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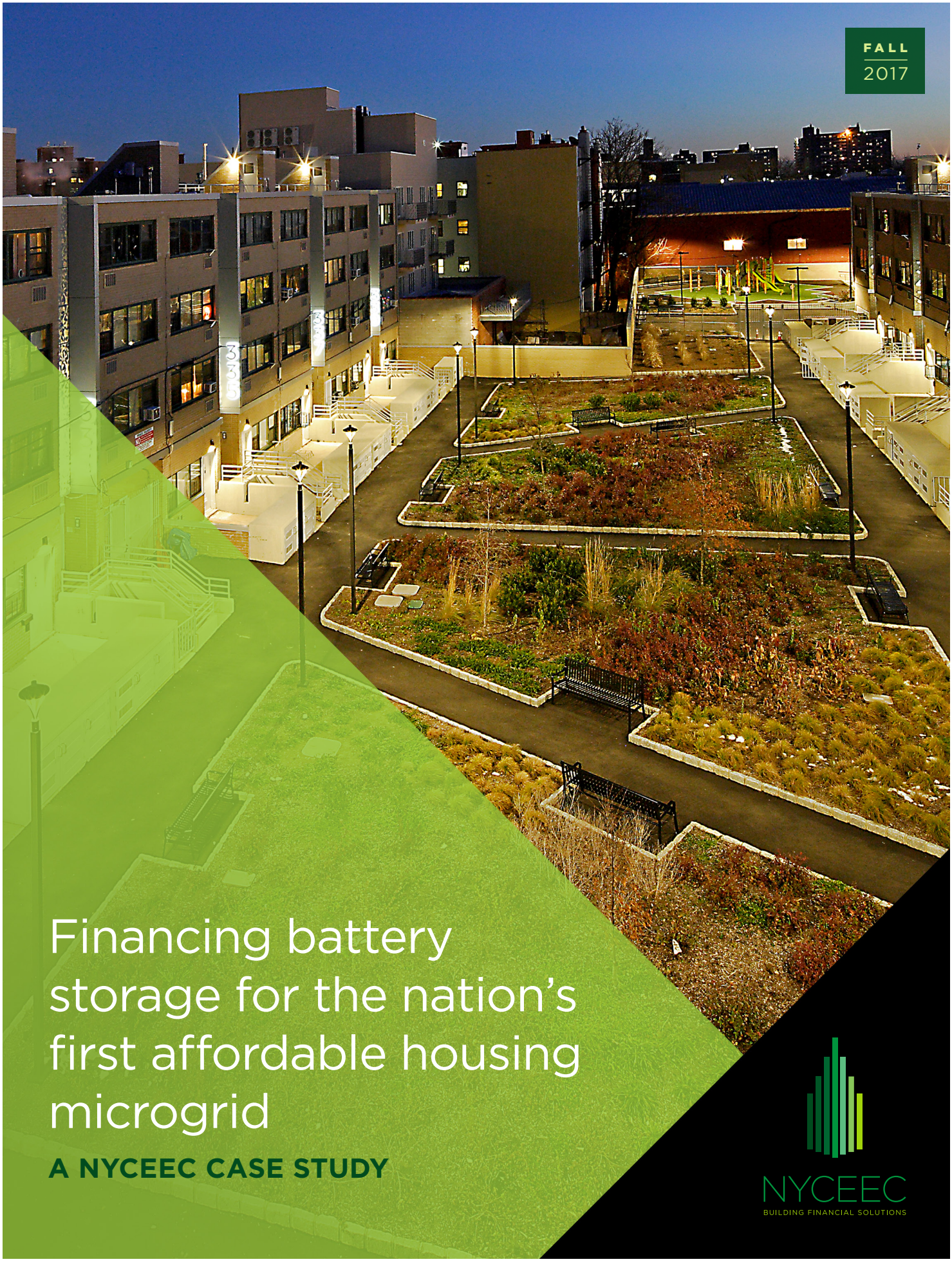

Financing battery storage for the nation's first affordable housing microgrid

A NYCEEC CASE STUDY

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Photo credits: Demand Energy

BATTERY STORAGE

IS POISED TO BECOME A COMMON PART OF BUILDING ENERGY SYSTEMS

NYCEEC's experience in financing the battery portion of a renewable-energy-plus-storage microgrid in an affordable housing development reveals both the significant financial opportunity and the intricacies of adding storage to an onsite electricity generation project. Brought live in June of 2017, the system at the Marcus Garvey Apartments in Brooklyn, NY, combines rooftop solar panels, electricity-generating fuel cells and large-scale battery storage to significantly reduce the 625-unit complex's demand on the local Consolidated Edison (Con Edison) electricity grid—while lowering operating expenses, generating revenue as well as electricity and cutting the facility's energy-related greenhouse gas emissions. Financing the $1.3 million onsite lithium ion battery served as a pilot for NYCEEC, which regularly considers new energy technologies for its loan portfolio.

The combination of two onsite generation sources with load-leveling battery storage is a prime example of the approaches to energy imagined and encouraged by New York State's Reforming the Energy Vision (REV) initiative. It is the first microgrid deployed under Con Edison's Brooklyn-Queens Demand Management (BQDM) Program, which offers substantial equipment incentives and ongoing payments for demand reduction. In August of 2017, the Energy Storage North America (ESNA) conference recognized the market leadership of the Marcus Garvey battery storage system with an ESNA innovation award.

Though deploying the three systems together is new to the affordable housing market, the technologies involved are increasingly well understood and relatively low-risk for the building's owners. A number of similar systems have been used in commercial settings. With promising projections and good initial results, the project offers a model for distributed energy generation with storage and the financing that makes it possible.

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THE CREATION OF AN URBAN HOUSING GRID

In the 1970s, when it was constructed, the Marcus Garvey complex was cutting-edge. Spread over nine blocks in Brooklyn, it offered low-income families low-rise, duplex apartments with private backyards or terraces, communal mews and private front doors. By 2014, however, when the property was acquired by a privately-held real estate company, L+M Development Properties Inc. (L+M), Marcus Garvey needed major renovations—an additional investment of approximately $50 million. One issue among many was the buildings' high energy costs, due largely to their use of electric heat. Because the buildings are master-metered, tenants do not pay individually for their electricity or heat; the costs are factored into the overall rent. As the property managers considered their renovation strategy, energy use was a major factor.

Con Edison, which supplies electricity to Brooklyn and Queens, was facing its own energy use challenge: rising electricity demand and an aging power distribution infrastructure in the neighborhood surrounding Marcus Garvey. Rather than build a new $1.2 billion substation, with approval from the NY Public Service Commission, Con Edison designated $200 million in capital to fund projects that would reduce local electricity demand by 41 MW through efficiency or distributed generation. The Brooklyn BQDM program offered incentives that made L+M's cost reduction and efficiency goal a possibility.

An analysis by experts from GridMarket, a firm dedicated to identifying and right-sizing large distributed energy projects, led L+M to consider the three-part system. Combining energy generation with energy storage would allow the system to maximize the revenue potential from demand response and peak shaving programs and would add stability and resiliency in times of grid outages.

HOW IT WORKS

Demand response

is the reduction of energy use at times of system overload. Utility customers contract with the utility or the grid operator, agreeing to reduce consumption for limited periods of time on short notice. The aggregated reductions allow the utility company to provide sufficient electricity to its customers when there is unusually great demand for power, like during a summer heat wave or when distribution is affected by an equipment issue. Many customers participate by turning off equipment or temporarily changing building temperature settings; those with battery storage can use their stored power during demand response events so there is no impact on the building's operation.

Peak shaving

is the regular limiting of demand at times of building peak demand. In peak shaving, the battery storage system anticipates a building's peak load event and "shaves" off the top of a demand spike and ultimately reduces the demand charges a customer sees on their utility bill.

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The power generation design for the project included a 479 kW rooftop solar photovoltaic (PV) array installed by Bright Power and a 400 kW Bloom Energy fuel cell system, which would generate electricity onsite from natural gas. Together, the systems produce a significant amount of the electricity needed at Marcus Garvey.

Battery storage completed the system, making the most of the energy generated by aligning its use with the larger grid's variable pricing and energy management programs. For example, the peak power generation for the solar array does not always match peak electricity usage times, and the local grid is not equipped to redistribute excess power. The 300kW/1,200kWh lithium ion battery storage system from Demand Energy would store that power and use it at times that would lower costs or generate revenue. Demand Energy's Distributed Energy Network Optimization (DEN. OS) software platform, manages the microgrid and integrates all of the different resources with the building load in real time to optimize the system's overall economic returns.

L+M established a limited liability corporation called Marcus Garvey Partners LLC (MGP) to contract with L+M for the electricity generated. MGP and L+M entered into a power purchase agreement (PPA) for long-term electricity at a fixed price, and a separate energy services agreement (ESA) with Demand Energy to provide storage and system controls, and to share related revenues.

Demand Energy came to NYCEEC to finance the battery storage portion of the overall project.

NYCEEC'S FINANCING ENGAGEMENT

Project loan summary	
Borrower:	Demand Energy SPE
Property location:	Brownsville neighborhood, Brooklyn, NY
Project:	300kW lithium ion battery (part of a microgrid involving a 479kW solar system and 400kW fuel cell, both of which were not included in the NYCEEC financing)
Building type:	Non-market rate rental housing complex with 625 units
NYCEEC product:	Direct loan
Total project cost:	$1.32MM
NYCEEC loan amount:	$1.25MM
Incentive amount & provider:	$0.54MM from Con Edison
NYCEEC interest rate:	Negotiated
NYCEEC upfront fee:	Negotiated

Project loan summary	
Construction period:	6 months
Duration of loan:	10.5 years (including construction period)
Security:	All equipment and incentives, and equity in SPE
Primary sources of revenues to pay NYCEEC loan:	1. BQDM incentive 2. Demand response revenues 3. Peak shaving revenues
ENGINEERING METRICS	
Average monthly peak demand reduction:	207 kW
Annual greenhouse gas emissions reduction:	6 metric tons of CO2 equivalent (Mtons of CO2e)

For NYCEEC, financing $1.25 million of the battery storage part of the project was an opportunity to add storage financing to its expertise in energy efficiency and distributed generation. NYCEEC recognizes that developing financing structures that facilitate increased investment in storage is important. NYCEEC would be able to use the Marcus Garvey loan as a potential financing template. That meant fully examining the benefits for the building owners and residents, and the incentive and revenue potential of the Demand Energy battery system.

NYCEEC loaned the money to a special purpose entity created by Demand Energy (Demand Energy SPE). Upon completing access to financing, Demand Energy SPE and MGP would enter into an ESA in which MGP agreed to host an energy storage and efficiency system, and Demand Energy SPE agreed to provide, install and operate the system.

Demand Energy SPE would receive a major reimbursement from the BQDM and would have two ongoing sources of revenue over the course of its contract with MGP, allowing it to repay its loan and profitably provide services to Marcus Garvey:

1. INCENTIVES

As part of MGP's commitment to BQDM load reduction, Con Edison would pay a total of $540,000 in BQDM incentives, which would be payable to the Demand Energy SPE. The amount would be paid in three installments: 70% upon bringing an approved system live; 10% upon completion of measurement and verification (M&V) approximately a year after commissioning; and 20% upon completion of M&V approximately two years after commissioning.

2. DEMAND RESPONSE REVENUE

MGP would receive monthly payments for providing load reduction capacity that would be utilized when called upon by either Con Edison or NYISO (New York Independent System Operator). The payments would be passed on to Demand Energy, providing an estimated 77% of Demand Energy's ongoing revenue from the battery project. Con Edison and NYISO each offer two programs for compensating load reduction. For the first two years of operation, the system would

not be eligible for Con Edison demand response payments because it would be receiving the BQDM payments. In year three, however, NYCEEC and Demand Energy estimated that the annual demand response payments from the four programs would total an estimated $135,705.

Con Edison's two commercial demand response programs are the Commercial System Relief Program ("CSRP") **& the Distribution Load Relief Program** ("DLRP")**:**

1. Con Edison CSRP: The CSRP is a program that gives customers a 21-hour notification within four call time windows that coincide with network peaks.

2. Con Edison DLRP: The DLRP provides a financial incentive for curtailing load during network emergencies. This program provides only a 2 hour notification.

MGP would receive monthly payments based on the amount of energy it pledged to reduce upon request, and additional payments for actual load reduced.

The NYISO Installed Capacity-Special Case Resource (ICAP-SCR) Program provides load reductions in response to NYISO Operations for a discrete period of time when operating reserves are forecast to be short or when there is a system emergency. ICAP-SCR participants are paid in advance (monthly) for agreeing to cut power usage upon request. The payment rates are established at monthly ICAP auctions. NYISO's program is divided into two seasons.

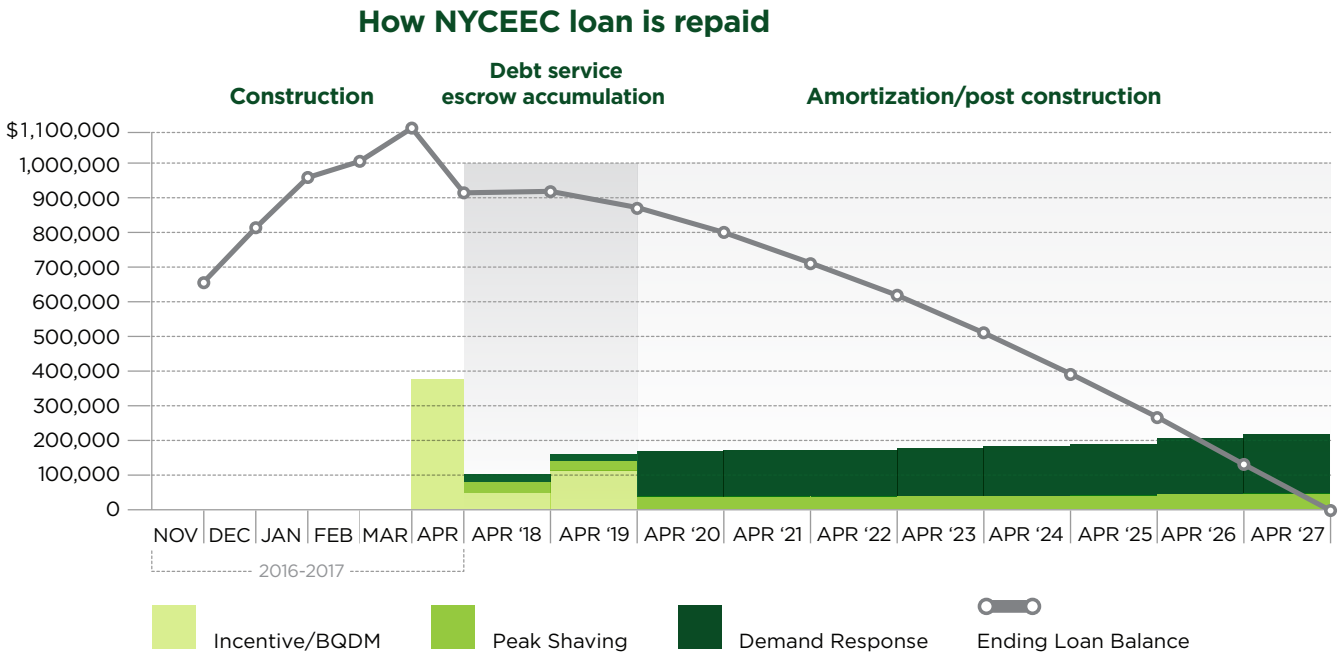
As part of the ESA, Demand Energy SPE would receive 100% of the demand response revenue associated with the battery system.

3. PEAK SHAVING REVENUE

Peak shaving is the ongoing reduction in demand for the building at peak usage times. Peak shaving reduces the amount of peak kW each month and results in savings on L+M's electrical bill. Demand Energy SPE (55%) and MGP (45%) share peak shaving revenues associated with the battery storage project in accordance with the ESA document.

LOAN DESIGN

NYCEEC's financing allowed Demand Energy SPE and, in turn, MGP, to engage in the project with little upfront cost. NYCEEC designed the 10-year loan to account for the large incentive payments and the time lag between the system installation and when the demand response and peak shaving revenues began to be substantial. The incentive payments would serve as loan prepayments over the first two years of the loan, and no other debt payments were required. Over those two years, net operating income from peak shaving and demand response would be held in a debt service escrow. Once the battery system was eligible to fully participate in demand response and peak shaving programs, the escrow would be released, with a small reserve held for market fluctuations. After two years, when the incentives had been paid and the project was participating in all four demand response programs, the $885,872 opening balance would be amortized quarterly over 8 years.



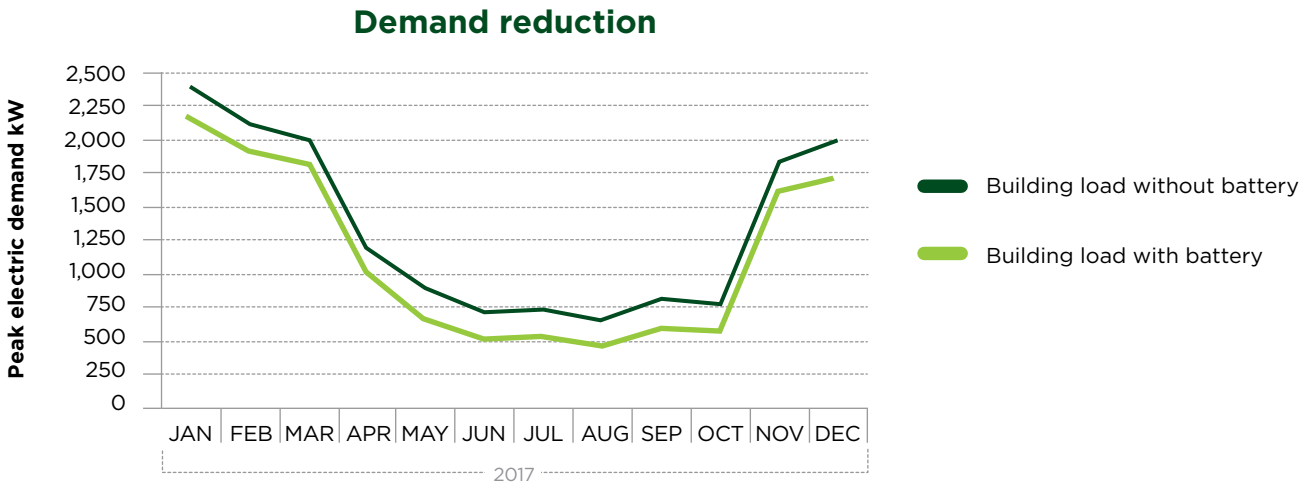
CONSTRUCTION AND IMPLEMENTATION

Putting a 300kW battery system in the middle of Brooklyn is no small feat. Safety and security are serious concerns, and the project was carefully reviewed and approved by the Fire Department of the City of New York (FDNY) and NYC Department of Buildings, along with the owners and residents of the buildings, and the power grid engineers.

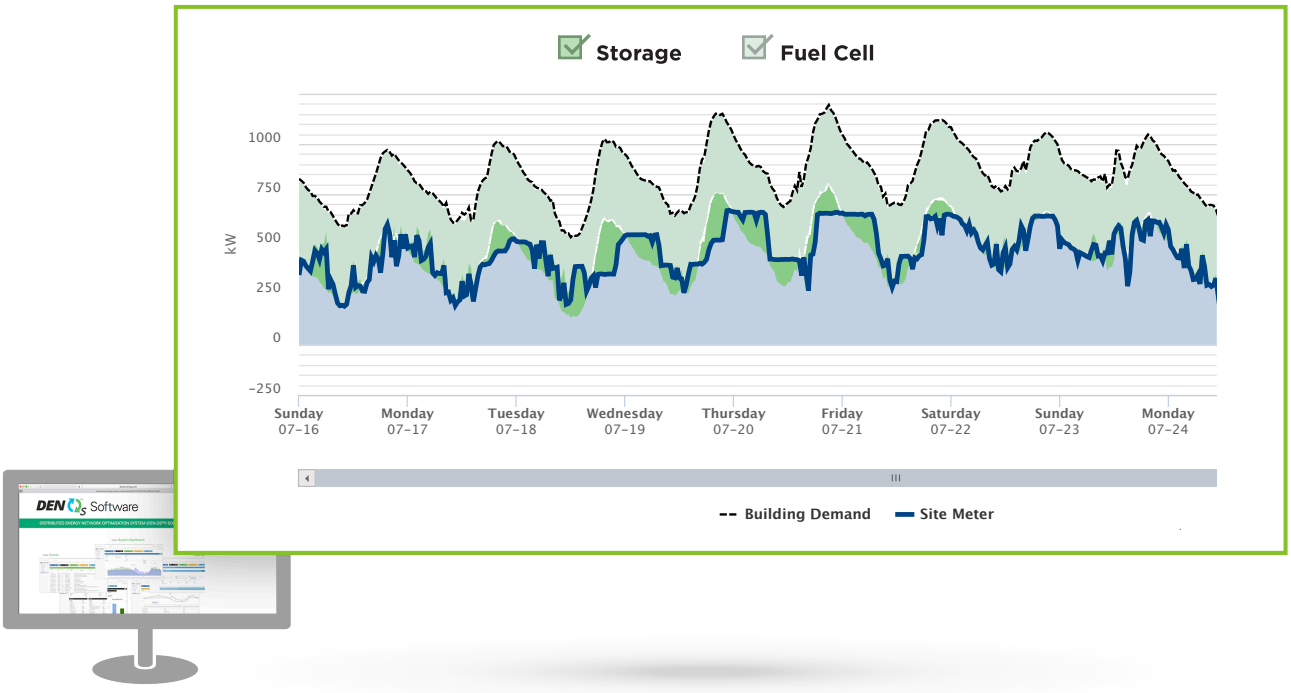
Ultimately, a 24-foot, temperature-controlled metal storage container was installed in the alleyway outside one of the Marcus Garvey buildings. Together, the batteries can deliver 1,200 kilowatt hours of electricity. The building load is monitored by Demand Energy's DEN.OS software which takes into account the load reduction by the solar and fuel cell systems. The software optimally controls discharging of the battery anticipating when a peak load event is about to occur.

PERFORMANCE

In addition to providing capacity for the utility's demand response programs, the battery system would provide a projected 207 kW per month in peak-shaving capability for the building (see chart). The projections were based on an analysis of the prior two years of billings, which included 15-minute power consumption interval data.



Actual performance of the battery storage system is currently being monitored through Demand Energy's DEN.OS dashboard. Data from the system can be seen in the screen shot taken below.



The "Building Demand" shown in the figure reflects the building demand net of solar energy production. The light green area is fuel cell production. The energy storage system (battery) then monitors the building load in real-time and shaves peak demand loads avoiding high monthly demand charges for the building (shown as the dark green area). The optimized and actual building load is shown as the "Site Meter".

The system is optimized to minimize cost, which means maximizing demand reduction while minimizing battery run time. The system typically charges during nighttime off-peak hours and discharges during the day when building loads typically peak.

OPPORTUNITY | IMPROVING ELECTRIC RATE STRUCTURES

Electric utility rates greatly influence the usage and economics of a battery storage system.

Electric demand charges are typically tabulated based on the highest peak demand reached during the previous month. Due to this infrequency, a peak demand day for the building could likely coincide with a demand response call from the utility, for example, on an extremely hot day when the building's load is high and the grid is constrained. When that happens, the customer must choose between honoring their commitment to the demand response program or shaving peak demand at their building. Either way, the battery owner loses one source of revenue for that event.

Rate structures could be improved to fully capture the value of battery storage. Utilities could tabulate daily peak demand charges rather than monthly charges, thus, making battery usage more efficient and economical. Location-based-marginal-pricing from the electric supplier would also improve the system by providing pricing signals to the customer a day ahead of time to optimize when charging and discharging of the system is most economical. This also helps manage the larger problem of leveling demand on the grid.

PROSPECTS FOR SIMILAR PROJECTS

While long-term proof of concept is still pending, the Marcus Garvey installation furthered NYCEEC's support of new technologies and it offers a model for NYCEEC and other lenders to use in financing battery storage and distributed generation projects. Minimizing upfront investment by the building owners made it possible to bring a microgrid to low income housing, potentially encouraging low-income owners/developers to consider energy reduction strategies. Investors seem to agree: shortly after the battery system was installed at Marcus Garvey, Demand Energy was acquired by Enel, a European energy company, which prepaid the loan to NYCEEC. And state policy makers and energy authorities such as NYSERDA are aware of the challenges of market uncertainty and are considering ways to make long-term demand response revenues more predictable.

In September 2016, New York City established an energy storage goal of 100 MWh by 2020, along with an expanded solar target of 1,000 megawatts by 2030. Storage is expected to play a key role in meeting the city's plans to cut greenhouse gases by 80 percent by 2050.

The BQDM program is proving successful; as of calendar year Q1 2017 it had spent just under $50 million of its $200 million budget, and achieved 137 GWh of annual energy reduction, according to its public reports. In July of 2017 the Public Services Commission extended the program, allowing for more projects. Con Edison is considering introducing the BQDM model in other parts of New York City under its “non-wires solutions” initiatives.

Combined generation and storage can lower operating costs, improve emergency resiliency and save expensive, avoidable investment in centralized energy distribution. NYCEEC looks forward to a thriving market for storage financing.

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