Renewable Energy and Resiliency

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Today's big buzzword in Renewable Energy (RE) design is "Resiliency". From keeping the lights on and the building warm to maintaining lines of communications Solar Electric systems with storage provide a level of resiliency that out performs all others. With it's fuel delivered each day when the sun rises – at no costs – these systems offer stability in what is becoming increasingly chaotic weather extremes.

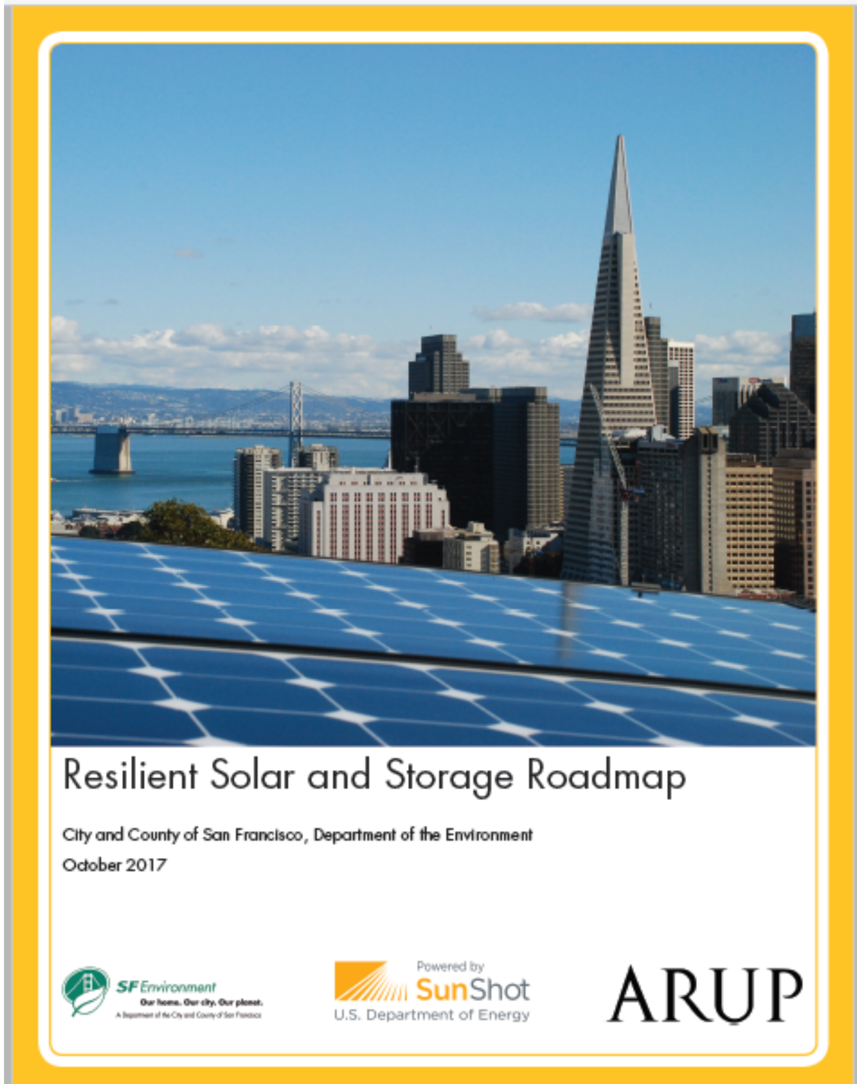
This session will outline the designs, options, and applications for using RE systems to provide clean stable energy sources that withstand utility power outages and other forms of disruption to daily life.

Key concepts in the field of Resiliency planning:

Resiliency – defined - the ability of a system to survive and thrive in the face of a complex, uncertain and ever-changing future.

A resilient system will minimize disruptions during shocks and stresses, recover rapidly when they occur, and adapt steadily to become better able to thrive as conditions continue to change.

Resiliency systems have these features:



Robustness

Redundancy

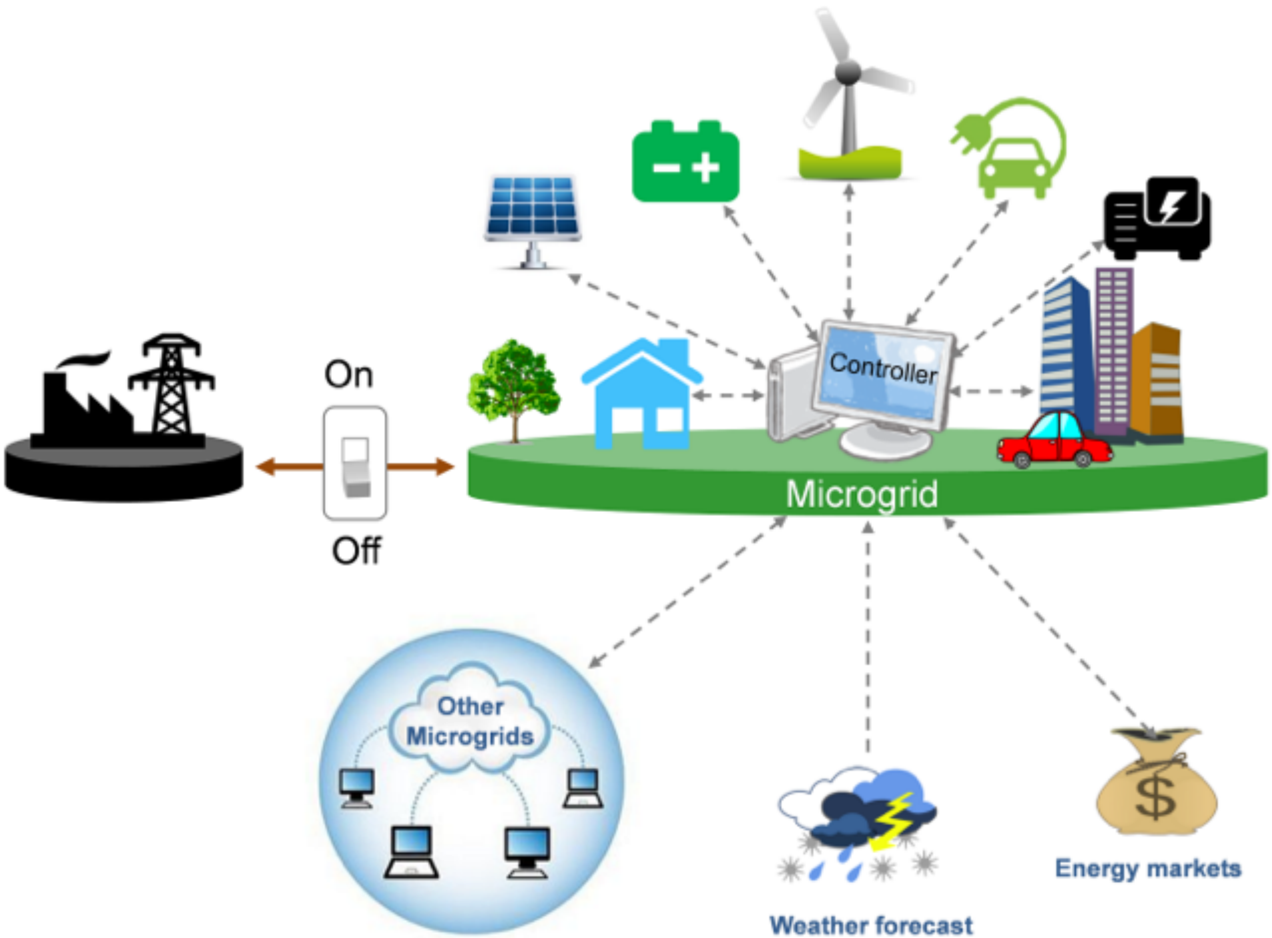
Diversity and flexibility

Responsiveness

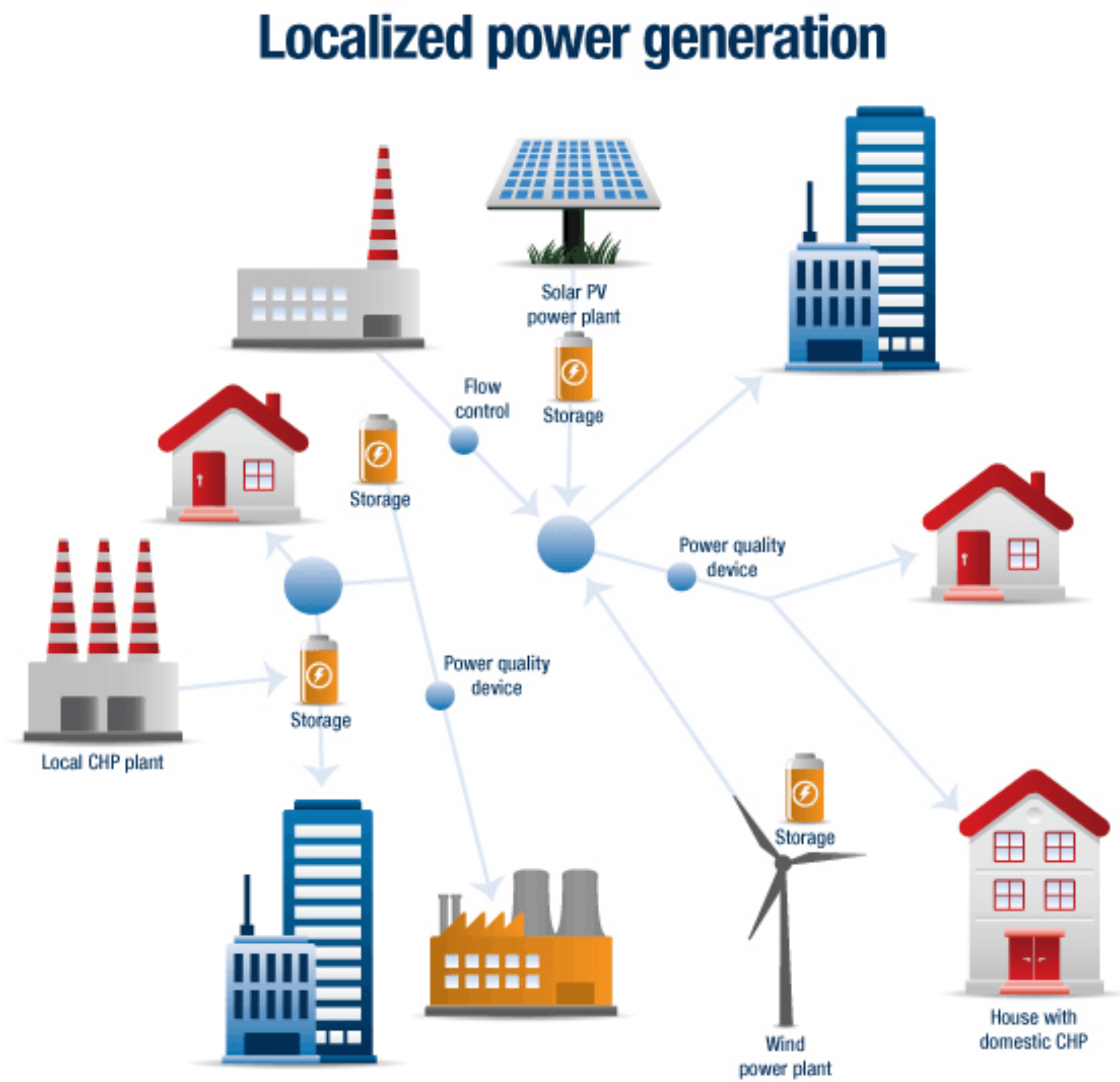
Coordination

Robustness: systems that can withstand the impacts of hazard events without significant damage or function loss…

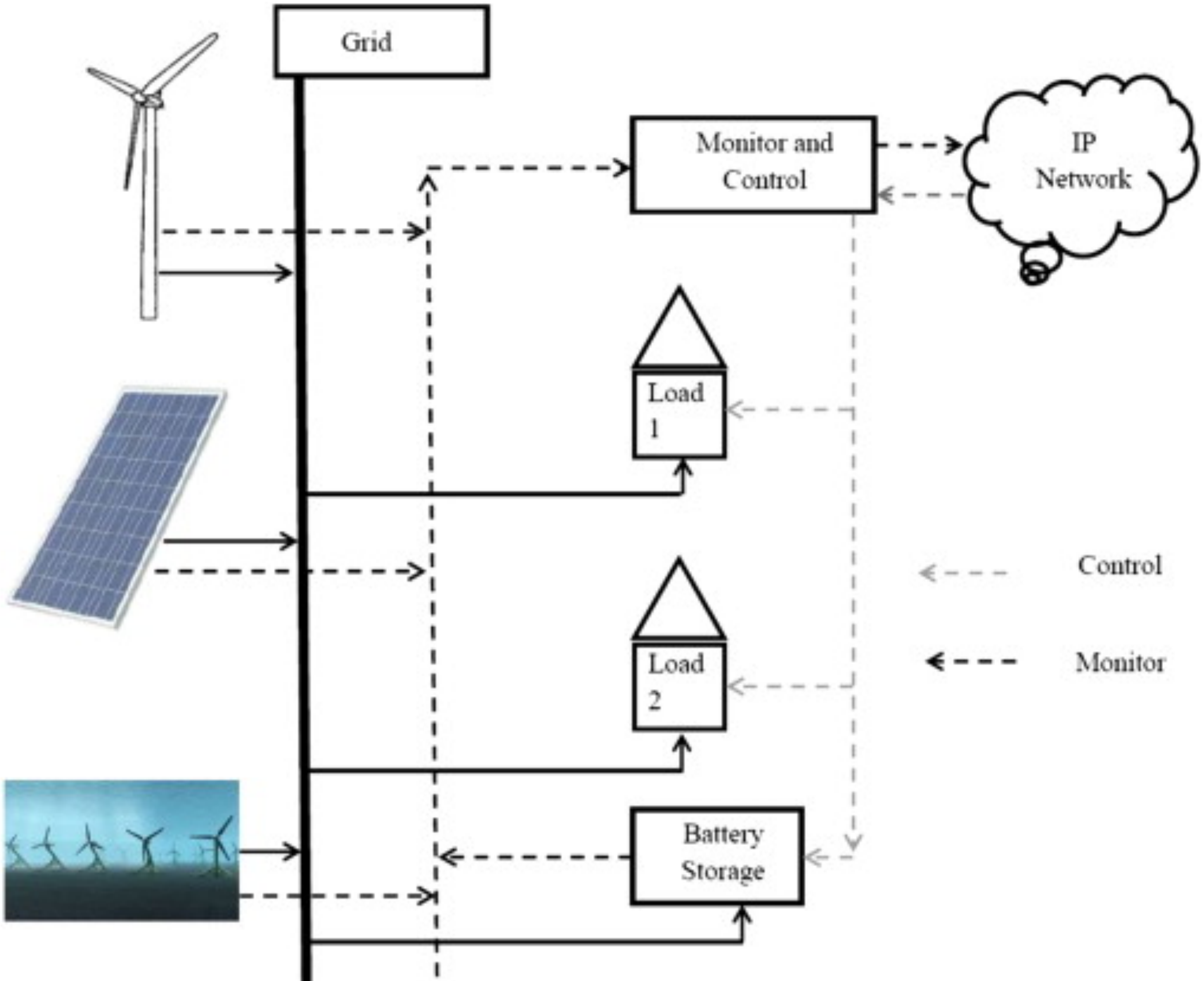
Redundancy: systems with the capacity to absorb sudden changes in demand or partial loss of supply



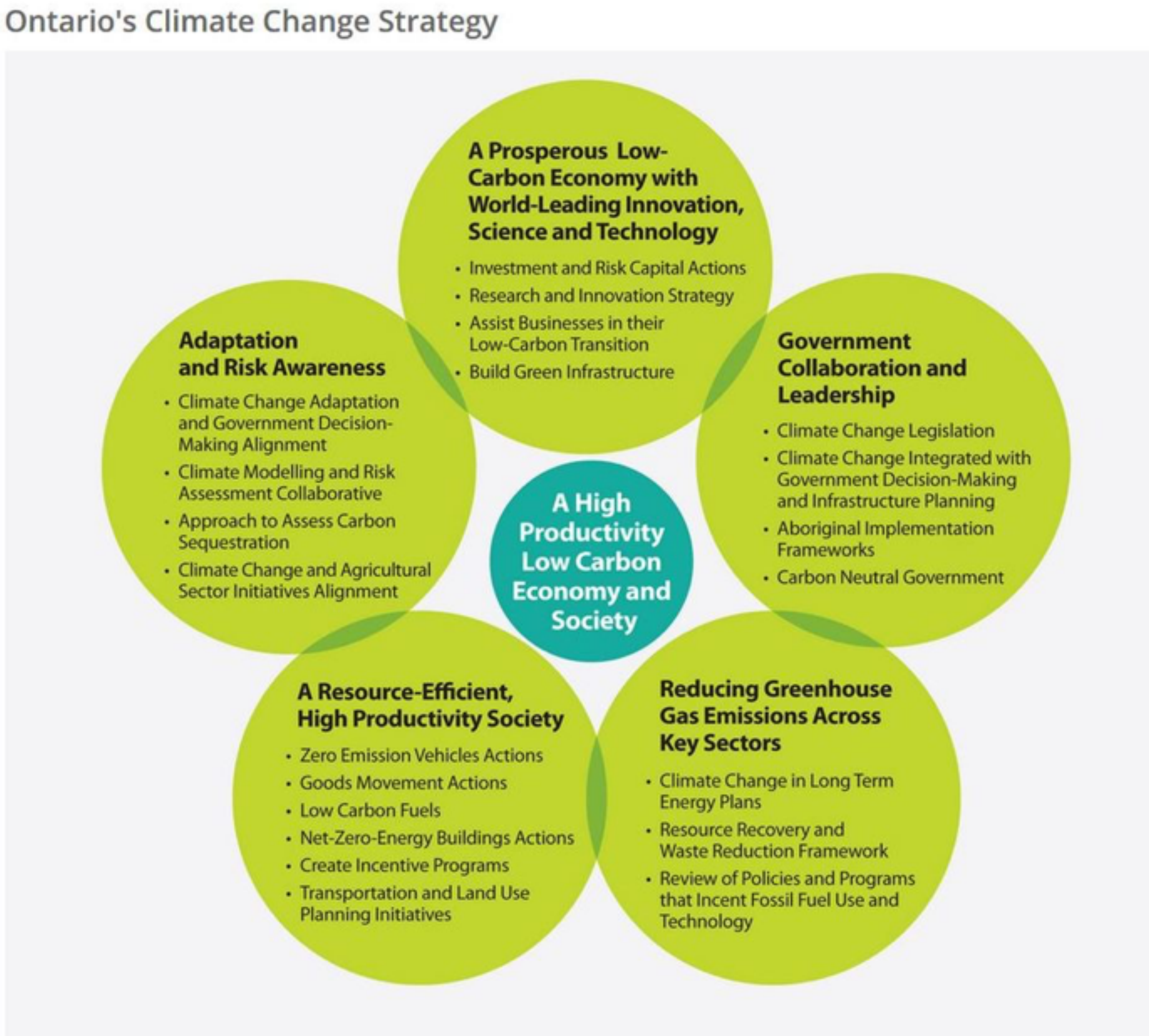
Diversity and flexibility: services are supplied through a number of pathways that use distributed resources



Responsiveness: responsive systems can use automated monitoring, short feedback loops and controls at multiple points



Coordination: knowledge is shared, planning is collaborative and strategic



The NREL study:

New York Solar Smart DG Hub- Resilient Solar Project: Economic and Resiliency Impact of PV and Storage on New York Critical Infrastructure (June 2016)

Provides a strong method for planning Resiliency into projects employing Solar + Storage…

Several NY projects are analyzed with the planning following a basic structure -

Beginning with a Site Overview - the planners look at the site load, the “critical loads” (what needs power during Utility outages) and the specific components that would provide for the site needs…

The Study is available from NREL: https://www.nrel.gov/docs/fy16osti/66617.pdf

The Susan Wagner High School is it’s first project example…

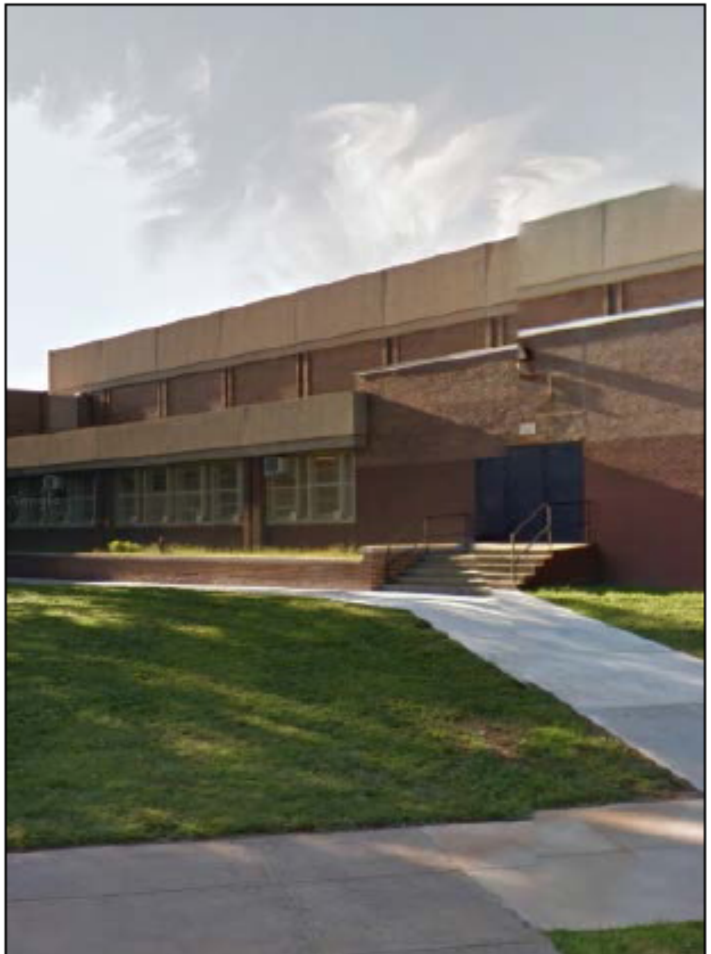


Table 1. School Shelter Load Data				
Data Source	DCAS			
Data Type	15-minute interval; September 2014 – August 2015			
Methodology	Interval data were synthesized by modeling the building based on DOE’s secondary school commercial reference building and the New York City climate zone (ASHRAE climate zone 4A).			
Load Size	*Minimum Load*	*Maximu m Load*	*Average Load*	*Peak Loads*
	42 kW	588 kW	177 kW	May – October

Figure 1. Susan Wagner High School

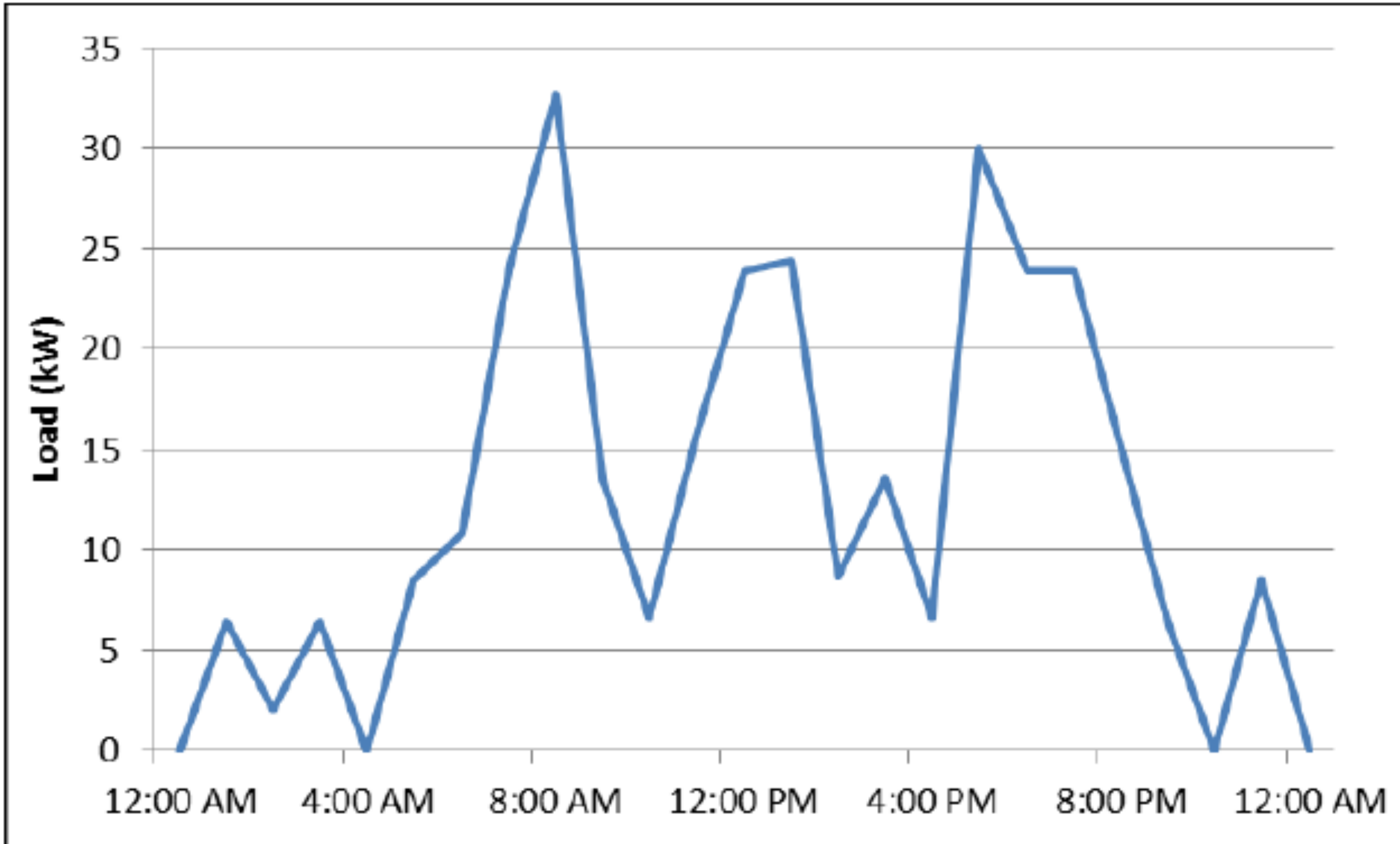


Figure 6. Critical load: shoulder season daily profile

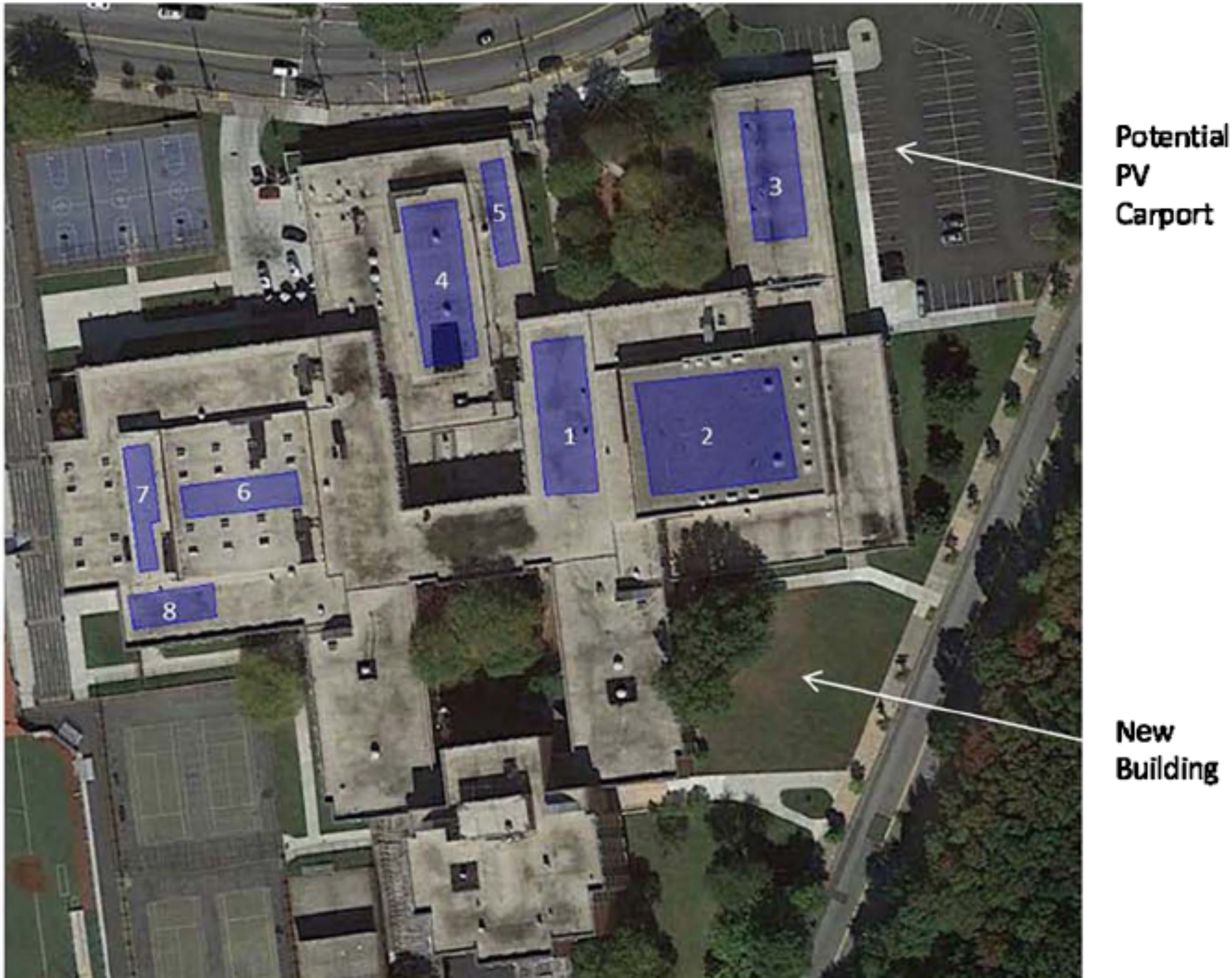


Figure 7. Susan Wagner High School/Shelter PV layout

“Building Resilience with Solar + Storage” is a SolarMarket Pathways project that Provides an extensive set of resources for Resiliency planning,

The DOE SunShot funded project presents information on the following goals:

Create plans and projects to implement solar and battery storage supporting community resilience

Explore the technical feasibility and cost-effectiveness of resilient solar

Engage stakeholders to integrate solar energy into city emergency planning and operations

Reduce costs, identify—and work to remove—regulatory barriers, and create new tools and resources to help other cities pursue resilient solar projects

http://solarmarketpathways.org/innovation/resilience/#layoutsection_toolkit-2

In the Web site the authors offer a hardware fact sheet : http://solarmarketpathways.org/wp-content/uploads/2017/09/CUNYDecHardwareFactSheet.pdf

The fact sheet shows how the major components are integrated…

Solar Array sends power to the *Charge controller* which energizes the *Storage system* (deep cycle battery) allowing an *Inverter* to provide AC power to *critical loads*, the *site loads* in general and to the *local utility*.

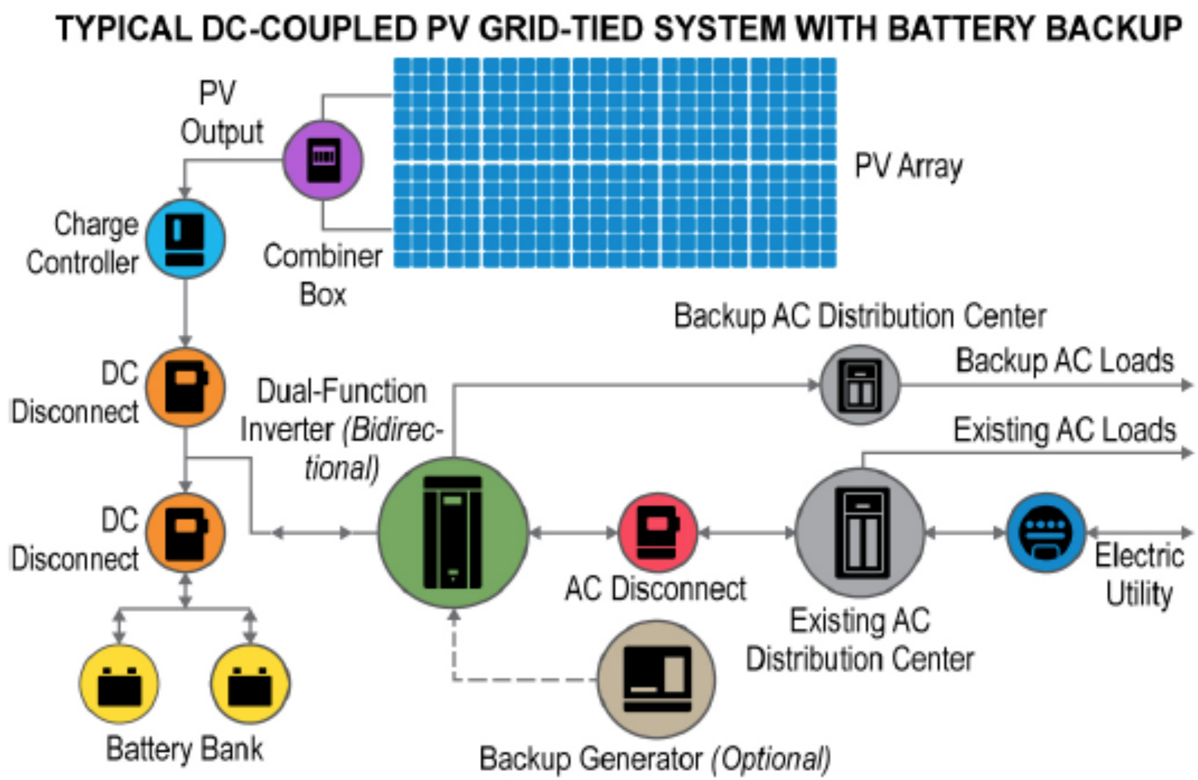
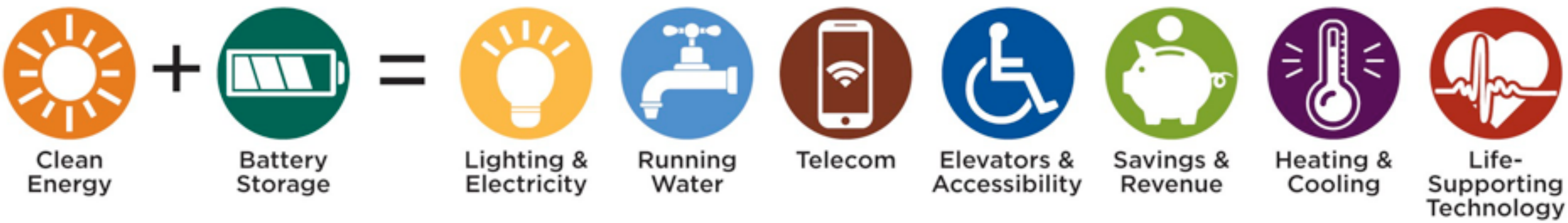


Figure 1. Typical components of a PV+ storage system (DC-coupled)

The Clean Energy Group has a detailed “Community Services Toolkit” for planning Resilient power projects…

https://www.cleanegroup.org/ceg-projects/resilient-power-project/toolkits/community-services/#toggle-id-2



Their approach is community minded, robust and concrete…

CleanEnergyGroup
Innovation in Finance, Technology & Policy

One project funded partially with CEG’s assistance is the Hartley Nature Center Resiliency station - one aspect of the Solar + Storage project completed in August of 2016

The City of Duluth participated in the project with the intention of using the Nature Center as a site with services for the public including charging stations for communication devices:

HARTLEY SOLAR PLUS STORAGE

SUNVERGE

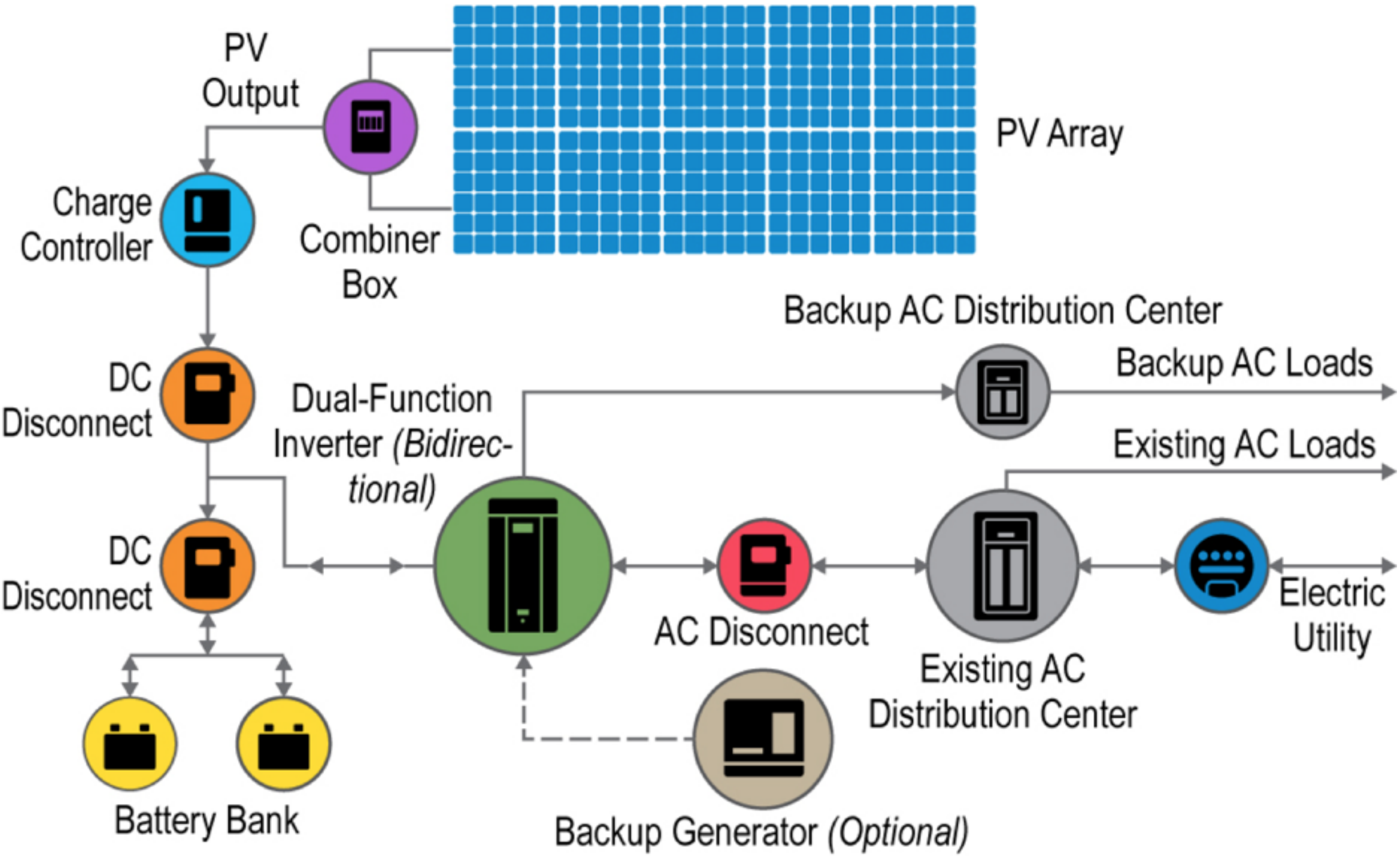
DC –coupled design, LiOn Battery with Schneider BOS

The Choice for deploying at Hartley Nature Center – August 2016

Critical Loads chosen to Provide for Resiliency During Utility outages and other disruptions…

Critical Load Backup	Description	Surge Load	Operating Load
Server, Wi-Fi, Phones	Plug load: mech. Room	135 W	15 W
Refrigerator	115 Volts, 7.7 Amps	250 W	250 W
Lighting	Bathroom	610 W	232 W
	Mechanical Room	128 W	128 W
	Classroom 1	46 W	46 W
	Classroom 2	46 W	46 W
Plug Loads	**Exhibit Hall:** **Hartley:** (1: 4 plug outlet) **Civil:** (3: 4 plug outlet)	8 W/phone 32 W 96 W	8 W/phone 32 W 96 W
	Office: 2 desktops	1200 W	10 W standby
	Office Library: 2 Laptops & 6 phones	248 W	248 W
	Classroom 2: **Hartley:**(1: 2 plug outlet)- 100 W laptop **Civil:**(5: 2 plug outlet)- (2) 100 W laptops, (8) 8 W/ phones	200 W 248 W	200 W 248 W
Maximum Total Loads		**H:2895 W / C:3007 W**	**H:1208 W / C:1319**

TYPICAL DC-COUPLED PV GRID-TIED SYSTEM WITH BATTERY BACKUP



In addition to the value of Resiliency that this project brings, each Resiliency project has the potential to add several additional value streams to a Project.

These can include:

Transmission Services

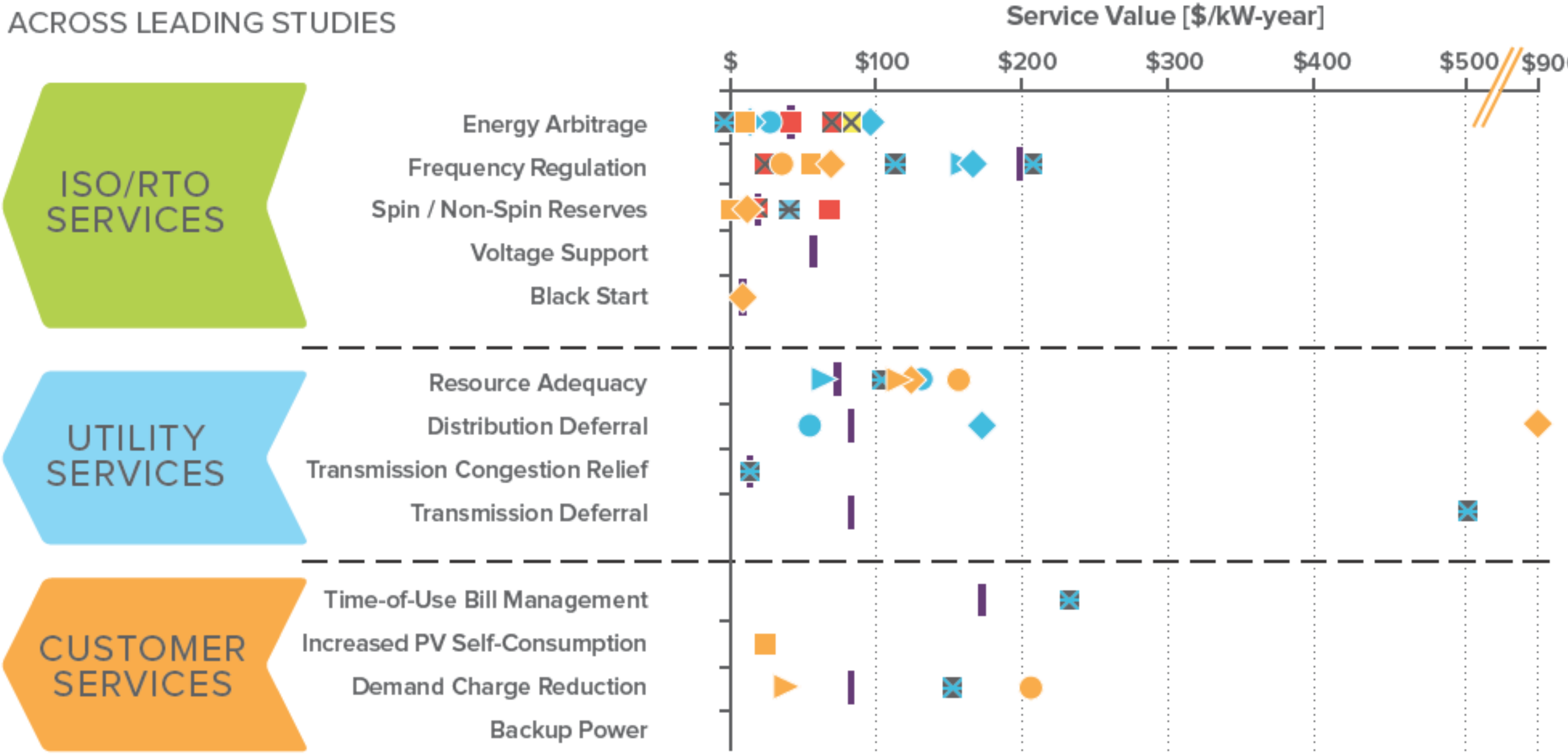
Utility Services

and additional customer level services…

By expanding the services provided by resilient systems the investment costs can be recouped by the revenue of the additional services….

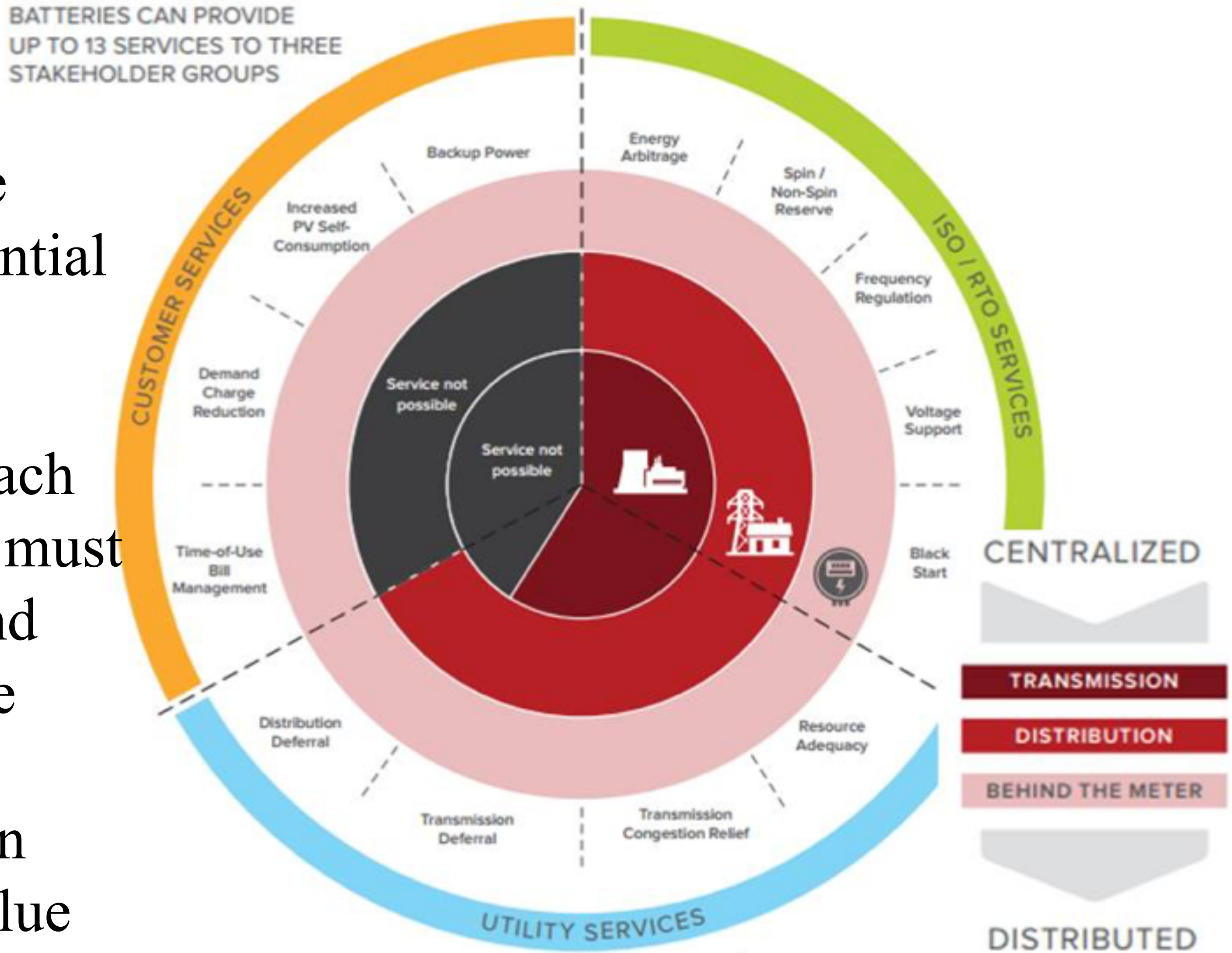
FIGURE ES1

ENERGY STORAGE VALUES VARY DRAMATICALLY ACROSS LEADING STUDIES



Results for both energy arbitrage and load following are shown as energy arbitrage. In the one study that considered both, from Sandia National Laboratory, both results are shown and labeled separately. Backup power was not valued in any of the reports.

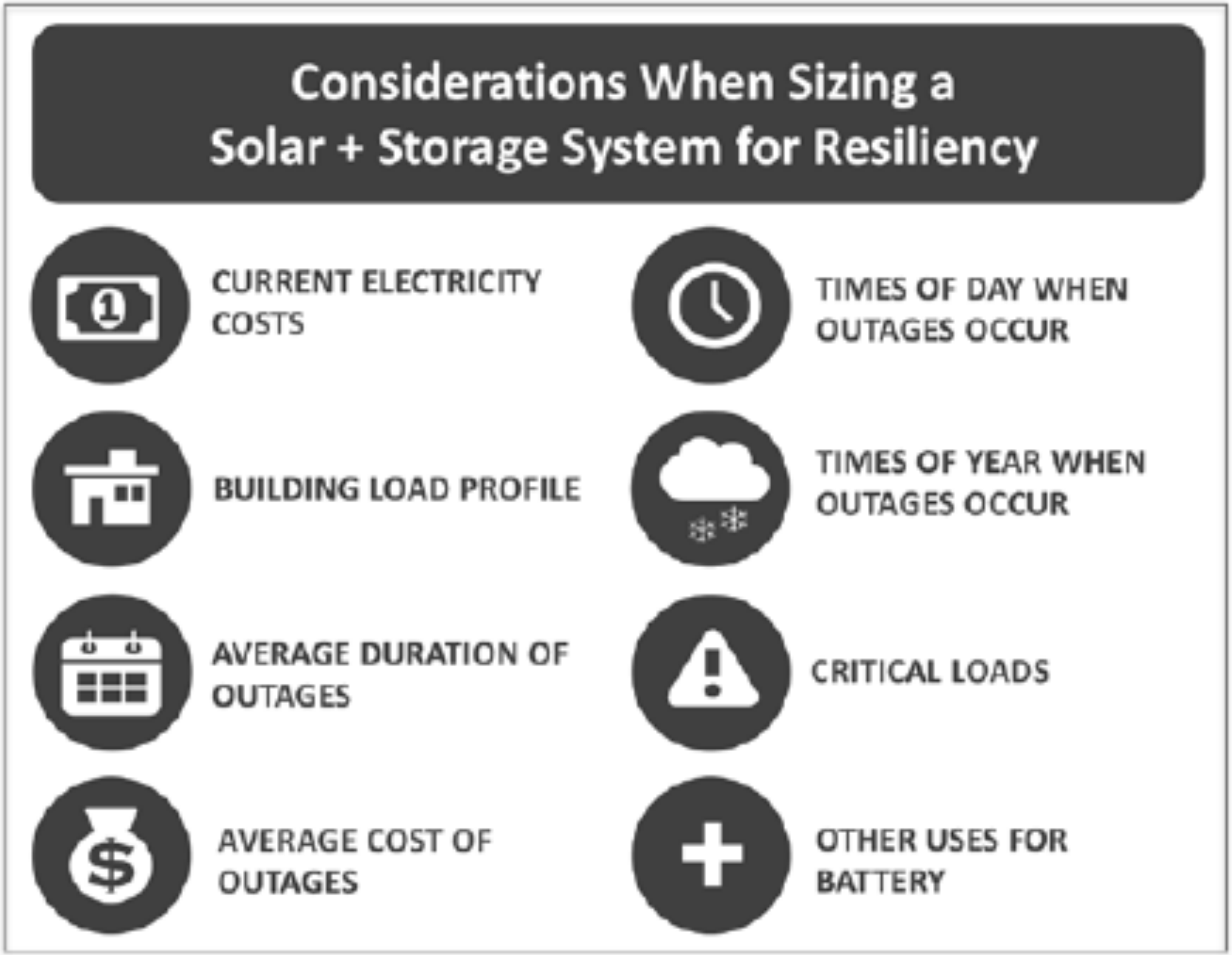
To achieve The total of all potential value streams available for a given system each potential value must be evaluated and that defines the maximum economic return and therefor value for a project.



How to Value Resilience?

Unfortunately, although the benefit of having a resilient power system is clear when the electric grid goes down, putting a monetary value on additional resilience investments is challenging. Each individual business or service provider will have widely varying values of resilience.

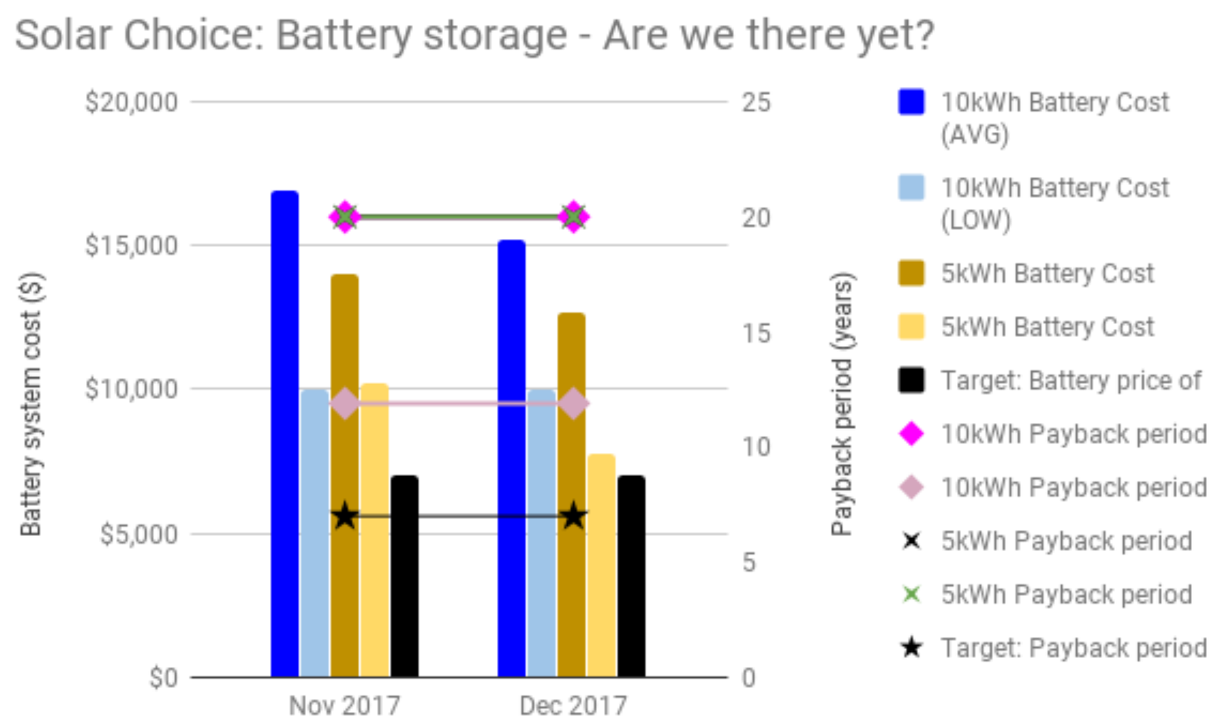
One method for Valuing Resilience on System Design is to quantify the effect as the avoided cost of a grid outage by quantifying the value resilience in terms of dollars lost per hour of outage.



Considerations When Sizing a
Solar + Storage System for Resiliency
CURRENT ELECTRICITY COSTS
TIMES OF DAY WHEN OUTAGES OCCUR
BUILDING LOAD PROFILE
TIMES OF YEAR WHEN OUTAGES OCCUR
AVERAGE DURATION OF OUTAGES
CRITICAL LOADS
AVERAGE COST OF OUTAGES
OTHER USES FOR BATTERY

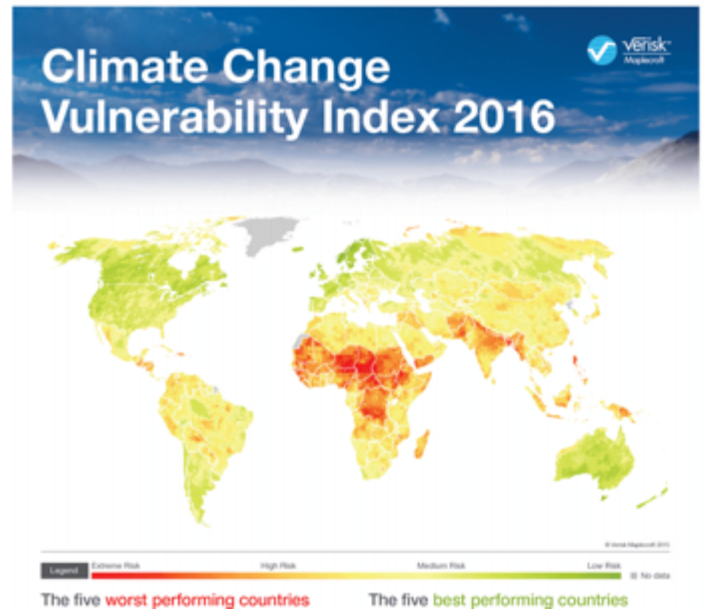
Today using current price assumptions, battery energy storage systems are often only cost-effective in locations that have relatively high utility demand charges or where there is a viable market for the grid services storage can provide.

While solar + storage might not appear to be justifiable economically under traditional cost-benefit calculations, placing a value on the losses incurred from grid disruptions can make a PV and storage system a more sound concept.

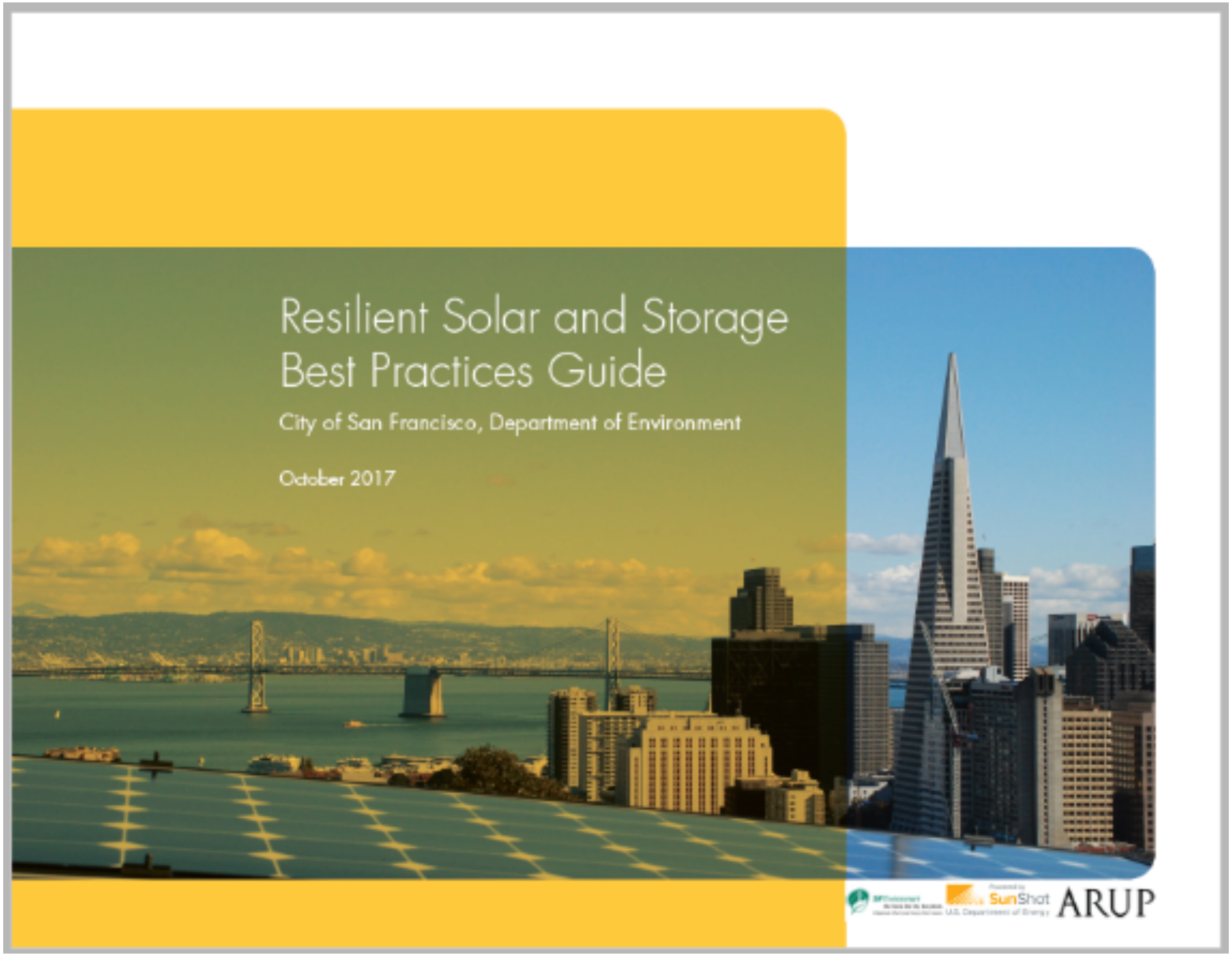


The value of resilience may increase the size of both the PV and battery systems, and the added cost to make a system "islandable" becomes an issue.

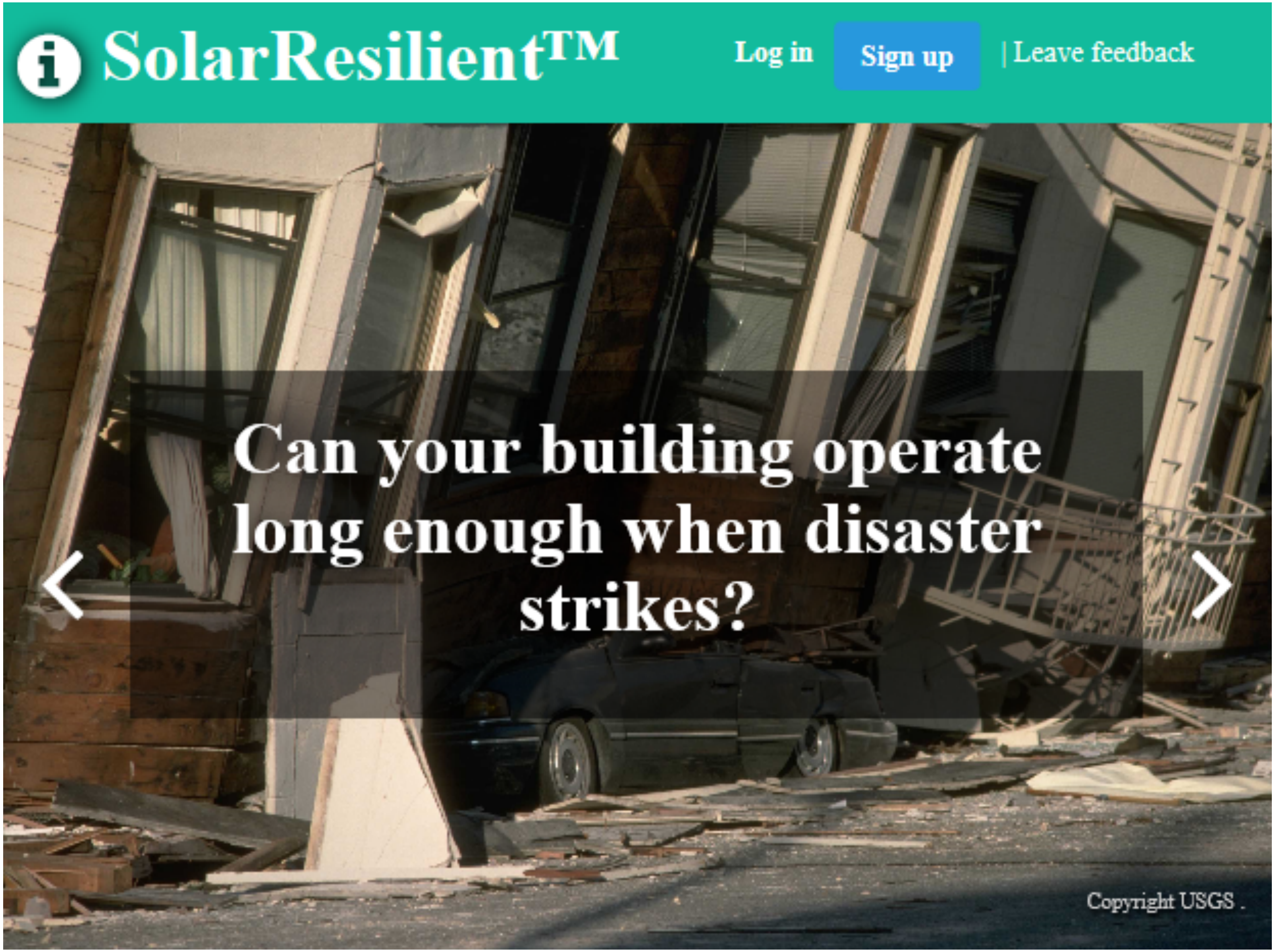
However as major weather events and widespread outages increase greater awareness of the need for localized, resilient power systems is growing. As technology costs decline and extended outages become more common businesses and building owners can measure the value of resilience and improve the viability of PV and storage systems.



The City of San Francisco has developed a best practices guide for developing Solar+ Storage Systems for Resiliency… fine it @ https://sfenvironment.org/solar-energy-storage-for-resiliency



They have also developed a free, online calculator to help size batteries to ensure a building has enough power to run critical loads during emergencies.



Solar system cost reductions are being mirrored by Energy Storage system costs …
As the cost decrease the widespread use of Solar+Storage systems will have an increasingly dramatic effect on all aspects of our energy systems…

Utilities, commercial and residential players all can benefit from the coming changes…

The changes will be disruptive, the for-thought and flexibility of the participants will determine their success…

Change is inevitable….

Questions?

For further information:

Clean energy group: https://www.cleanegroup.org

Solarmarket Pathways: http://solarmarketpathways.org

Great Northern Solar: gosolar@cheqnet.net