RESILIENT POWER

A project of CleanEnergyGroup

The Economics of Resilient Solar+Storage for Critical Infrastructure

September 14, 2016

CleanEnergyGroup

Innovation in Finance, Technology & Policy

Housekeeping

All participants are in “Listen-Only” mode. Select “Use Mic & Speakers” to avoid toll charges and use your computer’s VOIP capabilities. Or select “Use Telephone” and enter your PIN onto your phone key pad.

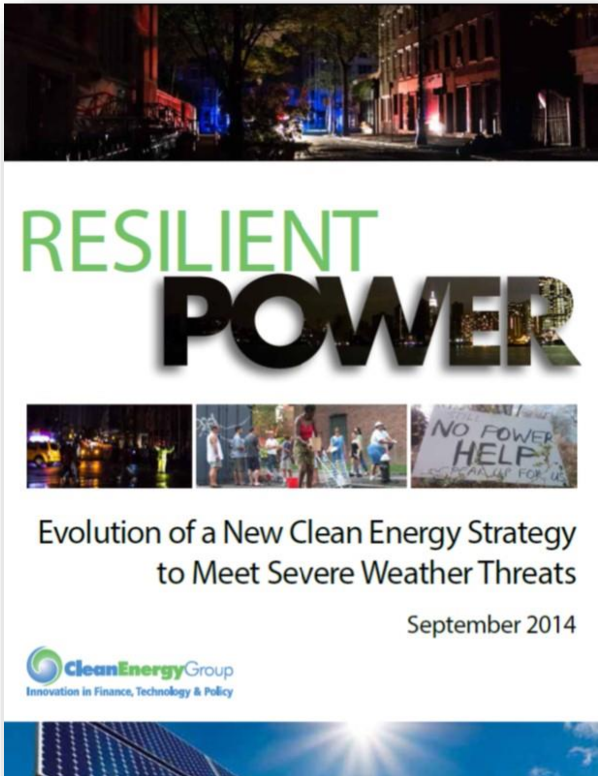
Submit your questions at any time by typing in the Question Box and hitting Send.

This webinar is being recorded.

You will find a recording of this webinar, as well as previous Resilient Power Project webinars, online at:

www.resilient-power.org

Who We Are



www.cleanegroup.org

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Connecting People to Solve Problems

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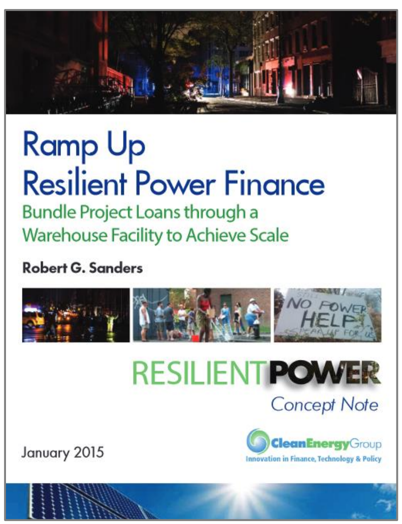
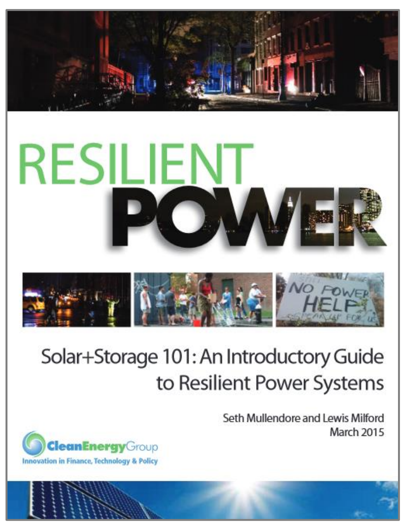
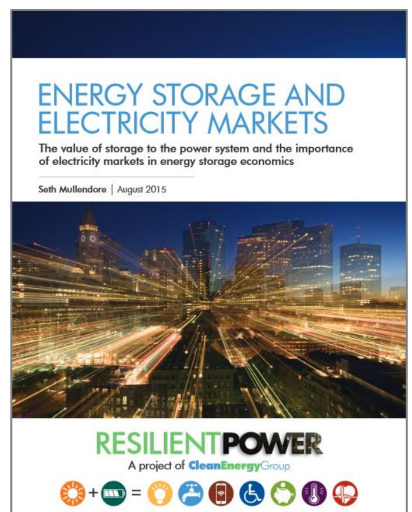
SURDNA FOUNDATION
Fostering sustainable communities in the United States

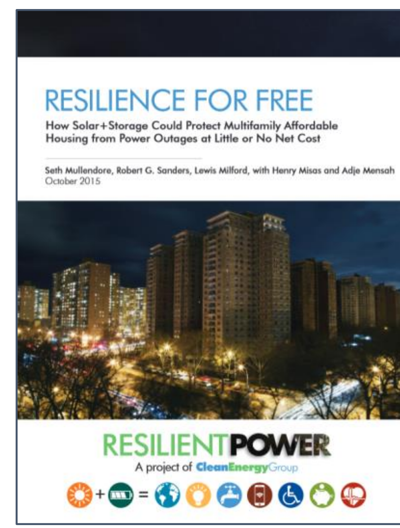
Resilient Power Project

- Increase public/private investment in clean, resilient power systems
- Engage city officials to develop resilient power policies/programs
- Protect low-income and vulnerable communities
- Focus on affordable housing and critical public facilities
- Advocate for state and federal supportive policies and programs
- Technical assistance for pre-development costs to help agencies/project developers get deals done
- See www.resilient-power.org for reports, newsletters, webinar recordings









www.resilient-power.org

Today's Speakers

- **Erica Helson**, New York State Solar Ombudsman, Sustainable CUNY
- **Lars Lisell**, New York State Solar Ombudsman, Sustainable CUNY
- **Kate Anderson,** Group Manager, National Renewable Energy Laboratory

NY SOLAR SMART DG HUB

CUNY

Economic and Resiliency Impact of PV and Storage on New York Critical Infrastructure

September 14th, 2016

AGENDA

I. Introduction – Erica Helson, Sustainable CUNY

II. Valuing Resiliency – Lars Lisell, Sustainable CUNY

III. Methodology and Results – Kate Anderson, National Renewable Energy Laboratory

IV. Findings – Erica Helson, Sustainable CUNY

V. Questions

NYSOLAR SMART DG HUB

Objective

A more resilient distributed energy system in NYC, with a path for expansion across the state and country

Engage Stakeholders → Create Strategic Pathways → Increase Resilient PV Deployment

NYSOLAR SMART DG HUB

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)

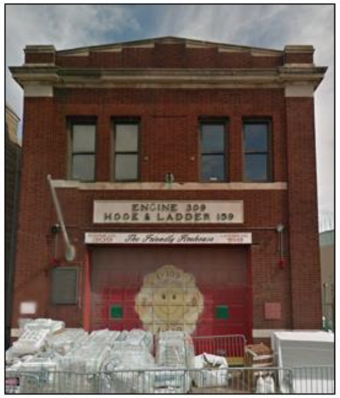
Erica Helson and Lars Lisell
City University of New York (CUNY)

Download at: www.nysolarmap.com/resources/reports/

Resilient PV Study on NYC Critical Infrastructure

- Technical and economic viability of emergency power systems
- Included a value of resiliency equal to cost of grid interruptions

School

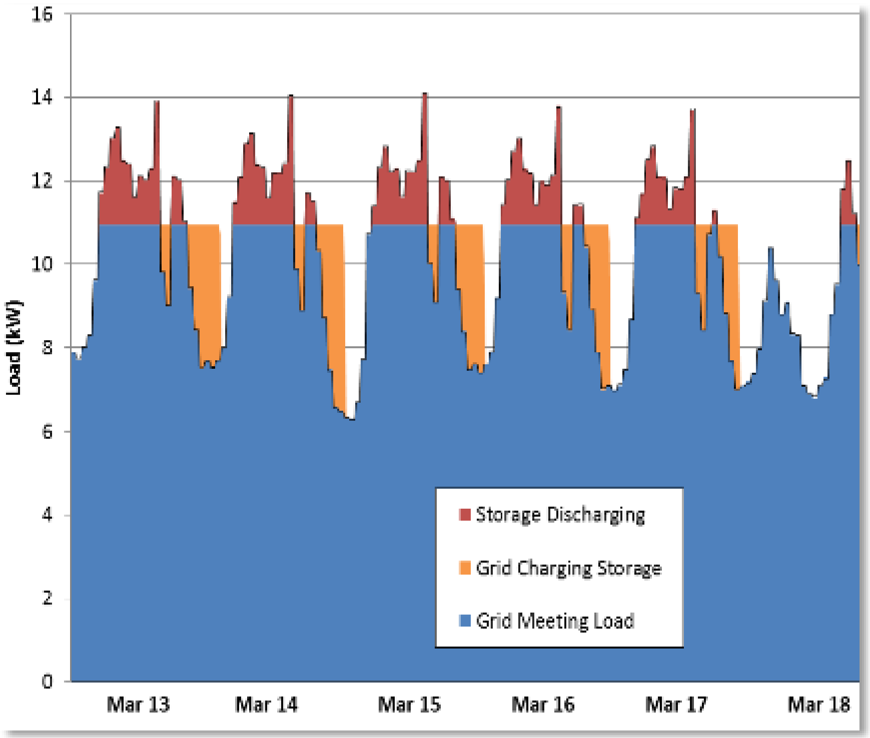


Fire Station

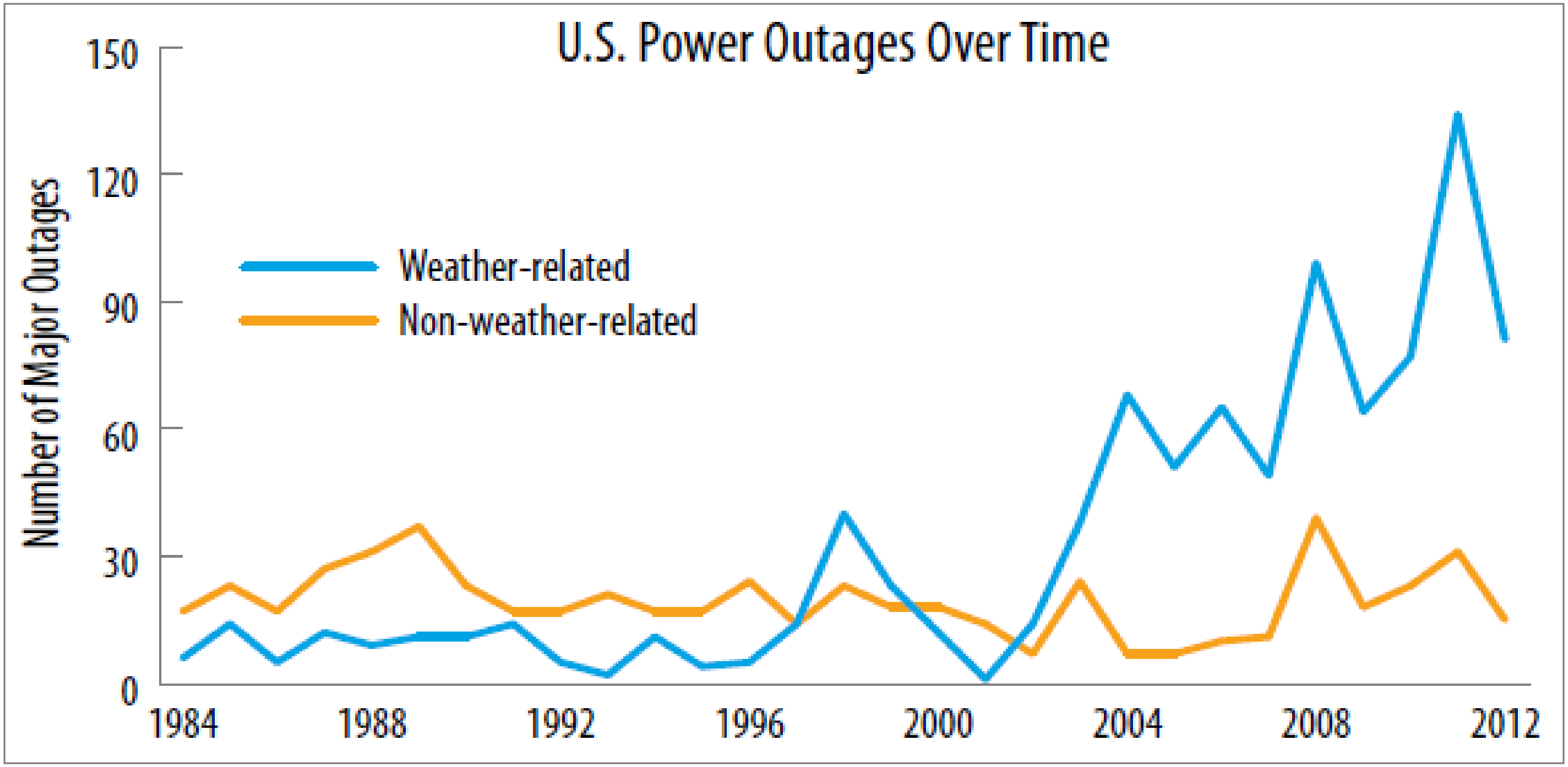
Cooling Center

Value of Resiliency

- Many solar+storage analyses do not factor in a value for resiliency
- DG Hub projects will value resiliency to expand the conversation

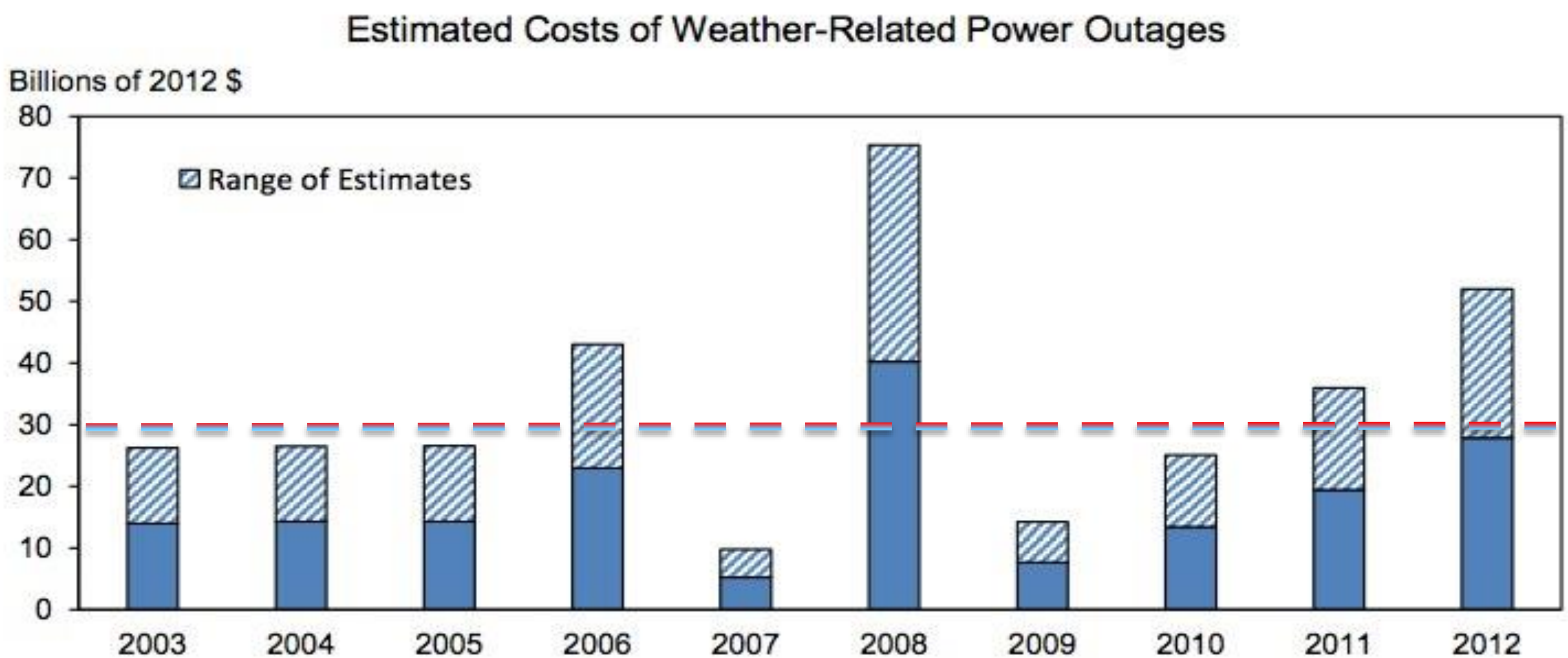


Value of Resiliency



Source: Blackout: Extreme Weather, Climate Change and Power Outages. (Kenward & Raja 2014)

Value of Resiliency



Source: CEA estimates using data from Census Bureau, Department of Energy , Energy I nformation Administration, Sullivan et al 2009.

From: Economic Benefits of Increasing Electric Grid Resilience to Weather Outages, Executive Office of the President.

Value of Resiliency

Methods of valuing resiliency

1) Cost of an outage
   a. Individual Site Characterization (EPRI Outage Cost Estimation Guidebook Method)
   b. National Outage Survey (Interruption Cost Estimate Calculator Method)
   c. NY PRIZE Workbook (Societal Costs)
   d. Insurance valuation
2) Cost of other forms of emergency power
   a. Generator
   b. Combined Heat and Power
   c. Uninterruptable Power Supply

Value of Resiliency

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Value of Resiliency

Methods of monetizing system resiliency

1) Monthly resiliency payment from site host
2) Reduction in insurance premiums
3) System incentive
4) Internal risk mitigation (contingency planning)

<u>Value</u> vs. Cash Flow

NYSOLAR SMART DG HUB

Value of Resiliency

Methods of monetizing system resiliency

1) ~~Monthly resiliency payment from site host~~ ← VPP REV Demonstration Project
2) ~~Reduction in insurance premiums~~
3) ~~System incentive~~
4) ~~Internal risk mitigation (contingency planning)~~

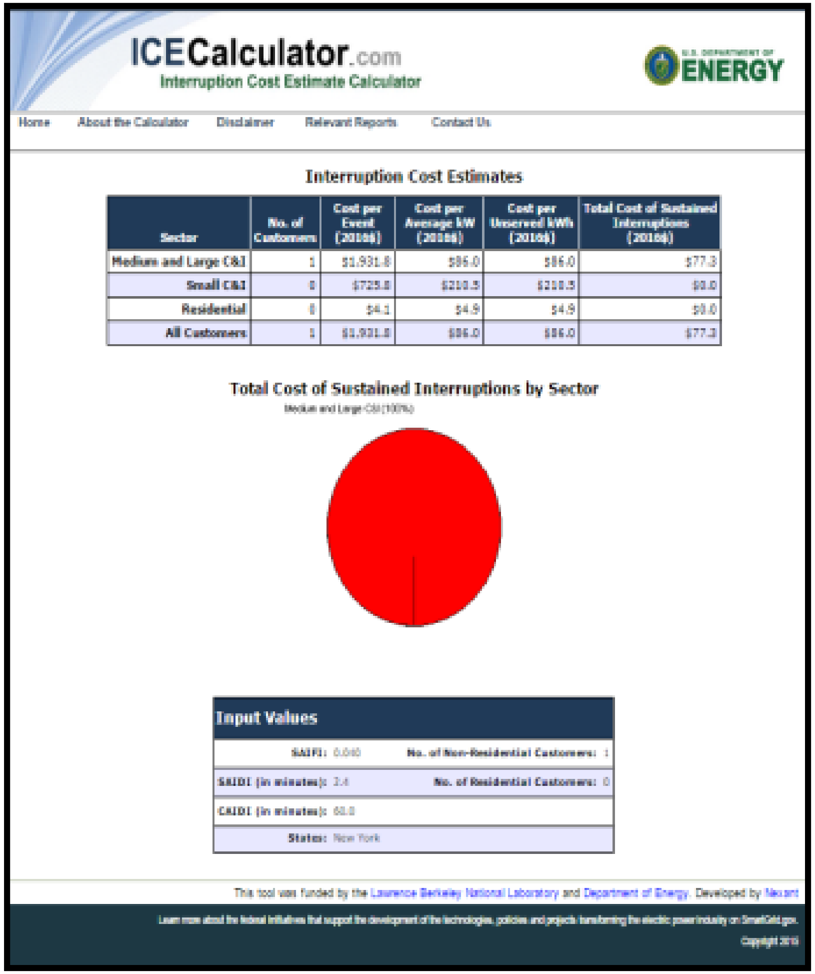
<u>Value</u> vs. Cash Flow

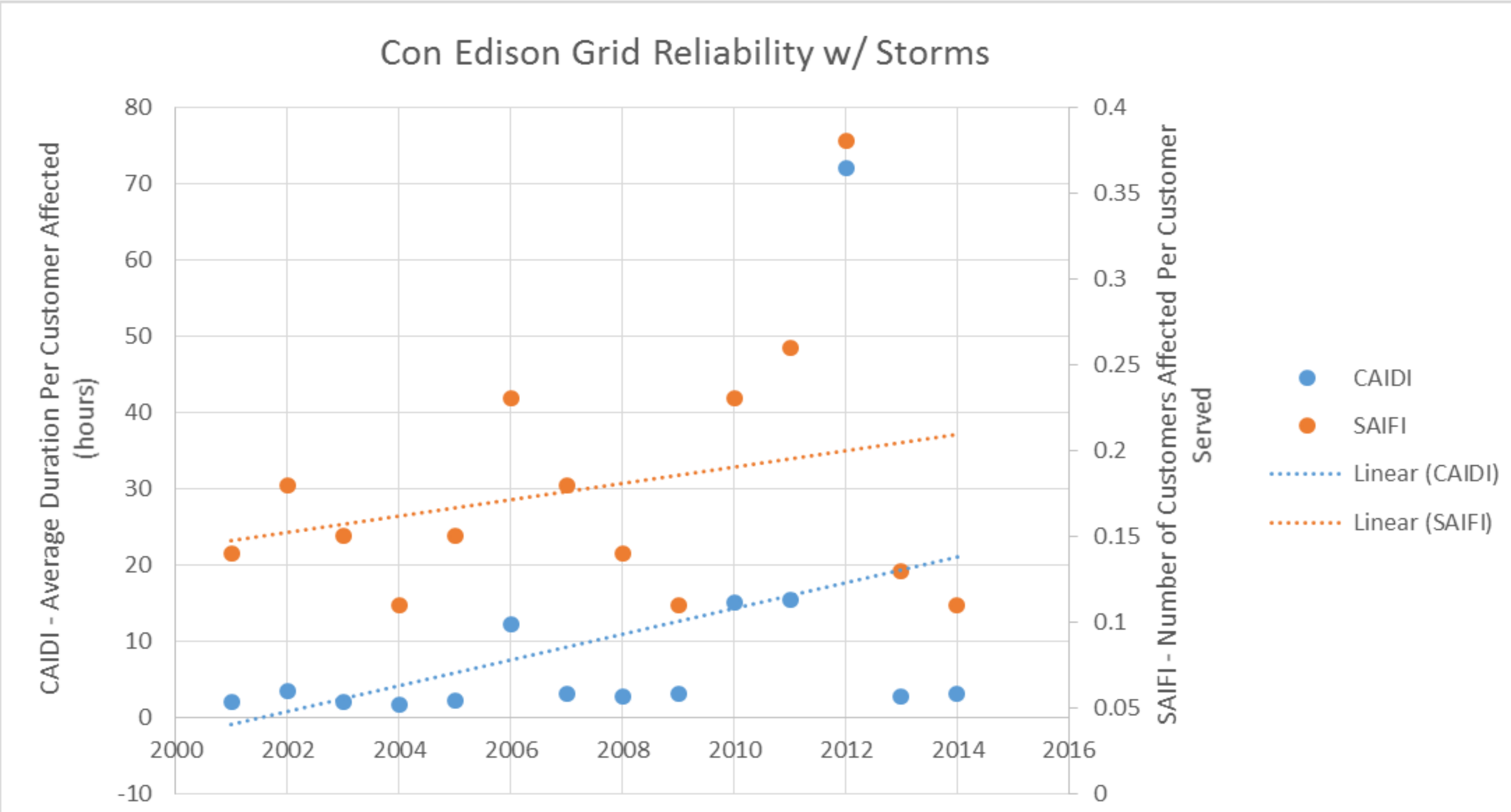
NYSOLAR SMART DG HUB

Estimating the Value of Resiliency

- Method
  *Macroscopic: Based on national estimates of past outage costs

- Used DOE ICE Calculator; key inputs:
  - Customer type, location, average energy use, industry type, backup capabilities
  - SAIFI: Average number of interruptions a customer experiences per year
  - CAIDI: Average outage duration per utility customer affected





5 Year Average Reliability Inputs		
	Duration (CAIDI)	Frequency (SAIFI)
Radial	21.88	0.77
Network	50.96	0.04

Worst Storm Year in the Past 14 Years		
	Duration (CAIDI)	Frequency (SAIFI)
Radial (2012)	73.5	1.39
Network (2012, 2007)	58.49	0.075

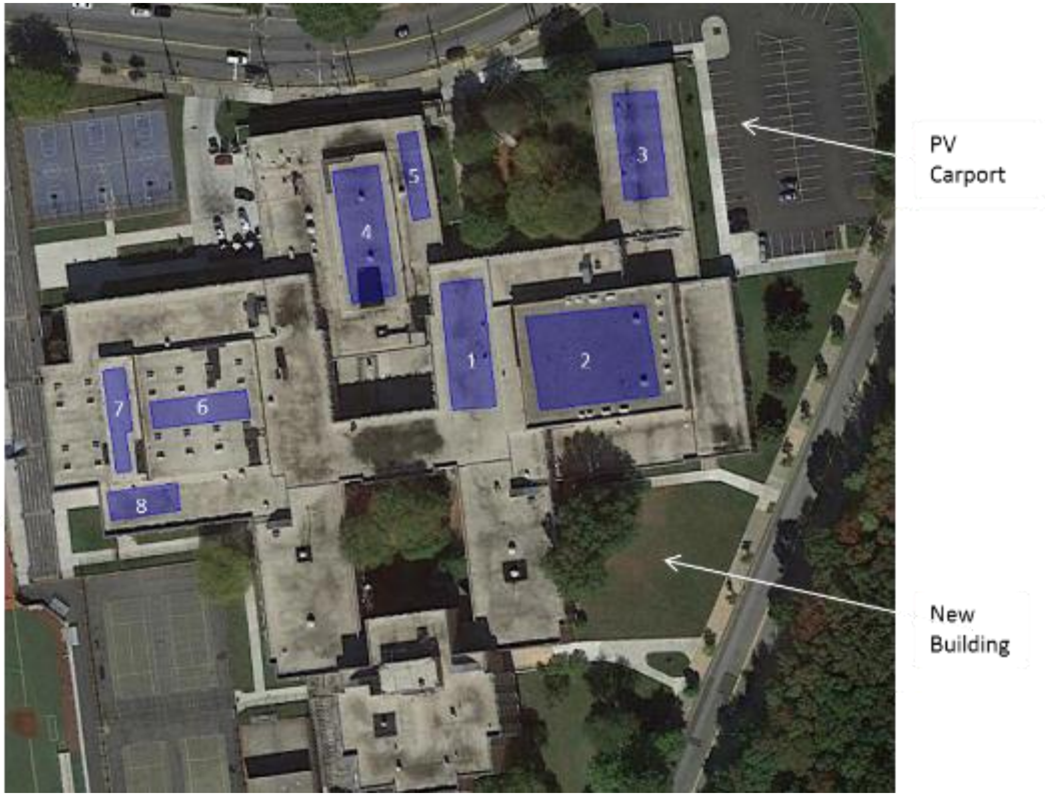
Site	Value of Resiliency ($/hour/year)	CAIDI (hours/year)	Cost of Outage ($/year)
School Shelter (network)	$68.97	50.96	$ 3,515
Fire Station (radial)	$917.43	21.88	$ 20,071
Cooling Center (network)	$32.02	50.96	$ 1,631

Model Input

Cost of Outages Average Year

Project Process

1. Completed site selection
2. Conducted site visits
3. Defined assumptions
4. Determined critical loads
5. Defined scenarios to model
6. Determined resiliency value
7. Completed modeling
8. Analyzed results and formed conclusions
9. Dissemination



Scenarios Evaluated

NREL REopt model used to size and dispatch PV, battery, and generator in 4 scenarios:

- **Scenario 1: PV + storage sized for <u>economic savings</u>; no resiliency requirement imposed**
- **Scenario 2: PV + storage sized to <u>meet critical load</u>**
- **Scenario 3: PV, storage, and generator (<u>hybrid system</u>) sized to meet critical load**
- **Scenario 4: <u>Generator</u> sized to meet critical load**

	Technologies	Goal
1	• Solar • Storage	Economic Savings
2	• Solar • Storage	Resiliency
3	• Solar • Storage • Generator	Resiliency
4	• Generator	Resiliency

Example Site: Fire Station

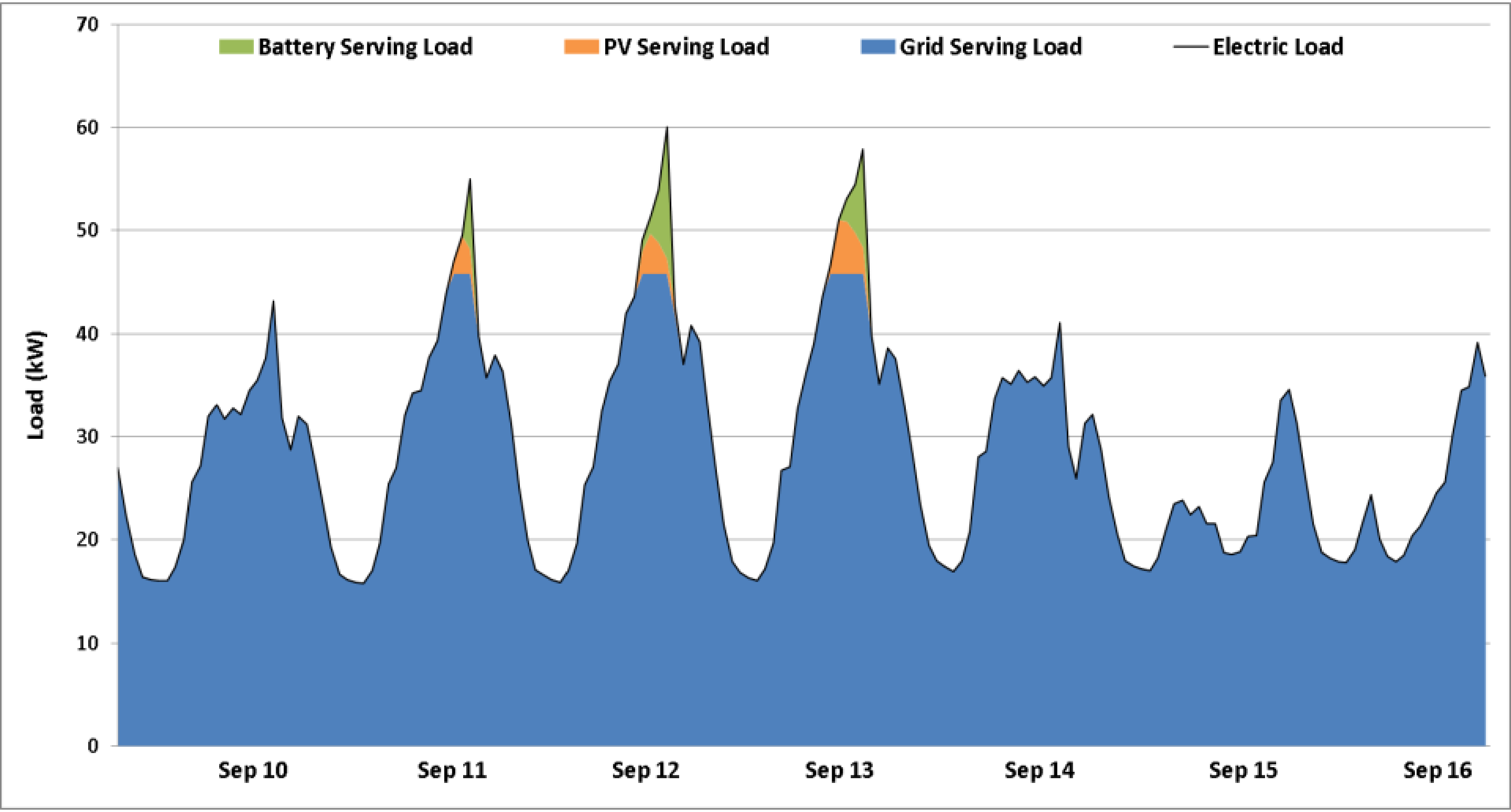
Fire Station				
Utility Rate	S.C. 91 Conventional • Demand: $32.63/kW with 12-18 month lookback • Energy: $0.0484/kWh in Summer $0.0434/kWh in Winter			
Maximum PV Size	10 kW			
Load Size	*Minimum Load*	*Maximum Load*	*Average Load*	*Critical Load*
	2.86 kW	63.2 kW	15.2 kW	65%

Scenario 1. Resilient PV Designed for Economic Savings

Fire Station		
Scenario 1: PV + Storage Sized for Economic Savings		
	Without resiliency value	**With resiliency value**
PV Size (kW-DC)	10	10
Battery Size (kWh)	43	213
Battery Size (kW)	16	31
Total Capital Cost	$69,413	$172,741
NPV	$22,365	$324,250
Simple Payback (years)	15.9	6.1
Percent of critical load system can support for 22 hour outage*	2-73%	47-264%

*The level of resiliency provided by resilient PV systems sized for utility cost savings depends on when the outage occurs, state of charge of the battery, and load size

PV and Battery Reduce Peak Demand

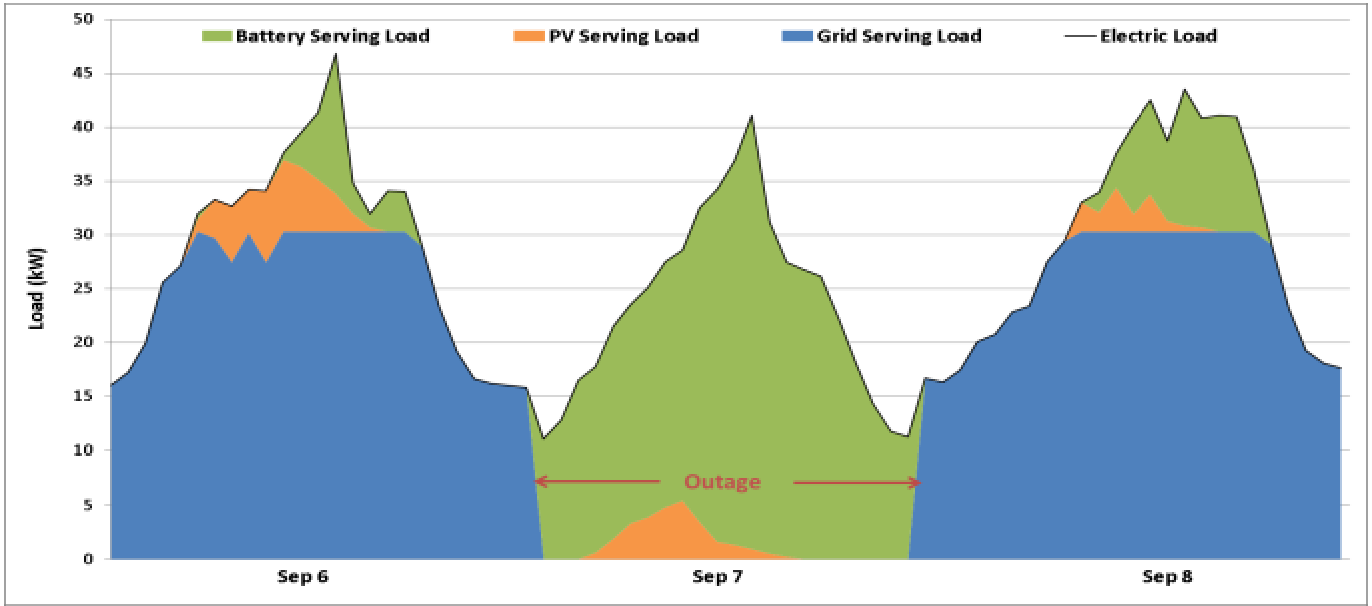


Scenario 2-4. Resilient PV + Generator Designed to Meet Critical Load

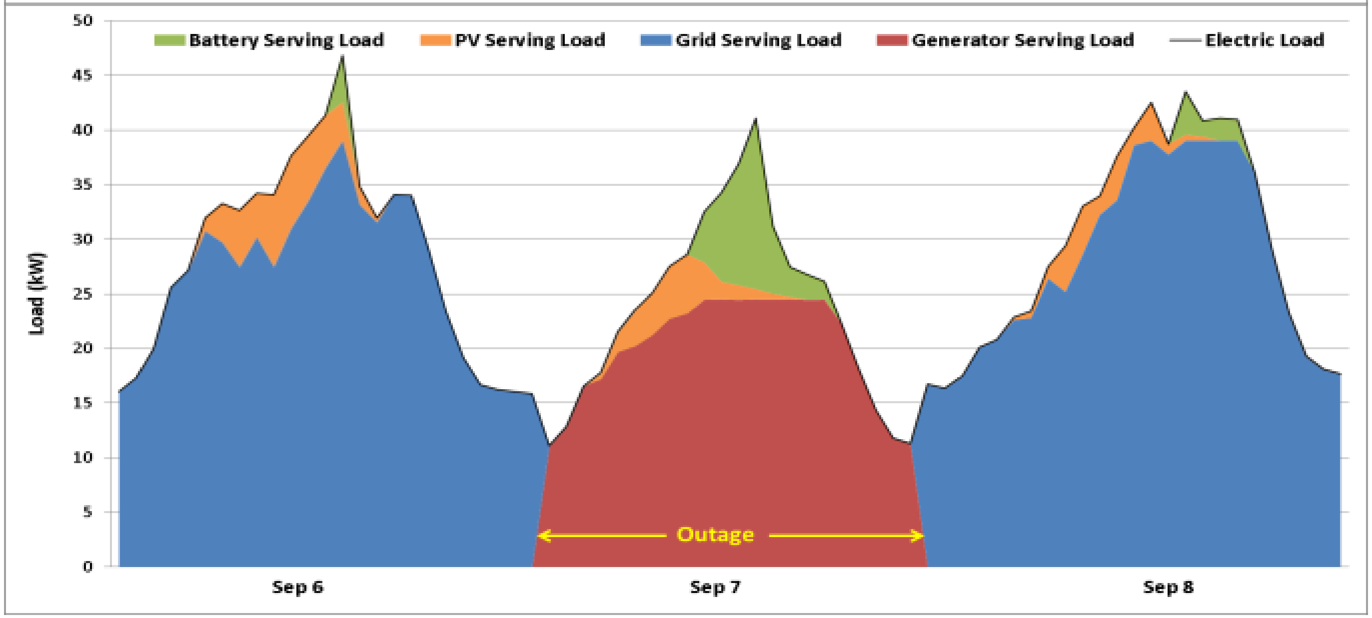
Fire Station			
Scenario 2-4: Sized to Meet Resiliency Needs			
	PV+Storage	**PV+Storage+ Generator**	**Generator**
PV Size (kW-DC)	10	10	0
Battery Size (kWh)	613	66	0
Battery Size (kW)	40	20	0
Generator Size (kW)	0	24	41
Diesel Fuel Used (gallons/yr)	0	41	47
Total Capital Cost	$389,706	$121,164	$61,620
NPV (no resiliency value)	-$256,158	-$1,679	-$52,896
NPV (with resiliency value)	$93,118	$344,848	$296,380

2-4. PV, Storage, and Generator Meeting Critical Load

PV+Storage



PV+Storage+ Generator



Key Findings

- PV+storage systems provide cost savings with some resiliency
  - Cost-effective due to high demand rates and shape of load
  - Sustaining full critical load with PV+storage is cost-prohibitive, however can sustain part of load for part of outage

School Shelter: Percent of Critical Load System Can Support				
System Size: 50 kW solar | 35 kW / 74 kWh battery				
Critical Load: 400 kWh/day, 35 kW, 10% of typical load				
7 hour outage	46% - 285%	46%	100%	2.85x
51 hour outage	12% - 50%	12%	50%	

Key Findings

- For emergency power, hybrid systems are most cost-effective
  - PV+storage provides utility cost savings while grid-connected
  - Generator provides extra power and energy to sustain outages
  - PV+storage extend diesel fuel supplies by 9-36%
  - However, hybrid systems have higher initial cost and are more complex

Key Findings

- Including the cost of grid interruptions improves project economics
  - Value increases for customers with more frequent outages or longer outages

School		
PV+Storage Sized for Economic Savings		
	Without Resiliency	With Resiliency
PV Size (kW-DC)	50	50
Battery Size (kWh)	74	74
Battery Size (kW)	35	35
Net Present Value	$51,560	$58,650

+7,090

Fire Station		
	Without Resiliency	With Resiliency
PV Size (kW-DC)	10	10
Battery Size (kWh)	43	213
Battery Size (kW)	16	31
Net Present Value	$22,365	$324,250

+301,885

Key Findings

- Adding storage can improve PV project economics by reducing demand charges
  - Adding storage to city solar deployments could also be an opportunity to align the city's sustainability and resiliency goals

Future Work

- Regulatory changes may be necessary in order to permit resilient PV as a code-compliant option for emergency power, similar to how Local Law 111 removed barriers to the use of natural gas generators for emergency power

- Obtaining more granular cost assumption data on resilient PV projects would help fill in any gaps on integration, critical load isolation, and other additional costs

- The question of how resiliency is valued for critical infrastructure needs to be answered in order to understand the economics of emergency power investments

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