The Challenges of Deploying Battery Energy Storage Infrastructure in New York State

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Abstract

Clarifying the deployment challenges of Battery Energy Storage System (BESS) infrastructure can better enable the improvement of energy transition. The flexibility of BESS infrastructure to store and deliver energy while avoiding the space requirement of energy generation and transmission systems is conducive to developing net-zero cities.

However, deploying BESS infrastructure brings comprehensive challenges for policymakers, investors, developers, and other market participants. From a planning perspective, available financing tools, tax incentives, the legal and permitting framework, zoning and regulation requirements are all potential factors that can lead to deployment obstacles.

At a state level, this thesis clarifies the benefits of developing BESS infrastructure, outlines the process from planning to implementation, points out the key players and partnership, discusses the obstacles to meeting the policy goals, and provides the planning leadership with recommendations for accelerating the deployment process.

Keywords: Battery Energy Storage System (BESS), Bridge Incentives, Mandatory Procurement, Ancillary Services, EPA's Planning for Sustainability, Long-term Contract, Utility Off-taker, CLCPA

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List of Abbreviations

BESS … Battery Energy Storage System
BTM … Behind-the-meter
CLCPA … Climate Leadership and Community Protection Act
DERs … Distributed Energy Resources
DG … Distributed Generation
DSP … Distribution System Platform
EOM … Energy-only-market
FTM … Front-the-meter
GHG … Greenhouse Gas
IPP … Independent Power Producer
ISO … Independent System Operator
LTC … Long-term Contract
MW/MWh … megawatt/megawatt-hour
NYPSC … New York Public Service Commission
NYSERDA … New York State Energy Research and Development Authority
PPA …Power Purchase Agreement
REV … Reforming the Energy Vision
RFP … Request of Proposals

SGIP … Self-Generation Incentive Program

SOEs … State-owned-enterprises

SPV …Special Purpose Vehicle

VRE …Variable Renewable Energy

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Chapter 1. Introduction

1.1 Objective and Significance

Energy transmission infrastructure is an emerging domain for planners to study. Although renewable energy generation infrastructure, such as solar panels and offshore wind farms, are deployed worldwide to promote clean energy applications, they cannot realize consistent energy production at all hours a day. One of the key solutions to mitigate such “intermittency” issues is to invest and build more energy transition infrastructure that ensures a stable energy market by linking front-the-meter (FTM) power sources and behind-the-meter (BTM) technologies. FTM sources usually include power plants and utility-scale grid infrastructure, BTM technologies are as residential solar panels and commercial electric vehicle charging stations.

The key player in energy transmission infrastructure will be the Battery Energy Storage System (BESS), which relies on lithium-ion battery technology and thus is able to efficiently store energy capacity produced by power generators and then supply electricity to urban use when needed. BESS has many advantages over other types of energy storage projects. It does not require many land areas to deploy, which has no land conflict issue between land use planning. It can store excess and low-priced electricity at off-peak times and distribute electricity during higher-priced peak hours, which benefits the intermittency mitigation. As a potential new urban infrastructure asset, it can also collaborate with solar panels and urban microgrids through co-location strategies, ensuring electricity supply efficiency and power independence for isolated urban areas.

However, compared to its clear prospect for enhancing the energy transition, transmission, and addressing the climate environment, the challenges of deploying BESS in urban areas are still high. As a new choice for urban infrastructure investment, BESS still needs to be further explored for lesson-learned based on real-world case studies, which could help provide timely recommendations for leadership to deploy BESS in cities.

Research Question

The thesis focuses on one research objective, which is to clarify the challenges of deploying battery energy storage (BESS) infrastructure in New York State, which can help provide timely recommendations for planning leadership to promote the battery energy storage infrastructure deployment.

Purpose Statement

This research aims to study the current process and real practice of deploying BESS in New York State, observe its compatibility with a sustainability planning framework, and discuss the key challenges for the State. It finally provides planning leadership with policy recommendations to better manage the current deployment process in a trade-off manner.

Significance to Urban Planners

Urban planners are in the irreplaceable position that can balance both social and spatial considerations by leading the net-zero urbanization processes from planning to implementation. The energy transition from conventional to renewable is a mutual task for policymakers, legislators, regulators, operators, and developers. One significant role of urban planners in the energy sector is promoting collaboration among two or more of these players by specifying the

social forces behind the projects and reframing the partnership. Therefore, for an emerging urban investment, such as BESS infrastructure, urban planners should clarify the limitations of the current deployment process and improve it based on proper planning approaches.

1.2 Research Design and Methods

The research design is essentially a process study that evaluates the current BESS deployment process in New York State. It collects factual information related to the current process of deploying BESS in New York State by case analysis, recategorize and critically discuss such information under a criterion-based planning approach (the EPA guideline) and clarify the challenges during such a process.

Focusing on New York State

The thesis focuses on discussing BESS practice in New York State. Although California has been the leader in the energy storage market for the past decade, New York State is positioning itself to become one of the fastest growing markets for BESS deployment. NYS has no advantage over California in overall installed capacity and utility ownership allowance, however, the gap between the two states' energy storage deployment may narrow due to a series of state-level policy goals and incentives.

The low-carbon development goals under the CLCPA policy in NYS encourage private investors (non-utility) to develop more energy storage infrastructure,[1] balancing the investment in storage equipment between FTM and BTM sides of the sector, and mandates electric

[1] New York's Climate Leadership and Community Protection Act (CLCPA) policy is the most leading energy development policy in New York State, which frames both social and economic development goals for energy infrastructure deployment and electricity market.

distribution utilities to contract targeted capacity. This latter step would provide BESS infrastructure with long-term predictable revenues and therefore accelerate the deployment of energy storage assets across the state.

Information Collection from Cases

This thesis selects two real-world projects in New York State. The Ravenswood project under development by LS Power, and the East River project under development by Hanwha's 174 Global Energy project. The East River is under construction due to winning the bidding process and contracting with the utility off-taker Consolidated Edison. However, the Ravenswood is on-hold since it has no contracts and incentives support.

One worthiness of studying these two cases is that both provide plentiful detailed information on exploring the factors to deployment success. They share similar backgrounds but currently their project status differs. This would be the basis for a comparative case analysis that intends to clarify the challenges of deploying BESS infrastructure for cities.

Another worthiness of studying these two cases is that they provide a lens to observe the collaboration process among stakeholders in NYS. The key stakeholders mentioned in these cases include government agencies such as New York State Energy Research and Development Authority(NYSERDA) and New York Public Service Commission (NYPSC), utility big buyers such as Consolidated Edison (Con Edison), and BESS developers such as LS Power and 174 Global Power. The research on their background and collaboration provides an accurate understanding of the responsibility and role of each player, and therefore can help lead to specific recommendations for every single participant for future actions.

Information Reclassification and Analysis under the EPA Criterion

The thesis seeks to adopt the EPA guideline from planning water infrastructure to planning energy assets like BESS. This guideline can be applied to any environmental, economic, and sustainable development project, as long as having clarification of the planning leadership during the deployment process and ensuring that the decision-making recommendations are tailored for them.

The EPA planning approach indicates four criteria as the required elements for planning a sustainable infrastructure, which is beneficial for reclassifying and analyzing the key takeaways we have found in two cases based on a sustainability standard. These four criteria are: (1) Sustainable Goal-setting, (2) Objectives and Strategies, (3) Project Alternatives, and (4) Financing Strategy.

By adopting these four elements as the analysis criteria, the thesis evaluates if the current BESS process and practice in New York State is compatible for a sustainable deployment process standard, and clarifies the specific actions for planning leadership to improve the deployment process.

Chapter 2. Background

2.1 Power Industry & Infrastructure

From an industrial perspective, the urban power industry includes 1) energy generation, 2) energy transmission, and 3) energy distribution. Generation infrastructure generally includes traditional fossil fuel-fired plants, nuclear, renewable solar, and on-shore and offshore wind farms. Transmission infrastructure includes utility grids connecting generators with the distribution infrastructure with some connections among micro-grida and storage systems. Distribution infrastructure commonly serves residential, commercial, and industrial customer/end-users.

From a market application perspective, power industry assets can be classified as having front-the-meter (FTM) and behind-the-meter (BTM) applications[2]. The FTM includes the infrastructure that brings power to customers: the large-scale configurations of generation that are fed directly into the grid infrastructure owned by utilities, managed by system operators. BTM, on the other hand involves end-user assets for the use of energy on-site and sometimes connecting with other electric customers in nearby areas within a microgrid or within industrial hubs or urban facilities. BTM serves the customer side.

Energy transmission is an intermediary between energy generation and energy distribution. The Battery Energy Storage System (BESS) can play a role as one component of energy transmission: excess power can be received and stored at load centers during off-peak hours for

[2] The classification of market applications are found in the introduction section from IRENA's Utility-scale Batteries.

later discharge during high-peak periods. This reduces the need for expanding transmission capacity.

2.2 Battery Energy Storage System (BESS) Infrastructure

Investment in Battery Energy Storage System (BESS) assets is becoming a trend for both BTM and FTM sectors. This is because battery prices continuously decline and BESS investments become more affordable. As a FTM asset BESS also complements system operators who dispatch generation to meet changing loads since the battery has a faster responding time than other generators such as hydrogen and thermal, such an attribute of BESS is more in line with the goal of developing a flexible and efficient power system for a sustainable city.

2.2.1 Technical-based Revenue Generation

Currently, investment in the BESS is primarily expected from private non-utility owners who measure their returns from a more limited range of revenue-sources: variable ancillary services sales and energy arbitrage.

1. *Revenue Stream One: Power system-wide benefits (ancillary services)*

A BESS infrastructure project is not only a physical property, also a package of energy services such as demand management, backup generation, power quality enhancement, and more – commonly referred to as *ancillary services* to the operation of an electricity system.[3] Ancillary services under BESS include frequency regulation, flexible ramping, load following, voltage support, spinning reserve, black start service, and frequency response. In the past, gas-fired

[3] Moody's report indicates that BESS could not only be an infrastructure, also a commodity for sale as one sort of service package.

peaking plants commonly performed these services, but in the future, BESS can support natural gas peaking facilities to make up for the shortcoming due to their long response time under high demands.

According to the IRENA's global case study, it is clear to see that the majority of ancillary services worldwide under successful BESS are flexible ramping, frequency regulation, capacity firming, grid stability support, resource inventory management, investment deferral, and congestion mitigation.[4] These ancillary services can be traded as commodities earning revenues for their investors in some liberalized electricity markets.

- *Flexible Ramping*: BESS could reduce the gap between the day's peak load and the day's minimum generation. For energy storage systems, the electricity demand for equipment increases after sunset, and the supply pressure is relatively large at that time. The Flexible Ramping service can alleviate the contradiction between supply and demand by reducing the peak ramp rate and peak load. The performance of improved flexible ramping using BESS can be seen by the Duck Curve analysis (Figure 1). The duck curve is a graphic representation of power production during certain times that show the timing imbalance between peak demand and renewable energy production. It could be used as a model to analyze the efficiency of ancillary services (i.e., frequency control).

[4] The case list covers more than 20 BESS projects developed worldwide and indicates the key service they have.

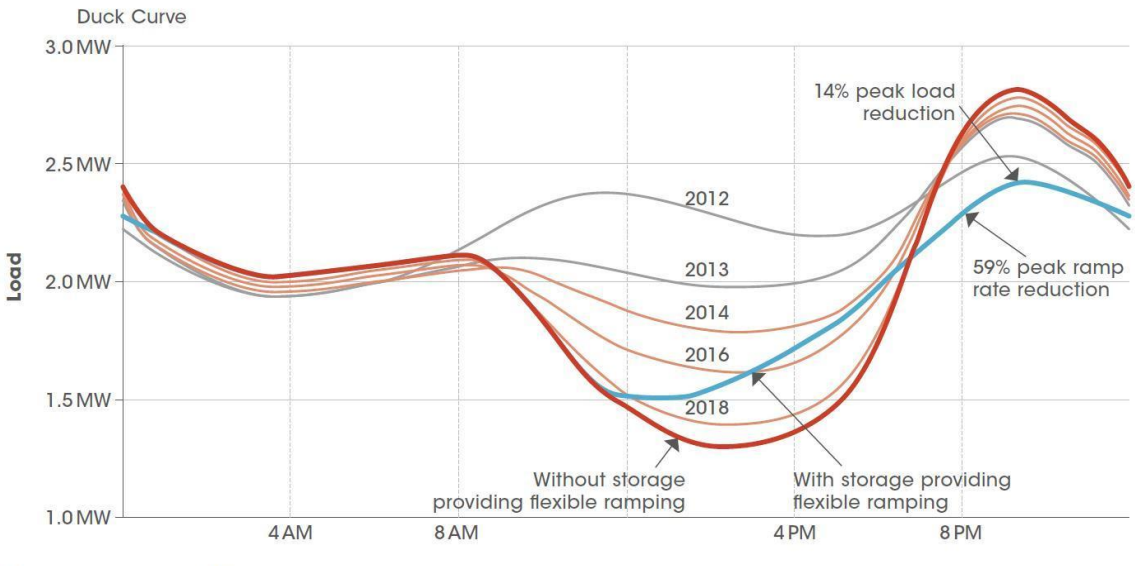

Figure 1: Duck curve explanation: The flexible ramping service is prominently improved by energy storage facility support. Source: Sunverge (2015)

- *Frequency Regulation*: According to IRENA's research, a 10-20% reduction in fossil fuel use led by frequency regulation will save $25-50 million. In Australia, frequency control within ancillary services is becoming the primary revenue stream for the BESS project (BloombergNEF, 2021).

- *Capacity Firming*: The essence of firming capacity is to ensure generation smoothening, which is beneficial for business negotiations as it increases supply certainty and the possibility of 24/7 supply (IRENA, 2018).

- *Grid Stability Support:* This service removes the fluctuating output of solar and wind energy that would otherwise disrupt the frequency balance on the existing grid infrastructure. Both solar panels and wind farms are prone to ramp up and ramp down during power generation processes, leading to grid instability. BESS with short

charge-discharge cycles on the order of seconds can respond to fluctuating renewable energy output faster and more accurately than thermal power plants (Barrow, 2017).

- *Resource Inventory Management:* BESS can help integrate renewables by shifting supply to better align with demand. By doing so, the curtailment of these excess sources is avoided. A potential challenge is that this service requires batteries with longer charge-and-discharge cycles on the order of hours.

- *Investment Deferral:* BESS could delay the investment in peak plant upgrades and infrastructure reinforcement. Such investment deferral "discharges electricity during peak hours, displacing peak generators and deferring further investment in peaking plants" (IRENA, 2019). Some pivot projects have been completed in New York City, California, and Texas, where utility-scale batteries serve as deferral strategies for delaying grid upgrades. Existing research work shows a quantitative algorithm for a successful BESS project that a 4MW/40MWh BESS project can help the independent system operator in the New York State (NYISO) save $2.03 million in project costs compared to such projects that would have been used as conventional fuel costs. Such a project, in the meanwhile, reduces almost 400 hours of congestion between transmission and distribution (IEEE, 2017). Another case shows that 11.5GW BESS can save $22 billion in scaled electricity markets, assuming these costs would have been spent on conventional grid infrastructure (NYSERDA, 2018).

- *Congestion Mitigation:* From a BTM perspective, a power congestion issue usually happens during transmission and distribution. Due to the high load-carrying capacity required for the grids during the peak demand hours, power operators generally increase

investment in improving existing grid infrastructure to solve the problem, but this does not solve the power transmission pressure for specific areas with unforeseen troubles. Considering the rebuild of the entire grid is often not realistic for stakeholders, BESS becomes a trade-off choice due to its capacity elasticity and intermediate response to transmission-distribution systems while facing unpredictable events like climate disasters (Walton, 2020).

2. *Revenue Stream Two: Energy arbitrage*

For a non-utility owner, the BESS projects' viability will mainly depend on the cost of storage and the revenues that storage can generate from electricity wholesale markets. This performance of BESS based on energy arbitrage validates the standpoint of some economists, they tend to regard energy storage infrastructure as a new type of generating plant "that buys energy when prices are low and then sells it when prices are high, effectively moving electricity generated in one period to a later period of time" (Joskow, 2019).

2.2.2 Economic and Societal Benefits

Planning utility-scale BESS infrastructure brings great opportunities for cities to be more beneficial for land-use planning, energy saving, climate resilient, and urban investment.

- *Higher Land Use Efficiency:* Scaling up investment in BESS does not require a lot of land areas. This is mainly because BESS is feasible to scale up deployment for its basic unit of BESS (i.e., lithium-ion batteries) , is easy to bundle and occupies limited lands. BESS is a storage solution for overplus capacity produced by solar panels and off-shore wind farms that need land area support. Therefore, deploying BESS is essentially a

compromise for the land conflict issue between land use proposals and renewable infrastructure development (IRENA, 2019).

- *Environmental benefits*: BESS will not emit greenhouse gasses. It compliments the reduction of carbon output by transiting renewable energy from offshore wind farms and solar PV plants to cities, lowering customer bills for energy transmission upgrades and improving public health and equity. In addition, BESS deployment results in more resilient electric grids that are more fast-responded to storms and climate changes (Walton, 2020).

- *Industry-wide collaboration:* For developing a future electricity market in a low-carbon manner, deploying more BESS infrastructure is one of the most important strategies.[5] BESS infrastructure is expected to replace or reduce the needs for the conventional gas generators during periods when wind and solar sources are unable to match dynamic demands (IRENA, 2019). As 2019 is the first time that energy consumption from wind plus solar exceeded coal consumption in the U.S., addressing this intermittency issue becomes increasingly urgent. The rise of BESS, as a signal of problem solving, means an industry-wide incremental innovation and discussion would jump-start in multiple fields: technologies employed, land-use requirement, locational advantages, legal framework, market structure, costs and revenue sources, social and spatial impact (Yearbook, 2021).

- *Phasing Out the Conventional Fossil Fuel:* The Hawaii case indicates that BESS is able to improve the local entire renewable energy networks and phases out the local reliance

[5] One of the key points indicated in *Trends in Project Finance for US Energy Storage*.

of traditional fuels.[6] In the Bakken Hale case, even with an installed capacity as small as 1MWh, the BESS project could help locals reduce 97% fossil fuel usage.

- *Developing during Pandemic:* Globally, the annual revenues of energy storage projects in 2019 are $0.75 billion and will double to $1.5 billion in 2020. It might be too early to claim that the development of energy storage is not affected by Covid-19, but annual revenues are further expected to be $7 billion in 2025, referencing this trend (Yearbook, 2021).

2.2.3 BESS Market Trends

With the increasing global demand for clean energy, there will be more needs for BESS deployment. The specific scale of storage capacity that infrastructure developers invest in depends on the market demands of the energy storage industry.

Global market: More than 50% of the energy storage projects in the worldwide energy storage industry are used for utility-scale, followed by commercial and residential usage.[7] The total installed capacity of the global energy storage deployment market in 2017 was 10GW.[8] The U.S. is the world leader and has the highest project growth rate, China and Japan are leading the Asian markets, Germany and the U.K. dominate the European market. For almost all the countries in statistics, their top three customer groups in the electricity market are utility-scale, residential, and commercial.

[6] Hawaii case description.
[7] Date collected from BloombergNEF energy storage system (ESS) market analysis report.
[8] Date collected from IRENA annual report 2019.

US market: utility-scale energy storage quadrupled in the five years, from 214MW in 2014 to 899MW in 2019. The annual deployment of energy storage resources in the United States is 311MW in 2018, 1.2 GW in 2020, 4GW in 2021, and 7GW in 2025, indicating an annual doubling development trend. The increasing amount of dispatchable renewable generation proves the active participation of stakeholders in this new market. Among them, the energy storage projects for FTM in the United States accounted for 83% of the total capacity in 2021 and are expected to be controlled in the range of about 65-70% in 2025.[9]

New York State market: the total number of development applications of energy storage projects has increased tenfold in the past eight years, from 3 to 35, which represents an incremental performance in response to New York State's sustainability policy, the Climate Leadership and Community Protection Act (CLCPA). The purpose of enacting CLCPA and signing it into the state law is to mandate the carbon emission for the state. CLCPA outlines several goals for New York State to reach “70 percent renewable energy by 2030, 100 percent zero-emission electricity by 2040, and an 85 percent reduction in greenhouse gas emissions by 2050” (Collins, 2022).

2.3 Key Players in New York State

The Operator: New York Independent System Operator (NYISO)

Independent System Operator (ISO) is an option, based on the ISOs found in the US and Latin America. It is responsible for energy system operation, transmission planning, and administering system delivery, however, the ISO would not own any transmission assets. The

[9] Data collected from the press release *Lacking Contracts*.

most key feature of the ISO is its independence from any market participants, so no substantial market code changes are needed under the ISO option (Strbac, 2014).

The basic responsibilities of ISO in New York State electricity markets (NYISO) is to be in charge of the energy market operation, reliability, and planning of overall regional grid infrastructure, supporting the state's high-voltage transmission network, and the administration and monitoring of the state's wholesale electricity, capacity, and ancillary services markets. There are two market behaviors for NYISO to play its role in electricity markets, 1) market-run, and 2) market-oversee. In terms of the market-run, NYISO runs both day-ahead and real-time spot markets for electricity. For the market-oversee, NYISO monitors direct transactions between buyers and sellers, which is called bilateral transactions (Charles River Associates, 2017).

The Regulator: New York Public Service Commission (NYPSC)

NYPSC is an umbrella organization of New York Department of Public Service (DPS). The PSC directs two things: 1) ensure the state could finish the capacity goals, 2) ensure the scope and speed of deploying energy storage infrastructure. They ordered that "each individual utility deploy and operate energy storage systems at a minimum of two separate distribution substations or feeders in an effort to provide two different grid service types (Kaatz, 2017).

A collaboration mode between the NYPSC and NYISO is that the PSC may increase the state's renewable builds, which could significantly impact both energy and capacity markets for the NYISO. For example, DPS requires New York State to generate 50% of all electricity from renewable sources by 2030 ("50 by 30"), which requires more installed reserve margin for

NYCA to ensure the maintenance of overall system reliability.[10] Such a reserve margin will have a substantial impact on the market design (Charles River Association).

From a project risk and cost perspective, regulation is essentially a kind of long-term contract. Although regulation cost is high, it has little risk of 1) profit risk and 2) price shocks for consumers (Cramton, 2006). This means that the regulation recommendations are also one sort of financing strategy.

The Off-taker: Consolidated Edison (Con Edison)

The utility off-taker (big buyer) like Con Edison could play a dominant role in leading the BESS market in NYS. As one of the types of incentive approach, a central procurement strategy, specifically, utility as a single buyer, is allowed to incentivize the renewable energy market. Specifically, in NYS, the utility is required to hold a competitive bidding process and sign a long-term contract with the winning bidder (developer). The prices paid usually reflect bidders' proposals. The utility has the right to determine the amount of capacity to be procured and the appropriate timing. Then a request for proposals (RFP) is issued for inviting investors to issue bids to supply renewable energy.

The disadvantage of central procurement is that there are too many complex administrative processes during project deployment. The central procurement provides agencies or institutions with high requirements to hold the bidding process with reasonable evolution criterion, otherwise third-party consultants will be relied on. Last but not least, a potential

[10] Reserve margin is (capacity minus demand)/demand, which is used to indicate the ability for markets to ensure a long-term balance of electric supply and demand.

disadvantage is that the winning bidders might not complete the power facilities according to the contracted time-frame.

2.4 The EPA Guideline: a standard for analyzing NYS process and practice

Planning for utility-scale BESS in cities is one of the most important strategies to pursue SDG 7.[11] However, bulk-scale BESS is still a new topic for urban planners. So, planning BESS should learn from a mature planning process, which is fundamental for planners to better ensure the long-term sustainability of BESS proposal to be built according to a series of core criterion: 1) clear objectives, 2) specific strategies, 3) sufficient alternatives, and 4) effective financial strategy.

In 2012, the United States Environmental Protection Agency (EPA) published a handbook for guiding water and wastewater utilities to improve services, named "Planning for Sustainability". This guidance is essentially an integration criterion for improving infrastructure services and water access. This guideline indicates a planning paradigm of utility services, overlapping several planning issues to one specific project, for example, to improve urban water access by revising land use proposals.

According to the EPA guideline, water and energy share the same sustainable value, social, and spatial concerns, including 1) access to safe, reliable & affordable service to the public, 2) adequate & equitable access, 3) environmental benefits like pollution reduction, and 4) efficiency enhancement of operation and management (EPA, 2012).

[11] SDG 7 aims to ensure access to affordable, reliable, sustainable and modern energy for all.

Chapter 3. Literature Review

The literature relating to the dilemma of energy storage infrastructure deployment could be classified into three categories: 1) planning and implementation obstacles, 2) incentives and regulation dilemma, and 3) financing challenges.

3.1 Planning and Implementation Obstacles

Lacking Leadership

To mitigate the investment and deployment lagging of energy infrastructure, a key task often arises as to who is responsible for planning. In the old industry model, national utilities played a role to link between planning, investment, decision-making and the procurement of new capacity. In the new hybrid industry, the planning role might need to be transferred from utilities to government agencies. However, they produce rigid master plans but soon become dated, which still undermines the process of timely and efficient private investment (Gratwick, 2008).

The core of such leadership is to realize the electricity sector's reform. A consensus on the sequence of electricity sectors' reform is 1) raise prices to ensure the cost-recovering, 2) reinvestment and create regulatory institutions and restructure the sector, and 3) only after that privatizing. However, two challenges of completing this process are 1) lacking specific institutions to implement the model, 2) lacking pricing reform that balances economic efficiency and social equity (Kessides, 2012). The essence of the sequence of reform is about how to define the order of 1) introduction of privatization, 2) market competition, and 3) market regulation. Further research could concentrate upon developing these three variables (Zhang, 2005).

Siting Strategy

The obstacles of siting energy infrastructure varies from project cycles of implementation and considerations of site conditions. Every single energy project or facility has every single condition, which means they have unique issues beyond those normal issues that can be solved by standard technical tools (Tierney, 2002).

"Intervention assistance" should be one recommendation to promote the implementation of energy infrastructure. The essence is to invest specific resources in to assist the public in siting selection processes. A good example is California encourages constructive public participation through the government agencies' support and ensures information transparency between potential parties and project applications. This strategy helps the public better understand the siting process and the purpose of project deployment (Tierney, 2002).

The Willingness of Implementation

Legislation conditions and implementation capacity are insufficient to help energy infrastructure be deployed. For example, the willingness to implement energy infrastructure is a barrier for Colombia to build more distributed generation (DG) schemes, although the country has a law that requires the DG to be established within the National Interconnected System. While in the US and EU, the legislation and incentives are limited to help grid operators to offset the upgrading cost of technical and operational equipment before collaborating with the grid systems (Hernandez, 2015).

Utility-scale BESS is Yet to be Built

One challenge of deploying storage infrastructure, such as distributed generation, battery energy storage, and demand response services for cities, is that they might not meet minimum size requirements (absent aggregation) or minimum discharge time requirements. Future recommendations might focus on governing capacity resource qualification with necessity and appropriateness (Commission, 2013). However, the rise of BESS could be a solution, for its possibility to be bundled and thus can provide utility-scale services. For example, BTM batteries are that they can be bundled together and to serve bulk systems with resource adequacy, field cost reductions, energy arbitrage, ancillary services, and transmission and distortion capacity investment deferral. The owners of the battery projects can even be awarded incentive payments due to such demand response participation (Hledik, 2018).

Therefore, the utility-scale of BESS needs to be widely built. Utility-scale BESS utilizes stationary batteries to store and distribute electric resources from current grids to anywhere that needs power, which helps renewable energy penetrate a more densely populated existing electricity grid. In addition, utility BESS could contribute to energy independence for isolated urban spaces far from distribution centers and further let them rely less on expensive diesel generators. These utility-scale applications effectively reduce GHG emissions for the regions by balancing demands for both generation and distribution (Moody's, 2018).

3.2 Incentives and Regulatory Dilemma

Limited Policy Incentives

The IRENA 2019 report mentions that the upfront investment costs are still a barrier to the growth of the large-scale battery storage market. Despite the significant reduction in the cost of several battery technologies, the upfront costs for deploying large-scale battery storage

systems remain high for most stakeholders. National and local governments can stimulate demand by providing subsidies to battery storage owners, which would scale up BESS deployment and reduce the upfront cost burden.

It is also valuable to notice that the policy incentives to make up for the economic viability gap of electricity storage projects could be similar to those used to support variable renewable energy (VRE) deployment in its early stages of development. These incentives could include capacity payment, grants, feed-in-tariffs, peak reduction incentives, investment tax credits, or accelerated depreciation (IRENA, forthcoming).

Immature Market Regulations

For regulators, there are many questions that are yet to be solved, including interconnection rules, the terms and conditions of participation in energy and ancillary services markets, and storage treatment as a capacity resource eligible for capacity payments (Joskow, 2019). The current efforts of state regulators, the Department of Energy, and the ISOs include policy adoption , development of pilot programs, and mandates to facilitate the entry of more storage capacity. As long-term contracts with predictable revenues seem to be most attractive to private (non-utility) investors, these policies rely on project procurement through competitive bidding to win long-term purchase power agreements (PPAs) designed for energy storage (Joskow, 2019).[12]

Another factor limiting the deployment of the energy storage infrastructure is that the regulator always uses the rate-of-return criteria to allocate project resources. However, the

[12] A power purchase agreement, or PPA, is a contract signed between power producers (sellers) and power off-takers (buyers). It can be used as an indicator for project finance investment, for the price within agreement would influence the credit rating and cash flow production. The seller under the PPA is typically an independent power producer (IPP) (Ross, 2021).

project developers are motivated to substitute between indicators that are difficult for regulatory agencies to detect to gain more resources. This behavior might lead to an ineffective pricing strategy (Averch, 1962). Regulators are the key players in pricing the market and promote project development based on the pricing strategy. The current fact is, pricing is a dilemma. The root cause is the dichotomy between market competition and resource monopoly (McDermott, 2012).[13]

One recommendation to help regulators improve the energy storage market is to encourage retail-scale business models to offset the wholesale market decline. According to the analysis of S&P (Hering, 2021), from a credit perspective, "the profitability of the retail and wholesale businesses move up and down in counter-cycles" (Tierney, 2002).

3.3 Financing Challenges

Lacking Investment

One big challenge for developing countries to develop hybrid energy markets is the investment limitation. Since utilities and SOEs are unable to finance power projects and the local governments do not want to commit public resources, the IPPs are invited to build the markets. It is true that SOEs, as the incumbent, still play a dominant role in managing the power industry in most developing countries, they continue to contribute more capacity (Gratwick, 2008). On the other hand, a major issue limiting investment in BESS is that the range of benefits it brings including enhancements to system-wide grid operators and to societal goals do not all flow to the investor.

[13] Since the 1880s and 1890s, the economic theory of firms defined a necessity of trade-off between service supply and price setting, which requires developers to pursue legitimate and prudent costs that could be recovered. (McDermott, 2012, pp7)

Limited Revenue Streams

Many non-utility investors are interested in investing in BESS assets to obtain revenues from energy arbitrage and *ancillary services* (described above), such as spinning reserves, frequency regulation, and voltage support. However, the wholesale electricity market is still challenging to monetize these services to ensure predictable capital returns. According to Barrow's article, a potential reason is that the electricity market design is yet to be able to frame a compensatory structure for these services. This shortcoming leads to a single buyer model being more common, which means most storage projects need a firm predictable revenue stream from a single off-taker to obtain financing. Barrow mentions that since the number of BESS projects is expected to increase in the future when only development costs decline and having multiple revenue streams, it is reasonable to judge that the scale-up deployment of BESS would not be realized if the revenue stream is limited (Barrow, 2017).

On the other hand, *ancillary services* are not enough to ensure capital returns for energy developers. Joskow's article noticed that the revenues produced by ancillary services are not predictable enough for BESS projects to attract investment resources. Ancillary services are usually determined in competitive daily auctions so they bring the BESS a complicated and variable revenue model. Whether a project is profitable depends on the sum of these energy arbitrage and ancillary services revenue streams. Even the sum of revenues generated by all these services are a relatively small fraction of the benefits produced by these projects (Joskow, 2019). The net revenues earned from merchant (i.e. uncontracted) sales of energy, capacity, and ancillary services based on price arbitrage opportunities have not been sufficient on their own to attract investment.

Revenue Conflict Between Renewables and Conventional

There is a revenue space conflict between renewable and traditional infrastructure. According to the AESO report, the negative impact of renewable infrastructure on the current electricity market is that it might reduce the revenue of non-renewable (conventional) energy generators. This is because solar panels and off-shore wind farms would lower the price in more hours for customers, and such a fact limits the revenue space for traditional energy generators.

This is one of the main reasons BESS is urgently needed. The key method to mitigate this issue is to develop energy storage infrastructure for cities, because "Increasing the amount of intermittent renewable resources and retiring coal-fired generating units will require additional firm dispatchable generation" (AESO, 2016).

Ownership and Long-term Contract (LTC)

Ownership is an essential factor used to influence the BESS deployment. Because they reduce the market competition if they can help power projects be operated under a centrally managed transmission system. Therefore, whether the deployment of BESS infrastructure could be accelerated varies on the ownership strategy (Wilson, 2002). The boldest example might be in California, which allows utility units to own generation properties and divest (non-nuclear) thermal generation in the state. The utility-owned model in California mitigates market power dominance, at the same time, it still allows a single buyer model (utility model) to let these projects participate in electricity markets (Wilson, 2002). However, utility ownership is controversial, for it stands on the opposition side to energy market liberalization.

Lacking long-term contracts (LTC) is another key factor that leads to cost and risk fluctuations which are the key consideration when deploying the BESS. Since LTC provides developers with long-term and predictable revenues, it is one sort of hedging strategy that helps the developers respond to external forces. Therefore, it should be examined firstly if LTC has become an issue when discussing the BESS deployment (Cramton, 2006).

Although LTC is a safe strategy for developers, it is not an ideal choice for the electricity market structure. AESO indicates four market structures to operate the electricity system.[14] Among these, the long-term contract (LTC) structure, which is currently encouraged by the New York State, does not provide a reasonable cost to electricity customers as the energy-only market (EOM) does. This is because although the LTC provides predictable revenue for developers and investors, it usually has the following disadvantages: 1) high risk of compensating technical barriers, 2) risk-sharing with consumers and the public, 3) lacking incentives to accelerate, 4) produce long-term costs of consumers, and 5) over-procurement risk during a long period of time like 20-plus years (AESO, 2016). In addition, not only for electricity market structure, the LTC also brings developers and investors limitations. As a consequence of signing long term contracts for the existing plants, there is not much revenue space for the project companies (SPVs), because they cannot share the benefits from the increasing feedstock price after contracting (Cramton, 2006).

Moreover, although a long-term contract is the only market mechanism to address the present concerns, and more forward contracts should be encouraged to sign as a hedging strategy to reduce the feedstock cost, the core of the current challenges of long-term contracts is that

[14] Two market-based structures, including 1) Energy-only market (EOM), and 2) Capacity market (CAP). Two non-market structures, including 1) Long-term contract (LTC), and 2) Cost of service regulation (COS).

residential and other small consumers are not appropriately represented in the contemporary market design, which results in no counter-party to contract, and thus the contracting is hard to be implemented (Cramton, 2006).

Chapter 4. Analysis & Findings

4.1 BESS in New York State: Process & Practice

It could be better to understand the New York State process from a comparative lens between California and NYS. The major difference between the energy markets in California and New York State is the regulatory approaches. The New York adopts Reforming the Energy Vision (REV) proceedings, redefining the utility model as a collection of functions called a Distribution System Platform (DSP), authorizing utilities the leadership role to combine planning and operation process. California regards distributed energy resources (DERs) as one component of the complex regulatory regime through the Self-Generation Incentive Program (SGIP), which is not a single framework (Kaatz, 2017).

NYS Process: Encourage multiple revenue streams

California's emphasis on incentivizing the investment in DER resources (decentralized), including increasing energy storage, electric vehicles (EVs), the planning and operational value of DERs for both end-use customers and distribution operators (DOs) without changing utility business models. California lacks a leading regulatory DER vision comparable to New York's REV, they regard the DER Action Plan issued by the California Public Utilities Commission (CPUC) as a policy guidance to develop projects.

New York State, however, emphasizes systematic planning and regulatory changes (centralized). The single framework (utility model) is implemented by NYPSC, who also opened the Distribution System Implementation Plan (DSIP) under the DSP to promote multiple revenue

stream based distribution markets that are supported by third-party participation (private non-utility investors).

A conceptual Distributed Energy Resource Roadmap (Figure 2) issued by NYISO is valuable to understand how NYS achieves its policy goals under the REV initiative and Clean Energy Standard.[15] However, NYISO also points out the current DERs are unable to support bulk power systems under current existing market rules.

This has led CLCPA, the market policy maker in the New York State, to require the market regulator NYPSC to develop programs for procurement of at least 3,000 MW of statewide energy storage capacity by 2030, which can ensure the statewide electrical demand system will generate zero emissions by the year 2040. According to the NYPSC's mandatory requirement, utility buyers like Consolidated Edison in New York State must purchase certain capacities based on their own schedule until 2030. The Ravenswood in Long Island City (300MW) and the East River in Astoria Queens (300MW) are two representative cases which are developed under this background.

[15] Distributed Energy Resources Roadmap for New York's Wholesale Electricity Markets: https://www.nyiso.com/documents/20142/1391862/Distributed_Energy_Resources_Roadmap.pdf

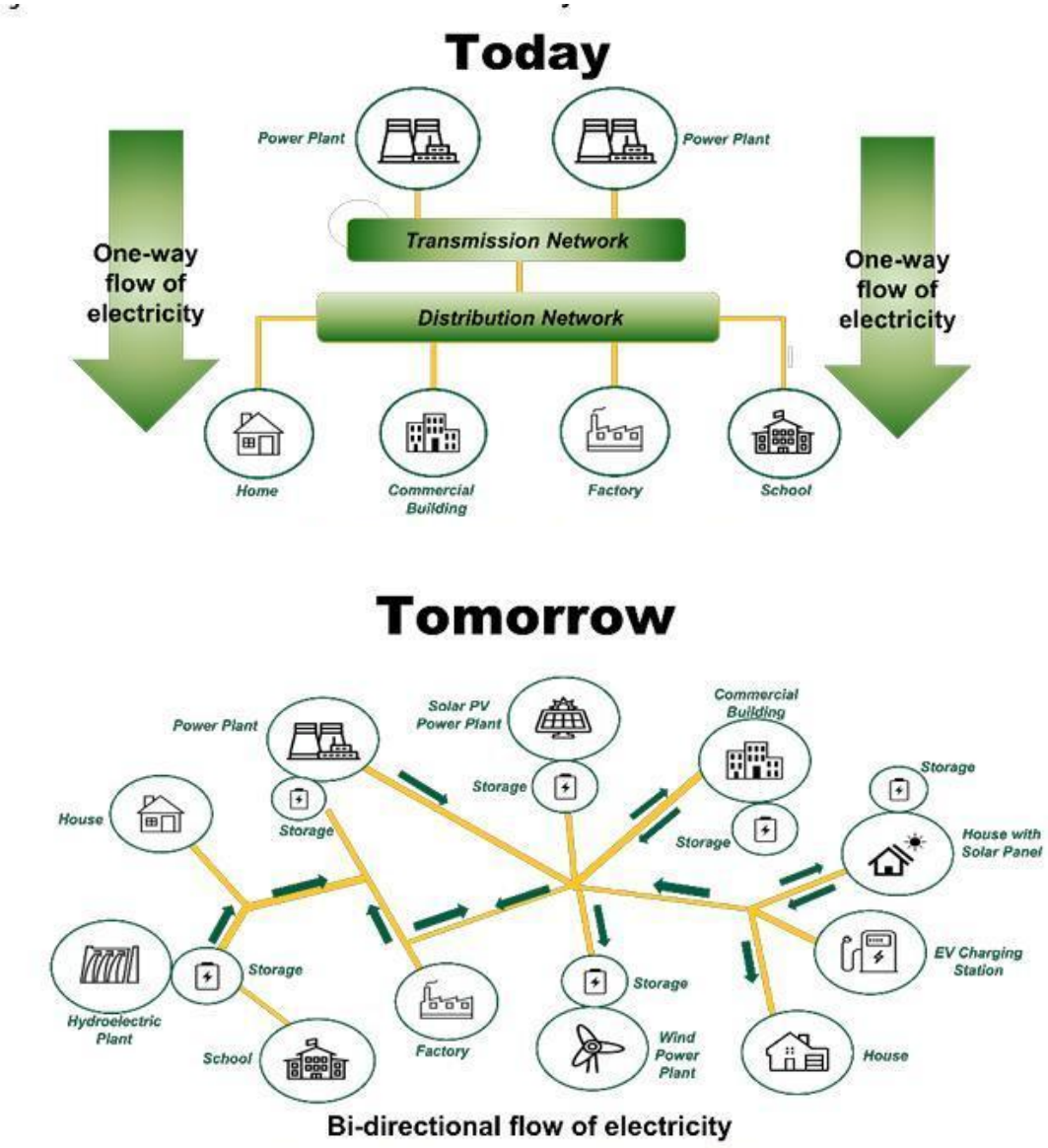

Figure 2. The NYISO roadmap for the future electricity market indicates the future electricity industry model in New York State, which encourages market competition under a centralized systematic planning leadership. However, bulk-scale energy storage is not well encouraged under this mode. Source: NYISO

NYS Practice: Utility-scale BESS as a market trade-off

Case 1: The Ravenswood (on-hold)

The Ravenswood in Long Island City was a highly expected bulk-scale battery energy storage project for New York City (Figure 3). The development goal of the Ravenswood targets a

fully installed capacity of 316MW/2528MWh. This means the project is designed to store up to 2,528 MWhs of electricity which can be discharged at a maximum rate of 316 MWs per hour over eight hours. The project cost was not disclosed but analysts estimate an initial capex cost range of $147-231/kwh for such projects (Lazard's Levelized Cost of Storage 2021) so the cost could exceed $400MM. This would provide 250,000 households with electricity support for 8 hours.

Figure 3. The Ravenswood brownfields site: an abandoned fossil-fuel plant.

In 2019, the Ravenswood project was selected by New York independent system operator (NYISO) to enter into their interconnection facility evaluation process. This means the project was expected to meet a state-level 2022 in-service requirement and probably sign a big contract with the largest power utility in New York City, Con Edison, if it could pass the process. Moreover, the project would be subsequently eligible to apply considerable financial subsidies from government agencies, such as NYSERDA's bridge incentives, which can be used to reduce the capital costs. At the same time, the regulator NYPSC believes that the Ravenswood can make Con Edison's grid infrastructure more stable and also help the city less rely on traditional energy

and natural gas. However, the Ravenswood failed to contract with Con Edison and even passed the process. The specific reasons are yet to be disclosed.

The failure to contract with utility off-taker made the Ravenswood a lost-opportunity to operate with long-term predictable revenue. This could lead to a “merchant” alternative where the project might generate revenues by energy arbitrage, which means charging the electricity from the grid during low-priced non-peak hours and discharging electricity to the grid during high-priced peak hours. The merchant alternative could also have the project participate in the ancillary services sales auctions managed by the New York independent systems operator (NYISO). As the revenues from the merchant alternative are uncertain, the Ravenswood project is being paused.

The failure of contracting with Con Edison also forced the developer to submit a petition to the regulator NYPSC, which asked for a three-year delay in project construction. In this petition, the developer stated that the first phase (129MW) will not start until June 2024. And, currently, the project status is on-hold.

Case 2: The East River (On-going)

The East River project is located in Astoria Queens. Its primary energy source is offshore wind service capacities. The project has a 100MW/400MWh capacity. This means the project is designed to store up to 400 MWhs of electricity which can be discharged at a maximum rate of 100 MWs per hour over four hours. The project cost was also not disclosed but with analysts estimating an initial capex cost range of $147-231/kwh for such projects (Lazard’s Levelized Cost of Storage 2021) this project’s cost could be in the range of $60-100 MM. This would be sufficient to support 16,000 average-sized homes for several hours or enough to power the World

Trade Center for about 24 hours. In the meanwhile, it helps the current urban grid infrastructure balance energy transmission from offshore wind or other sources.

According to the project documentation, the landowner of the current site is New York Power Authority (NYPA), a state-owned utility. The East River has its own project company, which is a special-purpose-vehicle (SPV) that is able to help developers share financial risk. The SPV of the East River is East River ESS, LLC, which is also owned by the project developer, 174 Power Global, a wholly-owned subsidiary of Hanwha Corp.

The East River successfully responded to the Request for Proposal (RFP) issued by Con Edison in July 2019, and they became the winner during the bidding process. That means, they successfully signed a contract with the off-taker. The contract signed with Con Edison allows the largest power utility to have the dispatch rights of the project's overall production capacity, then bidding the output energy to the wholesale electricity market. The success of contracting ensures the East River to receive the avenue from energy arbitrage.

The project is under construction. In December 2020, the project developer, 174 Global Power, a wholly-owned subsidiary of Hanwha Corp, started to build the battery system. The SPV is responsible for obtaining any project permitting documents. Con Edison is responsible for bidding for the electricity to wholesale energy markets within a seven-year contract, with a mandate requirement of which is scheduled to start the East River project operation by December 31, 2022. The contract, finally, mandates the developer to take back the operation right after the contract ends.

The BESS Deployment Process in NYS: a utility-investor-led framework

According to the event roadmap of these two cases, it is clear that the traditional planning leadership (i.e., NYSERDA, NYPSC) contribute crucial actions in structuring the cross-sector collaboration by directing the deployment processes, while utility off-taker (i.e., Con Edison) plays a more important role in project implementation, leading to different destiny for the Ravenswood and the East River projects (Figure 4).

In the context of planning and motivating energy storage investment within New York's competitive energy market which has been liberalized so that utilities do not have a monopoly on generation and energy storage, the planning role would belong to New York State (the legislature passing CLCPA) and its agencies the NYPSC and NYSERDA.[16] Nevertheless, the key player influencing the market and process is utility Con Edison.

[16] The detailed planning responsibility of NYPSC could been seen in Directory of Office: https://www3.dps.ny.gov/W/PSCWeb.nsf/ArticlesByTitle/22A45BCD55E5C09385257687006F3968?OpenDocument

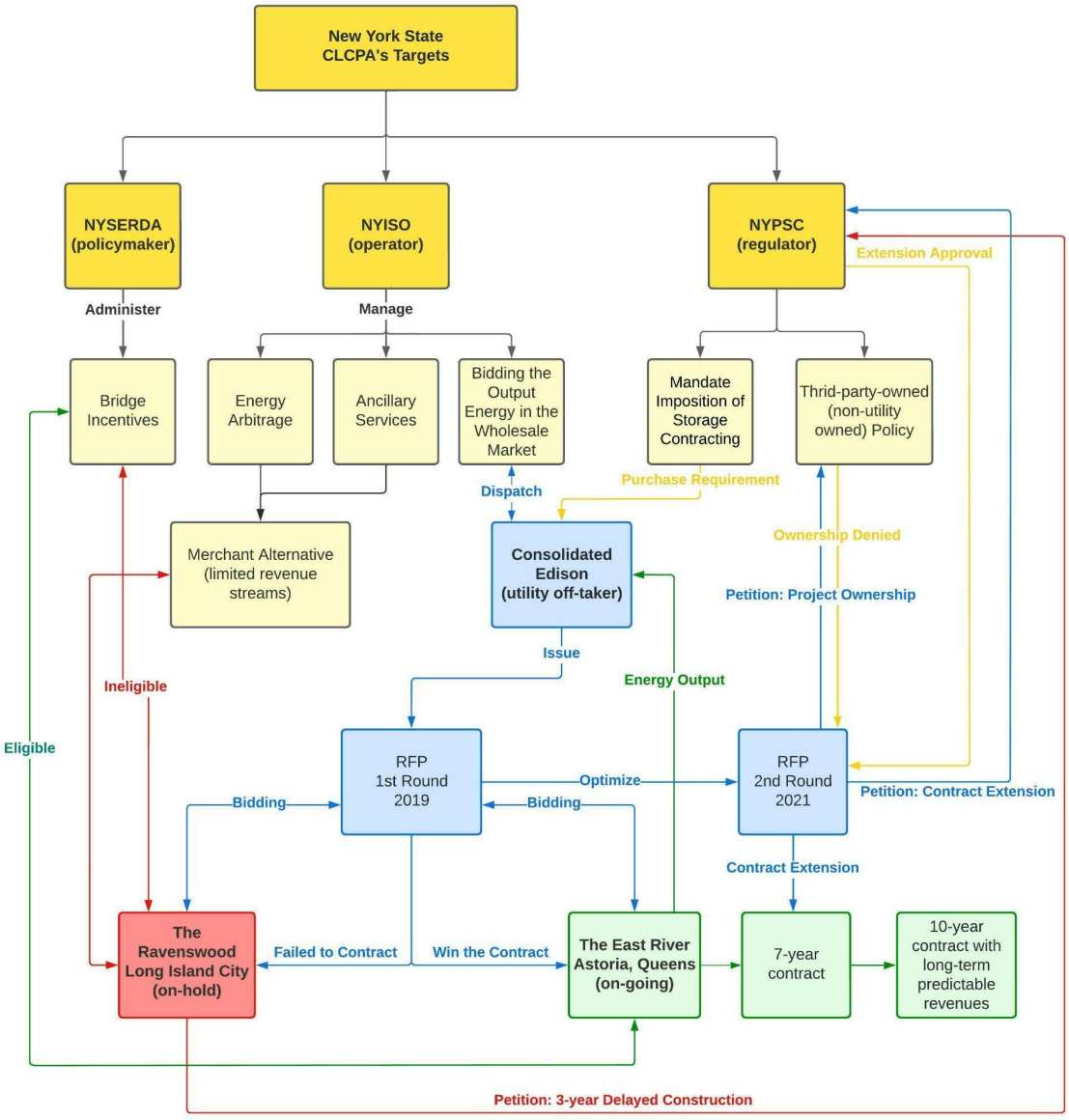

Figure 4: The event roadmap of New York State's BESS practice: Con Edison as the key player.

4.2 Adoption of the EPA Rules: Information Reclassification and Evaluation

The analytical discussion based on information collection from cases would be reclassified and discussed by the four elements mentioned by the EPA guideline. The four

elements are 1) sustainable goal-setting, 2) objectives and strategies, 3) project alternatives, and 4) financial strategies.

Such a verification of compatibility with existing planning methods will answer this question: what challenges are NYS's processes facing in order to better deploy BESS.

4.2.1 Sustainable Goal-setting

New York State Government and Its CLCPA's targets

The policy goals under the CLCPA define the scale of the BESS market in New York State (Figure 5).

In New York State, the Climate Leadership and Community Protection Act (CLCPA) was signed into law and played a role as low-carbon leadership in multiple fields. The CLCPA is a sub-policy of the Cuomo Administration's version of a "Green New Deal," and its target contribution among environment, economy, and employment can be understood through a series of achievements: the investment of over $21 billion in 91 large-scale renewable energy projects across the state, $6.8 billion in building emissions reductions, $1.8 billion in scaling up solar, over $1 billion in clean transportation initiatives, and over $1.2 billion in green NYC Bank commitment. The state has credited these actions with supporting more than 150,000 jobs in New York's clean energy industry in 2019. Under this policy support, the distributed solar industry has grown 2,100% since 2011 and has committed to developing 9,000 megawatts of offshore wind by 2035.[17]

[17] Climate Action Council Draft Scoping Plan, 2022. https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan

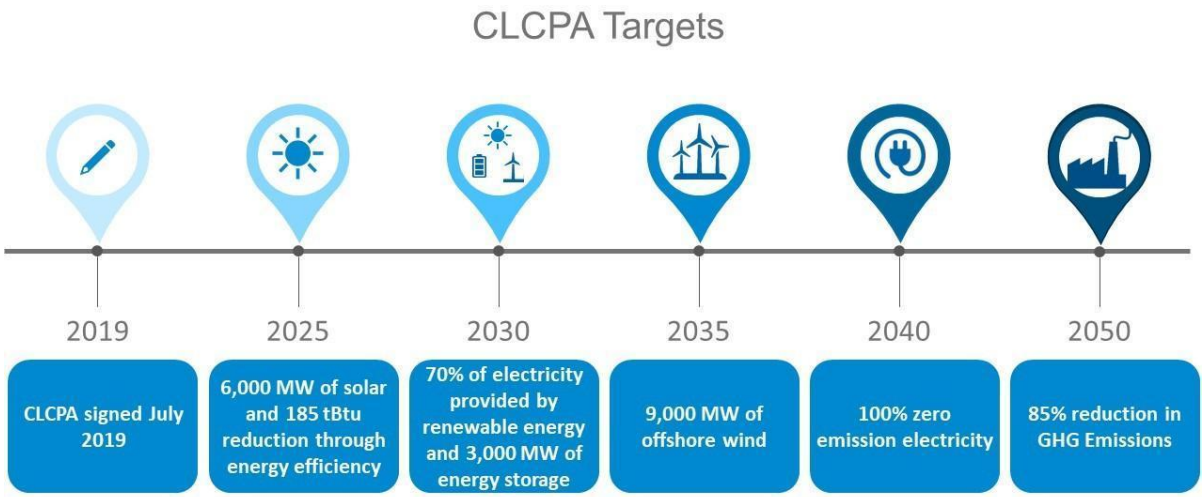

Figure 5. CLCPA goals for the next three decades. Source: Google Image

NYPSC's Purchasing Requirements

The NYPSC's mandate purchasing requirements accelerates the deployment of BESS.

As New York's largest power utility, Con Edison is required by regulators (NYPSC) to complete the energy storage capacity procurement mission. NYPSC directed Con Edison in December 2018 to procure and deploy 300 MW/1200 MWh of qualified energy storage systems for the city by 2023. In 2040, Con Edison needs to purchase 9GW offshore wind, 6GW solar, and 3GW storage. These requirements and goals might put Con Edison under high pressure to facilitate the incorporation of more renewable energy capacity into its energy system in New York City, which would speed up utility-scale battery energy storage to become a necessity to balance power supply and demand.

These purchasing goals of BESS capacity ensure Con Edison to provide customers with a stable energy supply, and provide developers with long-term predictable revenues. However,

although Con Edison complies with the CLCPA targets and NYPSC requirements, it is unclear whether Con Edison will face any penalties if the procurement standards are not met.

4.2.2 Objectives and Strategies

According to the EPA guideline, the second element is to help leadership, for example, in these two cases, NYSERDA, and NYPSC, to establish explicit, measurable objectives for each sustainability goal and identify strategies for meeting the objectives.[18] In New York State, the state's strategies are the two key programs: the NYSERDA bridge incentives, and the storage contracting mandate imposed on Con Edison and the other utilities by the NYPSC.

Bridge incentive is an important policy to promote New York City to meet the capacity goals by developing more large-scale energy storage projects. The city has the largest electricity demand in New York State, but its storage capacity is less than 1/3 of the state's total. The city is facing a shortage of the transmission infrastructure that transits wind and hydro power from upstate New York to downstate load centers. In 2035, New York will be expected to build 9GW of offshore wind (compared to 1.7GW in 2020), which brings the city a challenge to develop more BESS projects.

The total amount of Bridge Incentive is $280 million. The state government expects to build 1.8GWh of energy storage (residential, commercial, and utility-scale) for the state in 2025, and then successfully achieve 3GW in 2030 to meet the CLCPA targets. In addition, this incentive clarifies the definition of a "bulk-scale" energy storage project: greater than 5MW. $150 million of the incentive fund will be used for the bulk-scale projects, while the other $130

[18] The EPA Handbook, p25-32

million will be used for retail projects. The source of funding for Bridge Incentives is the surcharges from utility bills.

In the case studies, the East River was eligible to apply Bridge Incentives, while the Ravenswood not. This is because the Bridge Incentives requires the project developers to have a signed contract with off-taker as an application prerequisite, which is not an easy standard for many projects to complete. Therefore, for most BESS developers, the benefits of the Bridge Incentives are conditional. This in some way reinforces the role of utility off-takers like Con Edison during the BESS planning projects, as they are the solely player who provides developers with long-term predictable revenues and subsequently deciding whether developers are eligible to apply for cost subsidy.

NYSERDA is responsible for processing Bridge Incentives applications. Once the project is approved, the foundation will grant more money to the project in the early stage and less after that.[19] This subsidy policy was launched in April 2019, supporting funds for energy storage projects which are difficult to obtain funding resources from the existing energy market frameworks. A successful case shows that a BESS with a capacity of 20MW/16.5MWh can get a subsidy of 1.3million, while there is no evidence that the size of the subsidy depends on installed capacity (Spector, 2019).

4.2.3 Project Alternatives

The EPA guideline defines the importance of setting explicit and consistent evaluation criteria to analyze a range of infrastructure alternatives to help planning leadership roles make

[19] The Incentive Dashboard of NYSERDA introduces the basic responsibility of NYSERDA in energy affairs.

decisions. As the core for the third element,[20] this part firstly 1) describes the RFP process that guides third parties to compete for contracts, 2) explains how these alternative project proposals would have been analyzed by Con Edison, and 3) further develops the details of the two case studies responding to the RFPs.

Con Edison's Request for Proposal (RFP)

In July 2019, Con Edison issued a bulk storage project RFP, which is essentially the project brief the Ravenswood and the East River referenced to respond.[21] The RFP is the official document for Con Edison to solicit BESS projects. It is designed to give utility off-takers the right to bid and schedule the energy assets in the NYISO markets for a contract term.[22] According to Con Edison's RFP, bidders must meet the revenue benchmarks and be able to start the operation by the end of 2022. Moreover, the RFP requires the project to have the possibility of receiving financial support from Bridge Incentives administered by NYSERDA. The RFP allows developers to sign a portion of their overall capacity into the final contract instead of signing the total capacity.

The RFP was an instrument for collecting project alternatives, so it might be issued for multiple rounds, not only one. For example, the Request for Extension written by the Ravenswood mentioned that Con Edison and other utilities plan to form Joint Utilities and will likely issue a second Bulk Energy Storage RFP in the future.[23] This represents a new bidding process based on a new RFP being launched, the process of which might be evaluated by new

[20] The EPA Handbook, pp33-46.
[21] The permitting report mentions the process of bidding, evaluation, and contracting.
[22] Spector's article discusses the collaborative relationships between developers, big buyers, and regulators.
[23] The official documentation is published on the NYPSC website. https://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterSeq=59074&MNO=19-E-0122

qualitative and quantitative considerations. Therefore, the new uncertainties and new bidders (like Ravenswood and East River) in the electricity market would make the bidding process more competitive.

The sample form of storage agreement between Con Edison and bidders(appendix) indicates that Con Edison would pay for 75% of the bid construction cost of the BESS project at completion plus an additional 7 years of payments in the 2019 RFP, and the numbers of year will update from 7 to 10 years in the 2021 RFP. These further payments will cover the bidders' operating costs and a return of their investment.

Con Edison's Evaluation Criteria

Con Edison evaluates all BESS proposals during the bidding process by considering both qualitative and quantitative factors.[24] According to the implementation plan issued by Con Edison in 2021, we find the key criteria for them to sign a big contract.

The quantitative analysis is based on a key formula as follows.[25] This formula is a combination of the forecast of value, benefits, pricing, and potential subsidiary (like NYSERDA's Bridge Incentives), which provides the off-takers with a specific score from high to low to rank the bidder proposals. Although in both cases, it is difficult to find evidence from actual project financing models and detailed contracts due to non-disclosure agreements, studying these formulas could help planners know the key metrics utility off-takers care about. These metrics could be key factors that are used to further specify the key challenges for BESS planning.

[24] The Implementation Plan 2021 issued by Consolidated Edison indicates the key criteria they use when evaluating the bid.
[25] Con Edison Process Implementation Plan of 2021, pp9.

Quantitative Score = Net Market Value + Distribution Benefit + Environmental Benefit – Offer Price

Net Market Value = (Energy Value + Ancillary Services Value + Capacity Value) – (Charging Cost + NYISO Fees)

The qualitative considerations of the RFP evaluation include project location, developer's experience, system design, credit quality, and legal viability. Both projects are brownfield redevelopment projects. In each case, the respective developer has chosen the site of older outdated power plants because some of the existing infrastructure, such as switching yards and transmission lines, can be utilized.

In the Ravenswood's site, since outdated equipment is not in service at the current site, the developer LS Power plans to remove and replace 16 combustion turbines that have been in use for 50 years to support future pollution-free energy transition work, creating both environmental and economic benefits for cities. Like the Ravenswood, the East River is a brownfield redevelopment project that renovates existing facilities. The original equipment in the current site was expected to provide the urban grids with a charge and discharge rate of 100MWh based on lithium-ion batteries technology. The total area of battery installation is 130,680 sq ft. (12,141 sq m.).

According to the Environmental Impact Assessment report, both projects have no essential impact on the surrounding environment, which means the land-use proposals have no need for revision and thus there are no additional costs required to compensate for the new development.

Although both projects share almost the same inspection result, the slight difference between both can be seen by the zoning maps. The surrounding land use pattern of the Ravenswood is more complicated, including commercial, residential, and mixed-use, with an inspection radius of 250 miles. In the East River case, the zoning map shows there is no complicated land use and equipment nearby, and the inspection radius is 1000 miles (Figure 6).

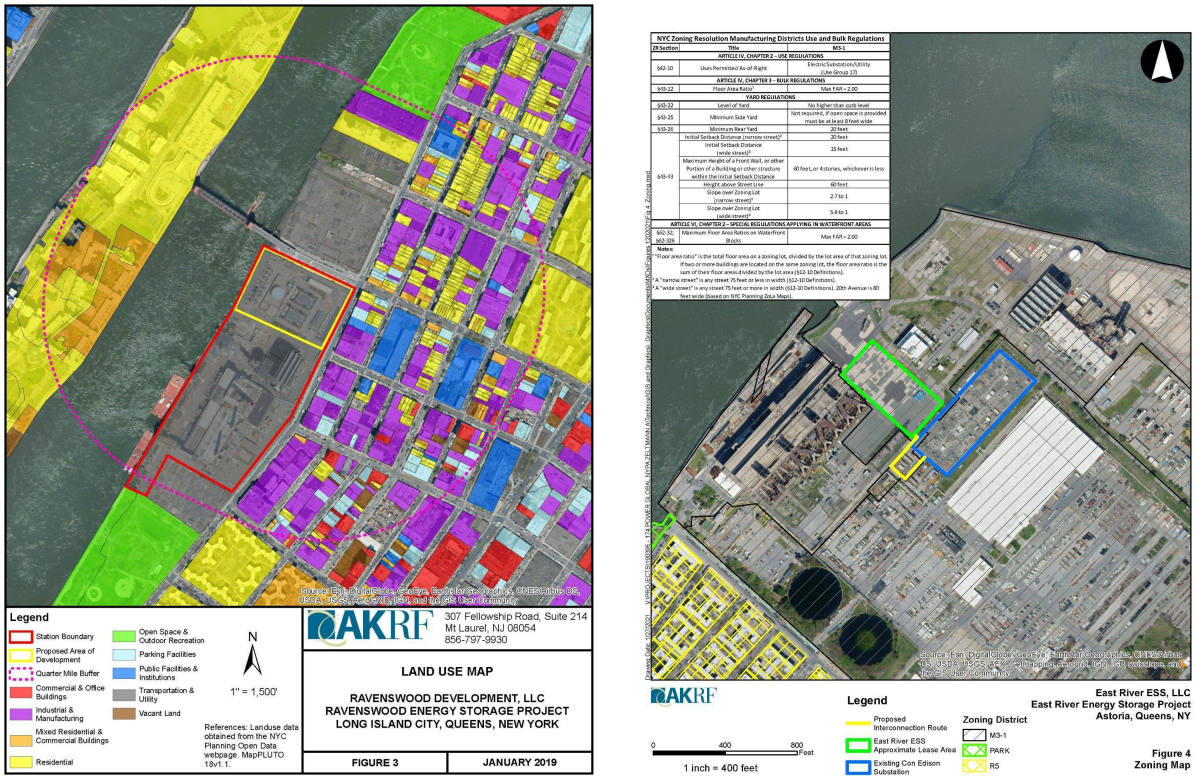

Figure 6. Comparison of zoning maps between the Ravenswood (left) and the East River (right). The Ravenswood is located in a more complicated urban context. Source: NYPSC

A noticeable point is that, as Con Edison mentioned in the RFP report, they "will evaluate proposals on whether the proposed project is in a preferred load area as designated by Con Edison and O&R.", which inevitably reminds us that the land where the East River is located is previously the land Con Edison owned. However, based on the materials covered so

far in this thesis, there is no evidence that the location factor was a factor for Con Edison to judge the project risk.

4.2.4 Arriving at Financing Strategies

According to the EPA guideline, implementing a financial strategy including adequate revenues so that new infrastructure and operational investments—as well as the overall system—are sufficiently funded, operated, maintained, and replaced over time on a full lifecycle cost basis, with appropriate considerations for disadvantaged households.[26]

Since BESS is quite new for capital investment markets and thus there are few cases so far that could help provide BESS research with adequate data and information, the financing strategy could be better observed from the recent actions of Con Edison.

Con Edison has two key requests in their 2021 petition to the NYPSC: 1) an extension on Con Edison's deadline to comply with the mandate to enter into contracts for 300MWs of storage; 2) permission for Con Edison to purchase and own storage projects.

In 2019, Con Edison signed a contract with the 100MW/400MWhs East River project to meet 100MWs of its 300MW mandate through its first-round REF. Under its 2021 implementation plan Con Edsison sought to launch a new round of RFP which proposes to source overall 200MW capacity to complete the contract mandate. Such a new effort is to optimize the current contract model to ensure more benefits for themselves. Stephen Wemple, the

[26] The EPA Handbook, pp 47-61.

general manager at Con Edison, mentioned five improvements of storage contracting in his presentation material.[27]

1. Contract term extended from 7 years to 10 years to provide higher profit certainty

2. Increase contract bid ceiling

3. Reduce the competition in buying land, EPC contract, and battery cells to reduce costs

4. Identify interconnection costs before contracting with developers

5. Increase developer confidence, such as working with NYSERDA Bridge Incentives

These optimizations focus on two aspects: 1) increase the cash flow by extending the period of years for contract, 2) reduce the capital cost by curtailment of EPC expenses and obtain additional financial subsidies from policy markets. Contract period, EPC cost, and total subsidy are all the key variables of the project financing; these two aspects imply that the original contract between Con Edison and the bidders (i.e., the East River) could be improved based on a better non-recourse project finance model.

Subsequently, Con Edison submitted two petitions to regulator NYPSC to 1) extend the contract and 2) require ownership of the BESS project to reduce the costs.

Petition One: Contract Extension

[27] Stephen Wemple claims the key improvement of Con Edison in the next round of RFP. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Faec2021.aertc.org%2Fwp-content%2Fuploads%2F2021%2F07%2FSteve-Wemble-Consolidated-Edison.pdf&clen=825256&chunk=true

In 2021, Con Edison applied to NYPSC to extend its offered operation contract to bidders from 7 to 10 years. Stretching the payment period from 7 to 10 years means that any bidder (e.g. Ravenswood) could charge lower annual payments from Con Edison to recover the bidder's investment over a longer period -- benefiting Con Edison. This application was approved by NYPSC.

Petition Two: Project Ownerships

In its 2021 petition Con Edison also challenged the NYPSC's contracting mandate policy by applying for permission to own energy storage projects. However, the state planning agency NYPSC in this context is so far sticking to its strategy to have competing third parties own the storage.

According to New York State energy storage policies[28], the utilities can only be the facilitators or buyers but not the owner of the energy storage properties, only if they meet the following four conditions: 1) project alternatives are inadequate or expensive, 2) a project is integrated into distribution system architecture, 3) the project enables LMI to benefit if markets fail to be inclusive, or 4) if the project is used for demonstration purposes.

Based on the action of the NYPSC denying Con Edison's petition for permission to own storage assets, it would seem the utility could meet these four conditions to become the project owner.

4.2.5 Criterion-based evaluation of NYS process

[28] Order Adopting Regulatory Policy Framework and Implementation Plan (2015)

The process performance of NYS BESS deployment collected from the Ravenswood project and the East River project can be reviewed by the EPA four-elements criteria (Table 1).

	The EPA Guideline: Planning for Sustainability			
Leadership of BESS Planning in New York State	Element 1. Sustainable Goal-setting	Element 2. Objectives and Strategies	Element 3. Project Alternatives	Element 4. Financing Strategy
	Project priorities, stakeholders, engagement	Explicit, measurable strategies to meet goals	Multiple selection under reliable evaluation criterion	Adequate revenue
NYS (the legislature passing CLCPA)	CLCPA's targets			
NYPSC (regulator)	Purchasing goals for energy storage capacity	Mandate imposition of storage contracting	Project approval / permitting	1. Third-party-owned policy 2. Review project ownership applications
NYSERDA (policymaker)	Issue incentives	Bridge Incentives		
Con Edison (utility off-taker)	300MW/1200MWh of qualified energy storage systems for the city by 2023. 9GW offshore wind, 6GW solar, and 3GW storage by 2040.		Request for Proposals (RFP), a bidding process that purchases the target BESS project	1. Contract extension 2. Petition for being project ownership
Lesson learned from two cases	The East River was the first RFP project for Con Edison, which is also currently the largest utility-contracted BESS project in New York State, actively responding to CLCPA's sustainability goals, serving NYISO and the wholesale energy market.	The East River is eligible for additional financial subsidies from Bridge Incentive, but the Ravenswood not. This is because only contracted projects could apply to bridge incentives. Therefore, the benefits for developers from the current incentives are conditional.	It is Con Edison's RFP to collect project alternatives and decide the winner who can sign the big contract. According to the sample contract between Con Edison and developers, Con Edison would pay for 75% of the bid construction cost of the BESS project at completion plus an	Con Edison failed to own the East River but was approved by NYPSC to extend the contract period from 7 to 10 years, which benefits Con Edison to reduce the annual charge cost to the SPV.

			additional 7 years of payments in the 2019 RFP, and the numbers of year will update from 7 to 10 years in the 2021 RFP. However, Con Edison did not purchase any other BESS project during the 2021 RFP.	

Table 1. The key findings from the EPA criterion-based analysis at a glance.

4.3 Discussions and Findings

1. *Government agencies play a limited role in deploying BESS*

Both projects have advanced through some level of approval by city and state agencies. However, it is not enough for BESS developers to only receive the project approval from the regulator. Although the supportive statement from the regulator NYPSC and the mayor's office can be validated by checking the legal documentation, these voices centered on public interests, not private developers' benefits.[29] An excellent match to public concerns might not be sufficient for non-utility investors in BESS projects to move forward with construction, operation & management. Such approval by NYPSC might provide the BESS project with a validation that helps developers negotiate with potential off-takers (e.g., Con Edison); due to this approval can demonstrate the developer with a high credit to avoid political and completion risk.

2. *The Key Player of Implementing Bess is Utility Off-Taker*

[29] According to the legal approval documentation between the Ravenswood and NYPSC, the public departments care more about the positive impact of political, industrial, and environmental concerns: 1) the Ravenswood helps grow the social industry, 2) the project creates jobs, 3) it meets CLCPA policy targets, and 4) it improves air quality and reduces carbon emissions. The summary paragraph in the approval documentation between NYPSC and Ravenswood, October 2019.

In New York City, the key player of BESS planning is Consolidated Edison. Both the Ravenswood and the East River cannot ensure long-term, predictable returns without winning the bidding process led by Con Edison. The Ravenswood has to choose the merchant alternative to earn revenues, which far from covers the total investment of the BESS. In addition, Con Edison is in charge of issuing the project brief (RFP) to solicit projects from the markets and evaluate these bidders by its own criterion. The winner could not only sign the contract also be eligible to apply for Bridge Incentives for reducing capital costs. Last but not least, Con Edison is the intermediary between wholesale markets and private-owned BESS infrastructure, it has the dispatch right to balance the supply and demand.

3. *The Key to Bess Success is Request for Proposal (RFP) and Long-term Contract (LTC)*

Through the case study and criterion-based discussion, it is reasonable to claim that the key to project success is whether the BESS developer could sign the contract with the utility off-taker (e.g., Con Edison) after winning the bidding process guided by RFP. In New York State, successful business models for bulk battery storage are not completely established, and there is no exception with the Ravenswood and the East River. Financing BESS requires revenue and risk certainty. Their stable revenues need support from big buyers (e.g., Con Edison) to ensure long-term, predictable revenues. The East River project has a contract with Con Edison as a user/off-taker that could help that project, while the Ravenswood has not, which is the major reason why the East River is still ongoing.

4. *The NYS's Partnership has Internal Competition rather than Cooperation*

There are multiple stakeholders participating in BESS planning in New York State. The current objectives and strategies are led by the government and its agencies such as NYS,

NYPSC, and NYSERDA, and they are explicit and measurable which are in line with the EPA guideline. However, the current partnership of BESS is over-reliance on utility off-taker, which might lead to a distortion to the four-step planning approach.

The dominance of utility off-taker is hard to be replaced by other participants, which is based on two reasons. 1) The off-taker provides the only solution for developers to obtain alternative revenue streams rather than a simply merchant model, 2) it is exactly the utility drafts the bidding brief and decides the winner of contracting, and 3) the lacking of data disclosure leads utility be difficult to be monitored by the regulator, which reinforces their irreplaceable role in influencing the BESS implementation processes.

Chapter 5. Conclusion & Recommendations

As a mega drive of change, BESS infrastructure still needs to accelerate deployment at the state level. While policy goals are supportive, technologies are feasible, and feedstock prices are declining, the planning and implementation process of BESS projects is still challenging.

Both the Ravenswood and the East River provide detailed information from the New York City practice, and the EPA criteria analysis reclassifies and discusses the roles, actions, and performance of each stakeholder. The thesis concludes with one key challenge of deploying BESS infrastructure in New York State with specific two factors behind it.

5.1 Conclusion

Challenge in NYS: The conflict between deployment speed and market liberalization

One of the most key challenges New York State is facing while deploying BESS infrastructure is the conflict between ensuring deployment progress and ensuring market liberalization. To achieve the CLCPA goals by 2030, the state is making an effort to mandate utilities to procure a certain amount of storage capacity which can accelerate the deployment schedules. However, at the same time, these utilities are not allowed to own storage assets, which in return delays the deployment progress of BESS due to utilities becoming more prudent to be an investor rather than being an owner. There are two factors that lead to such a conflict between a fast-deployed market and a liberalized competitive market.

Factor 1. NYS's BESS assets is over-reliance on the LTC model

Currently, the financing strategy of developing BESS is too limited to ensure multiple revenue streams. According to the literature review, case analysis, and criterion-based discussion, we find that lacking diverse financing strategies actually makes NYS's BESS deployment rely heavily on long-term contracts from utility off-takers. The long-term contract (LTC) is still the most efficient method for the State to deploy BESS infrastructure. That means, for developers, it is necessary for a successful BESS project to win the bidding process first and contract with a big buyer subsequently. Only after contracting will they have the right to apply for financial subsidies such as NYSERDA's Bridge Incentives to cover the cost. Such a financing path for BESS projects is an over-reliance on utilities' appetite, which is not beneficial for a fast-growing energy storage market that seeks to pursue efficient deployment of BESS.

In both cases, Con Edison is required by regulator NYPSC to purchase targeted energy storage capacity by 2030, so they issue a request for proposals documentation, named RFP, as a bidding brief, in 2019, to solicit project alternatives and evaluate those projects based on their criterion, and selected the East River as the winner. However, in 2021, Con Edison issued a second-round RFP, but they did not choose any projects during the bidding process. It might be possible to speculate that the big buyer, Con Edison, heavily considered the total cost when contracting with the winning developer. They intend to choose the lowest price asked by the developers; otherwise, they might submit a petition to the regulator for a contract extension, which saves their costs by paying the lower annual fee to developers. In a nutshell, Con Edison's preference to spend more time waiting for the lowest price will delay the schedule of BESS deployment.

Factor 2. The Bridge Incentives are unable to support a fast-deployed BESS market

Lacking strong policy incentives also slows down the deployment process of BESS. New York state currently has two strategies for supporting the financing of private non-utility-owned storage projects to address the risk of lacking financing strategies, as mentioned before. These two strategies are 1) NYSERDA's bridge incentives and 2) The mandate imposition of storage contracts. The first strategy, Bridge Incentives, requires the BESS projects to have LTC contracts as the prerequisite, which is difficult for many early-stage developers to realize. Therefore such financing support plays a limited role in accelerating the statewide BESS deployment.

The Ravenswood demonstrates this limitation. The Ravenwood is ineligible to apply for a further financial subsidy to cover the capital cost due to failing to contract with Con Edison. However, it might still be valuable to be invested in for its 300MW installed capacity can be conducive to helping the state meet the CLCPA procurement goals for storage capacity (3,0000MW). Therefore, the conditional policy incentives should be revised to accelerate the BESS deployment for New York State.

5.2 Recommendations

NYPSC and NYSERDA play key roles in deploying BESS infrastructure and monitoring Con Edison's bidding process in New York State; the policy recommendations seek to improve the current NYSERDA's Bridge Incentives and NYPSC contracting mandatory requirements to ensure a more profitable and accelerated BESS market to be established, by which to strengthen their dominance in the deployment process.

NYPSC's regulatory reform is the key to policy improvement

To ensure a liberalized electricity market, the private non-utility model adopted is the regulator's bottom line to ensure positive market competition. The policy is designed to prevent utilities from becoming owners of BESS assets. However, the price of creating positive market competition is to sacrifice the deployment speed. As mentioned before, the third-party-owned model has limited revenue streams; they usually adopt a merchant business model with simply ancillary services and energy arbitrage to obtain revenue without wholesale market support. As the literature review inspired, this business model is not enough for developers to attract more capital investment and cover their costs.

The regulator NYPSC needs a big buyer like Con Edison as an investor to participate in BESS deployment actively, but in the meanwhile, the PSC frames the mandatory policy to prevent the utility's monopoly on the electricity markets. This is actually a trade-off between market competition and deployment speed. And such a trade-off can explain why NYPSC had two attitudes when dealing with Con Edison's petition: they approved the contract extension requirement but rejected the project ownership petition. From a sustainable perspective, such a balance is understandable, but this trade-off is a hindrance from a fast-growing market perspective.

Therefore, two recommendations are provided as follows to help NYPSC better balance the market speed and the market competition.

- Consider enacting a new trade-off policy for utilities when applying for a contract extension. Utilities should purchase more installed energy storage capacity from the market in the incoming year if they do so, which can compensate for the procurement

goals of storage capacity when utilities' decision-making process delays the deployment speed.

- Reconsider whether allowing utilities to own storage as a strategy for accelerating the statewide BESS deployment. Integrate California's decentralized investment strategy of DER, which is based on a utility business model, is an option that makes NYS produce more revenue streams for BESS developers.

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