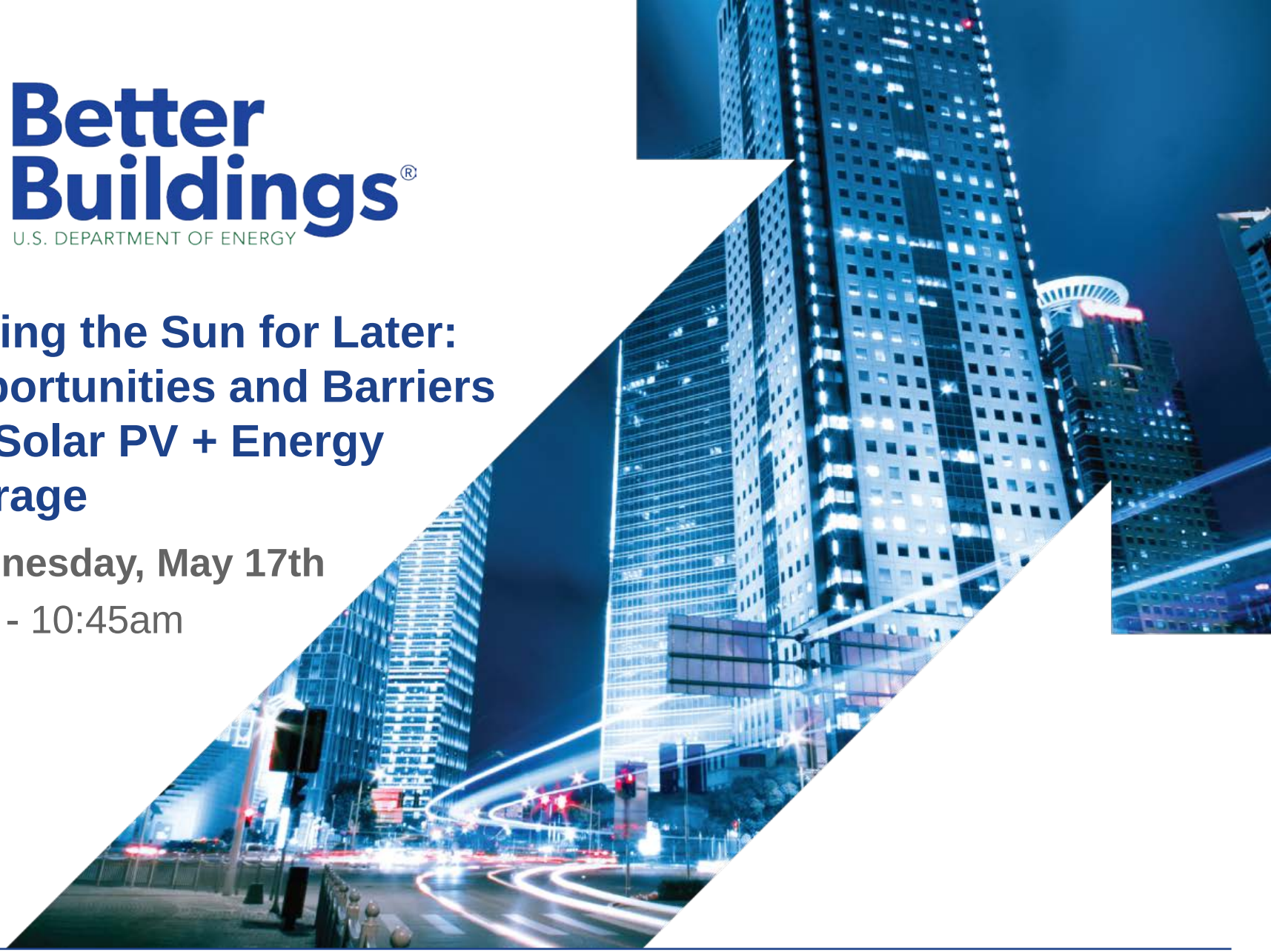
Better Buildings®
U.S. DEPARTMENT OF ENERGY

Saving the Sun for Later: Opportunities and Barriers for Solar PV + Energy Storage

Wednesday, May 17th

9:30 - 10:45am



U.S. DEPARTMENT OF ENERGY

Panelists

- Karen Butterfield, Stem
- Ben Myers, Boston Properties
- Jessie Denver, City of San Francisco
- Moderator: Jay Paidipati, Navigant

Introduction and Agenda

- Session Objectives:
  - Provide update on the Better Building Alliance's Renewables Integration Team
  - Discuss use cases, drivers, barriers, best practices, and case studies for solar PV + energy storage.
- Agenda:
  - Jay Paidipati - Navigant Consulting, Inc.
  - Karen Butterfield – Stem, Inc.
  - Ben Myers – Boston Properties
  - Jessie Denver – City of San Francisco

Association of Climate Change Officers - CEUs

The Better Buildings Summit has been accredited by the Association of Climate Change Officers. Attending the following sessions will allow you to satisfy CC-P® elective and continuing education requirements.

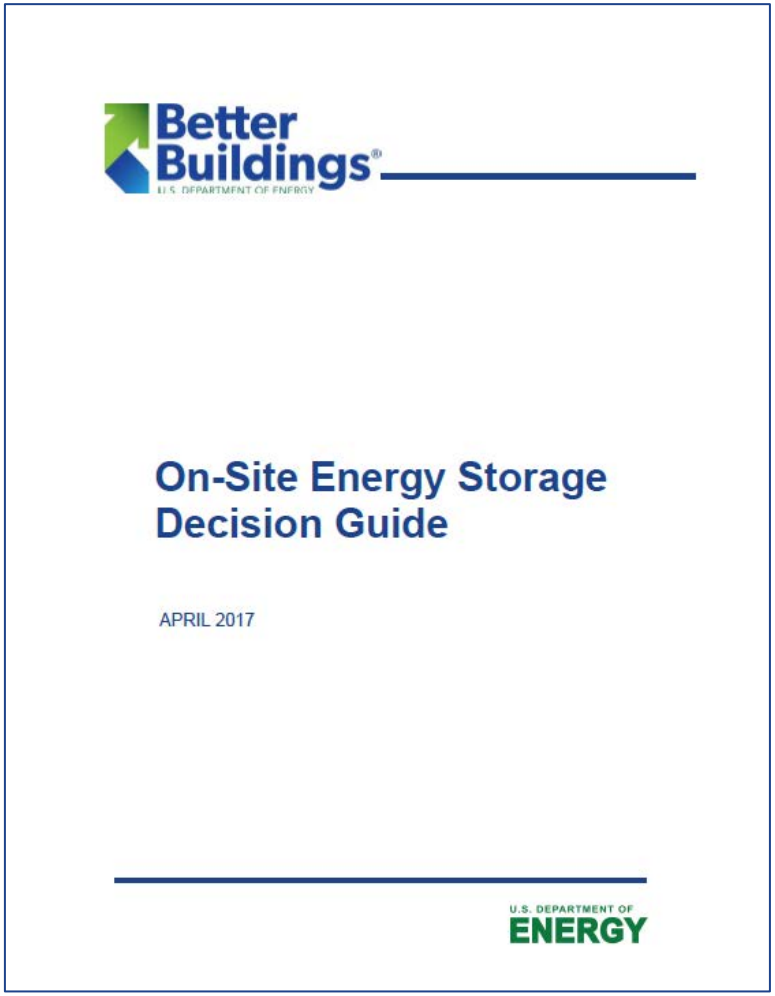
Interested attendees should fill in the sign-in sheet placed in the session room.

ACCO
2017 ACCREDITED PROVIDER EVENT

- **Workshop - Part 1 + 2: Expect the Unexpected: Planning Energy-Resilient Communities**
- **Addressing the Energy-Water Nexus: The Next Wave of Challenges and Solutions**
- **Renewable Energy Fuels Clean Water: What's Not to Like?**
- **Making the Business Case for Water Savings**
- **You Can Do That? Pioneers in Using State Clean Water Revolving Funds for Energy Efficiency**
- **Achieving Data Center Cost Savings Through Renewable Energy**
- **Saving the Sun for Later: Opportunities and Barriers for Solar PV + Energy Storage**
- **Reimagining Cities! Achieving Efficient, Resilient and Sustainable Communities Through Zero Energy Buildings**

BBA RE Integration Team Updates

- We recently released a new resource – the On-Site Energy Storage Decision Guide - to help building owners and operators make decisions regarding energy storage.
- Available on the Better Buildings Solution Center at https://betterbuildingssolutioncenter.energy.gov/ or follow up with Jay for a copy.
- The team is now focused on off site renewables and solar PV + storage.



Context

- Solar PV + energy storage landscape
  - Falling costs
  - Evolving procurement contracting structures
  - Rapidly changing policy and regulations
  - Multiple uses cases

- The goal of today's session is to help you understand use cases, drivers, barriers, and best practices for solar PV + energy storage to do the following:
  - Assess feasibility;
  - Making the business case internally;
  - Conduce procurements; and
  - Execute contracts.

Karen Butterfield

Stem

U.S. DEPARTMENT OF ENERGY

Storage, Customers and the Grid

Better Business Summit May 2017
Karen Butterfield, Chief Commercial Officer

stem

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stem

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Agenda

Why intelligence is the key to storage
What can’t storage do
Solar plus storage is a growing trend
But it is not enough
A business model that customers want

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The timing of *when* you use electricity increasingly drives costs…

- **Demand charges**
- **Time of use rates**
- **Demand response**
- **Critical peak pricing**
- **Solar output balancing**

…and avoiding the most expensive rates requires greater **control**.

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Intelligence is the key

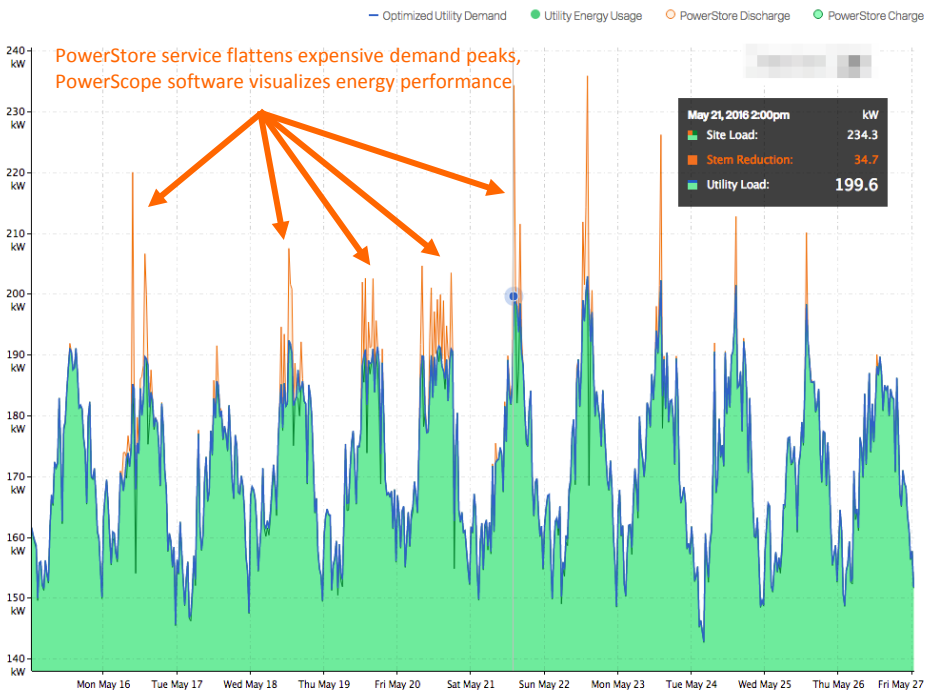
Energy costs are not just about ***how much*** you use…

When buildings use electricity, and how intensively, makes a big difference in cost and grid impact

Providing intelligence in the building and in the network of buildings is what makes storage intelligent

Customers know that changes are coming to rates: TOU periods, escalating demand rates, changes to DR programs and they feel anxious and exposed.

Predict and react to energy patterns



Stem's software analytics predict and react to fluctuating energy consumption in real-time to catch monthly peaks before costs are incurred.

Over 3 million hours of operating data from Stem's fleet help continuously fine-tune the system's predictive capabilities.

"Stem's predictive analytics, in tandem with reliable energy storage hardware, help manage our energy use more efficiently at peak times."

Jonathan Francom, VP Global Workplace Solutions, Adobe Systems Inc.

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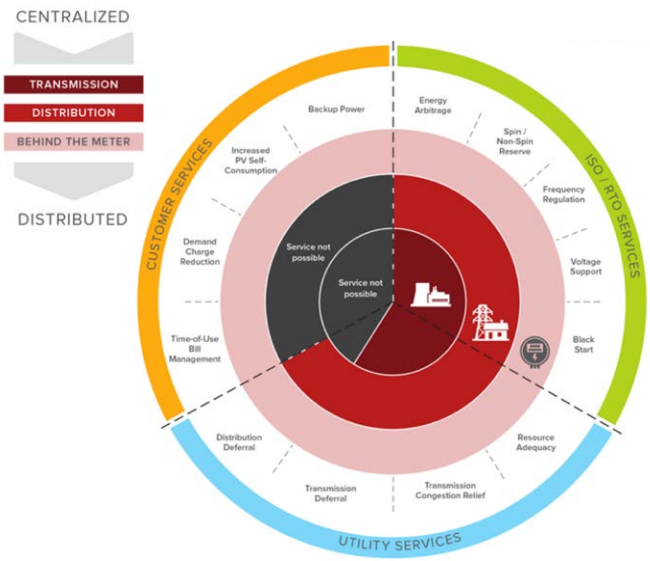
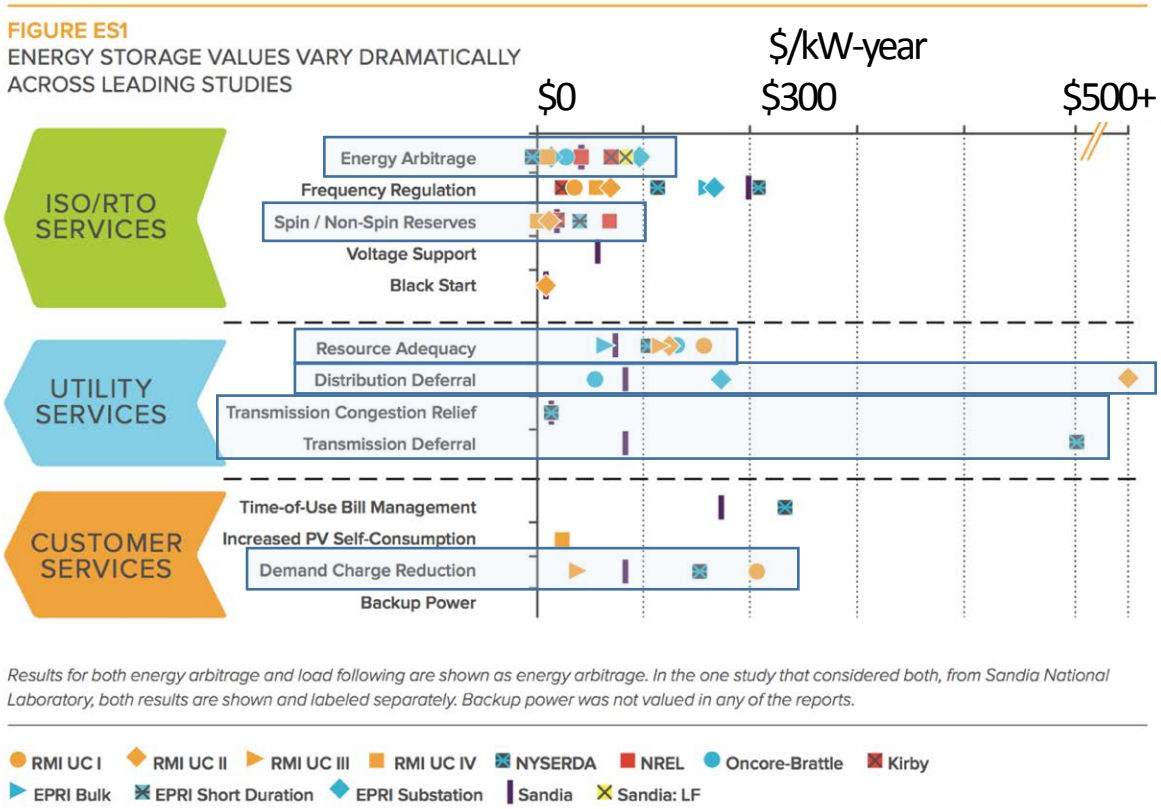
What can't storage do



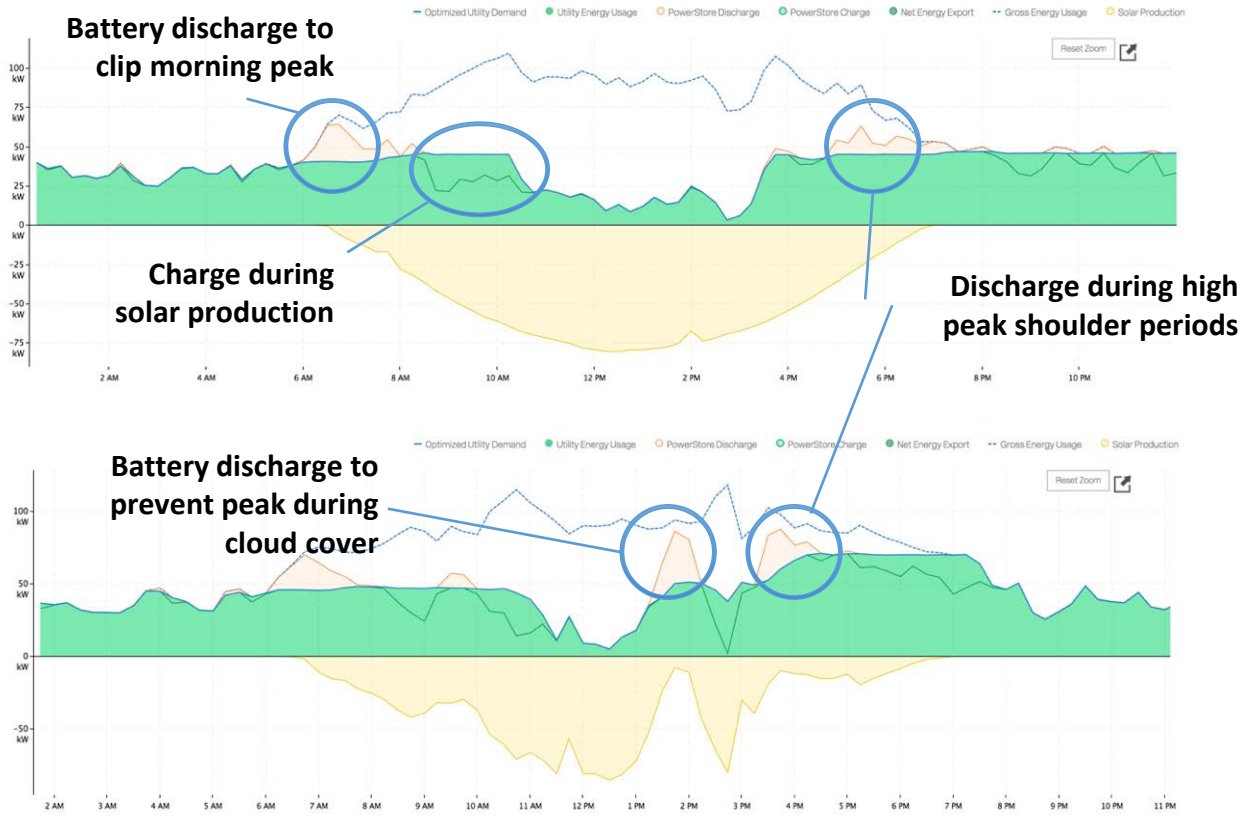
Both centralized and distributed storage can earn grid revenues

Only customer-sited storage can also benefit energy customers



Source: Rocky Mountain Institute (RMI), The Economics of Battery Energy Storage, October 2015

Solar + storage motherhood and apple pie



Case study: ShoEi Foods USA

"If I can use the software, anyone can. I noticed that in late October when it gets dark earlier, we get a little less energy from our solar panels. Stem's software and alerts make it easy to adjust for that – it's really all about knowing what's happening in order to act on it."

Dwight Davis, Facility & Plant Manager, ShoEi Foods

ShoEi Foods USA is a leader in the food processing industry – preparing, processing and storage high volumes of prunes and walnuts. By pairing solar with storage, ShoEi was able to switch to a more favorable rate tariff.

Stem's PowerScope software allows ShoEi to stay below the tariff's 500 kW threshold, sending alerts when the facility nears its maximum desired peak. The result is $6,000 in savings each month.

- System size: **72 kW**
- Total projected savings over 10 years: **$720,000**

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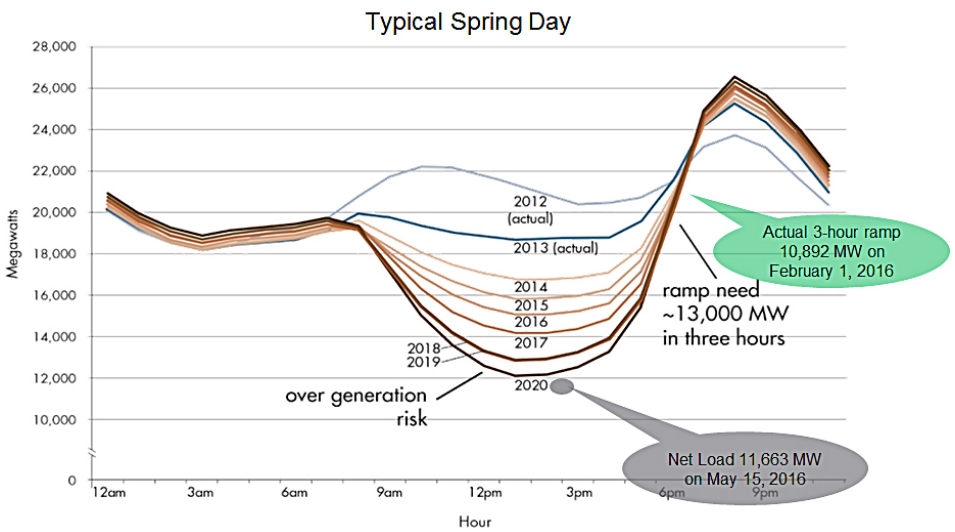
But it’s not enough if we can’t solve the duck

Figure 2: The duck curve shows steep ramping needs and overgeneration risk



Graphic courtesy CAISO

Curtailment of renewable energy is occurring in CA now – 11MWh on March 11, 2017

Over-generation is expected to occur in the middle of the day

Energy Storage facilitates renewables

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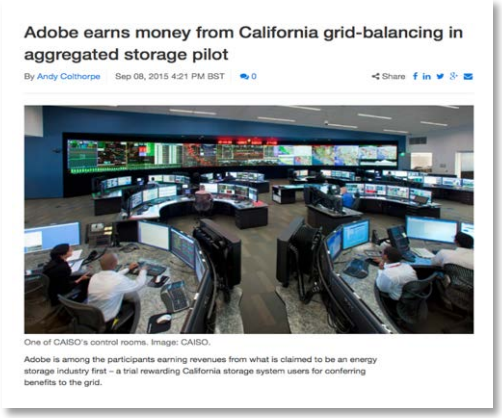
The smart grid can pay customers to solve it

How it works:

- When the grid faces high demand, like a hot day…
- Stem uses extra battery power as virtual power plant to reduce grid stress.
- In exchange, the smart grid pays Stem for the service provided.
- Stem passes the savings on to customers through the service agreement.



Adobe earns money from California grid-balancing in aggregated storage pilot

By Andy Colthorpe | Sep 08, 2015 4:21 PM BST | 0 | Share

One of CAISO's control rooms. Image: CAISO.

Adobe is among the participants earning revenues from what is claimed to be an energy storage industry first – a trial rewarding California storage system users for conferring benefits to the grid.

New revenue sources from intelligent storage include:

- Demand savings plus grid service payments from utilities
- Earning CAISO market payments for customers
- DR revenue by enrolling in existing programs

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Case study: LBA Park Place

"We continue to demonstrate leadership in enhancing our properties with smart building technologies that increase sustainability, strengthen the local power grid, and reduce costs for our tenants. The installation of Stem's cutting-edge technology is the most recent demonstration of this commitment."

Perry Schonfeld, Principal and COO, LBA Realty

LBA Realty installed the world's largest indoor energy storage system at Park Place to reduce operating costs and to support sustainability efforts. In addition to providing value for the owners and tenants, this system participates in Stem Grid Rewards with Southern California Edison to help relieve grid congestion in the West LA Basin.

- System size: **1.3 MW**
- Annual demand charge reduction: **7%**
- System lifetime savings over 10 years: **$450,000**

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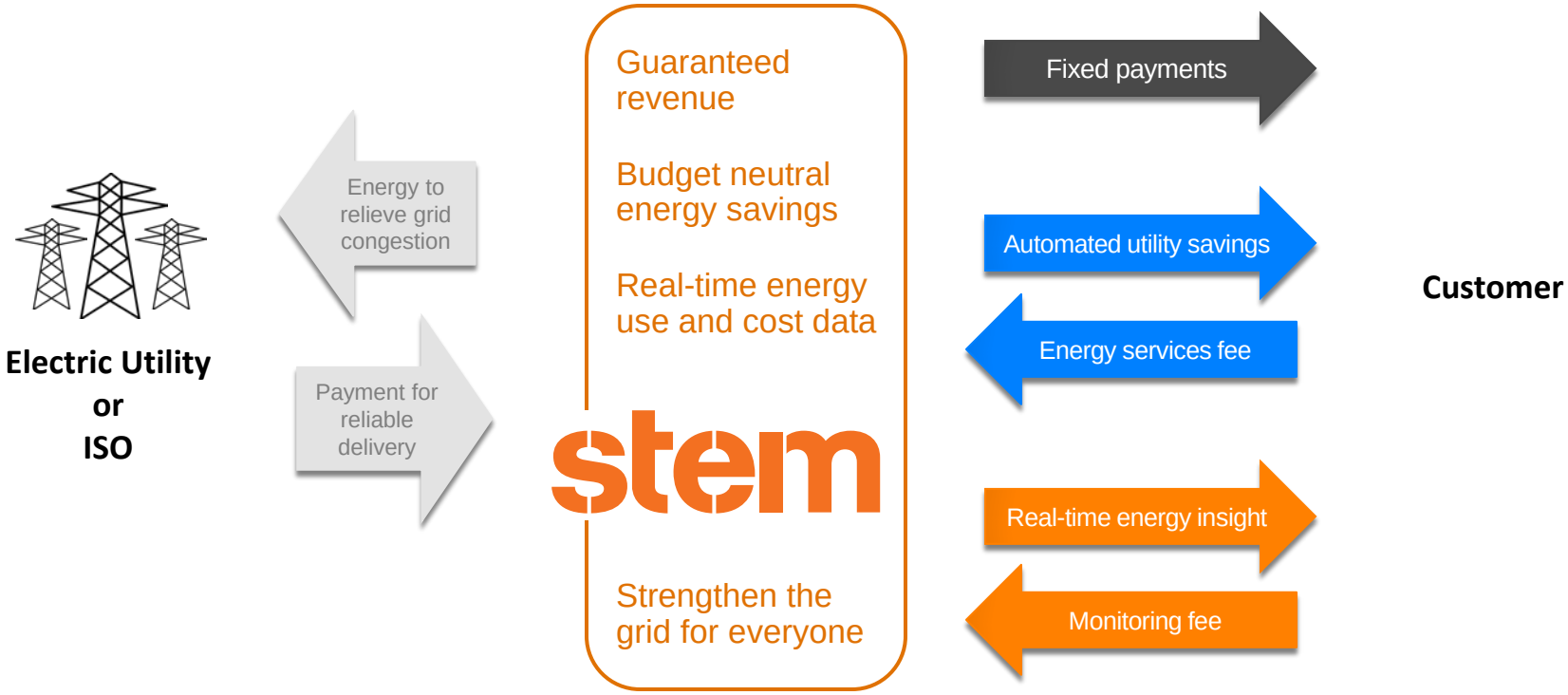
A compelling business model for customers



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Solution components

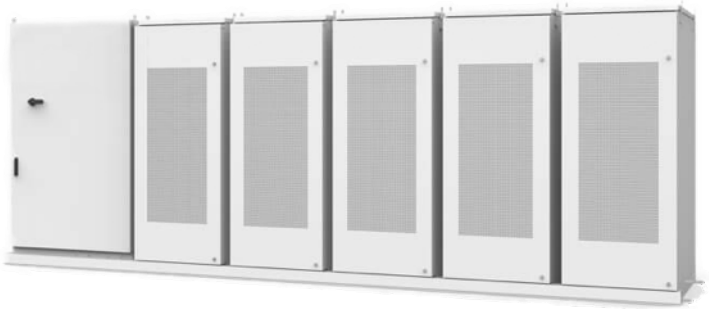
PowerStore energy storage systems

Options for all facility sizes and locations.
Batteries from leading global manufacturers.

Medium indoor
100 kW modules
(server rack size)

Small indoor
18 kW modules
(gym locker size)

Large outdoor
250 kW modules
(parking space size)



PowerScope energy intelligence software

Visibility into past, current, and future energy use.
Alerts before expensive peak demand costs.

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Case study: JC Penney

"Subscribing to Stem is a no brainer. It is easy to implement, requires no capital outlay and operates in the background to deliver effortless savings."

"We have had consistent results in avoided demand charges and Stem has gone out of their way to ensure that we are cash-flow positive in every month."

Jonathan Hooser, Energy Project Manager at JC Penney

Location: 26 sites in California
Phase 1: Fall 2015
Phase 2: Fall 2016
Phase 3: Current

System Size: 54 kW – 108 kW
Annual net savings: $103,000
10-Year Estimated Savings: >$1 million

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Uncover costly equipment issues

PowerScope's high-resolution energy data reveals a large piece of equipment cycling on and off.
Cycling can lead to harmful equipment wear and tear, or more serious maintenance issues.

"With PowerScope, we can monitor different processes in real-time to understand which of our equipment are the heavy hitters. The real-time energy use is the best part of the software."

Dwight Davis, Facilities & Operations Director, ShoEi Foods USA, Inc.

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Case study: Safeway

"Stem reduces our operating costs. I find their team knowledgeable, customer focused and ethical."

George Waidelich, Business Director, Safeway

- For grocery retailers, electricity represents significant portion of operating costs despite relatively flat load profiles.
- Low margins mean shareholder returns are directly affected by energy cost reductions.
- Refrigeration and customer experience are non-negotiable operating requirements.
- Automated storage reduces demand charges without operational compromises.
- PowerScope software enables multisite view from headquarters.
- Stem system delivering savings for 8 Safeway stores in California and Hawaii.

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Energy storage supports LEED

Stem contributes to LEED points for both new and existing buildings.

- Optimize energy performance (EAc1) – 18 points possible
  - PowerStore reduces energy costs, which translates directly into points.
- Advanced energy metering – 1 point
  - PowerScope provides real-time energy visibility to expose hidden waste.
- Demand response – 3 points possible
  - PowerStore provides fully automated DR, so there's no disruption to operations or comfort.
- Renewable energy production and distributed generation – 3-4 points possible
  - PowerStore enhances the value of onsite solar by cutting demand when it's cloudy or dark.
- Innovation – 5 points possible
  - Stem helps with onsite solar, alternative metering, and more.
- Green Vehicles – 1 point possible
  - PowerStore reduces the demand charge impact of adding EV charging.

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Case study: Soka University

"Stem made the effort to understand the culture of the campus and its sustainability initiatives so that the project was relationship based. When this project was presented to the senior administration for consideration, the response was that it was a 'no brainer.' The installation and coordination with SCE and municipal building permitting was seamless as well."

Tom Harkenrider, Chief of Operations, Soka University

Soka University is using Stem to reduce operating costs without using staff labor, and to support the university's dedication to sustainability and creating value.

Watch this video about the Soka operations team's experience with Stem.

- System size: **400 kW**
- System lifetime savings over 10 years: **$780,000**

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Software provides real-time building visibility

PowerScope revealed that by staggering the morning startup, this school can reduce peaks by 10% or more.

- View energy use, Stem's storage activity, onsite generation (solar, fuel cells), and costs.
- Receive email or text alerts when demand is high.
- Identify anomalies, equipment failures, and hidden waste.

Insight = Value

A recent Verdantix study shows that real-time data provides 42% faster payback period than half-hourly metering, and 5X the savings from utility bill data.

According to a 2013 study by Berkeley National Lab, the use of energy intelligence software, especially load profiling and peak monitoring, led to median energy cost savings of 17% for participants.

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No change to operations

- Storage system is 100% automated.
- Requires no extra staff time, manual effort, or disruption to normal operations.
- Participate in demand response without lifting a finger.

"The Stem system is invisible to our guests and our staff. It's simply a great way to save on energy costs. In addition, the software provides us with a clear view of electricity usage and activity."

Larry Fichuk, Director of Energy and Sustainability, Extended Stay America

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What makes a successful energy storage project?

Critical success factors and capabilities

- Automated, predictive, and self-learning ESS controls
- Conservative savings estimates informed by real-world data
- Grid-interactive platform and utility partnerships to access DR revenue
- Pre-integrated, turnkey systems
- Coordination with on-site generation
- Insights into energy use and costs

Things to watch out for

- Inflated energy savings estimates
- Impossible “value-stacking”
- Disruptive installation process
- Rudimentary or “dumb” algorithms
- Upfront capital investment or technology ownership
- Lack of experience / testimonials
- Custom project development

Reliable savings. Risk free. Low hassle.

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Stem Experience

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Q&A

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Ben Myers

Boston Properties

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Energy Storage Strategy

Harnessing the Power of an Organization…

a work in progress

bxp Boston Properties

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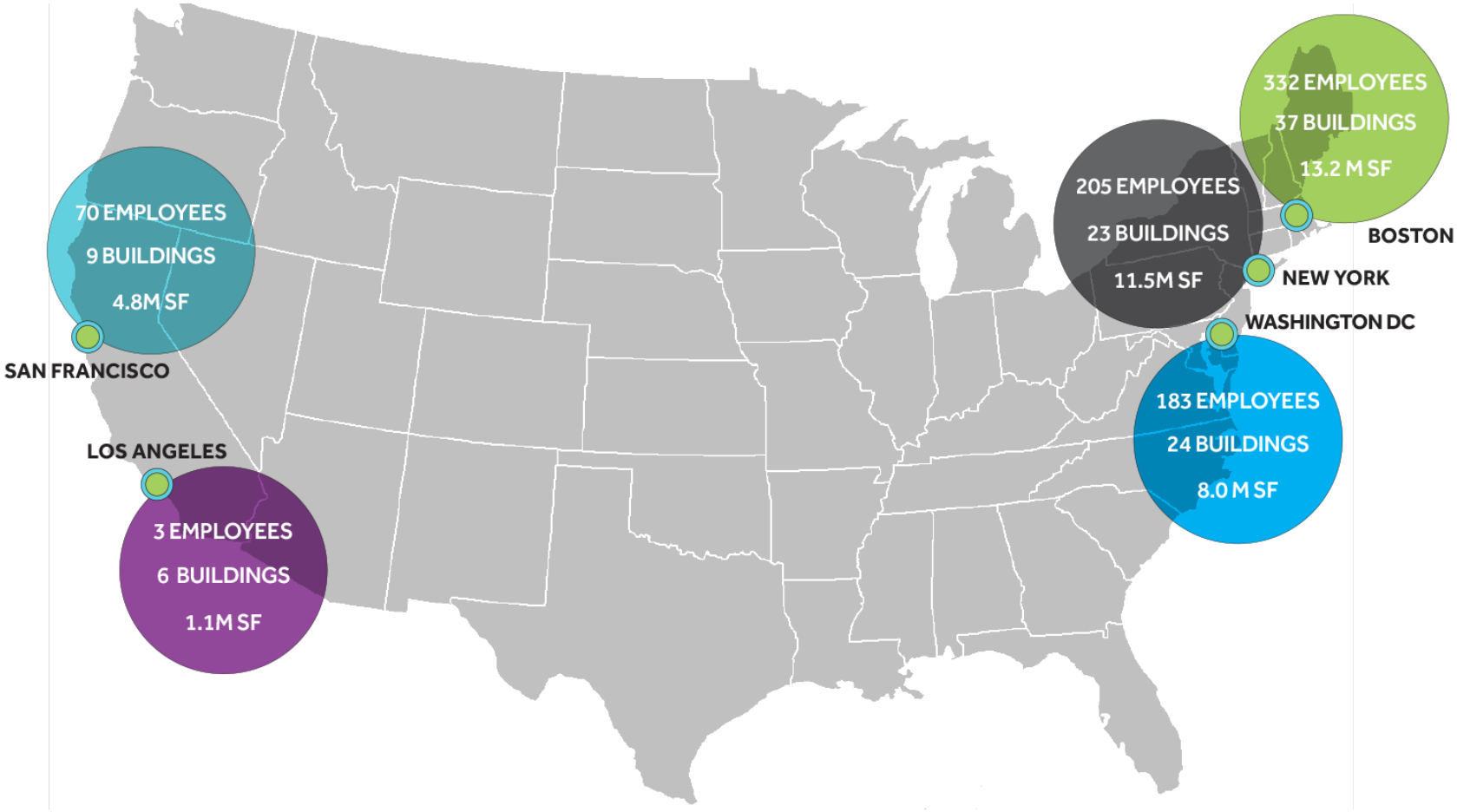

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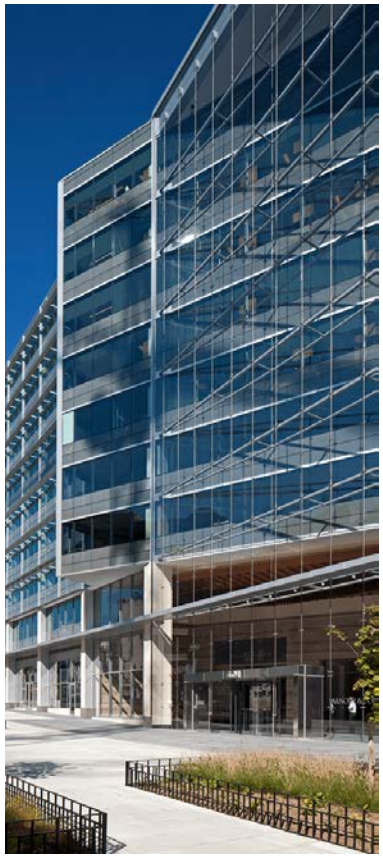
Times Square Tower
New York

Atlantic Wharf
Boston



601 Massachusetts Avenue
Washington, DC

888 Boylston Street
Boston

Salesforce Tower
San Francisco

SUSTAINABILITY STRATEGY

- Promote our growth and operations in a sustainable and responsible manner across our five regions
- Focus on the economic, social, and environmental aspects of our activities

bxp Boston Properties

[b]responsible

Reduce Operating Costs

Protect Asset Value

Grow Socially Responsible Investment

- **17.1M SF LEED Certified**
- **95% at Gold & Platinum Levels**
- **All new development projects are pursuing LEED certification**

- **Executive Member of EPA's Certification Nation program**
- **62 ENERGY STAR labelled properties – representing 68% of our actively managed portfolio.**

- Ranked 36th out of 733 global companies in 2016 (**among the top 5% of all participants**)
- **Ranked 2nd among US Office companies in 2016**
- Achieved highest "Green Star" last 5 years
- NAREIT Leader in the Light award winner in 2014 and 2015 for superior energy and sustainability performance

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ENERNOC

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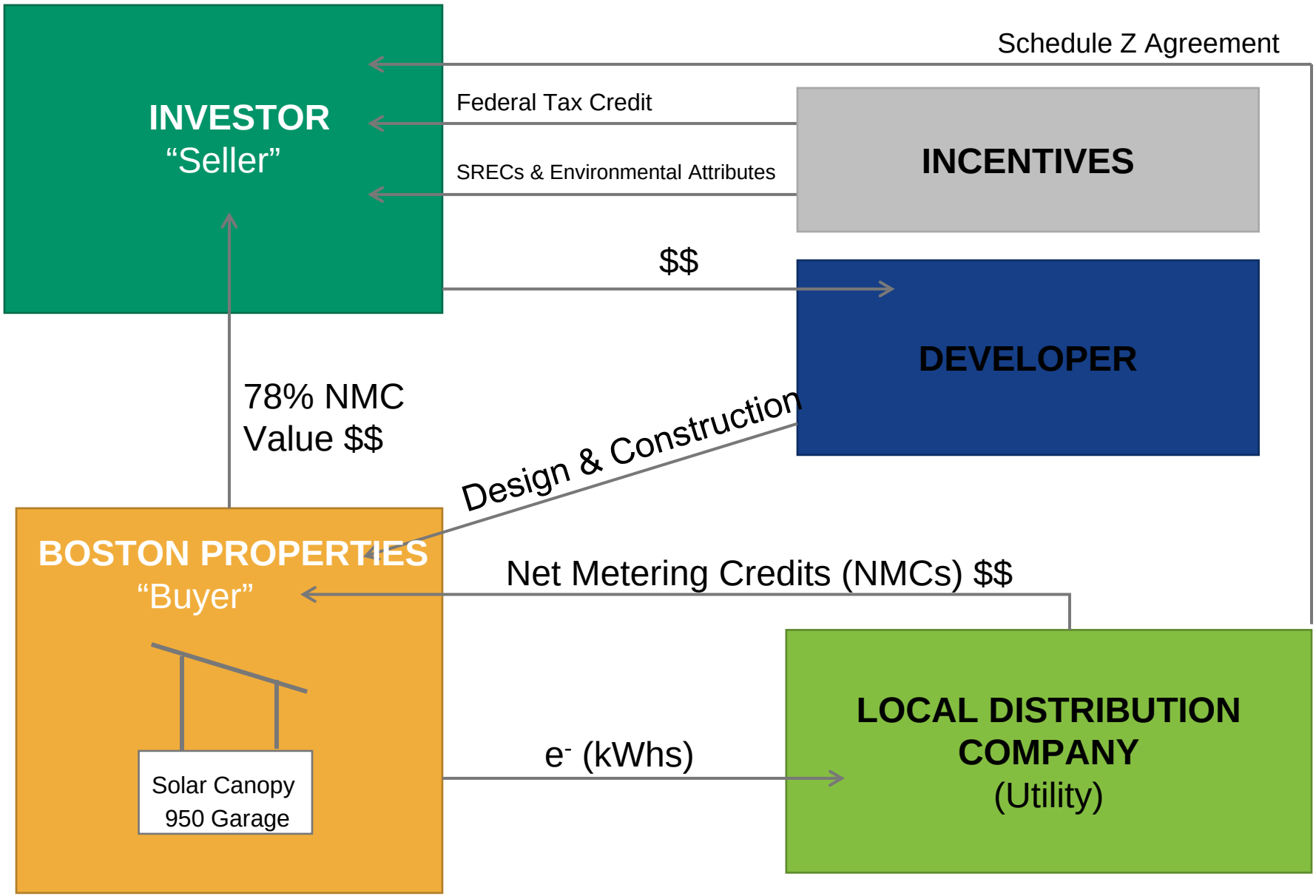
Schedule Z Agreement
INVESTOR
"Seller"
Federal Tax Credit
SRECs & Environmental Attributes
INCENTIVES
$$
DEVELOPER
78% NMC
Value $$
Design & Construction
BOSTON PROPERTIES
"Buyer"
Net Metering Credits (NMCs) $$
Solar Canopy
950 Garage
e- (kWhs)
LOCAL DISTRIBUTION
COMPANY
(Utility)

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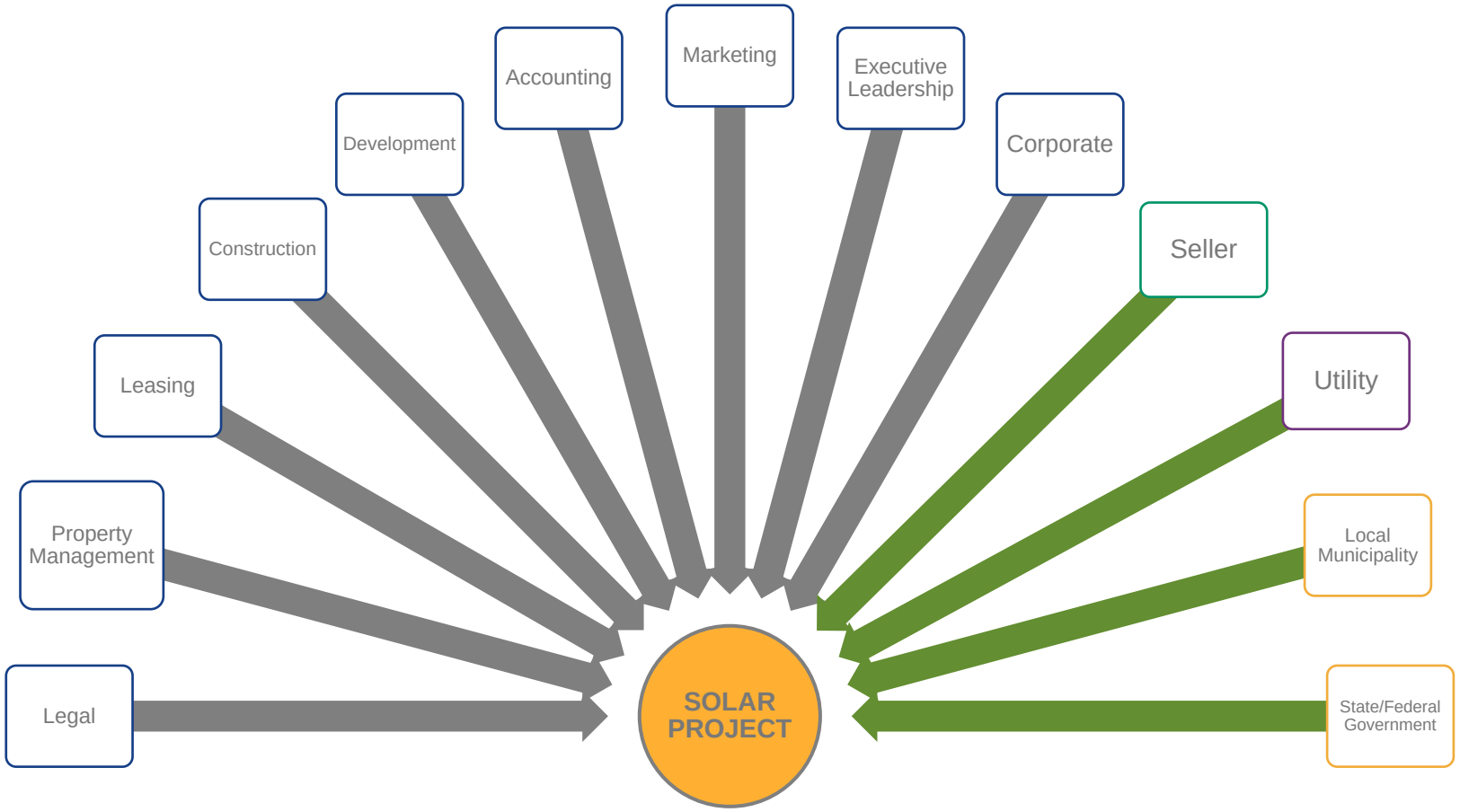
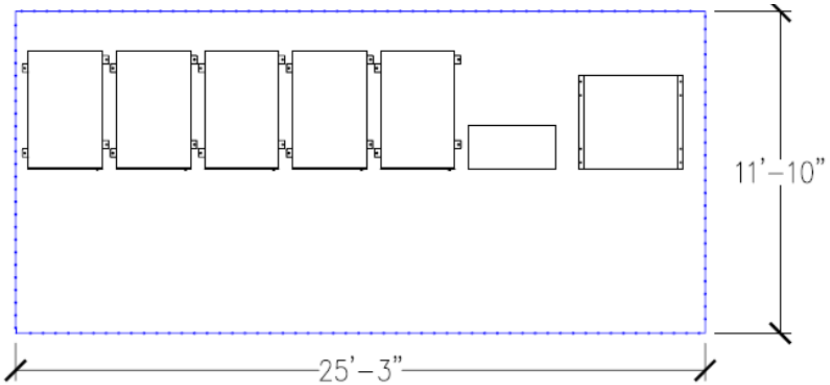


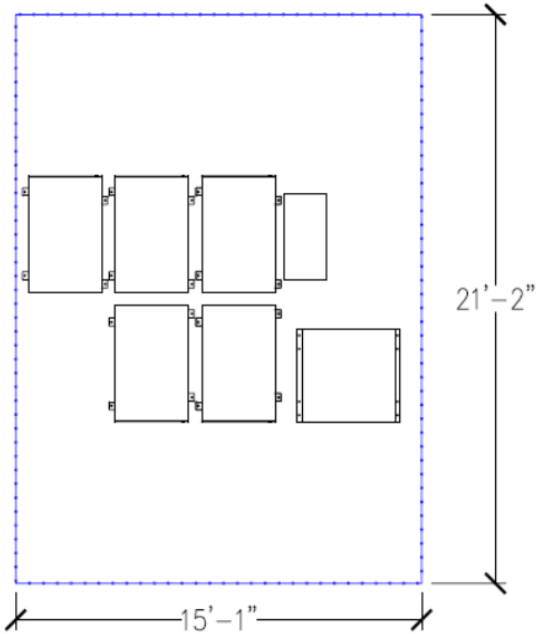
Energy Storage Opportunity

- Reduce peak demand charges 20-40% of utility bill
- Increase resiliency with backup power supply
- Generate savings and/or revenue with shared savings agreements
- Large incentives are being offered in New York, Princeton, Boston, Los Angeles and San Francisco
- BTM is 15% of the market now, predicted to rise to 50% by 2021 (20 GW)

250KW/500KWH SYSTEM, "INLINE"



250KW/500KWH SYSTEM, "2-ROW"



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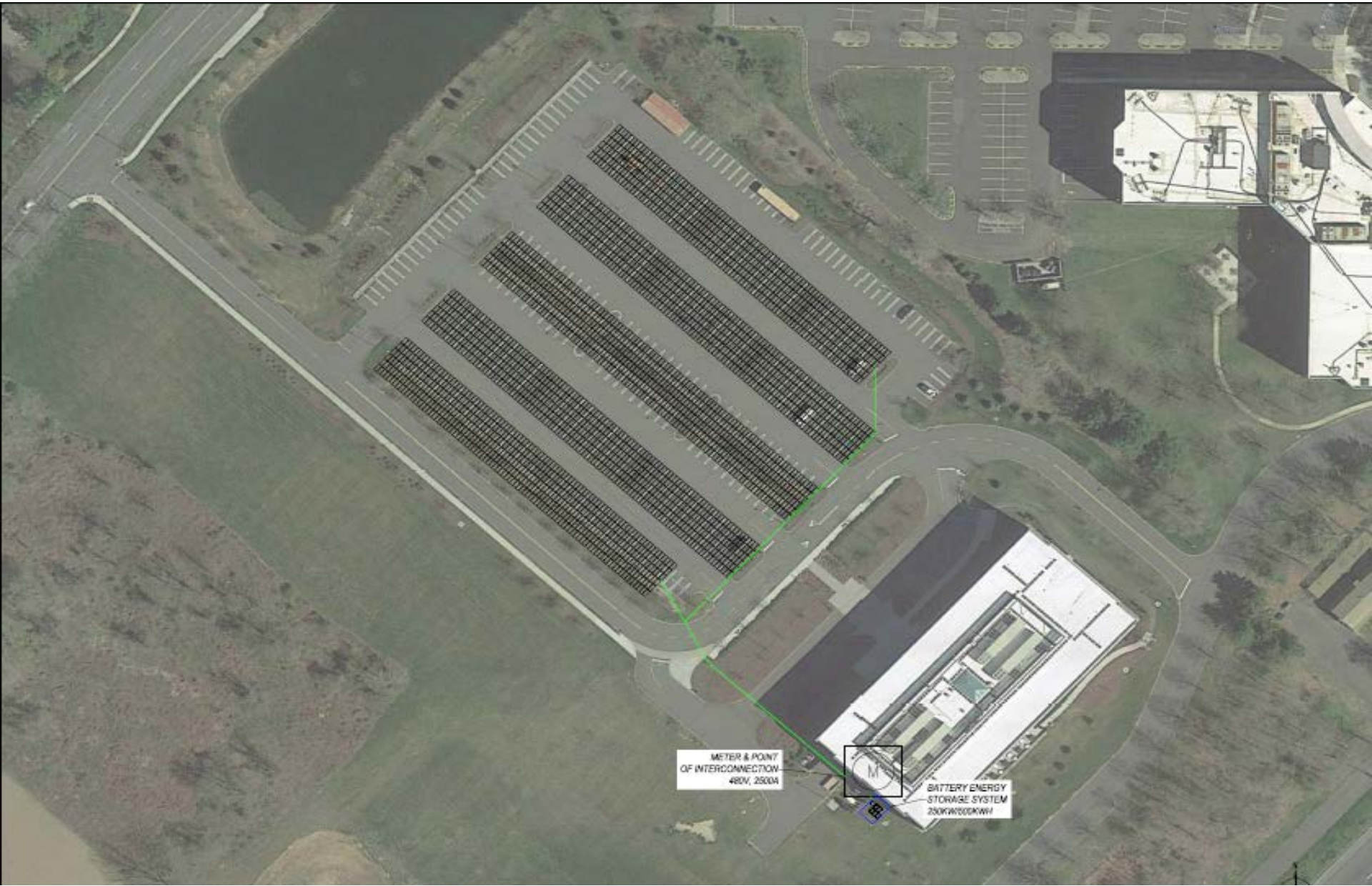
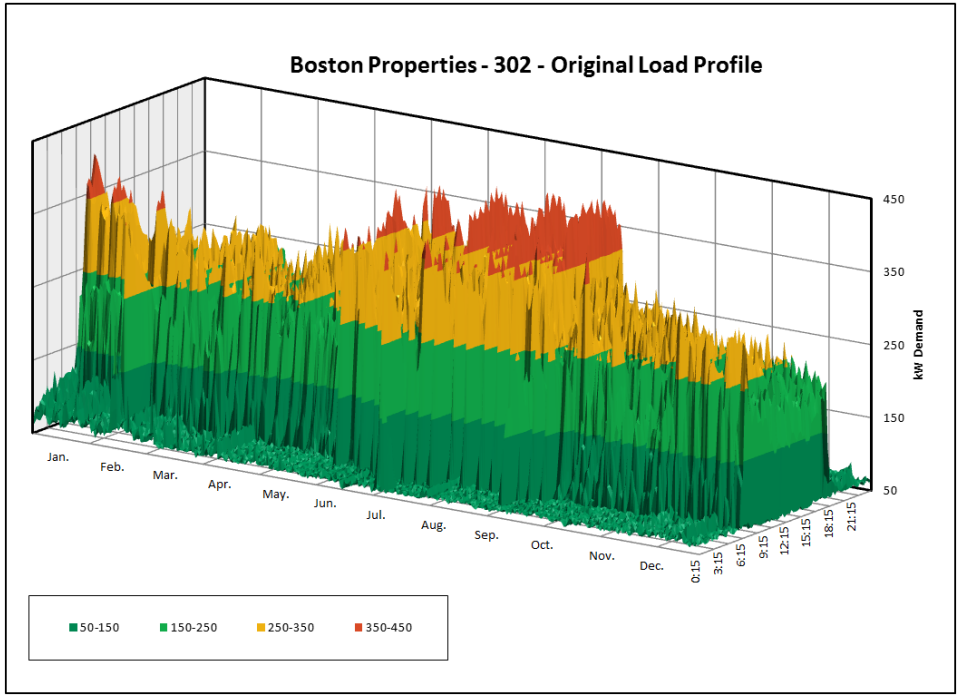
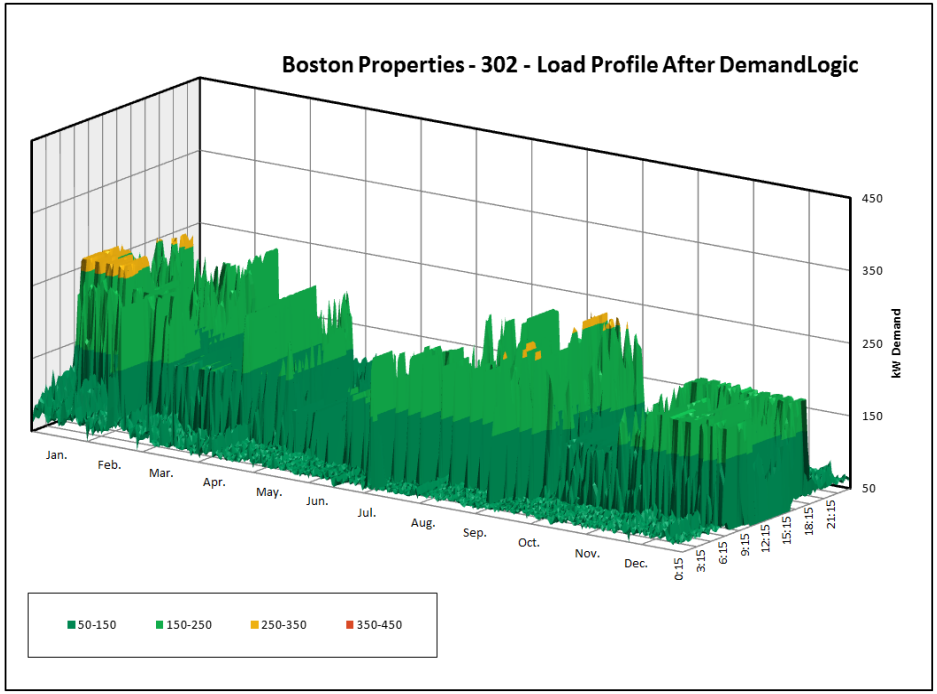


Before and After





Contract Terms

- A 20 year Power Purchase Agreement (PPA)
- PPA positive cash flow with year one utility cost savings in year one and an aggregated savings over the term of $1.67 Million
- Approximate 50/50 split of demand reduction savings
- Includes turnkey design and installation of covered parking systems, integrated solar arrays and battery storage system at no cost to BXP
- Performance guarantees for both solar and energy storage components of the system

bxp Boston Properties

800 Boylston Street, Suite 1900
Boston, MA 02199
www.bostonproperties.com/sustainability

Jessie Denver

City of San Francisco

U.S. DEPARTMENT OF ENERGY

SF Environment

Our home. Our city. Our planet.

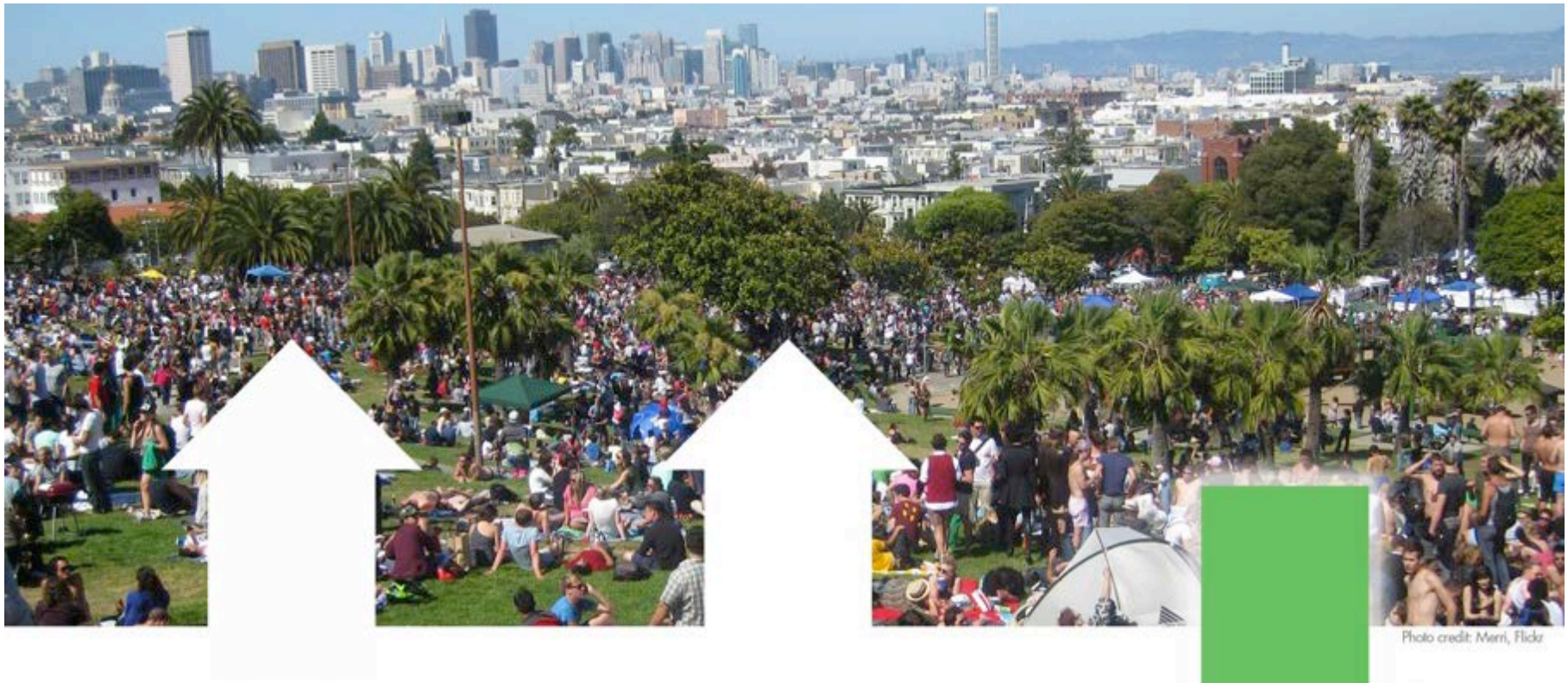
A Department of the City and County of San Francisco

Powered by SunShot

U.S. Department of Energy

San Francisco Solar + Storage for Resilience

Climate Action



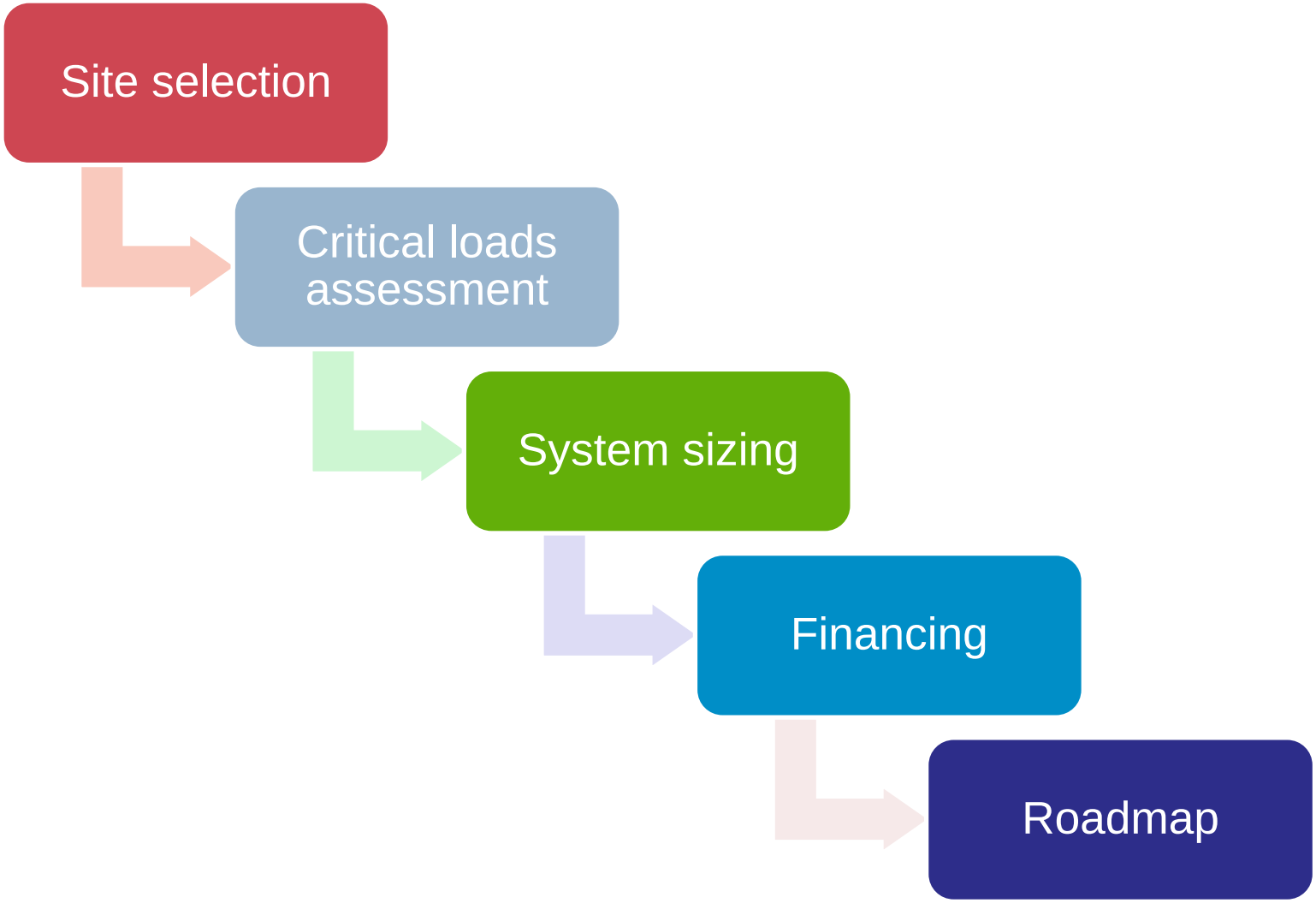
19.5%
Population

78%
GDP

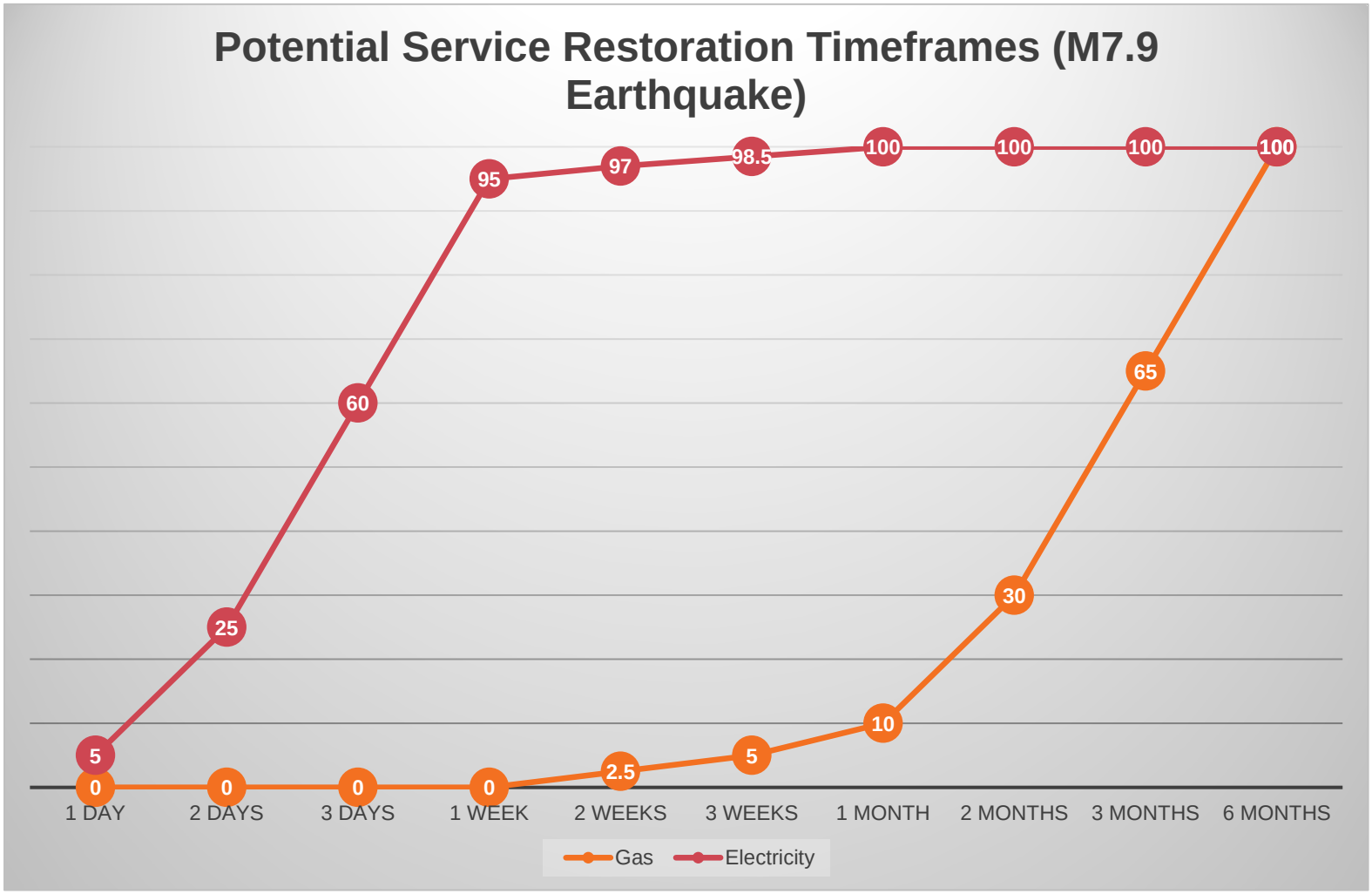
28%
GHG Emissions

Solar + Storage = Climate + Resilience

Project flow

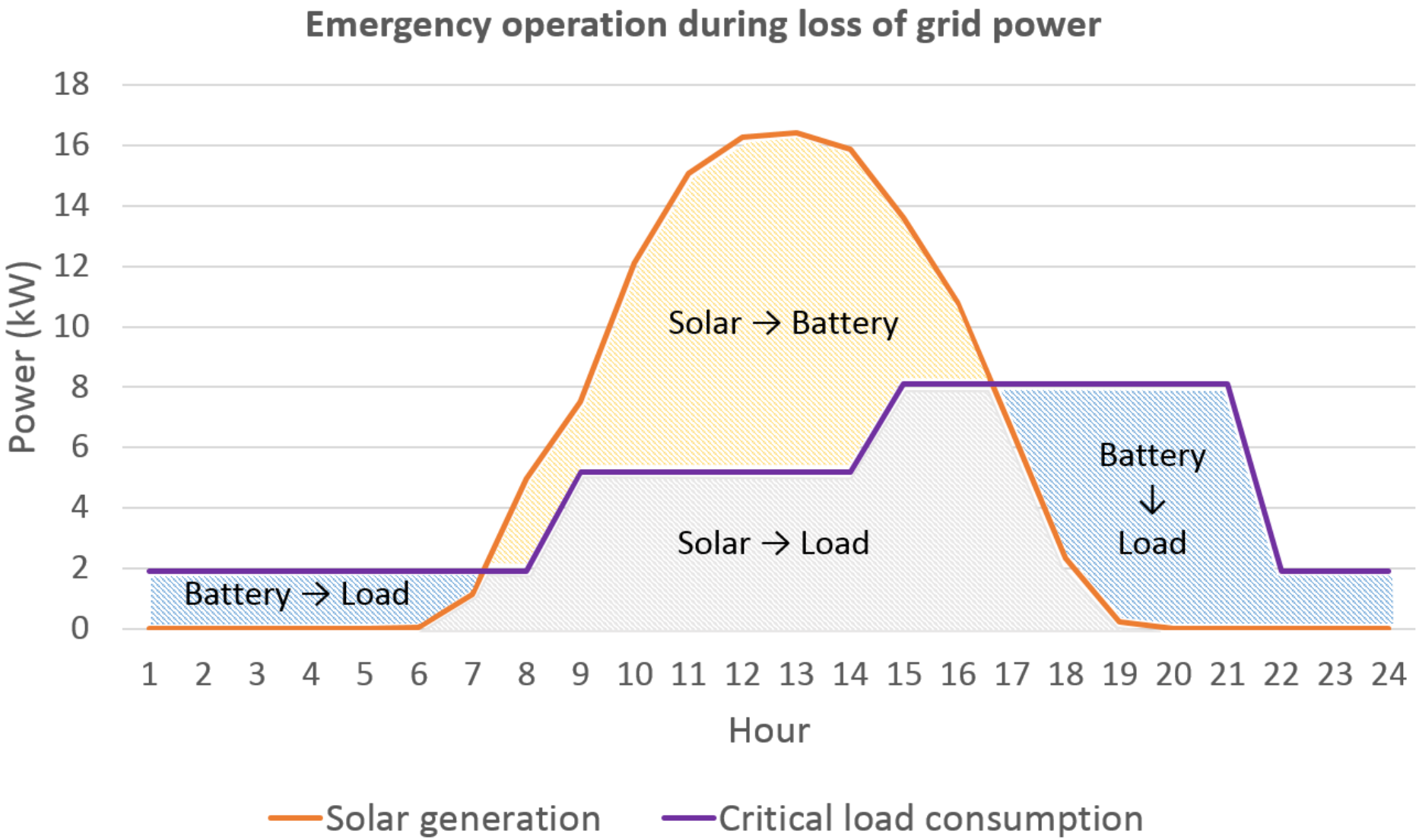


Plan for 3-7 day electricity outage

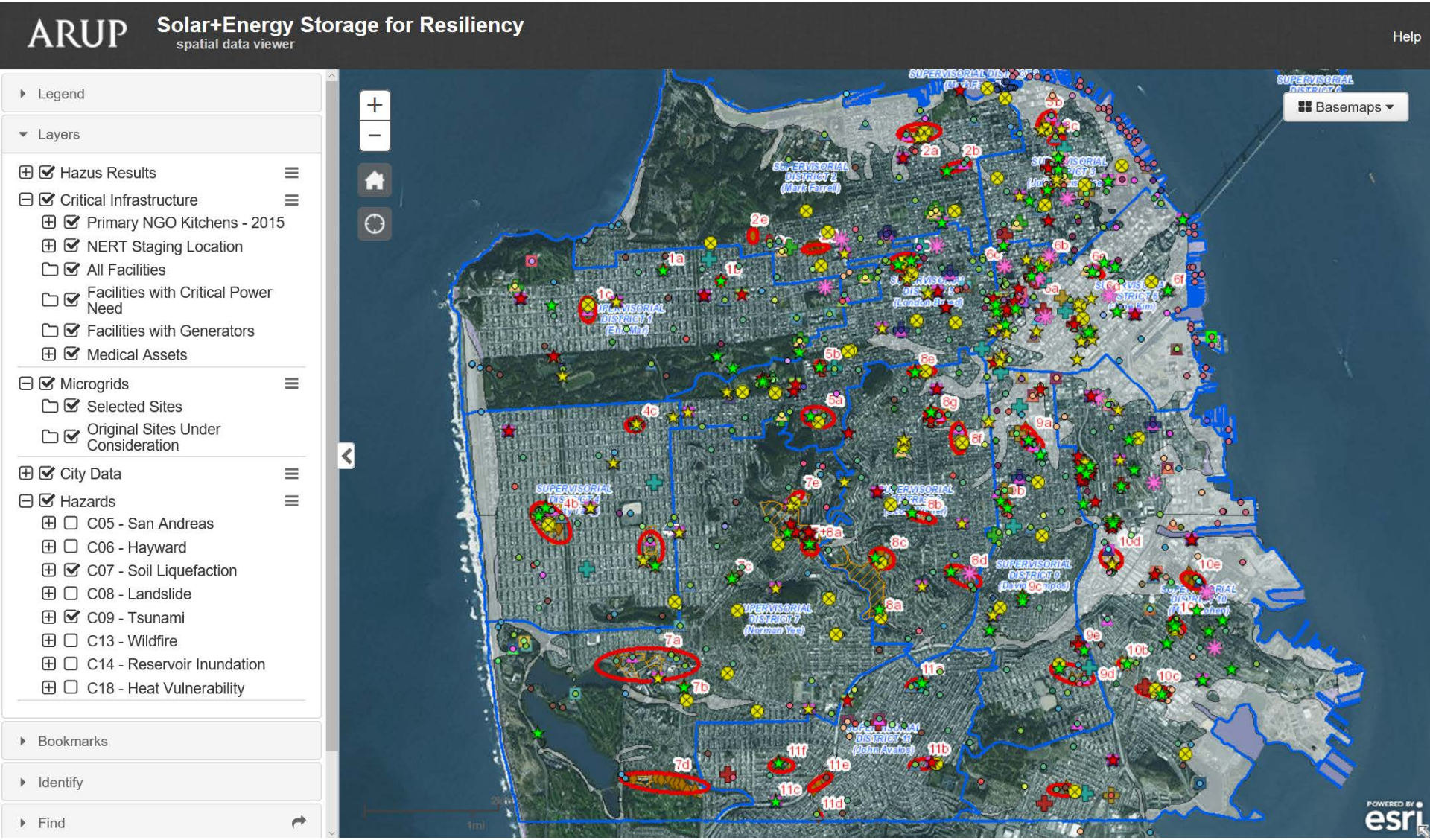


Data: SF Lifelines Council, April 2014

Design for emergency operation



Site selection



12 sites

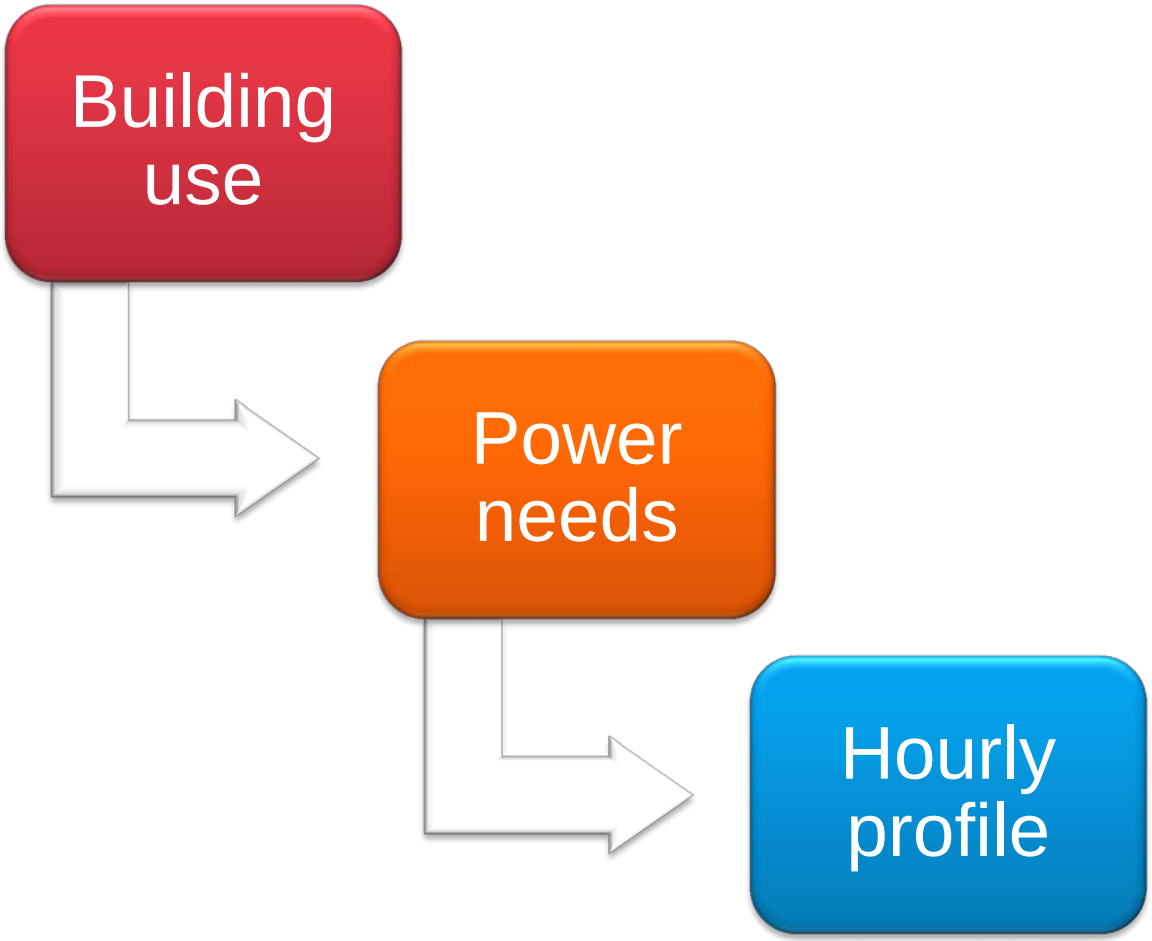
ARUP **Solar+Energy Storage for Resiliency**
spatial data viewer

Help

- Legend
- Layers
  - Hazus Results
  - Critical Infrastructure
  - Microgrids
    - Selected Sites
    - Original Sites Under Consideration
  - City Data
  - Hazards
- Bookmarks
- Identify
- Find
- Measurement
- Print

Typical site

Critical loads assessment



System sizing – SolarResilient.org

PV System

Array size:
76 kW

Existing array size:
0 kW

Annual generation:
118,000 kWh

Roof
5,100 sq.ft.

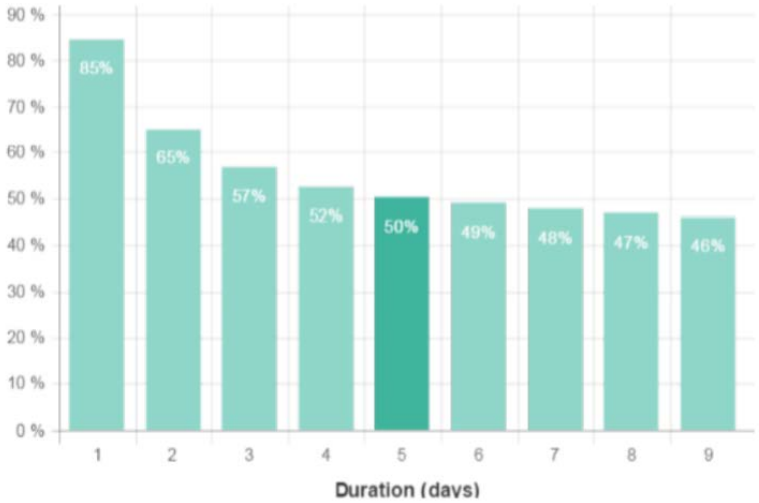
Parking
0 sq.ft.

Battery System

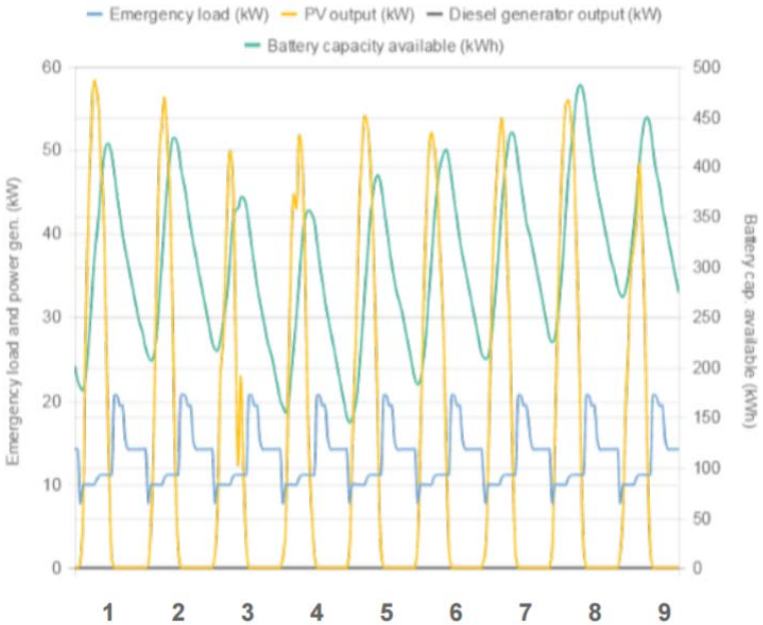
System size:
125kW / 500 kWh

Space required:
430 cu.ft.

System Duration - Probability



System Operation During Design Days



Existing PV systems

Partners

ARUP

STRATEGEN
STRATEGIES FOR CLEAN ENERGY

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