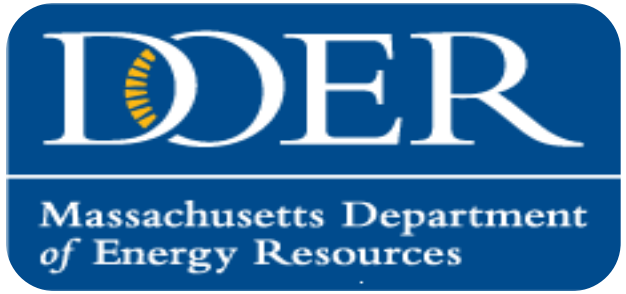
Creating A Clean, Affordable, and Resilient Energy Future For the Commonwealth



COMMONWEALTH OF MASSACHUSETTS
Charles D. Baker, Governor
Karyn E. Polito, Lt. Governor
Matthew A. Beaton, Secretary
Judith Judson, Commissioner

Energy Storage Public Stakeholder Forum

May 30, 2018

Boston, MA

Background and History of the Alternative Portfolio Standard (APS)

Michael Judge
Director, Renewable & Alternative Energy Division

What is a Portfolio Standard?

- State program requiring a certain percentage of the in-state load served by retail electricity suppliers come from renewable energy
- Retail electricity suppliers meet their yearly obligations by procuring Renewable Energy Certificates (RECs)
- One REC = 1 MWh
- Obligation typically expressed as percent of total electric load

Example:

Utility serves 1,000,000 MWh of load in 2018 and has an obligation to procure 13% of that through the purchase of RECs

1,000,000 MWh x 0.13 = 130,000 MWh (number of RECs they must procure)

Certificate Pricing

- Market driven
- State usually sets two variables:
  - Minimum Standard
  - Alternative Compliance Payment (ACP) Rate
- Minimum Standard refers to yearly percentage obligations placed upon compliance entities (i.e. market demand)
- ACP rate is the price retail electricity suppliers must pay for every MWh they are short of meeting their obligation (i.e. ceiling price)

Alternative Energy Portfolio Standard (APS) Background

- The APS was established as of January 1, 2009, under the Green Communities Act of 2008
- Supports alternative energy technologies that increase energy efficiency and reduce the need for conventional fossil fuel-based power generation
- The following technologies were eligible under the Green Communities Act:
  - Combined Heat and Power
  - Flywheel Storage
  - Gasification with Carbon Capture and Permanent Sequestration
  - Paper Derived Fuel
  - Efficient Steam Technology
- Eligible technologies are able to generate one Alternative Energy Certificate (AEC) for each MWh of electricity or 3,412,000 Btus of Useful Thermal Energy produced
- Each retail electricity supplier in MA must demonstrate that a percentage of the electricity they sell to customers is met by these eligible technologies via the purchase of AECs or the payment of Alternative Compliance Payments (ACPs) each year.
- The 2018 requirement is 4.5% of retail load served, and is set to increase 0.25% each year.
- The 2018 ACP rate is $22.64/MWh and changes each year with the Consumer Price Index (CPI)

APS Compliance (2009-2016)

	2009	2010	2011	2012	2013	2014	2015	2016
Aggregated APS Obligation (MWh)	163,844	626,902	911,748	1,185,236	1,448,421	1,681,759	1,799,094	1,874,294
Total Certificates Used for Obligation	119,325	235,432	317,801	357,575	525,673	838,080	894,602	945,003
ACP Credits Used for Obligation	44,519	391,470	593,947	827,661	921,626	835,505	902,605	928,636
% of Obligation Met w/ ACP	27%	62%	65%	70%	64%	50%	50%	50%
ACP Proceeds Received by DOER	$890,380	$7,829,400	$12,116,514	$17,397,429	$19,750,452	$18,147,169	$19,875,362	$20,429,992

- Over 99% of APS certificates from 2009 -2016 were generated by natural gas CHP facilities
- Market has been undersupplied since its creation and APS obligations have historically been met with more than 50% ACP since 2010
- Market supply/demand situation has recently changed with the introduction of new technologies as a result of legislation enacted in 2014 and 2016
- Growth of CHP and introduction of new technologies has resulted in what is likely a small market oversupply in 2017

2014 and 2016 Statutory Changes

Chapter 251 of the Acts of 2014 requires DOER to make changes to the existing APS regulations, including:

- Adding the following generation and fuel sources as eligible renewable thermal technologies:
  - Ground Source Heat Pumps (GSHP) and Air Source Heat Pumps (ASHP)
  - Solar Hot Water (SHW) and Solar Hot Air
  - Biomass, Biogas, and Biofuels
- Remove the following technologies as eligible:
  - Gasification with Carbon Capture and Permanent Sequestration
  - Paper Derived Fuel

Chapter 188 of the Acts of 2016 further requires DOER to make changes to the APS regulations, including:

- Adding the following generation and fuel sources as eligible technologies:
  - Fuel Cells
  - Waste-to-Energy Thermal

Rulemaking Process

- Stakeholder meetings were held in late 2014 and early 2015 to discuss implementation of statutory changes
- Regulation incorporating renewable thermal technologies was initially filed on May 19, 2016
  - Public hearings were held on June 15, 2016 and June 17, 2016 in Amherst and Boston
  - Written comments were accepted through June 30, 2016
  - Over 50 sets of comments received
- Second draft of the APS Regulations incorporating 2016 statutory changes and changes in response to the first public comment period was filed on June 2, 2017
  - Public hearings were held on July 14, 2017 and August 7, 2017 in Boston and Holyoke
  - Written comments were accepted through August 7, 2017
  - Over 75 sets of comments received
- On October 13, 2017, DOER filed with the Clerk of the House of Representatives the amended draft with changes in response to public comments. It was referred to the Joint Committee on Telecommunications, Utilities, and Energy on October 16, 2017.
- After receiving no comments from the Joint Committee, DOER filed the final regulation with the Secretary of State's office on December 15, 2017
- Final regulation incorporating changes was promulgated and became effective on December 29, 2017

Summary of APS Eligible Fuel and Technology Types

- Combined heat and power (including natural gas)
- Flywheel energy storage
- Renewable thermal technologies:
  - Heat pumps (air source and ground source)
  - Solar thermal
  - Liquid biofuels
  - Biomass
  - Biogas
  - Compost heat exchange systems
- Non-renewable fuel cells (i.e. natural gas)
- Waste-to-energy thermal

Purpose of Today's Meeting

- M.G.L. c. 25A § 11F1/2 allows DOER to 1) add new technologies to the APS following an administrative proceeding conducted under chapter 30A (i.e. a rulemaking) and 2) establish the Minimum Standard with which retail electric suppliers must comply:

  (a) The department shall establish an alternative energy portfolio standard for all retail electricity suppliers selling electricity to end-use customers in the commonwealth. Every retail electric supplier…shall provide a minimum percentage of kilowatt-hour sales, as determined by the department, to end-use customers in the commonwealth from alternative energy generating sources and the department shall annually thereafter determine the minimum percentage of kilowatt-hour sales to end-use customers in the commonwealth which shall be derived from alternative energy generating sources. **For the purposes of this section, "alternative energy generating source" shall mean a source which generates energy using any of the following:** (i) combined heat and power; (ii) flywheel energy storage;…**or (vi) any other alternative energy technology approved by the department under an administrative proceeding conducted under chapter 30A.**

- Today DOER plans to begin the process of exploring how energy storage might be included in the APS or another portfolio standard, such as a separate Clean Peak Portfolio Standard. In particular:
  - What types of storage might be included?
  - What use cases should be included and how should they be valued?
  - What is the appropriate level of the incentive value?
  - How much additional demand is needed to support the storage being added?

Creating A Cleaner Energy Future For the Commonwealth

DOER
Massachusetts Department of Energy Resources

Panel 1: Storage Applications and Use Cases: Benefits, Reasoning, Considerations to support via Portfolio Standard

Energy Storage Public Stakeholder Forum

May 30, 2018

Boston, MA

Thermal Storage in Mass.

General Overview & Benefits to the Commonwealth

May 2018

Evan Berger
Director of Energy Solutions
Calmac – now part of the Trane Company
New York, NY
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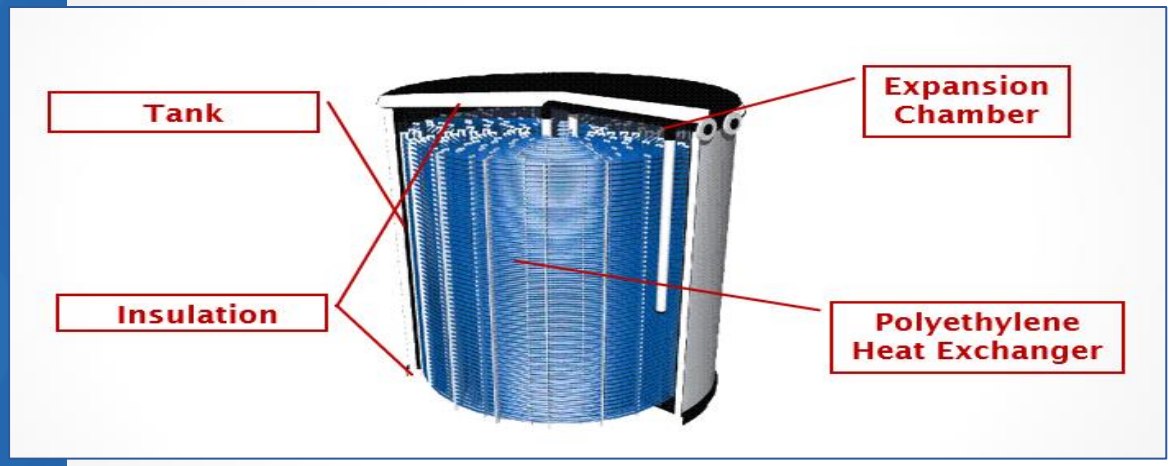
Thermal Batteries

The most efficient way to store cooling



- Tank is 10% polyethylene tubing, 80% tap water, and 10% expansion space
- Model 1190 (7.5’ in diameter, 8.5’ tall): 15-25kW load shift for 6 to 10 hours
- Design life is 40 years; no degradation of storage capacity

Public School, FL
100 kW / 600 kWh

University of Arizona
4 MW / 27 MWh

New York Class A Office
20 MW / 150 MWh of installations in NYC

Thermal Storage Reduces Peak Power

Partial Storage configuration

Partial storage keeps upfront cost to a minimum

- Cost of thermal storage tanks offset by reduction in chillers, cooling towers, pumps and other ancillary equipment
- A chiller/ice storage system on its own would cost $2,000/kW; as part of an integrated system, the cost per kW is significantly less
- A 300kW reduction saves Boston-area owners $80,000 per year; 6-8 year simple payback before incentives

Pros & Cons vs. Battery Storage

Pros:

- Water **less expensive** as a medium of storage than lithium or lead, particularly on a per-kWh basis
- **Long duration** – thermal storage is designed for an 8-10 hour load shift
- Part of the building's core operation; designed into a critical process that would already be there

Cons:

- Limited to cooling load – for many applications, solely deployed in the summer months
- Part of the building's core operation; difficult to finance and tied to building owner's capital cycle

Thermal Storage

Benefits to Massachusetts

The #1 societal benefit of all energy storage is to integrate intermittent renewable energy at grid scale.

Most thermal storage systems today are designed to store cooling at night, when wind power peaks but grid-wide load is at its trough.

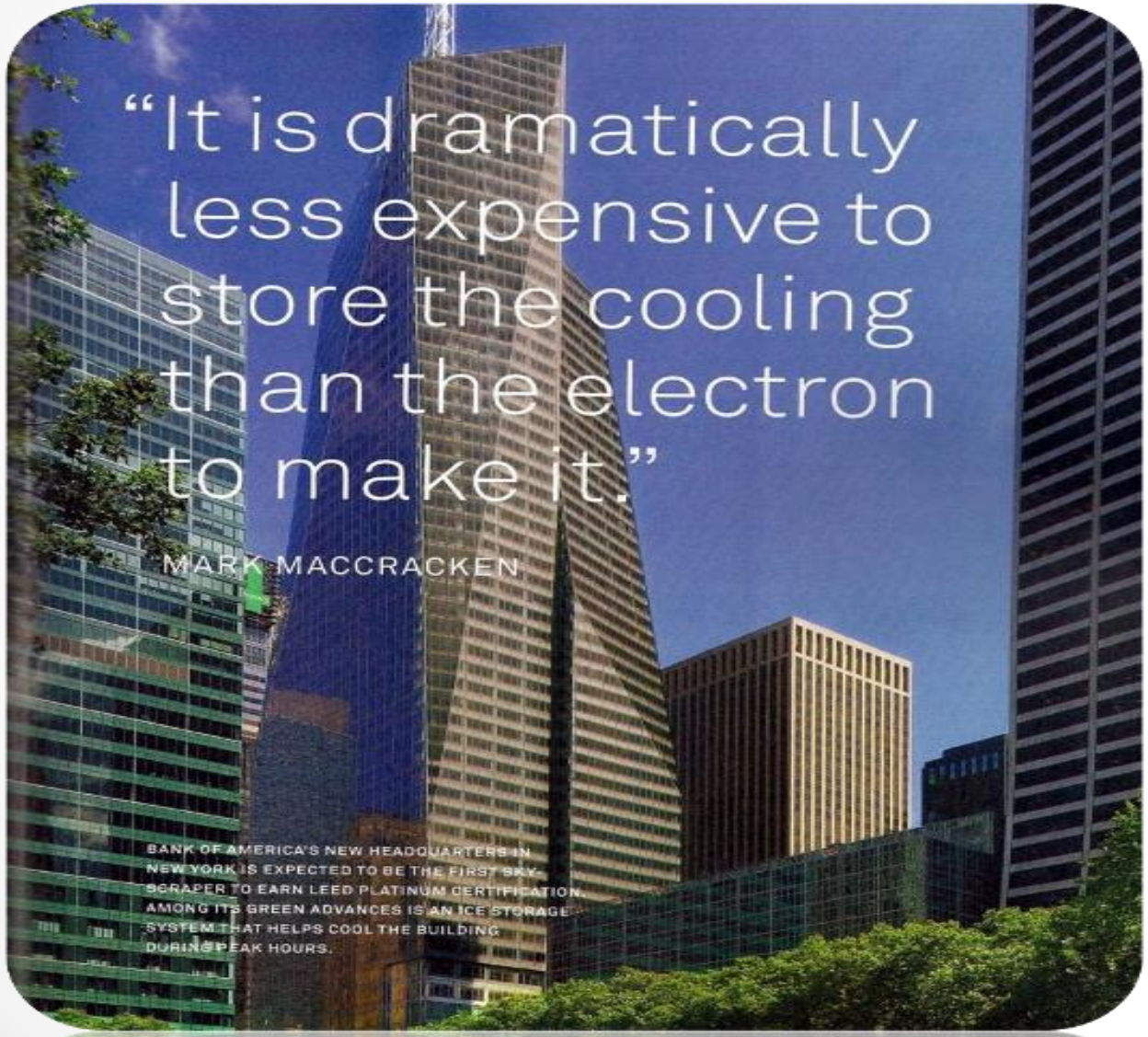
- Captures bulk amounts inexpensive nighttime wind and dispatches it during the day

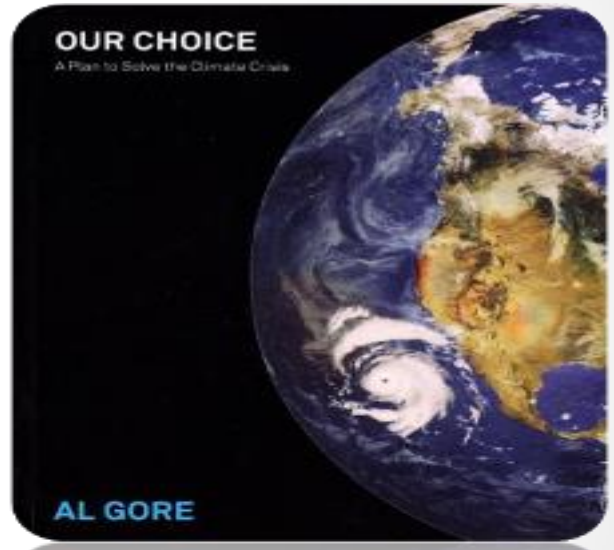
In last 3 years we have begun integrating thermal storage with solar:

- Caribbean hospital: oversizing solar field to run chiller and make ice for use at night, displacing diesel generation
- California: Half of new projects at sites with solar array, designed to charge at midday and discharge in late afternoon-evening. Alleviates duck curve and saves customers under the new rate design

Thermal Storage

Benefits to Massachusetts

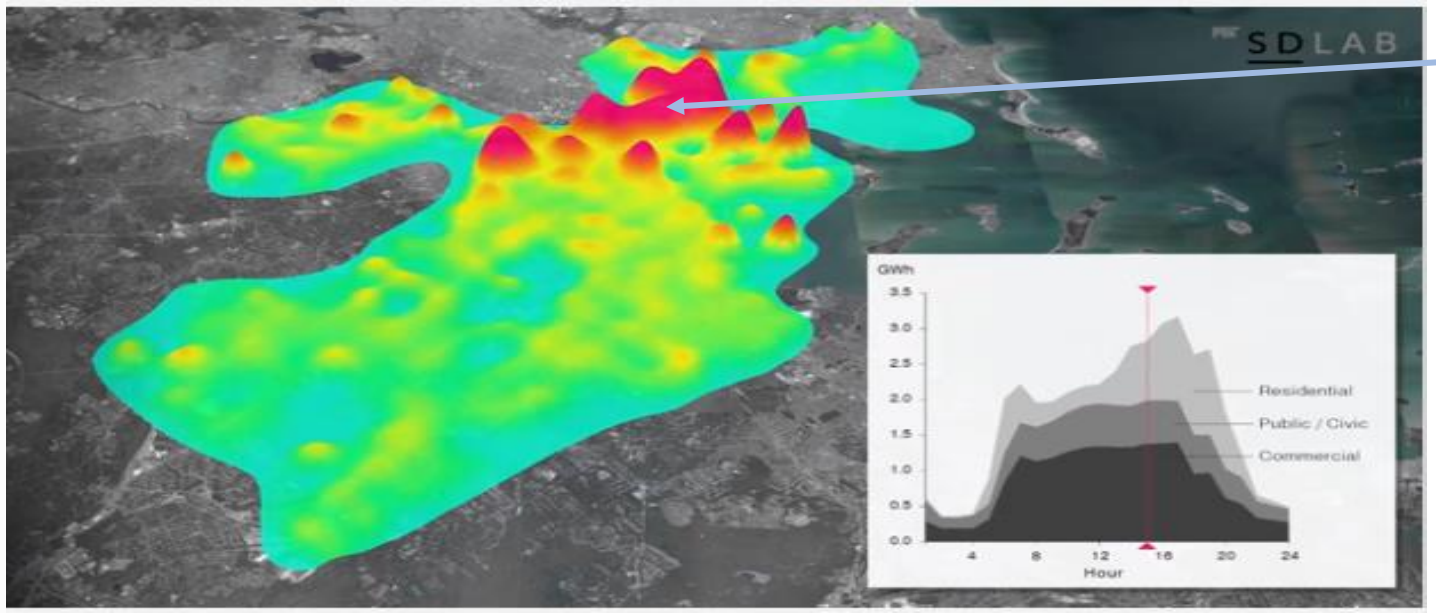




Thermal Storage

Benefits to Massachusetts

Reduces peak grid congestion, reduces GHG emissions



Moakley Courthouse

Source: MIT Sustainable Design Lab, Boston Community Energy Study

ISO-NE Hourly Marginal CO_2 Emissions, 2016:

- Charge: 62.7 lbs CO_2 per MWh (11pm-7am, weekdays from May-Oct)
- Discharge: 73.1 lbs per CO_2 MWh (10am-6pm, weekdays from May-Oct)

Greenhouse gas reduction of 17% per MWh

Round-trip efficiency equivalent of thermal storage – 92-100%

Incentivizing Thermal Storage

Best Practices

More than half of Calmac's sales are to schools and hospitals – a customer base that freely admits it is not energy-savvy.

Therefore, effective incentives need to be:

1) **Transparent to the customer** – customers need to be able to calculate how much they will be receiving
2) **Front-loaded** – received at commissioning or after one year's operation; otherwise they will be discounted or ignored
3) **Regularly available** – incentive must be available on an ongoing basis, or applications must be scheduled annually and publicized well in advance

Otherwise, "everyday" customers will not be in a position to access these incentives.

Incentivizing Thermal Storage

Best Practices

FPL's Thermal Storage Program

- Rebate of $600 per kW
- Available on a rolling basis – you can apply for it anytime
- Pays after you've run the plant successfully for one month

ConEd's Demand Management Program

- Rebates change annually – currently set at $1,700 per kW for thermal storage
- Auction dates and installation deadline posted well in advance
- Pays after one year's successful operation

- ***A key component to both plans: excellent customer service***

  If a utility does not want to comply with a state mandate, they are ***experts*** at dragging their feet or creating onerous M&V requirements.

Questions?

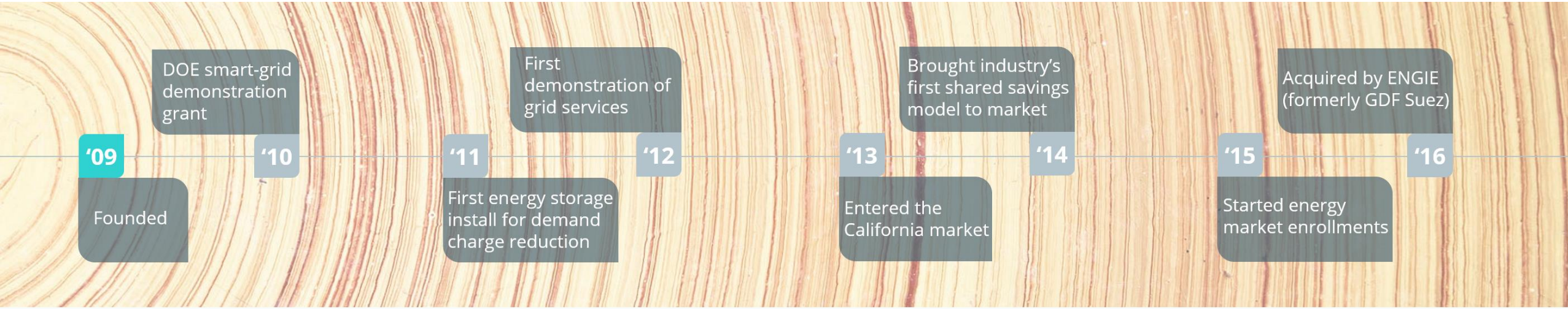
Evan Berger – eberger@calmac.com
CALMAC, now part of the Trane Company

ENGIE Storage

C&I Storage Applications & Use Cases

Juliana Mandell, Director of Market Development & Policy

- In Business over 150 years
- $150 billion in energy assets
- Largest independent power producer
- Largest provider of energy services
- Over 100 energy storage projects (60+ MWh)
- Extensive operating track record (6+ years)
- Industry's first shared saving model
- US Storage offices in Charlestown, Massachusetts and Santa Clara, California



Customers We Serve

We build energy storage solutions that serve customers on both sides of the meter.

Commercial, Industrial & Public Sector Customers

Utilities & Network Operators

Intelligent dispatch of flexible, fast ramping C&I energy storage creates value for customers and ratepayers.

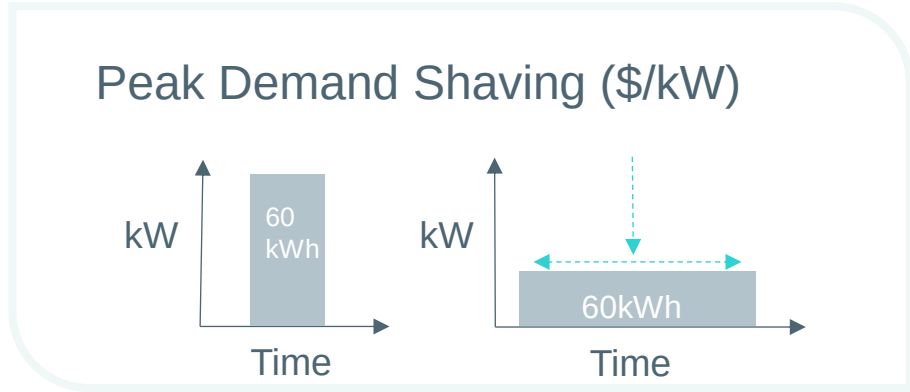
Existing Massachusetts C&I use cases:

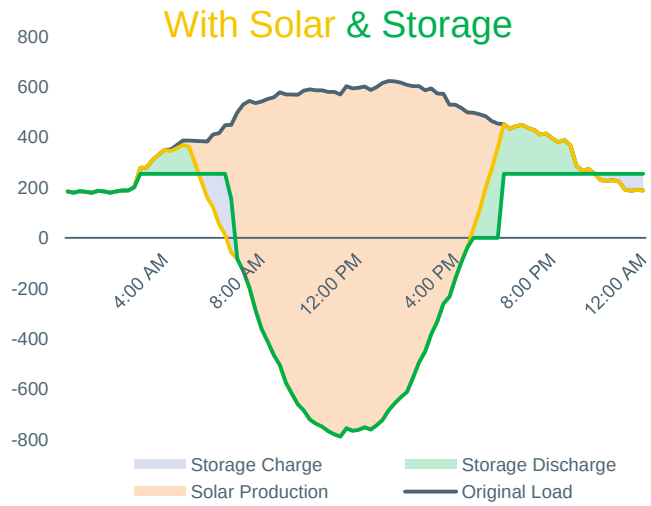
Customer Value:

- Peak shaving to reduce demand charges and capacity tag charges
- Firming and optimization of on-site solar
- DR and wholesale market participation revenue
- Energy arbitrage (limited price signal)

Grid Benefits:

- Smooth and flatten consumer demand to improve grid congestion, improve DER solar grid integration, and reduce peak demand
- Lower wholesale market prices across ISO-NE
- Reduce emissions

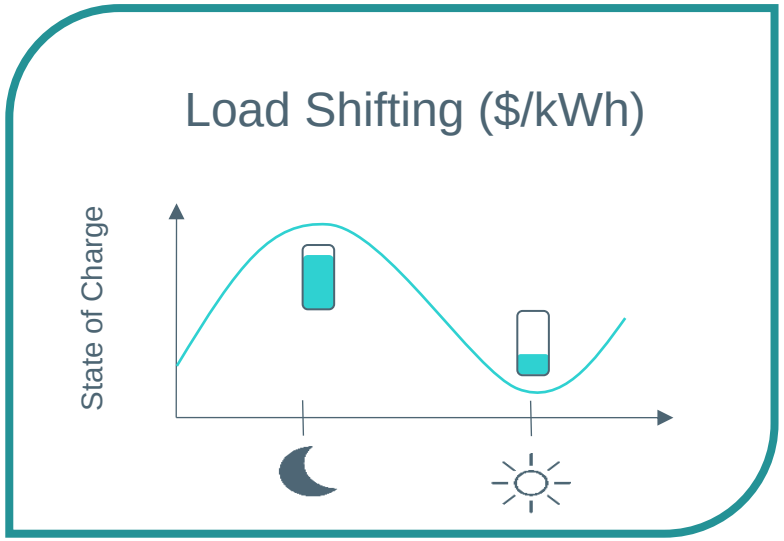


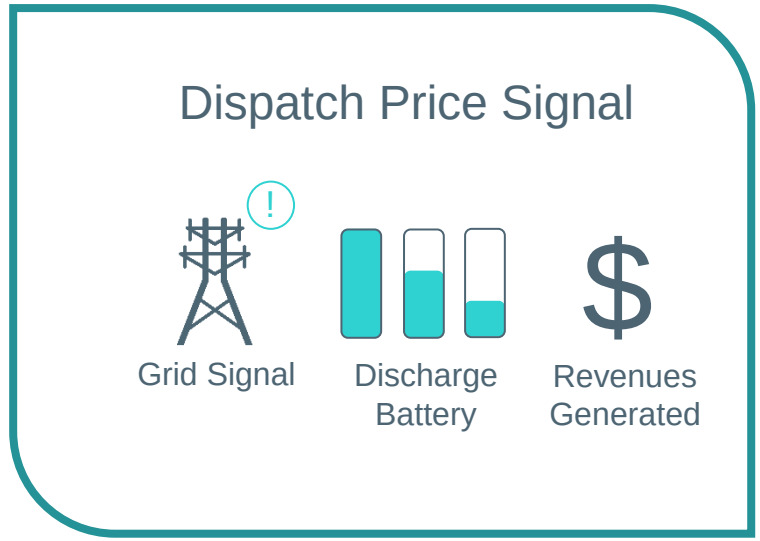


Inclusion of energy storage in a Portfolio Standard enables additional C&I energy storage use cases and market segments to generate value.

1. Additional market based incentives needed to reach standalone storage and solar retrofit market segments, which don't qualify for SMART Storage Adder.

2. Create price signals for non-monetizable grid benefits. ESS Portfolio Standard potential to generate stronger price signals for ESS to dispatch to meet grid needs.





Key considerations for incorporating energy storage into a Portfolio Standard:

Time Varying Performance Incentive

- Divergence from traditional Portfolio Standards primarily concerned with kwh output
- Instead, incentive value determined by discharge during peak hours or other high value grid time needs

Non-obligatory Dispatch

- Enable value stacking to create greater value for ratepayers and customers, intelligent software algorithm can optimize across value streams
- Incentive payment based on ESS dispatch
- Data reporting up to 15 min intervals, yearly true up

Forecasted and Bankable Signals

- ESS responds to pre-set operational window or day-ahead call signal, minimize forecast risk
- Bankable incentive revenue streams, instead of fluctuating market price
- Potential for declining block incentive to foster market development

Energy Storage as a T&D Resource

DOER Energy Storage in a Portfolio Stakeholder Forum

May 30th, 2018

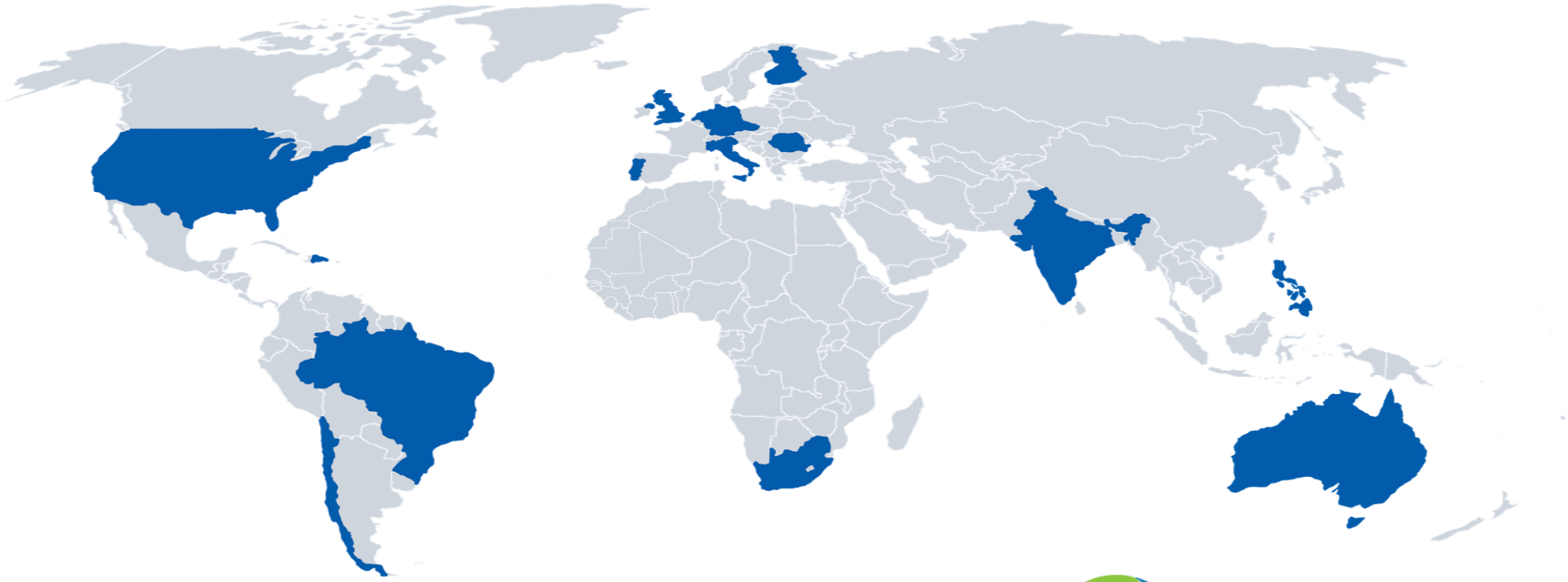
FLUENCE

A Siemens and AES Company

FLUENCE
A Siemens and AES Company

Fluence is the global leader in energy storage

- 10+ Years
- 16 Countries
- 60+ Projects
- 500+ MW



Created and backed by two industry powerhouses

SIEMENS
Ingenuity for life

+

AES
we are the energy

Using energy storage to defer traditional T&D upgrades

Front-of-the-Meter Use Case

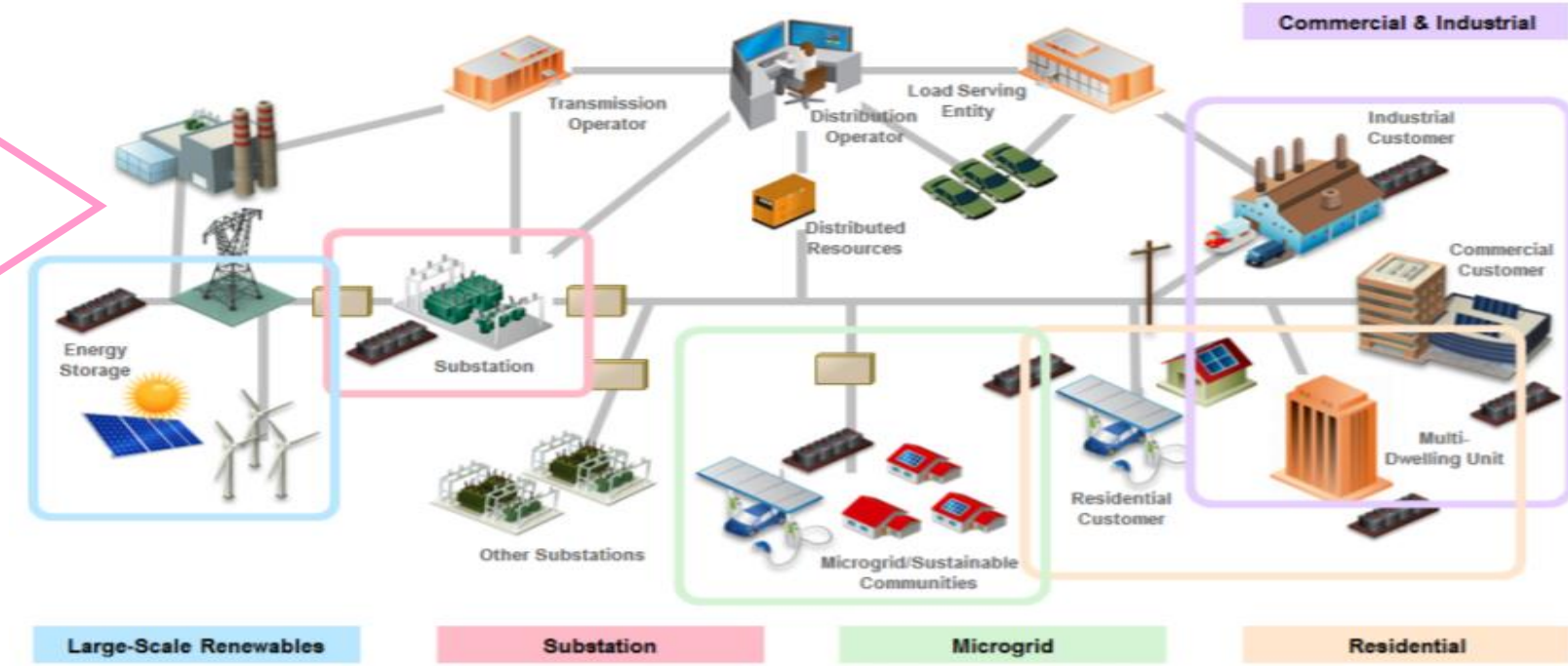
Substation

Use case

- Inject power downstream of thermal constraints during peak hours
- Avoid or defer new “poles & wires” infrastructure
- Improve power quality and voltage conservation

Value

- Reduced electricity price
- Reduced investment cost
- Reduced peak demand
- Increase flexibility and reliability
- Reduced GHG emissions



Source: “State of Charge,” Massachusetts Energy Storage Initiative Study

Transmission & Distribution Enhancement

Arizona Public Service (APS)

Punkin Center

Arizona, United States

2 MW / 8MWh

SERVICES

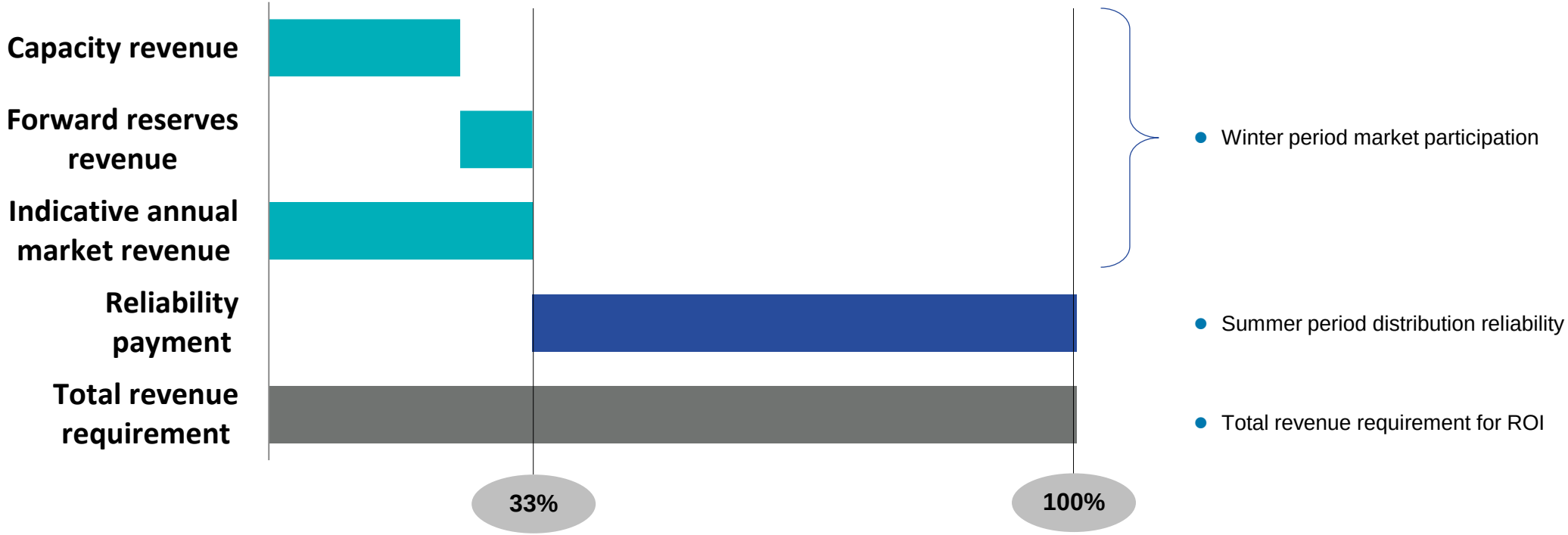
- Transmission upgrade deferral
- Peak management

IMPACT

- Power reliability at half the cost of a transmission

Effective compensation mechanisms for the system's reliability benefit are key to unlocking a large value pool

Indicative annual revenue stack for a hybrid BESS distribution asset in ISO-NE



Thank you

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Create a planet run by the sun.

MA DOER Presentation, May 30, 2018

Sunrun

The nation's largest residential solar, storage, and home energy management company

LYNN JURICH

CEO & Co-Founder

SUMMIT PARTNERS · STARTUP AMERICA PARTNERSHIP · SIERRA CLUB

EDWARD FENSTER

Executive Chairman & Co-Founder

Blackstone · asurion

Sunrun's Policy Leadership - Nationally Renowned

ANNE HOSKINS

Chief Policy Officer

MD PUC Commissioner & PSEG

ALEX McDONOUGH

VP, Policy, West & Fed

Office of Sen. Harry Reid

EVAN DUBE

Sr. Dir., Policy, East

Office of Gov. Deval Patrick

Sunrun's Brightbox solar+storage product serves a range of utility and customer needs

Sunrun is delivering solar+storage to thousands of residential customers with Brightbox. This turnkey solution, integrating hardware from global technology leaders, can be aggregated as a grid resource.

Back-Up Power
(Island during Outage)

Grid Services
(Capacity, Voltage
Active/Passive)

Bill Management
(TOU, CPP, Hourly)

Energy Self Supply

Brightbox solves for market and customer needs:

- HI: Backup Power and Solar Self Supply
- CA: Backup Power, TOU Bill Management, Grid Services
- AZ: Backup Power, TOU Bill Management
- NV: Backup Power, TOU Bill Management
- NY: Backup Power, Grid Services
- MA: Backup Power, Grid Services
- Puerto Rico: Donated systems on fire stations for 24/7 power, future rebuilding asset

Distributed Solar + Batteries Create a More Resilient, Reliable Energy System

Puerto Rico, October 12, 2017

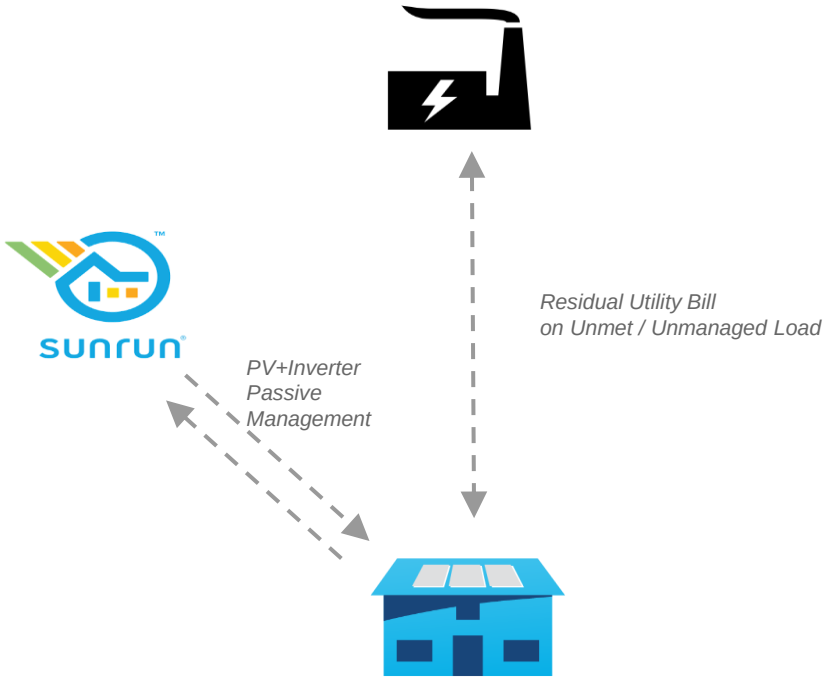
Sunrun continues to install donated solar + storage systems on Fire Stations, in partnership with Empowered by Light Foundation, and Aireko, a Puerto Rican energy and construction company. Powering critical equipment 24/7 through grid outages.

Brilliant Home Energy & Grid Services

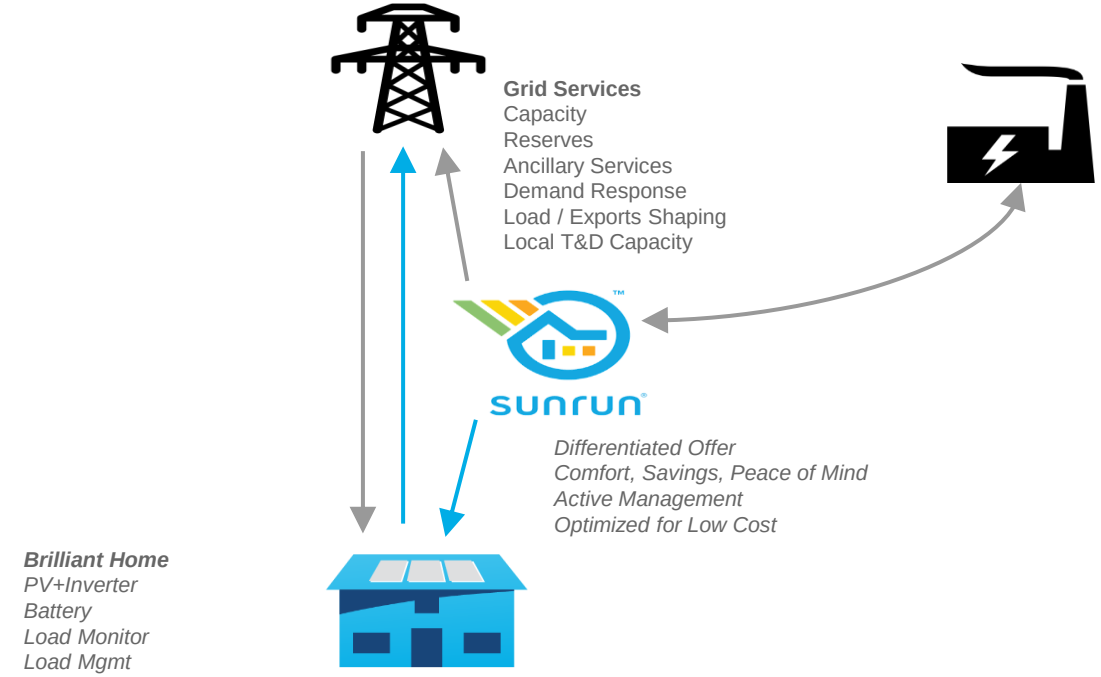
Unlocking additional value for consumers and the grid

- DERs are at the most valuable grid locations, where energy is consumed, helping address imbalances or congestion, challenges that can't be cost effectively solved with centralized resources or increased T&D investments.
- Yet, regulations and policy have not caught up with storage technology. This is the opposite of NEM/PURPA and PV - the market frameworks existed, in some cases, for decades before solar cost declined and market scaled.
- Regulators must work to unlock the value of DERs by enabling market access through mechanisms like "Bring Your Own Device" tariffs, Demand Response programs, and wholesale participation.

Home Solar



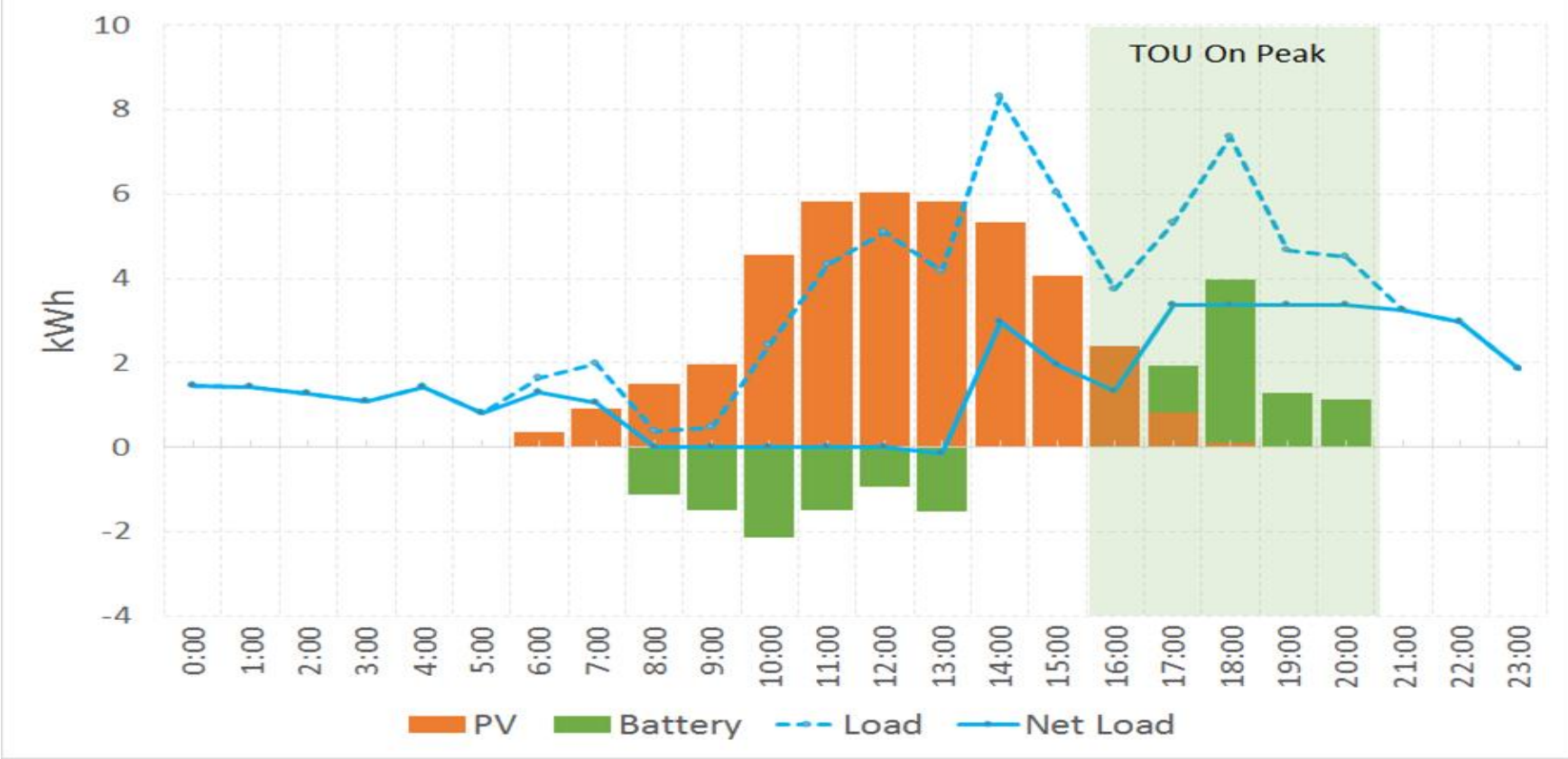
Brilliant Home + Grid Services



Brightbox is a flexible resource, managing energy costs for customers and delivering value to the grid

Illustrative Brightbox managing residential load shift in CA - managed for TOU, to minimize midday solar exports, and to flatten evening load - with flexibility for Demand Response or other targeted shift.

Illustrative Residential Solar+Storage and Load Curve



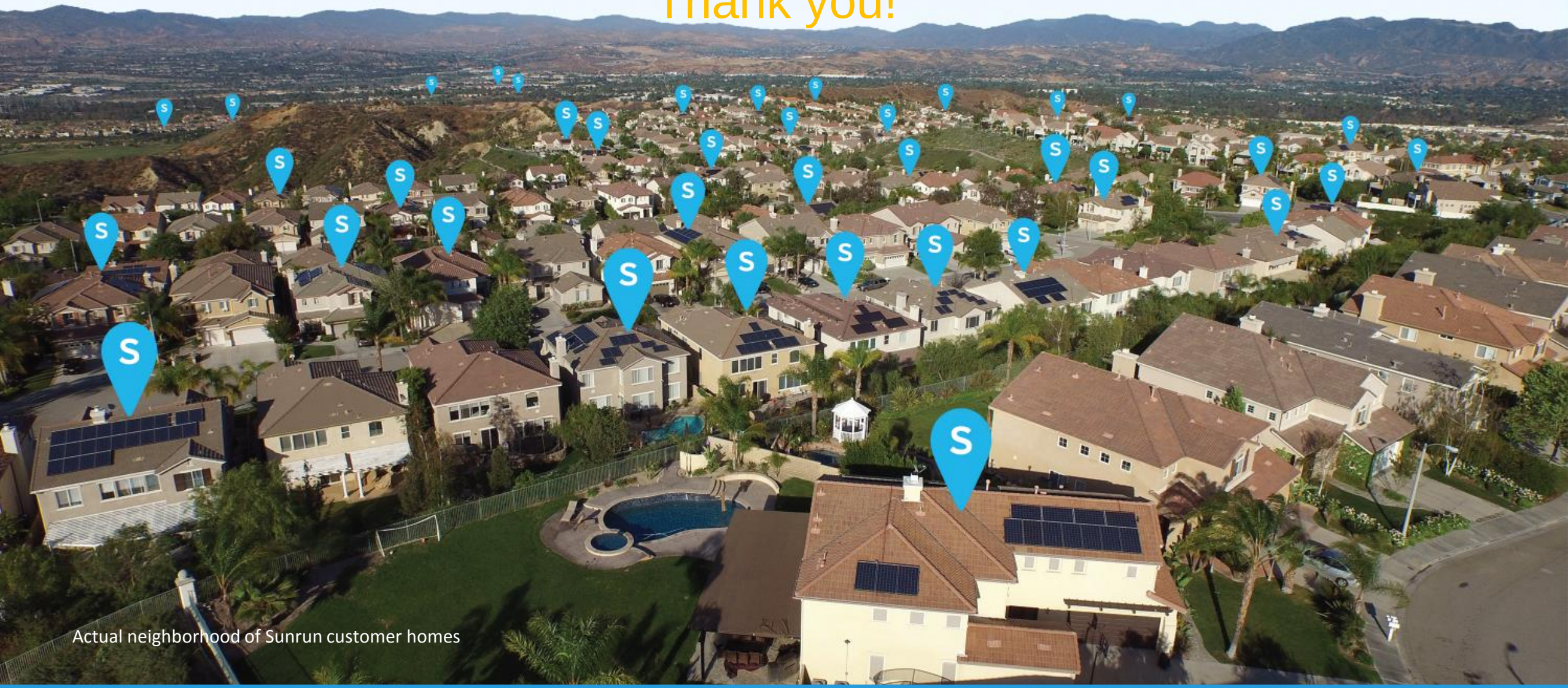
Unlocking Residential PV + Storage Value in MA

Incentivize deployment and create price signals

- Resi pv + storage inherently reduces emissions, increases renewables
- Resi has ultimate flexibility for load shift/clean peak & line loss avoidance
  - Target clean peak but also avoid T&D (day ahead peak/ICAP/Trans)
- Market intervention to jumpstart and scale deployment
  - Unlock retrofits
- Predictable, financeable pay-for-performance
  - Load shift such as DR or BYOB
- Nimble, iterative programs with data lookback
  - Non restrictive metering

Create a planet run by the sun

Thank you!



Actual neighborhood of Sunrun customer homes