# Electricity Energy Storage

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The mass deployment of energy storage and distributed energy resources has become a major goal across several states in the United States. However, the viability and reality of such a goal in New York City has been put in question as possible financial burdens and execution risks are still unclear, while policies and regulations are still not fully settled. This entry provides a foundational overview of the Lazard LCOS study with emphasis on forward states which have successfully implemented mass deployment of energy storage technologies. "Adders" are related to the practicality in deploying these systems in a highly regulated and densely populated urban area such as New York City. It also discusses details on the typical financial structure/incentives that support the policies and regulations that allow for achieving these clean energy goals.

authority having jurisdiction (AHJ) batteries energy storage distributed energy resources (DERs) energy storage deployment

## 1. Introduction

The need for energy storage systems has increased as countries are begining to utilize more renewable energy technologies. Energy storage eliminates the need for synchronizing generation and demand. It becomes essential at high penetration of renewable energy resources. Moreover, the ability to store energy for later use is imperative in a society that relies heavily on energy for several daily activities. Batteries, in particular, are a very disruptive technology, enabling higher renewable energy penetration in the grid, increasing the resiliency of the grid, and allowing demand response in terms of finding a load to take excess energy. The addition of energy storage, batteries or not, will help smooth the duck curve (a curve that visualizes the difference in electricity demand and the amount of available solar energy throughout the day) and dragon curves (a curve similar to the duck curve but describes the effect that electric vehicle charging patterns might have on electricity use). However, large energy storage and placement of additional storage can be extremely expensive, leading to a challenge of balance between cost and overall benefit of performance.

Finding the proper balance between cost and overall benefit of performance is what stakeholders are most concerned about. While the most obvious solution would be to place energy storage technology everywhere, this relatively new technology comes at a cost encompassing real-estate-related expenses and additional charges that go toward regulation compliance, among other factors. Several publications have been made regarding the financial and regulatory aspects of energy storage. However, the EPRI paper fails to address the hurdles of policy and regulation to energy storage deployment in New York City, which increase the costs when it comes to compliance. Another paper published by Florida State University's (FSU) Law Review, "Reconsidering Regulatory Uncertainty: Making a Case for Energy Storage," briefly discusses the costs while focusing primarily on the regulatory uncertainties that deter energy storage penetration and also providing an overview of how states such as California are able to provide more certainty through Energy Storage Law (AB 2541), requiring targets to be determined [1]. Similar to California, New York City is a place that also has policies and regulations that are being made or modified to remove such uncertainties but is still lagging behind in the amount of storage deployed. FSU's paper does not address other factors that play a major role in the barrier to ESSs such as extremely tight building regulations or a limiting environment which forces the developers and owners to spend more for extra modification. In terms of a limiting environment, New York City is densely urbanized in comparison to Arizona and California, leading to stricter zoning and deployment requirements for ESSs, which will be discussed further in the paper. These publications, as well as the study this entry will build off of, focus on either costs or policy and regulation, but do not focus on both at the same time. These studies also seem to address only national and other state-specific examples, specifically forward states. They lack framework for New York City, which this paper is geared toward highlighting, especially since New York State set aggressive energy storage goals and passed legislation to set up financial structures, such as incentives and investment tax credit, to support such goals.

In the United States, costs for energy storage projects can differ tremendously based on the location, policies, regulations, etc., across each state. These highly variable expenses are an important factor in the penetration of energy storage. Costs can slow down or even discourage stakeholders from investing in such technologies. New York, although one of the most aggressive states in the push for renewable integration and energy storage, is still behind other states, such as Arizona and California. Furthermore, with the recent gubernatorial doubling of the energy storage target in New York State to 6000 MW by 2030, intervention from the federal government via infrastructure bill and investment tax credits are crucial to the economic viability and increased deployment to meet climate change objectives. Using the “Levelized Cost of Storage” analysis by Lazard as a basis, this entry gives an insight into determining other “cost adders,” which are additional factors that would increase cost, as well as highlighting policy and regulation points that may also be slowing down New York State from achieving its energy storage goals.

## 2. Background of Lazard’s LCOS

The Levelized Cost of Storage (LCOS) analysis conducted by Lazard, a financial advisory company, assesses the costs of a specific selection of energy storage systems across several use cases and their associated operational parameters. The latest iteration, version 6.0, was published in October 2020 [2]. The key findings of these LCOS analysis reports cover the trend of declining costs of energy storage systems (ESSs) particularly in shorter-duration application, an overview of annually improving project economics, their conclusion on the viability of solar PV, wind and storage, and the trends of battery ESS technology. On the trend of BESS technology, lithium-ion technology costs have continued to decline faster than alternate storage technologies, which is great for higher lithium-ion BESS penetration. However, New York City also seeks to increase the diversity of its ESS profile by including a large variety of non-lithium technologies as well.

This entry seeks to build upon the LCOS analysis’s key findings in the context of New York City and develop an analysis of possible cost adders that is not only unique to New York City but considers additional cost challenges in the form of policies and regulations with respect to the two states that are currently leading in the push for renewable energy and energy storage in the United States, California and Arizona. New York State in recent times has started several initiatives for creating a “greener community,” starting with New York City.

The Climate Leadership and Protection Act (CLCPA) is the overarching law enacted in 2019 for New York State to reduce its contribution to climate change by reducing emissions and using zero-emission electrical power sources [3]. The primary targets listed by the CLCPA are as follows: an 85% reduction in greenhouse gas (GHG) emissions by 2050, 100% zero-emission electricity by 2040, 70% renewable energy by 2030, 9000 MW of offshore wind by 2035, and 6000 MW of solar by 2025. Acknowledging the grid challenges posed by high renewable energy penetration, the State has also recently doubled its initial goal to deploy 3000 MW of energy storage systems (ESS) to 6000 MW by 2030 [3]. Consolidated Edison data (**Figure 1**) show that undecided regulations led to the lack of ESS penetration, and the trend can be seen where over a period of six years (2016–2021), there was an uptick in installed ESS projects as the Department of Buildings and the FDNY relaxed restrictions on ESS deployment [4]. It is also important to note that the total capacity of installed projects up to and through 2021 was 30,772 kW, all of which were projects less than or equal to 5 MW in size and included a mix of front-of-the-meter (FTM) and behind-the-meter (BTM) installation [5]. The notable uptick in projects during 2021 is directly correlated to the reprieve from COVID-19 lockdown and incentives received through the state entity NYSERDA and local utility (Con Edison) via their Non-Wires Solutions Solicitations (NWS), thereby lowering the capital cost associated with execution. With such aggressive goals set for New York, it is important to consider the major factors of costs, regulations, and other challenges that stand in the way of ESS penetration in the state, both unique and non-unique to New York.

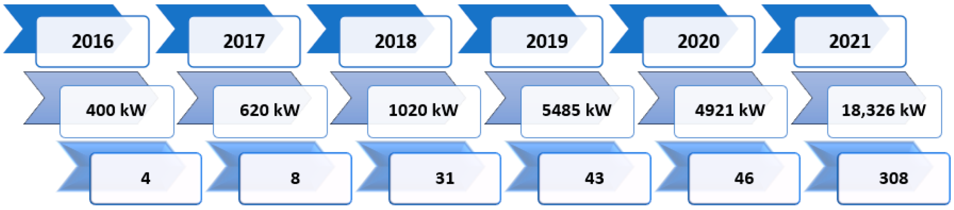


**Figure 1.** A timeline of the annual installed ESS projects by approximated total capacity (kW) and the number of completed projects per year under Consolidated Edison from 2016 to 2021.

While the LCOS study is generally useful at the national level, New York requires its own study unique to the state itself to inform stakeholders about the true values and costs. The LCOS study contains an overview of the operational parameters and use cases of commonly deployed ESSs, a summary of the levelized costs of storage based on capacity and energy, a list of revenue potential of use cases, an overview of international case studies, an overview of long-duration storage technologies, and comparisons of the international case studies in each of the previous topics relative to the United States.

## 3. Cost Adders to Consider for NYC

Looking at the "forward states," California and Arizona, gives insight into some of the most important costs to consider for ESS penetration. California is particularly aggressive with a previously set target of 1325 MW energy storage capacity and an approved procurement of 1533 MW as of February 2021, 506 MW of which is already operational [6]. California had a renewable generation capacity of approximately 26,500 MW installed, as of the latest CEC report published in 2018 [7]. Arizona has set a target of 15% of retail electricity to be produced through renewable generation, with no exact capacity determined [8]. However, as of March 2020, Arizona is third among the top solar energy producing states, behind North Carolina (second) and California (first), with a total installed capacity of 3285 MW [9]. For reasons that will be discussed later in this entry, several Arizona utilities intend to install large capacities of energy storage to accompany the State's large solar portfolio, one of which intends to install about 850 MW of energy storage capacity by 2025 [10]. Lessons learned from the project costs in different sectors of these forward states can set the very foundations for a much easier and more understandable approach to ESS penetration in New York City and Westchester, especially considering that more owners are installing PV and ESS hybrid systems. Costs, misinformation and lack of precedence become significant barriers next to policies when introducing new technology. The higher these costs and the uncertainty about where they originate and what the long-term benefits are, the less likely it is for stakeholders to provide the investment and motivation to ensure ESS technology's prominence in New York City. California and Arizona consist of a mix of urban, suburban, and rural areas with a number of ESS projects across these areas. Although New York City is exclusively a mix of urban and suburban areas, the zoning requirements add another layer of complexity as each lot in NYC is heavily regulated. This entry studies the urban and suburban areas of both the forward states for a comparison with respect to types of locations and lessons learned for ESS deployment. Places such as San Francisco and Los Angeles in California, or Phoenix in Arizona, are similar in structure and location types to New York City when looking past population density and environmental factors. These cities in particular hold great value in the considerations for possessing suburban, urban, and metropolitan equivalents to New York City that already have ESS projects developed within them.

Unique factors that incur additional costs are not necessarily mentioned in the LCOS study despite levelized costs of storage being considered. While these generalizations are great for New York State to make considerations for energy storage, the state government will have to analyze costs that arise from unique issues from within the state such as local regulation compliance or deciding on deployment strategies.

### 3.1. Lessons Learned from California

One important expense to consider when looking at California's numerous ESS projects in urban and suburban areas is the cost associated with retrofitting existing buildings in an urban area. The California Energy Commission (CEC) set a mandate for all newly constructed residential and commercial buildings to be zero net energy (ZNE) by 2020 and 2030, respectively [11]. Even if buildings were to be torn down and rebuilt from the ground up just as in California, this would only incur higher costs. An example in California provided by the CEC's 2018 "Microgrid Analysis and Case Studies Report" is the 2500 R Midtown Development Project in Sacramento, which is an USD 850,000 affordable housing project consisting of 34 single-family homes built from the ground up with built-in distributed energy resources (DERs) and ESSs along with modifications that increase their efficiency [12].

Other important costs to consider are ones which arise from compliance with differing local regulations. Across the United States, it should be recalled that all states are typically divided into several municipalities just as the states themselves are divided under the federal government. Local regulations differ between most municipalities regardless of the state, meaning ESSs that would be typically uniformly built must have additional changes made to them to comply with the local regulations that are present in the area which they are to be deployed. These changes, no matter how small, would mean additional costs. California has taken several initiatives to streamline regulations for ESSs, but very few seem to touch on these types of cost adders. They become prominent when placing energy storage across several municipalities.

### 3.2. Lessons Learned from Arizona

In Arizona, ESS penetration seems to be driven from a bottom-up need, as projects are built first while the policies and regulations follow suit. This is due to the utility companies taking initiatives ahead of the policymakers in Arizona's government [13]. Arizona Public Service (APS) and other Arizona utilities currently suffer from overgeneration during oversupply times. This causes DER owners to have to pay utilities to take the excess energy [14]. The additional cost arises from the high penetration of PV resources with insufficient amounts of available storage on the customer end. As a result, Arizona utilities have proposed a reverse demand response strategy in which end users turn up demand to help relieve the grid of excess energy through non-essential loads and smooth the duck curve at peak production times [14]. Energy storage is a long-term solution in smoothing the curve as the energy must go somewhere and may defer the addition of upgrades which would be another cost adder, as the suggestion of the reverse demand response strategy is that non-essential functions offtake energy at peak production times [14]. However, this implies that upgrades which can automatically account for this must be made to the existing systems which can be avoided with the use of ESSs. This is another reason to encourage higher penetration of energy storage in New York City since the use of ESSs allows the city to circumvent the higher costs of installing these upgrades.

## 4. Adoption of Regulations and Policies for ESSs in the Forward States

The LCOS study lacks any mention or discussion of regulations and policies that have been taken by the forward states. This is a topic of significance to cover since the development of New York City's regulations and policies is important to ensure the high penetration of energy storage and renewable energy resources. This entry's intention is to get stakeholders and New York State's government to consider revamping regulations and policies while taking into account any additional costs as a means to ensure confidence in increased ESS penetration.

### 4.1. Regulations and Policies in California

Overall, California regulations and policies are streamlined for energy storage as part of their ZNE plan. Most significantly, California's Assembly Bill (AB) 546 was approved to streamline the actual process for permitting ESSs in 2017 [15]. However, what is interesting about this bill is that it does not in any way uniformly set the actual regulations between the state government and the municipalities. Instead, it focuses exclusively on enhancing the accessibility of ESS permits by making all documents and forms available electronically, allowing for e-signatures and e-submissions and for the Office of Planning and Research to provide direct guidance on ESS permitting for the municipalities [16]. Ultimately, the AB 546 seems to only affect the logistical process. This bill does not address the obstacles and costs present with the risk of choice. Without standardized regulations across the state, battery owners will have to spend additional time and funding to comply with differing regulations between each jurisdiction a battery is to be located in. Standardizing ESS regulations across municipalities in New York could potentially save on time and costs by giving the battery owners a defined set of batteries that can be used across all jurisdictions in the state. Of course, New York may also include the use of a bill similar to AB 546 for the logistical side just as California does. Making the process virtual can allow NYC to facilitate an estimated timeline for the approval of certain permits associated with ESS projects.

#### 4.1.1. Fire Codes and Authority Having Jurisdictions on ESSs in California

The California Fire Code (CFC) was updated in 2019 to allow larger capacity sizes and new battery types to help increase the variety and prominence of ESSs in California [17]. This, along with the previously mentioned AB 546, enables a much clearer and more streamlined process for obtaining an ESS permit. It should also be noted that the CFC 2019's Chapter 12 Section 1206 on ESSs borrows directly from the International Fire Code (IFC) [18]. The CFC 2019 uses other codes such as the ANSI standards and NFPA codes which can be found in CFC Chapter 80. It lists all the referenced codes but does not use all sections of those codes, an example being the lack of reference to the NFPA 855 installation of battery ESSs section, where the CFC 2019 instead opts to use the IFC's installation rules for batteries [17][19]. It was not until late 2021 that New York City's FDNY adopted the approach that California uses, using a national/international fire code as a foundation while forming its own fire code around the unique characteristics of the city. Unique to the new 2021 fire code law are the distinctions between the highly urbanized areas and the suburbs as well as the difference in topography among the five boroughs and Westchester County.

#### 4.1.2. Municipalities versus Central Government of California

Looking further into the ESS regulations and policies of California, it was noticed that municipalities have a choice in what fire code is adopted, unlike the mandated statewide policy of streamlining the permitting process presented as part of AB 546. In AB 546, it is explicitly stated that all municipalities must maintain consistent statewide standards for a quick and cost-effective implementation of ESSs [20]. Comparing some municipalities' fire codes shows differences between them and the CFC. Santa Clara County had adopted the IFC as opposed to the city of Palo Alto, which adopted not only the CFC but several other codes unique to California [21][22]. The California Public Utilities Commission (CPUC) showcases Santa Clara County on its website for the municipality's unique, advanced guidelines of safety practices for ESS installation while also encouraging the usage of several other codes such as UL 1973, UL 9540, NEC 480, NEC 705, NFPA 70, etc. [23]. Knowing that fire code regulations can differ between each municipality, it is expected that there are cases where battery owners incur additional costs to make changes to a BESS in specific jurisdictions when that change would not have been necessary in another municipality. Addressing this pitfall and determining whether or not it is currently a major issue will only help reduce the costs in the long term in New York.

### 4.2. Regulations and Policis in Arizona

Arizona is in a special position with reference to the factors that drive ESS and DER penetration, most specifically, regulations and policies versus the initiatives. While Arizona is very proactive in its goal, very few policies and initiatives were put in place by the government itself. Instead, utility initiatives played the biggest role in furthering the development of the energy storage market in the state [14]. Unlike California, it cannot be said that Arizona has regulations and policies streamlined for energy storage. Rather, policymakers are falling behind on the development of these functions. Meanwhile, the APS, Tucson Electric Power (TEP), and Salt River Project (SRP), all utilities, have begun initiatives in the development and usage of energy storage and renewable energy technologies on their own [14]. While policy is not a concern in New York City, utility-driven initiatives could potentially be a gamechanger seeing that Arizona has made a large amount of progress in the approval of energy storage installation despite the lack of policy and regulation. Consolidated Edison (Con Edison), one of the largest investor-owned utilities in the United States and the main provider of energy for New York City, is already in the development of utility-driven initiatives such as non-wire solutions (NWS), tier-approach demand response compensation, or the EV Make-Ready Program [24][25][26]. The Con Edison programs aim to ease the burden of costs and barriers for both the ratepayers and the utilities. In Arizona, many of the utility-driven initiatives fund the direct development and installation of technologies.

Regardless, both approaches fundamentally achieve the same goal of furthering energy storage and renewable energy penetration.

#### 4.2.1. Fire Codes and Authority Having Jurisdictions on ESSs in Arizona

In line with Arizona's current stance on ESS penetration, fire code and AHJ regulations are still unclear despite the state being considered one of the forward states for ESS deployment, and they have yet to be fully adopted. In fact, several policies and regulations are being looked into following a battery explosion that occurred at the McMicken BESS project at Surprise, Arizona in April 2019 using the IFC as the baseline and asking for assistance from NYC's fire department (FDNY) [27]. Surprisingly, there were no local regulations for battery energy storage in Arizona prior to this accident, despite national organizations such as the NFPA having federal standards available as a reference [27]. As of now, the new regulations are still being looked at and reformed according to the uniqueness of the region [27]. Being that New York City is primarily an urbanized city, several safety regulations should address any potential dangers in addition to the deficiencies Arizona believed their fire codes had. Setting regulations in stone will not only ensure safety compliance for all the future deployments of ESSs but give stakeholders and investors of the deployments clearer guidelines.

#### 4.2.2. Municipalities versus Central Government of Arizona

Arizona is similar to California in that fire code regulations vary from one municipality to the other, but overall, each jurisdiction follows statewide policies. Following the McMicken battery explosion, the Phoenix Fire Department Marshall gave insight into some of the fire code differences and similarities between districts, mentioning that while regulations somewhat differ from one municipality to the other, homeowners are not allowed to store batteries directly inside their houses [27]. Only a few sectors, such as Surprise and Peoria, allow batteries to be stored inside utility closets, while most require batteries to be stored externally or in a garage [27]. However, Marshall suggested more regulations be uniform across the state to help the fire department complete its job more efficiently. In the case of other battery-related emergencies, he suggested a battery owner permit requirement across the state as a whole [27]. This detail should be noted, since New York City's FDNY already possesses a requirement for all energy storage owners to have a "certificate of fitness." Another important consideration to make is that the cities of Phoenix, Peoria, and Surprise finally passed laws that address the requirements for giant battery storage in these urban and suburban areas [27]. Next to the residential regulations, there is the topic of the utility-side of battery regulation compliance. There seems to be a lack of clarity on which entities have the responsibility to make the final decision on rules and regulations for utilities. First, the Arizona Corporation Commission (ACC) does not have a clear understanding of the limit of its jurisdiction as it is stated to be responsible for regulating public utilities, public health laws, and the safety of ESSs, yet Arizona's constitution defines the ACC explicitly as an entity separate from the legislative and executive branches [14][27]. They are implicitly given the responsibility to regulate public utilities, but the constitution does not explicitly give them the power to do so. Second, the local laws and regulations for utility-owned battery storage are ultimately determined by the municipalities of which the ESS is to be placed in, leading even Marshall Scholl to be confused on whether the ACC or the municipality's authority takes precedence on a utility [27]. Phoenix, Peoria, and Surprise now have regulations for public utilities that set up BESSs along the power grid in response to the Surprise explosion, requiring notification to the city, permits, inspections, and inclusion of certain safety features [27].

New York City can learn by paying attention to the approach that Arizona has taken so far and the approach it will take in the coming years as policymakers continue to address safety concerns and the more intricate regulations involving utility and residential owners. Although New York City currently possesses an additional requirement for a certificate of fitness for ESSs, Arizona is still considering the addition of such a requirement. What Arizona has done so far and will do serves as a template for the five boroughs and Westchester, which would help in forming regulations to ensure safety and fairness between the municipalities.

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