248	3,211
Hell Gate Peaker	4,137	4,113	3,407
Joseph J. Seymour Power Project	5,239	0	5,257
Kent Avenue	3,045	3,034	3,023
Vernon Blvd	5,860	5,848	5,852
Pouch	3,310	3,344	3,273

when renewables might otherwise be curtailed, and discharging during times of high prices to displace less efficient, higher-emitting fossil generation, storage replacement achieves additional emissions reductions of both system-wide and local emissions, beyond the direct reductions at the SCPP site. The modeling of battery storage replacement at the Seymour site led to projected regional CO_2 reductions of over 9,000 tons and local NO_x reductions in New York City of ~9 tons (0.4% reduction) relative to the Base Case in 2030, as shown in Figure 16 and Figure 17.

Similar benefits are achieved when modeling a hybrid configuration at Hell Gate, proportional to the size of the storage unit installed. When performing at its optimal discharge, the battery directly reduces generation and emissions from the SCPP by about 20%, while also further reducing fossil output elsewhere in Zone J. The modeling of hybridization at the Hell Gate site led to projected regional CO_2 reductions of 23,000 tons and local NO_x reductions in New York City of 12 tons (0.6% reduction) relative to the Base Case in 2030. The impacts of replacement and hybridization strategies on local and region-wide emissions are provided in Table 5.

The analysis also examined the system impacts of full replacement of the SCPPs with battery storage in 2035, consistent with NYPA's VISION2030 goals. This provides an initial assessment of the feasibility of "stacked" replacement, whereas the analysis in Section 4 only examined the feasibility of SCPP replacement individually. Two iterations of the "All Replacement" scenario were conducted for 2035. In the first iteration, local congestion increases due to the combined charging loads of the storage units, which in turn leads to an increase in fossil generation in Zone J and a corresponding increase in local emissions of over 60 tons of NO_x emissions, or a 3.7% increase in total Zone J NO_x emissions in 2035 relative to the Base Case. In the second iteration, local congestion was removed to reflect potential upgrades that could occur between now and 2035 with sufficient planning and investment,[41] which eliminated nearly the entire increase in fossil generation, although even with congestion removed, the All Replacement scenario did not achieve additional reductions beyond the direct reductions at the SCPP sites. Further study will be needed, in consultation with Con Ed, including an assessment of potential local transmission congestion pockets, to ensure that the replacement of the SCPPs can be done through a managed transition that ensures that there are not unintended increases in fossil generation and local emissions elsewhere in New York City.

6.2. Transition Analysis

The financial impacts and tradeoffs of each adaptation strategy will be examined. To do so, it is first important to examine the current financial situation of the SCPPs (i.e. the impacts of continuing to operate the SCPPs as-is until 2035 and the counterfactual of retiring the unit without replacement at or before 2035). Given the fiduciary responsibility of NYPA's Board of Trustees to act in the best interest of its mission, the authority, and the public, NYPA will further evaluate the economics of each adaptation strategy prior to implementation.

Historically, capacity market revenues have comprised a large portion of net revenues for each SCPP, with capacity prices in New York City at a premium relative to other capacity market auctions in the rest of the state.

However, in the 2021 capacity auction, Zone J capacity prices fell to historical lows, with a change in local capacity requirements due to the retirement of Indian Point leading to the removal of nearly the entire premium above rest-of-state prices. The future of NYC capacity prices is highly uncertain, as several factors place pressure on the market in opposite directions. The retirement or seasonal deactivation of peaker units due to the New York Department of Environmental Conservation NO_x rule will place upward pressure in the near term in advance of the 2023 and 2025 compliance deadlines, and in the longer term, owners of the existing aging generation fleet may choose to retire rather than making expensive retrofits, especially when faced with the prospect of how to convert the sites to be zero-emissions by 2040 to meet the requirements of the Climate Act. In addition, electrification of heating and vehicles will lead to increasing peak demand in NYC, and put upward pressure on capacity prices. On the other hand, the increase in downstate transfer capacity as a result of the AC Transmission projects as well as new offshore wind and battery storage could place continued downward pressure between now and 2025. In the long term, the Tier 4 projects expected to deliver over 2.5 GW of capacity into NYC, continued deployment of offshore wind to meet the 9 GW target, additional battery storage to facilitate renewable integration, and the achievement of the 100x40 target, could also mitigate potential capacity price increases.

Over the next two decades, SCPP operations are projected to decline significantly, leading to further decreases in energy market revenues – and further reliance on capacity market payments to recover costs. The installation of battery storage at SCPP sites requires a large upfront investment but provides an opportunity to diversify revenue streams; in contrast to the SCPPs which will operate less as renewable penetration increases, batteries are expected to

41 Con Ed is actively planning for local transmission upgrades that will help facilitate the achievement of the Climate Act requirements. In its 2022 rate case filing, Con Ed requested $250 million for investments in new electricity infrastructure. For more detail, see: https://investor.conedison.com/current-plan-information.

operate more over time due to the energy arbitrage opportunities created by renewable additions. In the near term, batteries may also receive substantial revenues from participation in ancillary service markets, though in the long term that source of revenues is highly uncertain given potential market saturation, as the volume of battery storage entering the market is likely to exceed the total requirements by a large margin.

The economics of the SCPP site strategies – including both continued operation of the SCPP until 2035 and replacement with storage – will depend heavily on future outcomes in the NYC capacity market. In addition to price uncertainty, storage additions face the additional uncertainty of market participation and accreditation. NYISO is currently evaluating an ELCC-based framework, in which the amount of UCAP capacity a storage unit would be able to bid into the market would depend on the total market penetration of storage.[42] The tradeoffs between hybridization, replacement, or retirement at the SCPP sites will continue to be assessed as part of the next steps. This evaluation will be performed in close coordination with additional analyses required to understand the system and local reliability needs and the role that storage could play in meeting those needs.

42 NYISO submitted a proposal to FERC in January 2022 to implement a marginal ELCC accreditation approach for renewables and battery storage participation in the capacity market. For more detail, see: https://elibrary.ferc.gov/eLibrary/docinfo?accession_number=20220105-5146.

7 Recommendations and Next Steps

7. Recommendations and Next Steps

7.1. Action Items

Based on the modeling results, NYPA will implement the following actions to enable the clean transition of its peaking assets:

ACTION: Continue Ongoing Stakeholder Engagement: It is vital that the clean energy transition be centered on community engagement and stakeholder buy-in to ensure that the communities most affected by the local impacts of fossil fueled energy resources are prioritized. NYPA will continue to collaborate with stakeholders such as the PEAK Coalition, and will facilitate discussions with other relevant state and city entities, such as NYSERDA, New York Department of Environmental Conservation, New York Department of Public Service, and New York City, as appropriate. NYPA will work with the PEAK Coalition, and other state entities, to proactively identify roadblocks and challenges for renewable resource deployment and identify opportunities for NYPA to facilitate resource deployment in underserved communities.

ACTION: Undertake Initial Reliability Analysis: As an important next step following this analysis, NYPA will engage with Con Edison and the NYISO to undertake the necessary reliability assessments to move forward with the decarbonization of the SCPPs in line with NYPA's VISION2030. This may include local reliability analysis, as well as system-wide planning with the NYISO.

ACTION: Develop Strategic Roadmap: NYPA will develop a working roadmap of the organization's near-term strategy for its SCPPs by the end of 2022, in alignment with VISION2030. This roadmap will include specific next steps to be undertaken over the next five years, along with a high-level plan for the full transition by 2035. The roadmap will be a living document revisited on a regular basis to reflect changes in reliability, system resilience, policy, and technological feasibility. NYPA will coordinate with NYSERDA, the New York State Department of Public Service, the City of New York, NYISO, and relevant investor-owned utilities on relevant analysis and studies underway.

7.2. Other Collaborations

To further advance its VISION2030 strategic goals, NYPA will look to pursue additional collaborations with the PEAK Coalition and other key stakeholders, as detailed below:

Jobs study

NYPA will investigate a collaboration with the PEAK Coalition, NYSERDA, and other relevant entities to support an examination of the economic development impact of decarbonization industry wide. This study will utilize existing research and identify expected job needs, necessary skills training to fill those needs, and business and community impacts.

Community resource engagement

NYPA is actively involved in providing energy services to our customers to enable distributed energy development. In line with Governor Hochul's expansion of the NY-Sun Program, which aims to achieve at least 10 gigawatts of distributed solar energy by 2030 and create 6,000 new solar jobs, NYPA will continue to provide advisory services in support of community solar. NYPA will work with NYSERDA and other state entities to support stakeholders in exploring the development of programs designed to incentivize and catalyze the installation of community-sited solar and energy storage and other distributed resources, including demand response, energy efficiency, and flexible electric transport load, particularly in communities that have historically seen lower levels of deployment of these important resources.