

Economics and Finance of Solar+Storage

Introduction

The NYSolar Smart Distributed Generation (DG) Hub is a comprehensive effort to develop a strategic pathway to a more resilient distributed energy system in New York that is supported by the U.S. Department of Energy and the State of New York. This DG Hub fact sheet is designed to provide solar installers and the general public with an understanding of the economics of solar photovoltaic projects that include battery storage systems (solar+storage) in New York City. For information on other aspects of the resilient PV market, please see the companion factsheets on solar+storage hardware components, policy, and a glossary of solar+storage terms at www.cuny.edu/DGHub.

Advantage of Solar+Storage

Solar+storage systems offer a unique opportunity to provide resilient back-up power while delivering cost-savings. During Hurricane Sandy, most solar PV systems were unable to operate after outages since they could not operate independently from the grid. Most lacked battery back-up. Pairing solar with storage can increase the host-site's resiliency, provide deeper utility bill savings and enable buildings to access performance-based incentive programs.

In contrast to traditional back-up generators, day-to-day operations of solar+storage systems for commercial customers can generate revenue streams from utility and NYISO programs (see [Appendix](#) for details). Solar+storage can also extend the viability of traditional generators during emergencies by reducing the need for fuel inputs.¹

Falling Costs

Solar+storage installations are becoming increasingly economical. The price of installing solar PV declined between 9-12% in 2014 from the previous year across all U.S. market segments, and decreased by almost 20% over the past five years. These price declines have led to a rapid growth in the number of PV systems. Last year the solar growth rate in New York surpassed California, and the United States saw its largest increase in solar capacity to date.²

Simultaneously, the price of storage is also beginning to decline for the dominant battery chemistries lead acid and lithium ion. For example, the total installed cost of commercial lithium-ion systems has dropped approximately 17% per year since 2010, from \$3,400/kWh to \$1,600/kWh³, for an absolute decline of more than 50%.⁴ Recent market reports record average lithium-ion battery costs between \$1,000-2,000/kWh with additional, significant declines expected over

Unique Aspects of Solar+Storage Costs

Solar+storage costs may vary by facility. This is partially due to the variety of ways batteries can be leveraged to support the host-site and/or the grid (see the Key Considerations Section for details.) The optimal use of the battery, its size, length of charge and chemistry are all highly dependent on facility characteristics and needs. As such, costs can vary significantly by application. A recent analysis by one of the Smart DG Hub project partners, the [National Renewable Energy Laboratory](#), illustrated the range of possible payback periods based on 98 different load profiles and battery sizes. The analysis below is for a 30-minute battery providing demand charge support paired with PV sized to 50% of peak load. The models' median payback ranges between approximately 4-10 years, with significant variance.

1 Clean Energy Group (February 2014). Clean Energy for Resilient Communities Expanding Solar Generation in Baltimore's Low-Income Neighborhoods. Retrieved from: <http://www.cleanenergy.org/assets/Uploads/2014-Files/Clean-Energy-for-Resilient-Communities-Report-Feb2014.pdf>.
 2 SEIA. (2015). Solar Market Insights Report Q4 2014. Retrieved from: <http://www.seia.org/research-resources/solar-market-insight-report-2014-q4>
 3 Storage are presented in terms of kW and kWh. The kW is a measure of the battery's power. kWh takes into consideration the battery's storage capacity. Batteries can have different durations in which they can hold charge. For more detail, please reference the fact sheet glossary at www.cuny.edu/DGHub.
 4 Maghani, R. (December 2014) GTM Research. The Future of Solar+Storage in the U.S. Retrieved from: <http://www.greentechmedia.com/research/report/us-solar-plus-storage>.
 5 Ivanova, N. Energy Storage Update. (July 2015). Energy Storage Cost and Performance Report 2015. Retrieved from: <http://analysis.energystorageupdate.com/lithium-ion-costs-fall-50-within-five-years>.



the next five years due to growing demand for batteries.⁵ Given these trends, solar+storage installations are expected to triple over the next year.⁶ These cost reductions have opened the door for a wider base of prospective customers and innovative financing options such as third-party ownership models (see Key Question #3 on page 4).

Economics for the Commercial Sector

In the case of commercial systems, batteries are able to provide savings through peak demand management. The lowered energy usage can save an estimated 20-30% on electricity costs from demand charge reductions (see Key Considerations Question 1 for additional details).⁷ Based on GTM Research’s cost databases, it is estimated that a 100 kW solar, and a two-hour 100 kW battery system would cost approximately \$500,000 before incentives.⁸ According to GTM Research, commercial systems installed on hotels, hospitals and retailers received an average 20% internal rate of return (IRR) in 2014. In Con Edison territory, commercial facilities saw IRRs averaging 25%, partially due to higher utility bills and incentive programs.⁹ Further modeling studies suggest solar+storage can achieve a five-year payback using the current investment tax credit (30%) and assuming peak demand charges of \$24/kW.¹⁰ Demand charge rates at this level are not common across the U.S., but Con Edison and several of the California utilities had among the best paybacks in the analysis.

Economics for the Residential Sector

Residential solar+storage systems are currently not as economical as commercial accounts, but still can benefit from back-up power provided by batteries. However, residential solar (without storage) remains economical throughout much of the country, and multiple financing options and group purchase programs are available throughout New York State.¹¹

At present, residential electric accounts in NYC are not subject to demand charges, which offer the greatest opportunities for savings from battery storage.¹² The addition of a battery back-up system can reduce a home’s energy needs from the grid, but until battery costs decline further or additional revenue streams are available, residential solar+storage is not as economical as commercial applications. Even though residential accounts are not subject to demand charges, batteries can still provide back-up power. The Lawrence Berkley National Lab estimated that an eight-hour outage can cost up to \$7.8/kW of lost productivity for residential accounts.¹³

An analysis of a potential residential solar+storage project in Connecticut concluded that under current prices¹⁴, payback for the system would be approximately 10 years, excluding battery replacement costs.¹⁵ In New York, the only major incentive available for residential solar+storage installations is the investment tax credit, which is expected to sunset on December 31, 2016. However, major residential solar installers are beginning to offer solar+storage packages for residential systems in select markets or directly to housing developers. In California, developers have installed solar+storage systems for approximately \$2,000/kW before incentives.¹⁶

8 Maghani, R. (December 2014) GTM Research. The Future of Solar+Storage in the U.S. Retrieved from: <http://www.greentechmedia.com/research/report/us-solar-plus-storage>.

6 Meza, E. PV Magazine. IHS: Top 10 Predictions for the Global PV Market in 2015. Retrieved from: http://www.pv-magazine.com/news/details/beitrag/ihs--top-10-predictions-for-global-pv-market-in-2015_100017698/#axzz3jT6t8LQP.

7 Ibid.

8 Maghani, R. (December 2014) GTM Research. The Future of Solar+Storage in the U.S. Retrieved from: <http://www.greentechmedia.com/research/report/us-solar-plus-storage>.

10 Krulowitz, A., Saueregger, S. and Chalendar de. J. (July 2015). Geli contributing to GreenTech Media. Analytic Design is the Key to Opening New Energy Storage Markets. Retrieved from: <http://www.greentechmedia.com/articles/read/Analytic-Design-is-Key-to-Opening-New-Energy-Storage-Markets>.

11 Sustainable CUNY. (2015). NYS Financing Options and Services for Solar PV. Retrieved from: http://www.cuny.edu/about/resources/sustainability/reports/NYS_FO_WG_Financing_Options_List_4_13.pdf.

12 Please note that multifamily accounts could be subject to demand charges, depending on the size of the building.

13 Sullivan, M. et al. (June 2009). Lawrence Berkley National Lab. Estimated Value of Service Reliability for Electricity Customers in the United States. Retrieved from: <http://emp.lbl.gov/sites/all/files/REPORT%20lbnl-2132e.pdf>.

14 The system was estimated to cost \$11,310 after incentives for a 7 kW (solar), 3 kWh (battery) system.

15 Martin, J. II. (October 2013). Clean Technica. At What Point Will Small-Scale Energy Storage Become Viable. Retrieved from: <http://cleantechnica.com/2013/10/09/point-will-small-scale-solar-energy-storage-become-viable/>.

16 St. John, J. (May 2012). Green Tech Media. The Numbers Behind Tesla and Solar City’s Home Energy Storage Play. Retrieved from: <http://www.greentechmedia.com/articles/read/the-numbers-behind-tesla-and-solarcitys-solar-home-energy-storage-play>.

Summary of Solar+Storage Economics¹⁷

Category	Description
Financing Options	<ul style="list-style-type: none"> • Direct ownership (widespread lending for solar PV, but limited for storage) • Third-party ownership (lease or power purchase agreement is typical)
Tax Incentives	<ul style="list-style-type: none"> • Investment tax credit valued at 30% of the installed cost of the solar+storage system (expected to fall to 10% for commercial and 0% for residential after December 31, 2016) • Property tax abatement available for solar in New York City (systems must be placed in service before January 1, 2019)
Utility Bill Impacts	<ul style="list-style-type: none"> • Energy charge reductions from solar PV • Demand charge reductions from solar+storage combination
Potential Payment Streams for Commercial Customers	<p>Performance</p> <ul style="list-style-type: none"> • Demand response payments for system performance • Ancillary service payments for providing regulation and reserve services <p>Upfront</p> <ul style="list-style-type: none"> • Funding available for system design and modeling • Funds available to support installation costs

Key Questions and Considerations for Solar+Storage in New York City

1. How can solar+storage provide benefits to my facility and community?

Utility Bill Savings

Solar+storage systems can help reduce both energy and demand charges (for commercial customers) on monthly utility bills.¹⁸ Stand-alone PV systems can reduce the amount of energy needed from the grid, but they cannot consistently provide demand charge support because of their intermittency. Battery systems can reduce a facility’s demand charges by strategically using energy from the battery to lower the peak demand of the facility’s load. The National Renewable Energy Laboratory recently completed an analysis that found that batteries can provide demand charge management support across a variety of facility types and system configurations.¹⁹ A leading provider of storage solutions indicates that demand charge savings can range from \$12,000-\$75,000 per year for commercial accounts depending on the facility and system size.²⁰

Back-Up Power and Resilience

Solar+storage systems can improve the resiliency of a facility by powering critical loads. Solar+storage systems designed to ‘island,’ or operate in isolation from the grid, can continue to power life safety functions in a building even during an outage. Reducing or eliminating downtime is critical for community infrastructure facilities such as shelters and hospitals to continue to provide as much service as possible during emergencies. However, resilience can also be important for retail locations and other facilities which supply residents with needed goods and services when sheltering in place. It is estimated that a day-long energy outage in New York City results in \$1 billion dollars in economic losses.²¹

¹⁷ The chart applies to commercial systems only. For more detailed information on available incentives, please see the Appendix. For further details on economic considerations, please see the Q&A section.

¹⁸ Charges on bills can be divided into two primary components energy charges which are based on the total amount of energy use and demand charges which are based on the highest peak consumption point of a facility over two consecutive 15-minute intervals.

¹⁹ Neubauber, J. and Simpson, M. (January 2015). NREL. Deployment of the Behind-the-Meter Storage for Demand Charge Reduction. Retrieved from: <http://www.nrel.gov/docs/fy15osti/63162.pdf>.

²⁰ Clean Energy Group. (2015). Energy Storage for Demand Charge Management. Webinar. Retrieved from: <http://www.cleanegroup.org/assets/Uploads/RPP-webinar-slides-6.24.15.pdf>.

²¹ Arup, RPA and Siemens (2013). Toolkit for Resilient Cities: New York Electrical Grid Case Study. Retrieved from: http://w3.siemens.com/topics/global/en/sustainable-cities/resilience/Documents/pdf/Toolkit_for_Resilient%20Cities_NY_Case_Study.pdf.

Grid Support Services

Batteries can also provide additional revenue streams for commercial customers participating in demand response (DR) programs run by Con Edison and the NYISO. DR programs require enrolled facilities to reduce load during anticipated periods of high demand upon request from the utility in exchange for payments. Schneider Electric estimates facilities can save 5-25% in utility bills from DR program participation.²² An enrolled customer committing to reduce demand by 100 kW in both Con Edison DR programs for a typical number of DR events is estimated to earn a maximum of \$50,400 over three years.²³ More detail on this program is available in the Appendix. Batteries up to 1 MW in size (including aggregated systems) can also receive payments from the NYISO for ancillary services, such as frequency regulation. For more on potential payment streams, please see the full list of New York incentives and programs in the Appendix.

Environmental Benefits

Solar is a renewable and clean energy resource with an approximately 25 year system life.²⁴ Battery life varies significantly based on the chemistry and the use of the battery, but it can smooth the intermittency of solar generation enabling renewable projects to be more easily integrated onto the grid. The electricity production from solar and solar+storage projects can help reduce a home or facility's reliance on higher emission resources for electricity, and this impact is magnified when comparing solar+storage to traditional back-up power, such as diesel generators, which have high CO2 emissions.

2. How should I prioritize benefits? Is it possible for solar+storage in NYC to provide all of these services?

Solar+storage can theoretically provide all of the services listed above; however software advancements and policy changes are needed to effectively leverage all revenue opportunities at once. There could be policy changes in the near-term through the New York Reforming the Energy Vision (REV)²⁵ process. However, there are also tradeoffs in pursuing different types of battery uses.

Critical load and back-up power can be an added cost for a solar+storage system, particularly for residential customers or commercial customers with relatively low demand charges or a flat demand profile (i.e. limited ability to reduce demand charges). The cost of enabling critical load support will vary depending on building characteristics, such as load profile and existing systems. Using the storage unit solely for back-up power is typically not externally financeable.

For commercial accounts, demand charge reduction currently offers the highest savings opportunity. Batteries have to operate on a specific schedule to reduce peak demand. If a battery is also providing other services, such as DR, balancing priorities can become a challenge. If a battery is used to respond to a DR event, it may not have enough charge to provide peak load support in later hours of the day. This could impact demand charge savings in a given month.

In order to appropriately size the battery, select an appropriate chemistry and determine which programs to leverage, facilities should work with developers to take into account their unique load characteristics, facility needs and cost drivers. The economics of the systems will also continue to change as ancillary service markets evolve and the REV initiative creates new markets for solar and storage.

3. What are my financing options for solar+storage in NYC?

There are two primary ownership models for solar+storage systems: direct ownership and third-party ownership.

In a direct ownership arrangement, the host facility would receive all of the utility bill savings benefits from solar+storage, in addition to the revenue streams it may be able to access from participation in DR programs and ancillary services. There is limited lending available for solar+storage systems on the market presently. As more solar+storage systems

²² LaMonica, M. (April, 24, 2014). Green Biz. Green Biz 101: What do you need to know about demand response? Retrieved from: <http://www.greenbiz.com/blog/2014/04/29/greenbiz-101-what-do-you-need-know-about-demand-response>.

²³ E-mail correspondence, ConEdison.

²⁴ NREL. (2015). National Renewable Energy Laboratory. Distributed Solar PV for Electrical System Resiliency. Retrieved from: <http://www.nrel.gov/docs/fy15osti/62631.pdf>.

²⁵ Reforming the Energy Vision (REV) is Governor Cuomo's comprehensive energy strategy for New York to help consumers make better and more informed energy choices, enable the development of new energy products and services, protect the environment and create new jobs and economic opportunity throughout New York State. For more information, visit: <https://www.ny.gov/programs/reforming-energy-vision>.

come online, lenders will be more likely to fund projects as the technology becomes more familiar. Direct ownership requires either significant assets or a strong credit rating to secure financing.

Third-party ownership models require no money down and are currently supporting the majority of solar+storage installations. Common applications include shared savings models, in which the host facility can receive a system for little to no-upfront cost in exchange for sharing savings from the solar+storage systems with the third-party developer. The third-party would receive the benefits of additional revenue streams and any tax or other financial incentives for solar+storage. The host facility would receive a reduction in its utility bills from the energy and demand savings provided by the system.

4. Can solar+storage in New York City take advantage of tax incentives?

Solar+storage systems have been able to monetize the 30% federal investment tax credit (ITC) for the cost of the solar and the batteries. The IRS has confirmed this in private letter rulings. In practice, if the solar+storage components are installed together and 75% of the energy used to charge the battery comes from the solar system, then the credit can be applied.²⁶ Solar+storage installers have successfully monetized the tax credit in several states. On December 31, 2016, the ITC is scheduled to expire for residential projects and decrease from 30% to 10% for commercial systems. At the local level, New York City has a property tax abatement available for solar systems. Further guidance is forthcoming on its application to storage systems.

Please note: Information included herein does not constitute tax advice. Parties should always consult with their accountants before proceeding.

5. What other programs are available to support the adoption of solar+storage in NYC?

New York State has a variety of programs to support the installation of solar+storage systems, including several incentive and payment programs. The NY-Sun MW Block program offers an additional incentive for solar systems >200 kW that integrate storage. ConEdison also provides incentives to support battery project costs. Details on these and other programs are available in the Appendix with links to additional resources.

If you are interested in contacting a vendor to assess the feasibility of a solar+storage project for your home or business, please visit the New York Battery and Energy Storage Technology Consortium’s (NY-BEST) [Supply Chain Database](#). Search for battery storage integrators to identify companies that provide energy storage systems.

26 Internal Revenue Service. (February 2013). Private Letter Ruling 121432-12. Retrieved from: <http://www.irs.gov/pub/irs-wd/1308005.pdf>.

About

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Appendix

Below is a summary of available programs for solar+storage installations in New York City with links to additional resources. This section will be updated annually to reflect the evolving policy landscape for distributed generation in New York City and the ongoing REV proceedings.

Last Updated: August 2015

Program Name	Incentive Amount or Compensation Details	Eligibility	Fund Distribution
Financial Incentives			
Con Edison Demand Management Program-Battery Storage	<ul style="list-style-type: none"> • \$2100/kW for energy storage • Bonus: 500kW+: 10% bonus on incentive • 1MW+: 15% bonus on incentive 	<ul style="list-style-type: none"> • Con Edison Commercial and Industrial Customers with systems installed by June 1, 2016 • Must reduce peak demand by 50kW or higher from 2-6pm, Mon-Fri, June 1-September 30 	<ul style="list-style-type: none"> • Capped at 50% of project cost • Measurement and verification of energy savings is required; applicant is not responsible for M&V costs
NYSERDA Megawatt Block	<ul style="list-style-type: none"> • Tiered incentives for solar based on region. Current prices can be found here. • Bonus \$50,000 Storage Integration incentive above approved amount for solar for storage systems which provides 250kW of monthly peak demand relief. 	Eligible for commercial and industrial solar systems that integrate batteries. Solar systems enrolled in NYSEDA's MW Block program must be over 200kW.	<ul style="list-style-type: none"> • First come, first serve until funds are exhausted • Used to support development, design and modeling—installation can be supported through other incentives • Project must be installed and performance measured for minimum of 1-year
Con Edison Brooklyn Queens Demand Management—BQDM	Goal of 52 MW (41 MW customer-sited, 11 MW utility-sited) of demand relief with \$200 million (\$150m for customer sited solutions, \$50m for utility sited solutions) in projected funds to avoid substation upgrade	<ul style="list-style-type: none"> • Projects must be located in target BQDM neighborhoods of Richmond Hill, Ridgewood, or Crown Heights (see map) • Four hours of demonstrated reduction between 12pm-12am is required • Target reductions required by 2018 • NYPA-served customers are eligible for funding 	<ul style="list-style-type: none"> • Initial round of projects will be selected through an auction process • Con Edison will still consider requests though the original Request for Information
Energize New York Property Assessed Clean Energy Financing (PACE)	<ul style="list-style-type: none"> • Loans available for solar PV and battery storage systems with demonstrated payback for commercial properties for up to 10-year terms • Repayment takes place on property tax bills, after a lien is placed on the property for value of investment • Financing available for up to 10% of appraised value of building 	<ul style="list-style-type: none"> • Projects must be located in municipalities which have enabled PACE financing. <ul style="list-style-type: none"> • New York City has not enabled PACE financing • Project savings must exceed loan payments • Improvements must have a savings to investment ratio above 1 • Existing lenders must consent to the loan enabled PACE financing 	<ul style="list-style-type: none"> • Applicants must complete a two-step process for funding. • After submission and approval of the pre-application, Energize NY invites applicants to complete a full application.

Program Name	Incentive Amount or Compensation Details	Eligibility	Fund Distribution
Demand Response Programs			
NYPA Peak Reduction Program	<ul style="list-style-type: none"> Measurable reductions are compensated at \$25/kW during June-September, with payments received at the end of the season Participation is mandatory during demand response events In the event a facility is not able to achieve its demand response commitment, compensation is pro-rated based on achieved reduction 	<ul style="list-style-type: none"> NYPA Customers in New York City with discretionary loads or on-site generation can participate in the peak reduction program Other NYPA customers can participate in the NYISO SCR or EDRP programs through NYPA's aggregation service 	Customers can enroll through NYPA in these programs.
Con Edison Demand Response Programs Distribution Load Relief Program Commercial System Relief Program	<p>Up to \$50,000 for every 100 kW of load relief over the course of three years</p> <p>Distribution Load Relief Program</p> <ul style="list-style-type: none"> Tier 1: Reservation \$6.00 per kW/month and \$1.00 per kWh Tier 2: \$15 kW per month, and \$1.00 per kWh reduced during event <p>Commercial System Relief Program</p> <ul style="list-style-type: none"> \$10 per kW per month and \$1.00 per kWh during event 	<p>Customers can participate in one or both programs under a reservation payment option (monthly), which offers a three-year incentive bonus to eligible customers (based on a pledge or actual reduction), or a voluntary option (for demand reduction on request)</p> <p>Distribution Load Relief Program: Demand reduction provided with 2 hours or more notice</p> <p>Commercial System Relief Program: Relief provided with 21 hours or more notification</p>	<p>Exclusion in the Commercial System Relief program of non-renewable DG and diesel generators in certain areas, which could impact hybrid systems</p> <p>If the facility can reduce more than 50kW can apply directly through Con Edison, otherwise facilities must use an aggregation service</p>
NYISO Demand Response Programs Special Case Resources Emergency Demand Response Resource Program Day-Ahead Demand Response Program	<ul style="list-style-type: none"> Special Case Resources: Must participate and sell into the installed capacity auctions, and offer mandatory demand response during reliability events. Capacity is sold in markets and energy performance is paid on market price and performance during events. Emergency Demand Response Program: Voluntary reduction during event when called by ISO, minimum of \$500/MWh or the actual market price if higher 	<ul style="list-style-type: none"> Allows dispatchable resources and on-site generators which can provide 100 kW of load relief to participate in Special Case Resources or Emergency Demand Response Resource Program Day-Ahead Demand Response Program Participation for DG still under review 	Registration with NYISO and ICAP program required for participation

Program Name	Incentive Amount or Compensation Details	Eligibility	Fund Distribution
Ancillary Services			
NYISO Ancillary Services Demand Side Ancillary Service Program	<ul style="list-style-type: none"> • Demand Side Ancillary Service Program (DSASP) Compensation available for customers who can provide real-time or day-ahead reserve and regulation support. Paid at reserve or regulation market clearing price. • The floor price for offers into the program is \$75/MWh. 	<ul style="list-style-type: none"> • Minimum 1MW aggregate reduction provided by participant. NYISO does allow aggregation for the programs. Facilities must have curtailable load and an on-site generator. • Participation is mandatory if scheduled. Penalties apply. 	<p>Solar+storage and storage have not traditionally participated in this market due to system size requirements.</p>
Relevant REV Demonstration Projects			
Con Edison Clean Virtual Power Plant Demonstration Project	<ul style="list-style-type: none"> • Con Edison submitted a REV demonstration project for a virtual power plant in July 2015. It would enable ConEdison to aggregate a fleet of residential solar+storage units as a dispatchable resource for the grid to provide distribution and transmission support. • The project proposes to offer homeowners a no-money down solar+storage system, owned by Con Edison in exchange for resiliency payments. 	<ul style="list-style-type: none"> • Con Edison is proposing to own the energy storage system to enable it to aggregate and dispatch the fleet of residential systems • Homeowners could own or lease the solar system with the battery unit 	<ul style="list-style-type: none"> • Program pending approval