Current Energy Storage Systems in NYC

Image: NYSolarmap.com
Project Development Checklist

Pre – Project Scoping
• Establish project objectives

System Design
• Location for equipment
• Ensure capture of Investment Tax Credit
• Battery sizing
• Equipment Compatibility

Implementation
• Paying for the system
• Work specification language to solicit project proposals
• Finding a good developer
Usage of solar and energy storage system (ESS) will influence the design components:

**Emergency power:**
- Dual function inverter
- Batteries with high efficiency

**Demand Management:**
- Batteries that are deep cycle and have high number of lifetime cycles
- Battery banks with sufficient capacity

**Grid Services:**
- Batteries that have quick response or low charge/discharge rate
- Need control software to communicate with the service organization

Source: ConEdison & SUNPOWER
http://www.sunpower.com/ny-solar-storage
Peak Demand Management

Figure 2. Peak Demand Reduction
# Back-up Power

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Description</th>
</tr>
</thead>
</table>
| Resiliency| • Emergency power  
             • Critical load                                                            |
| Economic  | • Critical load during outage prevents potential lost revenue               |
| Social    | • Shelter during grid outage                                                |

**Figure 24.** PV and battery support the critical load during a 51-hour outage
Resources

[Image]

Resilient Solar Photovoltaics (PV) Systems

Introduction

The NY Solar 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 provides information to installers, utilities, policy makers, and consumers on resilient PV hardware and design. For information on other aspects of the resilient PV market, please see the companion factsheets on solar-storage economics, policy, and a glossary of solar-storage terms at: www.carnegiesolar.com/DGHub.

What is Resilient PV?

Resilient PV is solar energy that is coupled with technology that allows it to continue to provide power during grid outages. Currently, traditional PV systems are configured to shut down during grid interruptions. This configuration protects the safety of utility workers. However, solar can continue to function and provide power during grid outages if configured for resiliency.

There are three standard ways to make PV resilient:

1. Pairing the solar modules with batteries to store energy for later use, known as PV with battery back-up.
2. Pairing solar with auxiliary generation like a diesel generator.
3. LIFEligning an inverter with an emergency power outlet that provides limited power when the sun is shining.

This fact sheet will focus on PV with battery back-up, providing details on the key components of the system, including solar arrays, batteries, charge controllers, and inverters. It also presents key hardware barriers for PV with battery back-up and offers a few case studies to demonstrate the importance of resilient PV.

PV with Battery Back-up

PV with battery back-up can function as both a stand-alone or grid-connected system, providing emergency power when the grid is down, and economic benefits when grid-connected.

System Design

Design of PV with battery back-up is described in terms of how the battery back-up is integrated into the system. Solar modules and batteries typically generate and use direct current (DC) electricity. However, most appliances and the grid typically use alternating current (AC) electricity. DC energy must therefore go through an inverter to be converted into AC energy for use by appliances and the grid. Battery back-up can be integrated into the system on either the DC (DC-coupling) or AC (AC-coupling) side of the system. The majority of new resilient PV systems use a DC-coupled configuration when solar is not already in place. Figure 1 on page 2 illustrates a typical DC-coupled, grid-tied configuration. Existing systems that are refurbished with battery back-up tend to use an AC-coupled design. Figure 2 on page 4 shows a typical AC-coupled system.

https://nysolarmap.com/solarplusstorage/

Also Available:
Sfenviornent.org/SolarResilient.org
Solar and storage sizing tool!
Project Development Checklist

Pre – Project Scoping
• Establish project objectives

System Design
• Location for equipment
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Implementation
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• Finding a good developer

Source: NREL
System Design

Batteries

Choosing batteries that are both economical and provide sufficient emergency power depends on:

• Cost
• Energy density (size)
• Cycle life
• Thermal stability/safety

A comparison was done between the common battery chemistries (*Resilient Solar PV Systems Fact Sheet*)

Source: ConEdison & SUNPOWER
http://www.sunpower.com/ny-solar-storage

Note: A full comparison table can be found in the *Resilient Solar PV Systems Fact Sheet*:
www.nysolarmap.com/resources/reports
### Battery Comparison Table

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Lead Acid</th>
<th>Lithium-Ion</th>
<th>Flow Batteries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VRLA (Deep-Cycle)</strong></td>
<td>LFP</td>
<td>NMC</td>
<td>LTO</td>
</tr>
<tr>
<td>Usage¹</td>
<td>Resiliency, Grid Support, Peak load shifting, Intermittent energy smoothing, UPS</td>
<td>Resiliency, Grid Support, Peak load shifting, Intermittent energy smoothing, UPS</td>
<td>Resiliency, Grid Support, Peak load shifting, Intermittent energy smoothing, UPS. Bulk power management</td>
</tr>
<tr>
<td>Energy density (Wh/kg)</td>
<td>30-50</td>
<td>90-120</td>
<td>150-220</td>
</tr>
<tr>
<td>Lifetime cycles (80% depth of discharge)</td>
<td>50-100²</td>
<td>1,000-2,000</td>
<td>1,000-2,000</td>
</tr>
<tr>
<td>Efficiency (%)</td>
<td>85-90³</td>
<td>90-95</td>
<td>90-95</td>
</tr>
<tr>
<td>Charge rate</td>
<td>5-16 hrs⁴</td>
<td>2-4 hrs</td>
<td>2-4 hrs</td>
</tr>
<tr>
<td>Cost</td>
<td>$150-300/kWh⁵</td>
<td>$400/kWh⁶</td>
<td>$428-750/kWh⁶</td>
</tr>
<tr>
<td>Advantages</td>
<td>Well-known and reliable technology, able to withstand deep discharges, relatively low cost, and ease of manufacturing.</td>
<td>High energy density, able to withstand deep discharges, and long cycle lives.</td>
<td>Relatively safe, well suited for bulk storage, long cycle life (claim 10,000-20,000 cycles), and easy to scale up the amount of energy stored by simply making the tanks larger.</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>Relatively low number of life cycles (must be replaced more often) and lower energy density (larger size for less energy storage).</td>
<td>More expensive than lead acid systems and may become thermally unstable. Overheating or short circuits in Li-ion cells may cause thermal run-away—a phenomenon where the internal heat generation in a battery increases faster than it can dissipate. This heat can damage or destroy the cells and is a potential source for fires. Electronic protection circuits are added to the battery pack to prevent thermal run-away.</td>
<td>Relatively high cost, low efficiency (less than 70%) and low energy density, high maintenance with pumps that often leak and precipitate out.</td>
</tr>
<tr>
<td>Safety (Thermal Run-away)⁷</td>
<td>Considered thermally safe</td>
<td>High thermal stability</td>
<td>Increased thermal stability</td>
</tr>
</tbody>
</table>

System Design

Siting/Practical Considerations

- Physical space for equipment
- Location of equipment
- Regulatory considerations
- Interconnection agreement
- Communications compatibility
- Equipment compatibility

Source: NREL
System Design

Sizing and Critical Loads

Example Critical Loads
- Refrigerators
- Lighting
- Computers
- Sump Pumps

Example Non-Critical Loads
- Exterior Lighting
- Irrigation pumps
- AC units

Calculating Size Requirements

\[
\text{Rated Battery Capacity (kWh)} = \text{Total Critical Load (kW)} \times \text{Run Time (hrs)}
\]

Example: 5 overhead lights at 300 watts per fixture need to be run overnight (12 hours)

\[
\text{Rated Battery Capacity (kWh)} = 5 \times 0.3 \text{ (kW)} \times 12 \text{ (hrs)}
\]

\[\text{Rated Battery Capacity (kWh)} = 18 \text{ (kWh)}\]
Resources

New York Solar Smart DG Hub-Resilient Solar Project: Economic and Resiliency Impact of PV and Storage on New York Critical Infrastructure

Kate Anderson, Kari Burman, and Travis Simpkins
National Renewable Energy Laboratory (NREL)

Erica Nelson, Lars Lisell, and Tria Case
City University of New York (CUNY)

https://nysolarmap.com/solarplusstorage/

Upcoming Resource (Q2): Critical Infrastructure Planning Guide
Project Development Checklist

Pre – Project Scoping
• Establish project objectives

System Design
• Location for equipment
• Ensure capture of ITC
• Battery sizing
• Equipment Compatibility

Implementation
• Paying for the system
• Work specification language to solicit project proposals
• Finding a good developer

Image: NREL
Financing and Installation

Limited local incentives
• A limited number of states have implemented or proposed utility, state-run or tax incentives for storage or solar and storage (MA, CA, MD, PJM)

Nationwide: Federal Investment Tax Credit (ITC)
• Batteries must be “integral” to the operation of the system
• Must be charged by RE 75% of the time or greater to qualify
Financing and Installation

**Financing**
- 3rd party financing
- Direct ownership

**Warranties**
- Ensure component warranty will not be voided

**Defining Requirements**
- Example language in Attachment A of the Fact Sheet
- Select a contractor with technology experience

Resources

https://nysolarmap.com/solarplusstorage/

Also Available:
RFP Guidance and Sample Work Specification Language

Q3: Solar and Storage Financial Calculators
Storage Now or Later?

Figure 41: Blended Battery Price Projections

BATTERY PRICE PROJECTIONS
[Y-AXIS 2012$/kWh]

Source: Rocky Mountain Institute

(Ndashed lines represent extrapolations)

Source: National Renewable Energy Laboratory
Storage Ready PV System

What is a Storage Ready PV System?

- Build a PV system now that allows for “plug and play” storage later on.
Storage Ready PV System

How much does storage ready PV cost?

• Components that add cost, switching, extra wiring, more expensive inverter, etc. Will increase the project cost between 12% and 17%.
  • Example Residential System: $2,000 - $3,000 increase in cost

How much can storage ready PV save?

• Opportunity to save between 18% and 27% of project cost.
  • Example Residential System: $3,000 - $4,500 cost savings
Thank You!

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