

Smart DG Hub Resilient Solar Project Final Report

April 2019



Sustainable CUNY of the City University of New York

Final Report

Project Title: NYSolar Smart DG Hub – Resilient Solar Project

Covering Period: 01/01/15 – 12/31/18

Budget Period: 01/01/15 – 12/31/18

Submission Date: 2/15/19

Recipient: Research Foundation of the City University of New York
230 W 41ST Street, 7th Floor
New York, NY 10036-7207

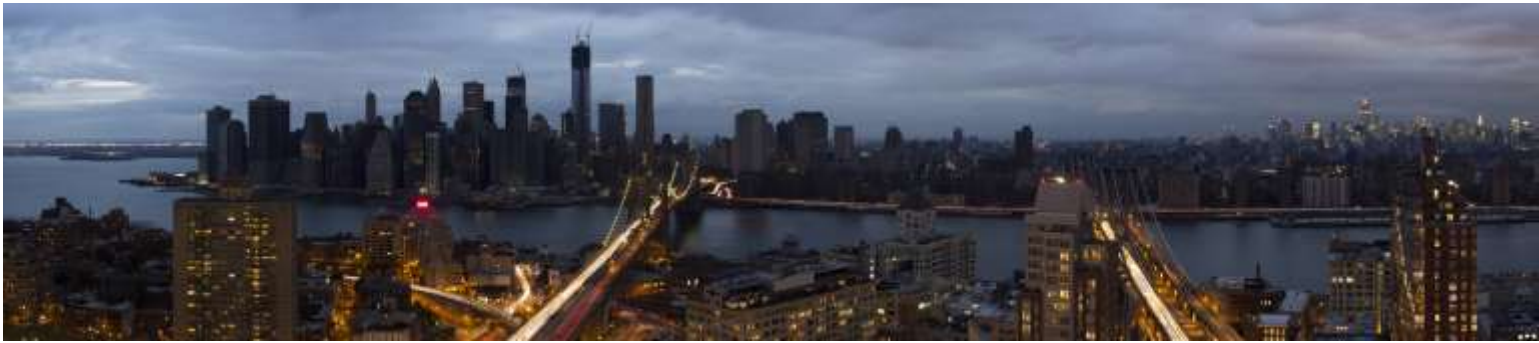
Website (if available) <https://nysolarmap.com/solarplusstorage/>

Award Number: DE-EE0006913

Cost-Sharing Partners: New York Power Authority, New York State Energy Research and Development Authority, Marty and Dorothy Silverman Foundation

PI: Tria Case
University Director of Sustainability
Phone: 917-675-2140
Email: tria.case@cuny.edu

DOE Project Team: **Technology Manager –**
Project Officer – Christian Philipsen
Grants Management Specialist -
Contracting Officer – Diana Bobo



Contents

Executive Summary..... 3

Project Activity Summary..... 4

 Original Hypotheses..... 4

 Approaches Used 4

 Findings/Results 5

 Conclusion..... 6

Storage Resources Developed 8

IT Resources 9

A Blueprint for Structuring Change..... 10

Tasks: Status and Timeline..... 12

Acknowledgment 17

Disclaimer..... 17

Executive Summary

Hurricanes, unstable fossil fuel supplies and increased energy loads have revealed the vulnerability of America's electric grids. Renewable energy has emerged as a viable option; however in order for this sector to reach its full potential it needs to be paired with storage. For example, all of the solar installations in New York City in 2014 were wired to automatically shut down during grid outages for safety reasons and lacked battery backup or other means to function during outages. Pairing solar with batteries can provide critical power needs and reduce dependency on delivered fuel. Additionally, resilient solar systems can also provide benefits outside of emergencies such as utility bill savings and grid support services. Solar+Storage needed a pathway through regulatory, policy and financial hurdles, some of which are unique to urban environments. Sustainable CUNY of the City University of New York (CUNY) formed the Smart Distributed Generation (DG) Hub to develop a strategic pathway to a resilient distributed energy system that integrates storage into resiliency planning and provide support to the grid on peak power days. Through the Smart DG Hub Resilient Solar Project, with support from the U.S. Department of Energy (DOE) as well as the New York State Energy Research and Development Authority, the New York Power Authority and private funding, Sustainable CUNY worked with project partners - including the National Renewable Energy Laboratory, Meister Consultant Group (now Cadmus), subject matter experts at utility companies, and authorities having jurisdiction - to develop a roadmap for the greater deployment of solar+storage as well as a toolkit of resources.

Ultimately, in addition to the completed deliverables of multiple resources, the project established a baseline of the current policy, financial, and market landscape, and an understanding of which key areas would require further actions. The DG Hub's collaborative platform and subject matter expertise gained through this project led directly to a new award from the NYS Energy Research & Development Authority to continue CUNY's work in targeted areas including energy storage permitting and stakeholder education, similar to the way DOE's prior support had sowed the initial seeds for the growth of the solar market in NYC, to the NYS market.

Finally, the Resilient Solar Project helped inform the New York City (NYC) administration, leading to a significant policy development that included Mayor Bill de Blasio setting a city-wide storage goal of 100 MW by 2020, the first of any city in the country.

Project Activity Summary

Original Hypotheses

Sustainable CUNY theorized that if the barriers to integrating resilient solar photovoltaics (PV) into emergency and resiliency planning in NYC were identified in four key categories: Hardware, Software, Policy/Legal and Financing/Economics; resources could then be developed or recommended that could remove the barriers to mainstream acceptance of solar+storage.

Specific goals included the creation of guidelines for resilient PV codes and permitting regulations; greater understanding of resilient PV among installers, code officials, and consumers; ombudsman support; a roadmap for market development; the expansion of the Solar Calculator to include resiliency factors; a developed cost-reduction pathway and framework; and broader adoption of the framework on both the state and national level.

Approaches Used

Project Based Change

Sustainable CUNY developed and utilized a project-based change management platform to remove the barriers to integrating energy storage systems into the NYC marketplace. This platform brings together all the necessary decision makers, such as Authorities Having Jurisdiction (AHJs) and utility companies, in coordination with other stakeholders, and enables them to take ownership of the outcomes by collaboratively establishing the processes and actions needed. The iterative process of feedback and response among stakeholders and the project team is of fundamental importance in the change management process and the key to success.

Ombudsmen and IT Team

It is imperative to the success of a storage or renewable energy program to have personnel who are solely dedicated to serving as the liaisons to the partners, collaborators and developers; can drive the completion of the tasks; and bring the project, initiative or plan to fruition. Sustainable CUNY utilized 'Storage Ombudsmen' and a Communication Director all who served under the direction of the PI along with IT staff.

Working Groups

The initial task at the outset of the project involved establishing four stakeholder Working Groups along principal areas that needed to be addressed in the resilient PV landscape – Hardware, Software, Finance/Economics, and Policy/Legal. These four categories were determined through group consensus during a 2013 meeting of NYC stakeholders from the public, private- including utility companies, military, and NGO sectors, which CUNY had convened in order to study the impacts and lessons learned in the aftermath of Hurricane Sandy. The principal objective for creating the working groups was to have a large pool of stakeholders from a wide range of perspectives, in order to help establish a baseline of understanding of the resilient PV landscape and help to identify pathways forward that could address barriers to deploying resilient PV.

Findings/Results

The working groups' tasks throughout year one and two were to develop a suite of tools intended to educate and inform policymakers, industry stakeholders, and the public about resilient PV. The CUNY team acted as trusted and objective third party to correlate data and information from the working group members and subject matter experts, investigate gaps and produce materials that summarized what resilient PV is and how it could be integrated into existing PV systems, as well as the state and trajectory of the technology, and the financial and policy landscape impacting its wider adoption.

A complete list of developed resources can be found on page seven

One of the most significant of these deliverables was the creation of the [NYC Energy Storage Systems Permitting and Interconnection Guide](#), which outlined the permitting process in 2015 for lead acid batteries in NYC, as part of the Policy working group's deliverables. This document brought transparency to what was a complex and confusing process for solar and storage project developers and was well received by both the industry and public agency stakeholders.

Simultaneously, CUNY and the working groups were also engaged in identifying the key market and policy barriers along the same four category areas, and utilized these to create the [Smart DG Hub NYC Resilient Solar Roadmap](#) to help inform and guide policy direction at the local level. By systematically laying out the key barriers, as well as solutions identified by the working group members, which included NYC AHJ's, the Roadmap provides a consolidated inventory of where policymakers can best prioritize their efforts and resources. Additionally, the CUNY team created an online Roadmap tracker that provides a way to readily update progress on the listed barriers, and for users to easily locate specific barriers from a drop-down list and see the current status.

Year three activities largely encompassed next-level educational and informational materials that synthesized findings from the four category areas, including publication of [three case studies profiling energy storage projects in New York State](#), a broad-based [Energy Storage 101](#) FAQ tool, and public-facing training and outreach events aimed at industry players as well as public agency representatives. At the beginning of year three CUNY also kicked off a new NYSERDA-funded initiative to continue its work specifically in the development of local permitting requirements for energy storage. NYC agency stakeholders expressed a desire to create a technology-specific [permitting guide for outdoor-sited lithium-ion batteries](#), mirroring the permitting guide for general energy storage systems that the team created in year one, and CUNY conducted this effort concurrently along with the other year three deliverables.

Adjustments and Extension

The project team completed the majority of project deliverables as initially identified. Some of the deliverables required approved adjustments and modifications to the original project plans in order to adapt and respond to simultaneous developments elsewhere, market needs, and efforts in the nascent resilient PV space. Throughout the duration of the project, the CUNY DG Hub team remained engaged with our primary stakeholder audiences in order to stay abreast of new and changing needs arising in the resilient PV and general energy storage space.

Year four of the project involves an extension period to finish conducting the project's training deliverables, as well as to complete the [storage calculator](#). The trainings conducted during this time included one in-person solar installer training in conjunction with Con Edison which reached over 100 attendees, as well as several webinar-based trainings.

The first webinar focused on the newly-released Energy Storage Permitting & Interconnection Guide, and the balance were focused on educating the installer community as well as code officials about large-scale fire testing which is a new requirement for battery installations in NYC. The ability to extend the portion of the project focused on training and knowledge dissemination was beneficial to the wider stakeholder audience, as during year three of the project several key factors from outside entities, such as code establishments, were not yet solidified and training at that time would have been premature for some audiences.

Several challenges arose during the development of the calculator, especially technical limitations of the data exchange between CUNY's calculator interface and the REopt platform. A lack of standardized information about battery system costs is also another factor. While the CUNY team has assembled a basic calculator tool, the team aims to refine it further over time as the market develops and more information becomes available.

Some individual deliverables required adjustments and modifications to the original project plans. For example, the project team elected to combine two separate fact sheets (*Guidelines for Ready for Market PV Specs and Schematics* and *Guidelines for Ready for Market Communication*) into a single expanded document, the *Resilient PV Retrofit Fact Sheet*, in order to avoid redundancy and streamline the information for the intended audiences.

Similarly, the original Policy working group fact sheet was planned as a more broad-based document providing an overview of barriers, soft costs, and areas requiring market education, such as policies for emergency power for critical infrastructure; zoning, fire, and building codes for resilient PV; standardization of specific components for operation/shut-off by first responders; and regulatory clarity of key terms.

However, the group unanimously elected to change the focus to a more "hands-on" document that would provide immediate assistance to the developer community as well as the agencies themselves and thus developed the Permitting & Interconnection Process Guide for VRLA batteries instead.

Conclusion

At the outset of the project one key segment of the anticipated audience for the materials and tools were stakeholders involved in emergency planning, disaster preparedness, and resiliency. These stakeholders provided valuable input to the development of the tools. However, the audiences with more immediate needs proved to be developers and the regulating agencies, and permitting considerations proved the most important and timely issue impacting resilient PV in NYC.

As the emergency planning and related stakeholder groups represent not only a public planning interest, but also more of an end user base, the project team anticipates that as issues of permitting are resolved, then these groups will be able to more directly benefit from the portfolio of tools and materials developed through this effort.



It also became evident that larger external dynamics at the state, national, and even international level must be factored in to project plans and it is important to maintain a degree of flexibility in order to accommodate the changes in this rapidly moving sector.

One prominent and ongoing example of this has been the concurrent development of national standards for energy storage, and national and state building and fire codes, which in turn have an impact on city-level code revisions.

Storage Resources Developed



- Energy Storage Permitting and Interconnection Process Guide for New York City: Lithium-Ion Outdoor Systems
- Lead Acid Energy Storage Systems Permitting & Interconnection Guide for NYC



- Smart DG Hub NYC Resilient Solar Roadmap
- Solar and Storage Cost Survey
- Value of Resiliency Survey



- Marcus Garvey Case Study
- Global Green Solar For Sandy Case Study
- SUNY New Paltz Microgrid case study
- Economic & Resiliency Impact on NY Critical Infrastructure
- Storage 101
- NYC Solar+Storage Glossary
- Resilient Solar PV Hardware Fact Sheet
- Solar+Storage and Microgrid Communications Fact Sheet
- Economics & Finance Fact Sheet
- Solar+Storage Retrofit Guidelines
- Guidance memo for Including Storage in Community Solarize Programs



- NY Solar Map Energy Storage Systems
- Critical Facility Solar+ Evaluator
- Storage Calculator Supplement



- NYC's Permitting & Interconnection Guide for Outdoor Lithium Ion ESS
- Energy Storage Opportunities with NY State Electric Utilities
- Energy Storage 101
- UL 9540A Stakeholder Webinars

The above documents are available on the NY Solar Map and Portal
nysolarmap.com/solarplusstorage/

IT Resources



Critical Facility Solar + Evaluator: Hosted on nysolarmap.com

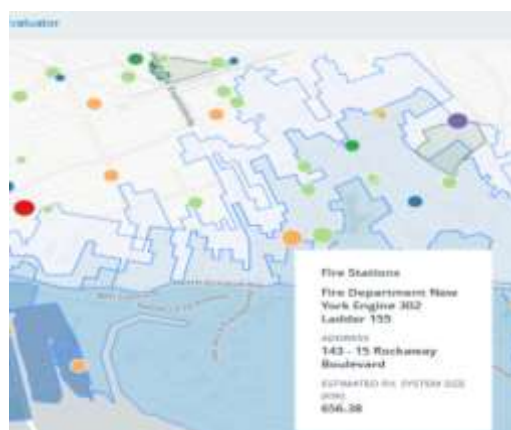


Dynamic interactive tool

Toggle on and off layers such as:

- Flood zones
- Grid constrained area
- Underserved areas.

- Hospital and healthcare facilities
- Fire Station
- Police Station
- Evacuation Center
- Energy Radio station
- Food Facilities



Scroll in and click on the locator dots to view the analysis on the potential size PV installation the individual facilities could host

A Blueprint for Structuring Change

A Replicable Model

The widespread adoption of renewable energy that can help address energy and environmental concerns in metropolitan areas require changes to infrastructure that are rife with political, technological, and economic barriers. Continuous collaboration and communication among stakeholder agencies is critical in order to foster change and attract the rapidly growing renewable energy market. This strategy served as the foundation of a clean energy platform created by America's largest urban university. A public university, CUNY, has a population larger than most cities and serves as an objective and trusted third party, influencing a transformational and measurable change in the New York City solar and storage market.

Project Based Change Management

Sustainable CUNY developed a project based change management approach to removing barriers and encouraging the wide spread adoption of renewable energy. Key steps include:

- ✓ Identifying a project that would benefit multiple stakeholders such as a strategic plan for integrating solar or storage into your city, or more specifically, building a Solar or Storage Map.
- ✓ Identifying funding sources, such as Federal, State or City agencies. Ideally, a grant with a deadline will provide structure and a timeline that encourages immediate participation and positive press for agency stakeholders.
- ✓ Before you make a plan, engage as early as possible, all the stakeholders that would be integral to the successful implementation of the proposed project. It is critical to include key personnel that have the ability to be, or reach, decision makers. Include:
 - ✓ Mayor's Office
 - ✓ Building Department
 - ✓ Code Officials
 - ✓ Fire Department
 - ✓ Economic Development.
 - ✓ Agencies
 - ✓ Utility Companies
 - ✓ Installers & Developers
 - ✓ Union Leaders
 - ✓ State Agencies
- ✓ Convene these stakeholders to clearly outline the intended benefits of the project. Work together to draft proposals and implementation plans.



Dedicated Ombudsmen

It is imperative to the success of a solar or distributed generation (DG) program or project to have personnel who are solely dedicated to serving as the liaisons, can drive the completion of the tasks, and bring the project or plan to fruition. Sustainable CUNY utilized DG Ombudsmen and a Communication Coordinator who served under the direction of the University Director of Sustainability at the City University of New York. Additional IT staff was leveraged as needed.

Implementation Platform

Even the most mature of technologies or services can have difficulty entering a marketplace. Further, solar and storage technologies are constantly evolving, resulting in:

- Frequent bottlenecks for buildings departments that must approve and inspect applications and installations
- Policy makers in need of value data before they can provide incentives or abatements to trigger the market
- Educational components for the public, installers, financial institutions, municipal leaders and first responders.



Sustainable CUNY developed a strategic platform for integrating solar, and now storage technology into the NYC marketplace across these many pillars. For example, ombudsman lead subject matter experts within partner organizations in 'Working Groups' that address specific areas such as 'Permitting and Interconnection' or 'Financial Options' and work with the IT team that includes contracted parties to ensure barriers are addressed.

As new technologies such as 'smart inverters' and the next generation of battery technology enters the market, the platform and process is already in place with long established relationships that can help ensure a more seamless transition.

Tasks: Status and Timeline

Task 1: Hire DG Ombudsman, Q1

Completed in BP1, Q1.

Task 2: Convene and Lead Action Area Working Groups, Q1-Q9

Subtask 2.1, Q1: Matrix of potential Working Group Members

Completed in BP1, Q1.

Subtask 2.2, Q2: Implementation Plans

Completed in BP1, Q2.

Subtask 2.3, Q5/Q9: Review and update project plans

Project plan reviews & updates were completed in BP2, Q1 (Q5) and in BP3, Q1 (Q9).

Task 3: Hardware Working Group Activities

Subtask 3.1, Q4: Complete Y1 Benchmark Survey

Completed in BP1, Q4 - a summary of survey results can be found [here](#).

Subtask 3.2, Q4: Develop recommendations and framework for the roadmap

Completed in BP1, Q4 - compiled from Working Group members.

Subtask 3.3, Q4: Resilient PV Technology Fact Sheet

Completed in BP1, Q4 - the final version of the fact sheet can be found [here](#).

Subtask 3.4, Q8: Resilient PV Retrofit Fact Sheet

Completed in BP2, Q2 - a final version of the fact sheet can be found [here](#).

Subtask 3.5, Q8: Guidelines for Ready for Market PV Specs and Schematics

The content intended for the Ready for Market PV Specs and Schematics Guidelines was covered in the [Resilient PV Retrofit Fact Sheet](#) (Milestone 3.4), which was expanded from a fact sheet intended to be 2-4 pages into a 20-page guidelines document.

Subtask 3.6, Q9-12: Packet of HT Lessons Learned

Completed in Q12, incorporated into “Storage 101 FAQ” document and web tool. Posted [here](#).

Subtask 3.7, Q9-12: Benchmarking Survey

Data analysis and finalization of survey report was completed in Q11; Q11 quarterly report describes challenges regarding publishing of results comparison to 2015 survey.

Task 4: Software Working Group Activities

Subtask 4.1, Q4: Technical Analysis of Critical Infrastructure

Completed in BP2, Q2 - the full report can be found [here](#).

Subtask 4.2, Q4: Develop recommendations and framework for the roadmap

Completed in BP1, Q4.

Subtask 4.3, Q4: Develop Solar Map Ideal Resilient PV Evaluation Layer Criteria

Completed in BP1, Q4.

Subtask 4.4, Q6: Smart Grid Communication Technologies Fact Sheet

Completed in BP2, Q2 - a final version of the fact sheet can be found [here](#).

Subtask 4.5: PV Islanding and Microgrid Integration Fact Sheet

This task was combined into Subtask 4.4. See the DG Hub SOPO revised March 2016 for details.

Subtask 4.6, Q8: Guidelines for Ready for Market Communication

The content intended for the Guidelines for Ready for Market Communication was covered in the [Resilient PV Retrofit Fact Sheet](#) (Milestone 3.4), which was expanded from a fact sheet intended to be 2-4 pages into a 20-page guidelines document.

Subtask 4.7, Q9-10: Identify Resilient PV Case Study for Software and Communication Technology Analysis

Candidate site selected in Q11.

Subtask 4.8, Q10-12: Publish Case Study Findings

Published on website and via newsletter in Q1 2018, available [here](#).

Subtask 4.9, Q9-12: Packet of SCT Lessons Learned

Completed in Q12, incorporated into “Storage 101 FAQ” document and web tool. Posted [here](#).

Task 5: Finance Working Group Activities

Subtask 5.1, Q4: Develop recommendations and framework for the roadmap

Completed in BP1, Q4 - compiled from Working Group members.

Subtask 5.2, Q4: Create a resilient PV financial and NYC incentive matrix

Completed in BP1, Q4 - incorporated into the Economics and Finance of Solar+Storage Fact Sheet, which can be found [here](#). Data from the fact sheet will be used to develop the resilient PV calculator on the NY Solar Map in BP3.

Subtask 5.3, Q6: Solar Calculator Resiliency Component Recommendation

Completed and submitted to DOE in BP1, Q4.

Subtask 5.4, Q8: Excel Model of Resiliency Calculator

Completed in BP2, Q4.

Subtask 5.5, Q8: Financing Options Fact Sheet

Completed in BP1, Q4. The latest version of the fact sheet can be found [here](#).

Subtask 5.6, Q9-10: Identify Resilient PV Case Study for Financial Analysis

Candidate site selected in Q10.

Subtask 5.7, Q10-12: Publish Case Study Findings

Case study was finalized and published in Q11, can be viewed [here](#).

Subtask 5.8, Q9-12: Packet of Economic Lessons Learned

Completed in Q12, incorporated into “Storage 101 FAQ” document and web tool. Posted [here](#).

Task 6: Policy Working Group Activities

Subtask 6.1, Q4: Develop recommendations and framework for the roadmap

Completed in BP1, Q4 - compiled from Working Group members.

Subtask 6.2, Q4: Policy Fact Sheet

Completed in BP1, Q4 - final version of the fact sheet can be found [here](#).

Subtask 6.3, Q7: Resilient PV Location Map Layer

Completed in BP2, Q3. The map layer can be accessed by visiting www.nysolarmap.com and selecting “NYC Installed Energy Storage Systems” from the “Available map layers” drop down list.

Subtask 6.4, Q8: Model Guidelines for Resilient PV Codes and Permitting

This initial document was completed in Q8. CUNY facilitated a 90-day period of working meetings between FDNY and DOB under a new program with NYSERDA, focused on development of permitting guidelines. The DG Hub team anticipates that the Model Guidelines document will ultimately serve as the starting point for creation of code and permitting guides for statewide dissemination over the course of this new project; as such we foresee this document

being a dynamic resource that will be regularly changed/updated and adapted to meet new needs.

Subtask 6.5, Q8: Protocol for Tracking (aka Mapping) Resilient PV Locations

This document is complete. Meetings with DOB and Con Edison around data transfer logistics for maintaining updated mapping of resilient PV installations will be incorporated into current permitting development activities outlined in the preceding section.

Subtask 6.6, Q9-10: NYC Provided with Guidelines for Model Codes and Permitting

As noted above, CUNY has begun facilitation of permitting guidance development under the aegis of a new program with NYSERDA. The DG Hub team anticipates that the Model Guidelines document from M6.4 will be changed/updated and adapted to meet new needs under this project, and the results of this work, which is anticipated to continue through Q11, will be the final document that is provided to NYC.

Subtask 6.7, Q9-10: Identify Resilient PV Case Study for Policy & Legal Analysis

Candidate site selected in Q10.

Subtask 6.8, Q10-12: Publish Case Study Findings

Published on website and via newsletter in Q1 2018, available [here](#).

Subtask 6.9, Q9-12: Packet of Policy and Legal Lessons Learned

Completed in Q12, incorporated into “Storage 101 FAQ” document and web tool. Posted [here](#).

Task 7: Roadmap and Trainings

Subtask 7.1, Q8: Critical Infrastructure Resilience Guide

This document is complete and will be incorporated into the training deliverables outlined for BP3.

Subtask 7.2, Q8: Resilient PV Roadmap

Completed in BP2/Q4, final review and publication completed in BP3/Q1. The Roadmap Implementation Tracker page is live and can be viewed [here](#). Last update completed in January 2018 and next is slated for Q3 2018.

Subtask 7.3, Q9-12: Conduct 8 NYS workshops/webinars/podcasts on Roadmap

This task is complete, with the eighth and final presentation conducted in Q12, conducted at a training session for solar industry professionals at the CUNY College of Technology Continuing Studies Program on November 30, 2017.

Subtask 7.4, Q9-12: Conduct 5 installer trainings and 5 code official trainings

Several training activities took place this quarter aimed at both code officials and installers, which fulfill the required deliverables under this Subtask. This series was aimed at convening a group of stakeholders from the AHJ as well as developer communities in order educate this community on the current process as well as to formalize feedback into the refinement of the UL9540A testing methodology and, especially, how the resultant data should be applied for establishing permitting standards and processes:

- 08/06/18 – Webinar: UL Presentation on UL1973 & UL 9540 and Facilitated Discussion
- 08/13/18 – Webinar: UL Presentation on UL9540A Deeper Dive and Facilitated Discussion
- 08/20/18 – Webinar: Use of Data from 9540a with focus on explosion analysis
- 08/27/18 – In Person: UL 9540A Stakeholder Workshop

The webinar recordings can be accessed [here](#) and subsequent tools/resources stemming from these discussions are in development and will be posted on this page as they are developed.

Task 8: Launch Resiliency Calculator and Solar Map Layers

Subtask 8.1, Q9-12: Resiliency Components of Solar Calculator

Refinement and completion of back-end linkage was slated for finalization in Q3 2018, with publication/launch anticipated for late Q3 or Q4 2018. A key staff member was limited in his availability due to health-related limitations, but completed beta version can be viewed [here](#) and further refinements are ongoing.

Subtask M8.2, Q9-12: Critical Facility Solar+ Evaluator (Ideal Resilient PV layer)

This task was completed in Q12 and can be viewed [here](#).

Task 9: Engage in Network Communications and Knowledge Dissemination

Subtask 9.1: Engage in Network Communications and Knowledge Dissemination

CUNY has consistently participated in all SMP quarterly meetings, workshops and Resiliency Affinity Group Calls, and completed documents & resources continue to be shared with the broader SMP community via Basecamp.

Subtask 9.2: Participate in Shared Network Meetings and Events

Two members of the project team attended the SMP leadership academy in Q10/BP3, and also attended both previous ISC-led workshops in BP2 in Salt Lake City and Boston.

Subtask 9.3: Participate in Affinity Groups to Further Solar Deployment

CUNY is an active participant in the Resiliency Affinity Group and has presented on several of its projects.

Publications/Presentations:

All current DG Hub publications can be found at
<https://www.nysolarmap.com/resources/reports-and-guides/solarplusstorage/>.

Acknowledgment

The information, data, or work presented herein was funded in part by the Office of Energy Efficiency and Renewable Energy (EERE), Solar Energy Technologies Office, U.S. Department of Energy, under Award Number DE-EE0006913.

Disclaimer

The information, data, or work presented herein was funded in part by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.