

2018 Local Solutions: Eastern Climate Preparedness Conference

**Community Energy: Planning & Financing Resilient
Energy Systems**

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May 2, 2018**



Who We Are



The Economics of Battery Storage

At current costs... the capital cost to deploy 1,766 MW of storage could be in the range of \$968M - \$1,355M, and the total value of storage over 10 years could be around \$3.4 billion. --*State of Charge*

Storage offers two kinds of benefits: *monetizable* and *non-monetizable*

Example:

Monetizable

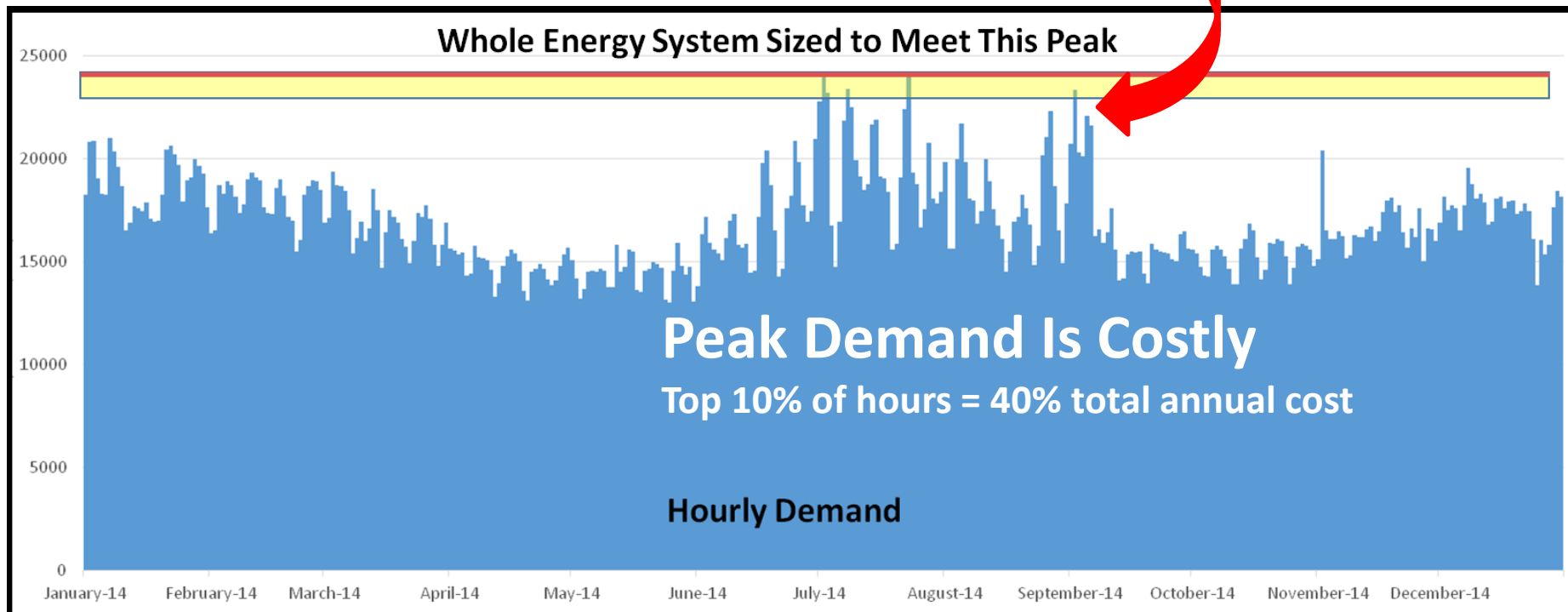
Demand Charge
Management

Non-Monetizable

Resiliency

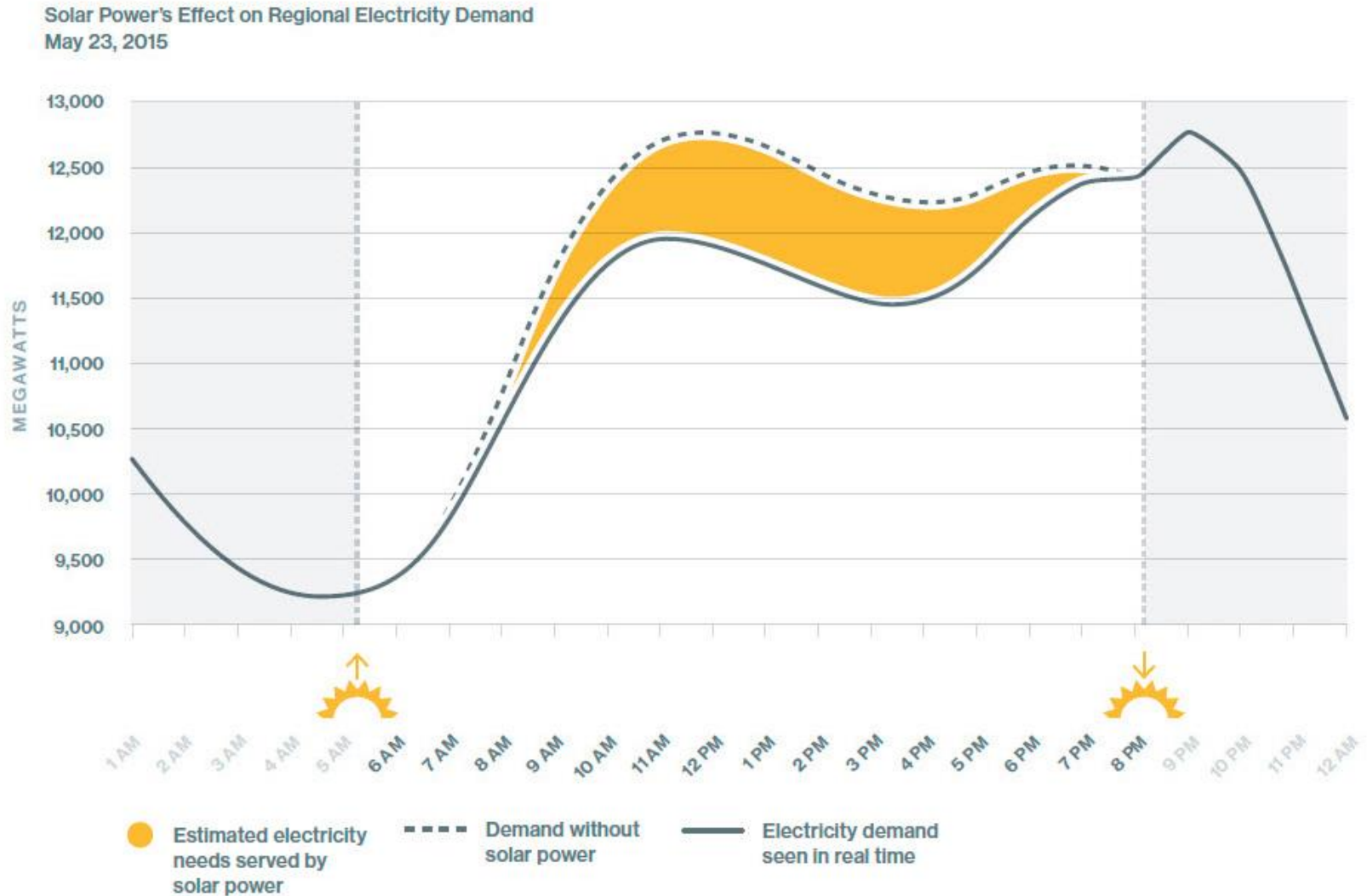
The monetizable value of storage is partly due to the high costs of our oversized grid

The highest value of storage is in providing *capacity* to meet demand peaks... *not* in providing bulk energy.

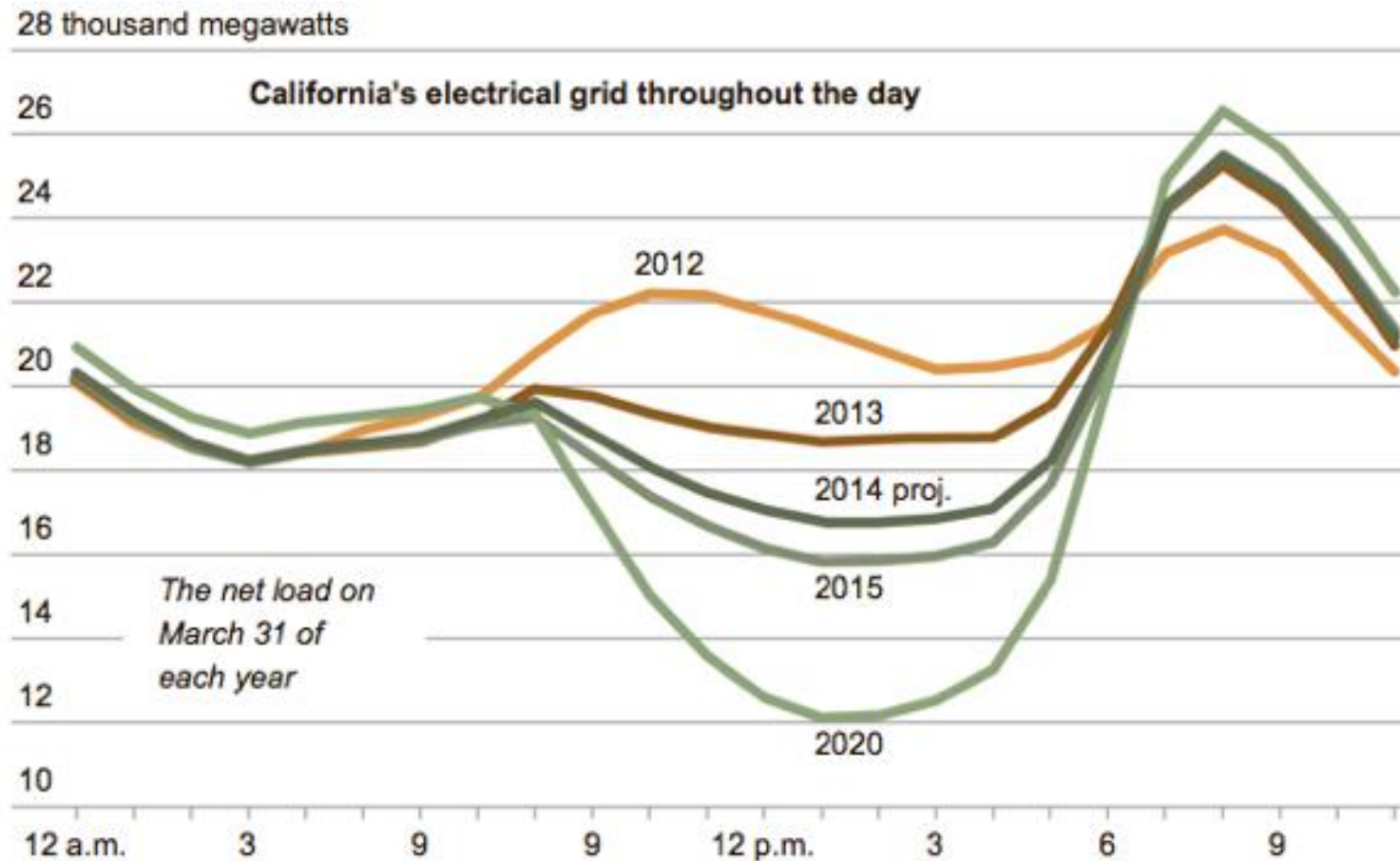


From Massachusetts *State of Charge* report

ISO-New England: Does this curve look familiar?



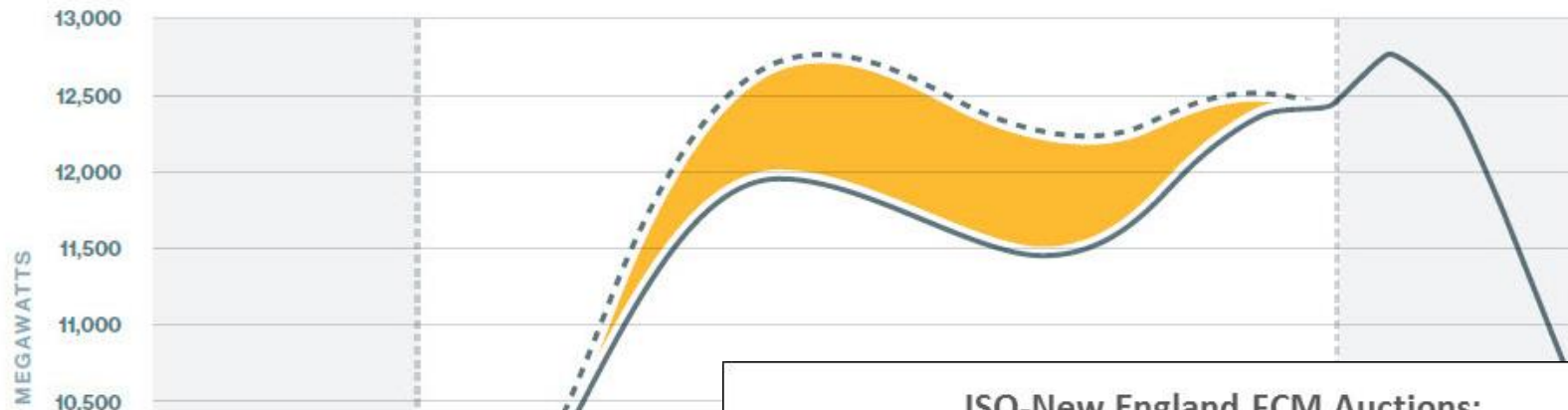
California “Duck” Curve



Source: CalISO

ISO-New England: Does this curve look familiar?

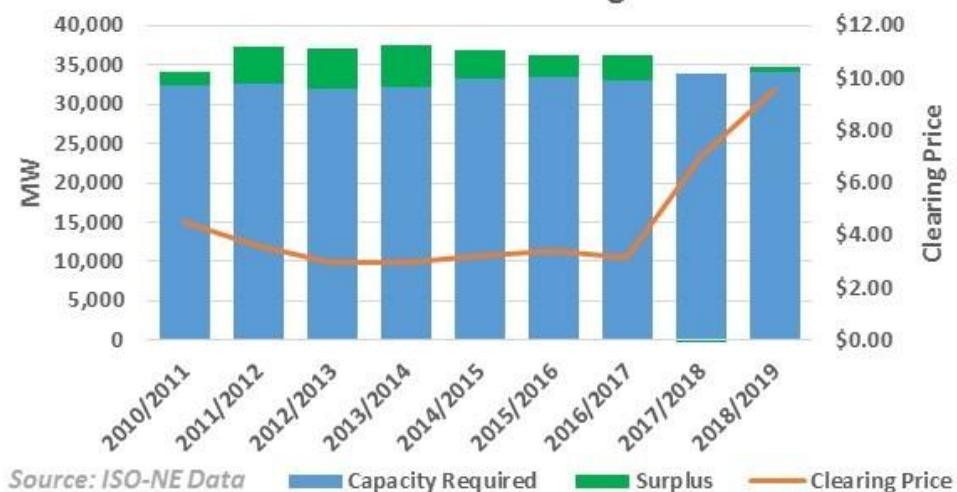
Solar Power's Effect on Regional Electricity Demand
May 23, 2015



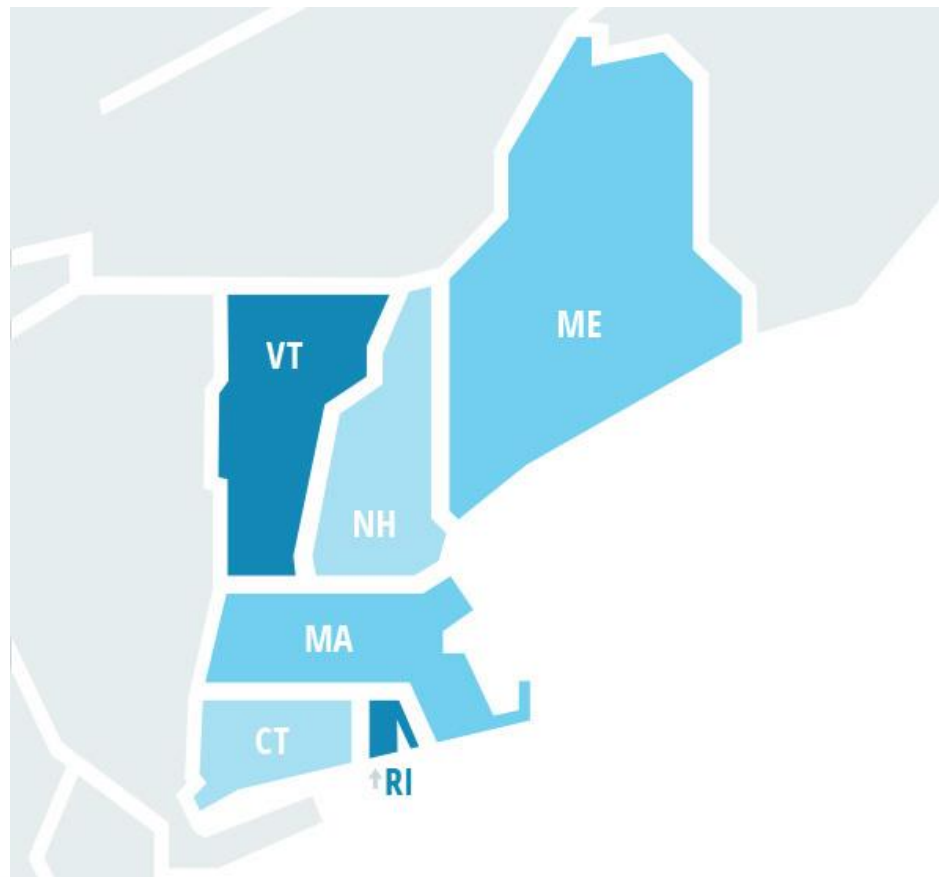
SMLD Capacity Clearing Price, ISO-NE.

Year	Price (\$/kW-Month)
2010-2011	\$4.254
2011-2012	\$3.119
2012-2013	\$2.535
2013-2014	\$2.516
2014-2015	\$2.855
2015-2016	\$3.129
2016-2017	\$3.150
2017-2018	\$7.025
2018-2019	\$9.551

ISO-New England FCM Auctions:
MW Procured & Clearing Prices



ISO New England storage markets: capacity and transmission cost reductions



Vermont: GMP Microgrid, Rutland (Stafford Hill)



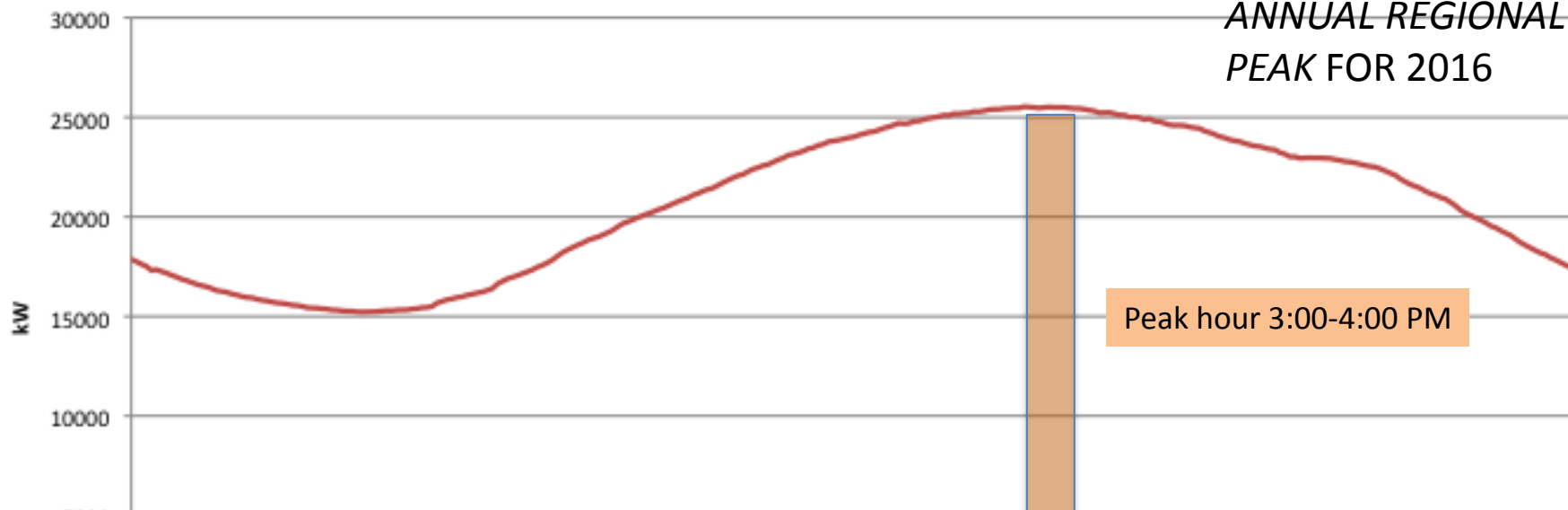
- 4 MW batteries (lithium ion and lead acid) + 2 MW PV microgrid
- Sited on closed landfill (brownfield redevelopment)
- Provides resilient power for school (public shelter)
- Project partners: Green Mountain Power, Dynapower, VT DPS, DOE, Sandia, CESA

- Grant funding: \$40K VT DPS, \$250K DOE-OE
- Total cost: \$12 M
- Payback < 7 years via utility capacity and transmission cost reductions
- Follow-on projects:
 - 14 LMI high-efficiency modular homes equipped with resilient power solar+storage (rural mobile home replacement project)
 - Burlington Electric Dept solar+storage microgrid at Burlington Airport

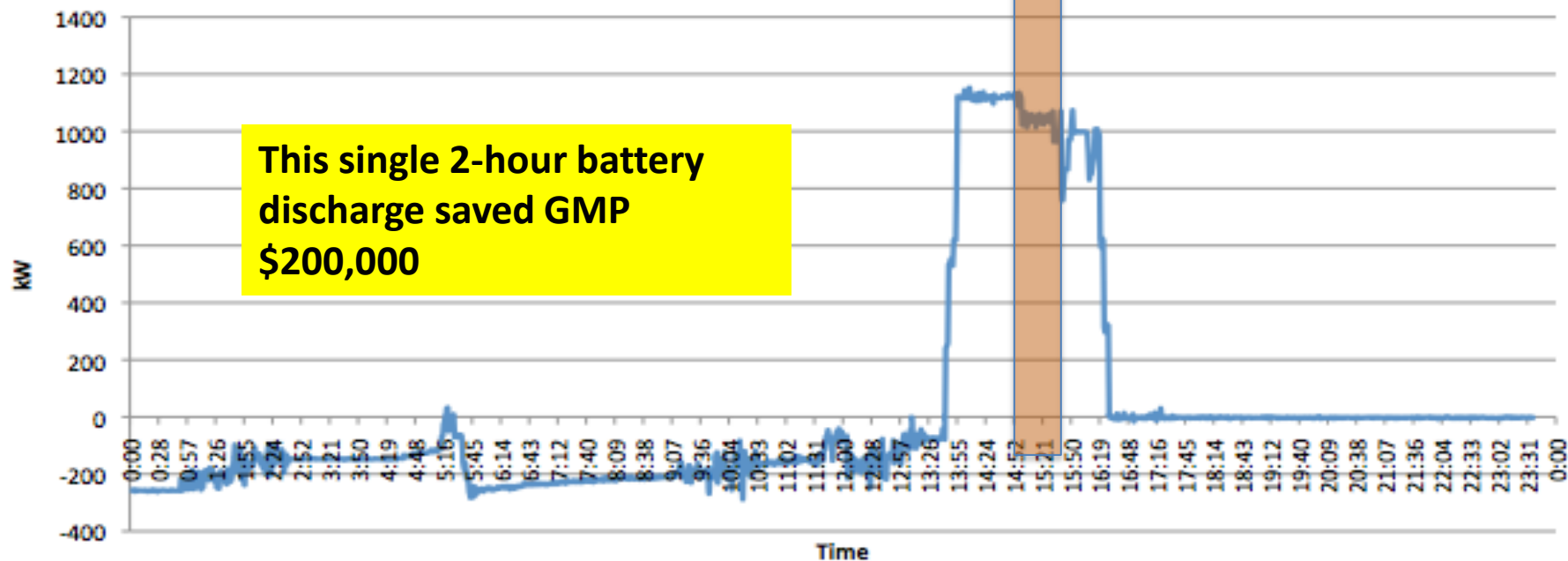


Actual Load, ISO-NE, August 12, 2016

This was the
*ANNUAL REGIONAL
PEAK* FOR 2016



Total Battery Output, kW - August 12, 2016



Sterling, MA 2MW/3MWh Solar+Storage Microgrid



Project partners: SMLD, DOER, DOE-OE, SNL, CESA

Project funding: State CCERI grant, US DOE grant

Project timeline: Groundbreaking in October 2016, commissioning by end of year

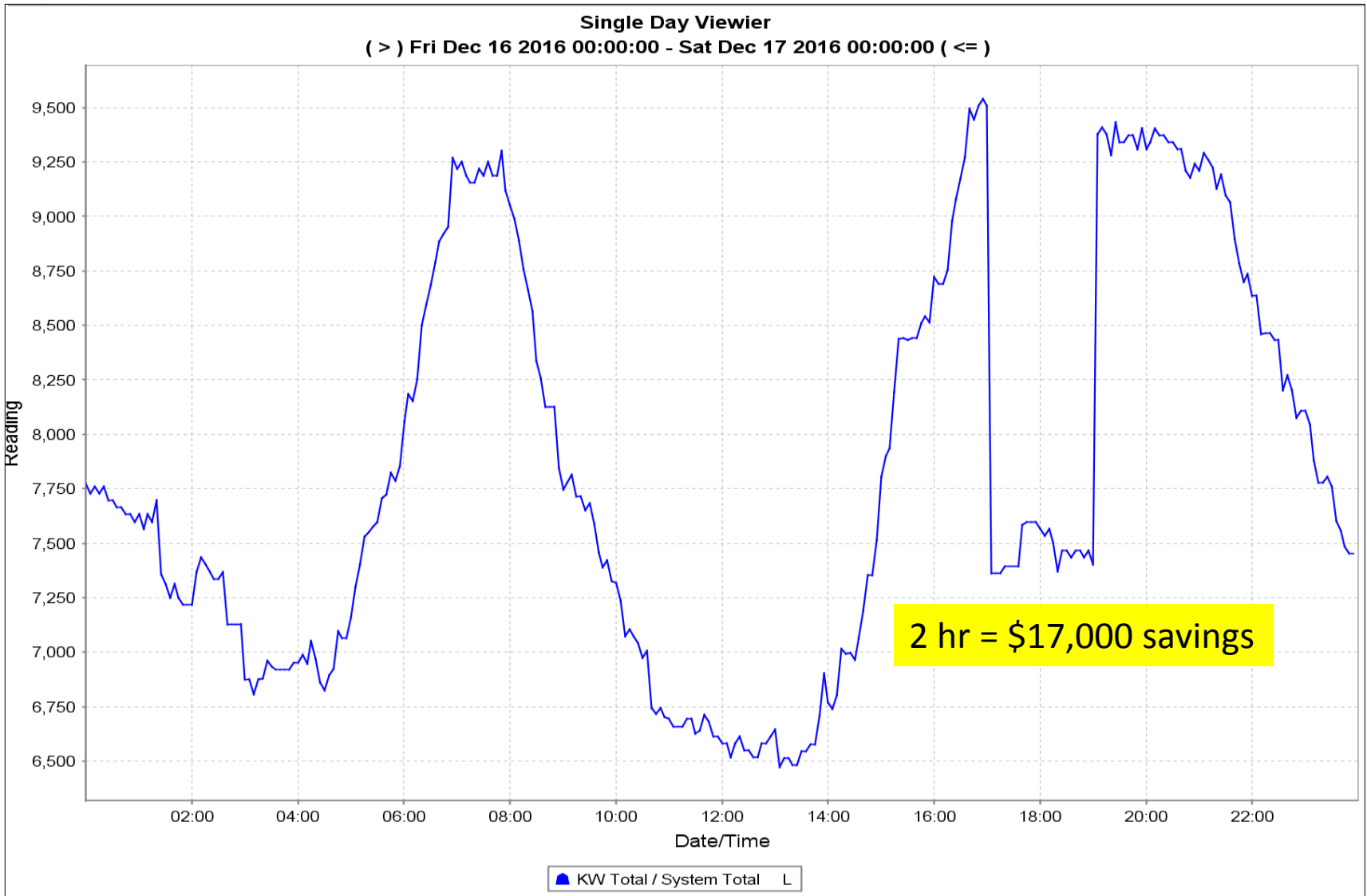
Project Summary: 2 MW / 3 mWh lithium ion battery project, connected with 3.4 MW solar PV at utility substation; islanding capability to support municipal emergency facility.

Project Benefits:

- Backup power to support town police station / dispatch center during grid outages;
- Cost savings through reduction of SMLD's capacity and transmission obligations to ISO-NE, plus arbitrage
- Integration of intermittent solar PV



Sterling, MA Monthly Peak Reduction



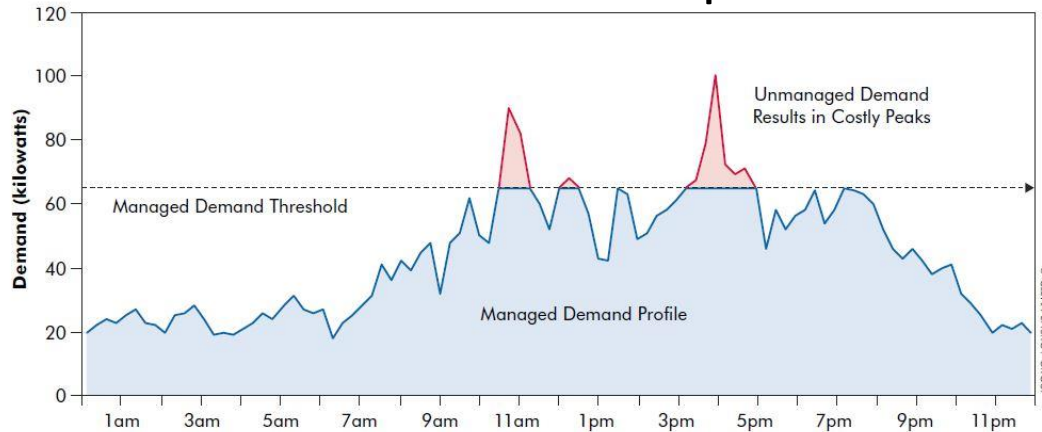
Sterling, MA Annual Peak Reduction

June 13, 2017 – ISO-NE Peak Day



Similar savings are available to C&I customers (behind the meter)

Behind the Meter Example



Peak reduced from 100
kW to 65kW = **35 kW**
reduction

Savings depend on **cost**
of demand

Demand charges @ \$10/kW = **\$4,200 annual savings**

Demand charges @ \$20/kW = **\$8,400 annual savings**

Generally, commercial customers paying **\$15/kW or more** in demand charges may be able to install batteries economically for demand charge management (without subsidies).

Three city analysis:

The economic impact of adding storage BTM

Chicago Project Summary

System Size	200-kW solar-only	200-kW solar + 100-kW/ 50-kWh lithium-ion battery	200-kW solar + 300-kW/ 150-kWh lithium-ion battery
Initial Cost*	\$493,000	\$606,000	\$832,000
Payback Period	20+ years	11.8 years	6.2 years

* Initial project costs refer to year zero net project expenses after federal tax credits and any additional tax credits have been applied.

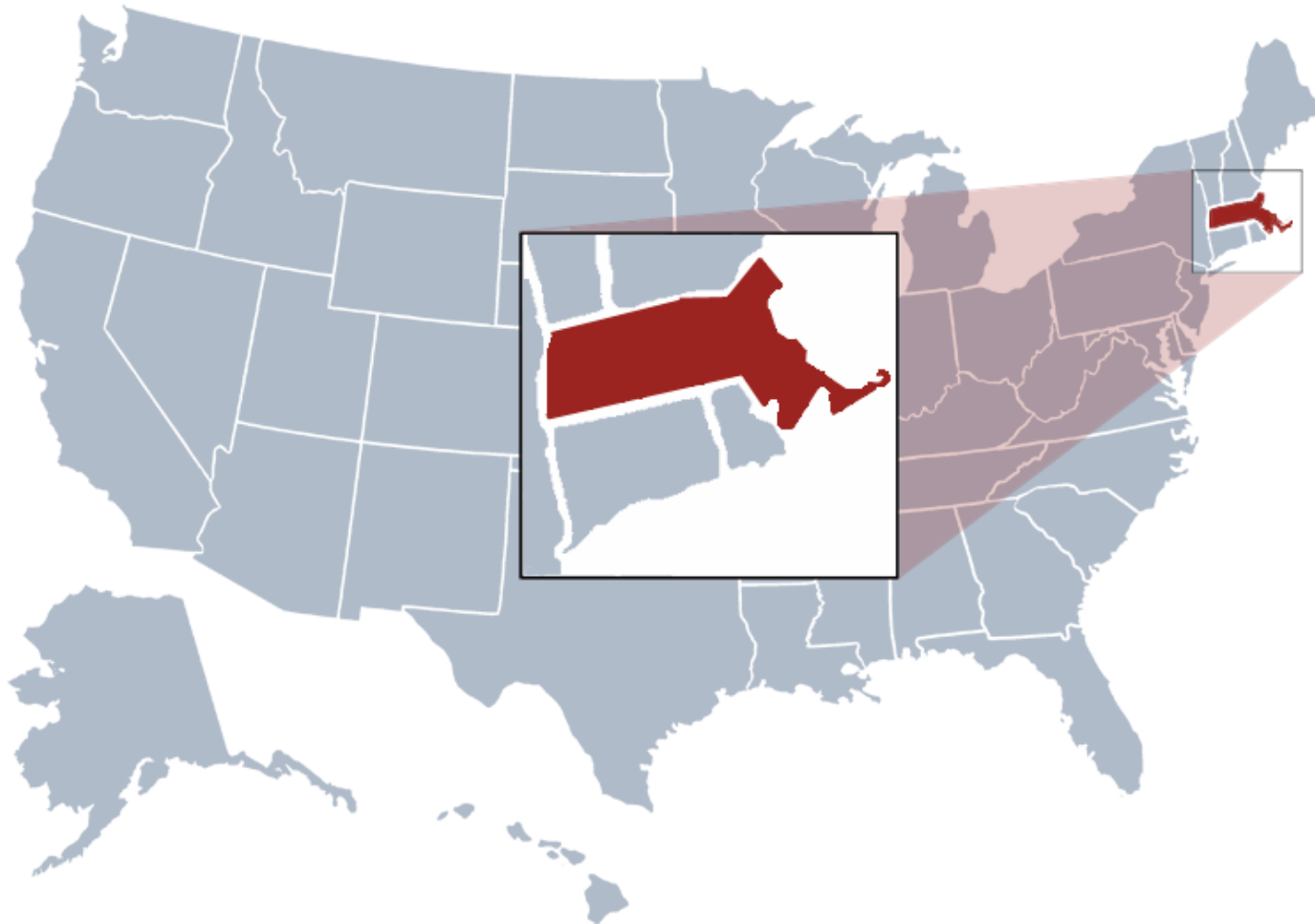
Washington, D.C. Project Summary

System Size	360-kW solar-only	360-kW solar + 100-kW/ 50-kWh lithium-ion battery
Initial Cost	\$788,000	\$901,000
Payback Period	3.5 years	3.5 years

New York City Project Summary

System Size	30-kW solar-only	30-kW solar + 30-kW/ 60-kWh lead-acid battery
Initial Cost	\$58,000	\$128,000
Payback Period	4.3 years	14.2 years

Energy Storage for Demand Charge Management (BTM) in Massachusetts

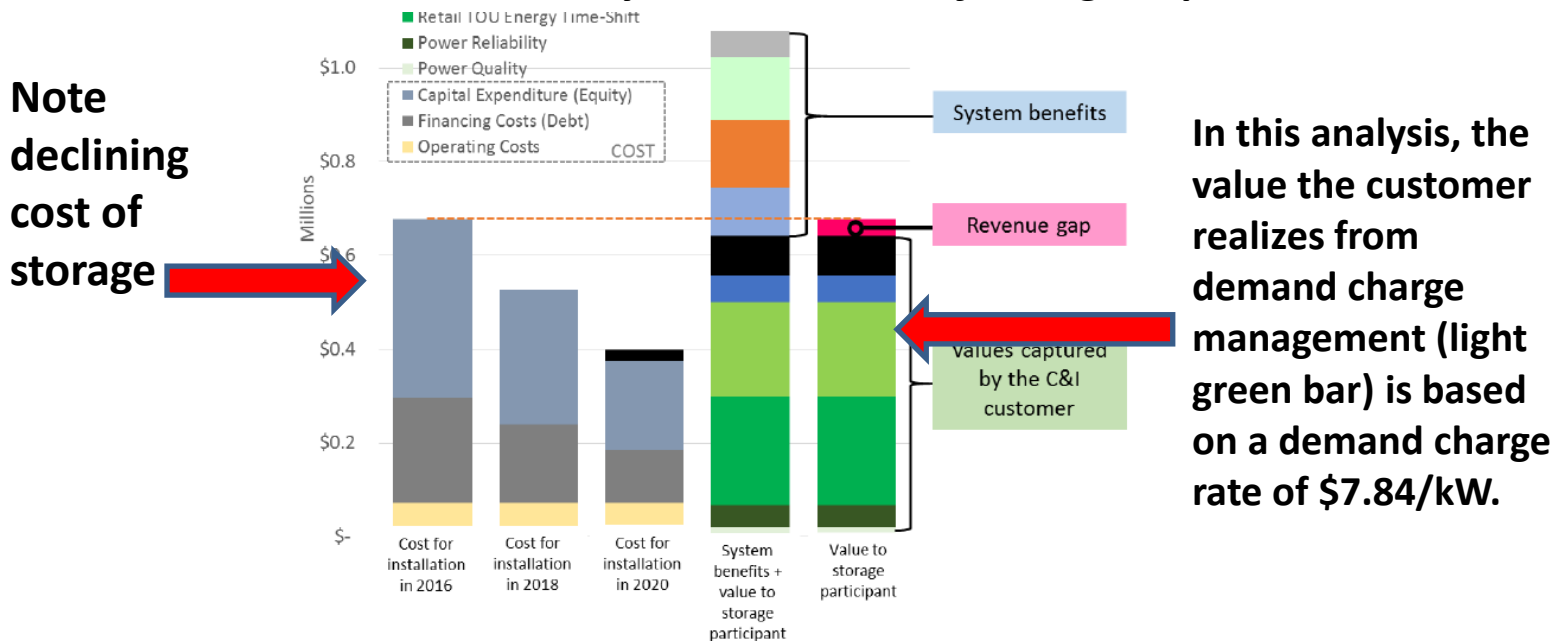


Demand charge rates in Massachusetts

MA demand charges as of July, 2016 (pre-Eversource rate case)

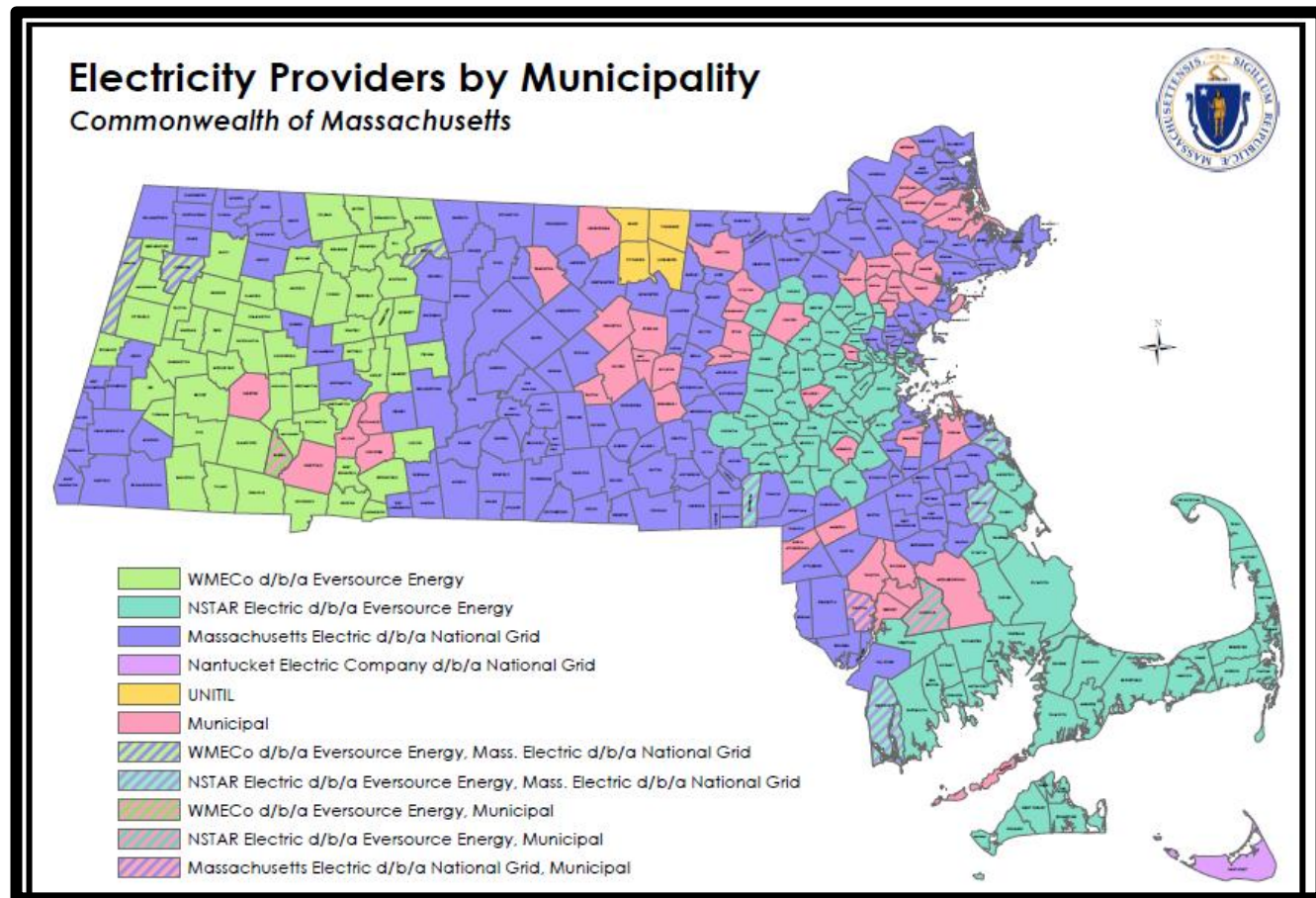
Utility / Demand \$/KW	Commercial (non-summer / summer)	Industrial (non-summer / summer)
National Grid	\$6.00	\$3.92
Eversource NStar	\$17.37 / \$41.25	\$19.15 / \$25.12
Eversource WMECO	\$13.36	\$10.74
Unitil	\$9.58	\$7.88

BTM economic analysis, from *State of Charge* report



Scale of opportunity in MA

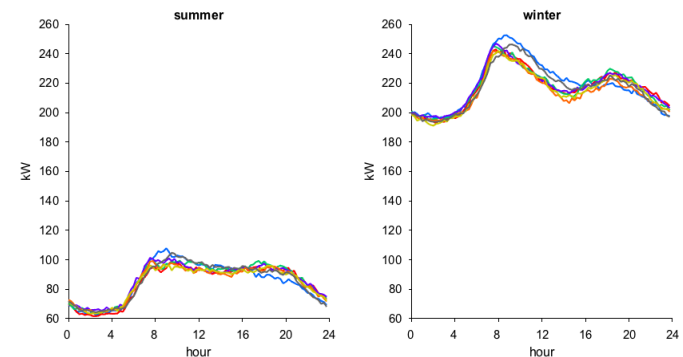
More than
70,000
commercial
customers in
Massachusetts
currently pay
demand charges
that would make
energy storage
economical
(>\$15/kW).



(Light blue areas are highest demand charges)

Edwards D. Hassan Apartments

- Boston Housing Authority affordable senior housing facility in Hyde Park, MA
- 100 apartments
- **Electric heating**
- Common areas include kitchen, four laundry facilities, common room, 2 elevators
- System modeled:
 - Solar: 150 kW DC (cost: \$375,000)
 - Storage: 30 kW/45 kWh Li-Ion battery (cost: \$88,604)
- Total capital cost: \$463,604



Seasonal load profile

Electric heat = high winter peak loads

Hassan Apartments Baseline Utility Bill

Analysis is on common loads only – not individual apartment loads

Baseline utility bill

ENERGY		baseline (T2)		
		Usage, kWh	Cost, \$/kWh	Total Cost, \$
Peak	Summer	72,196	\$0.0925	\$6,678
	Winter	489,413	\$0.0925	\$45,271
Part-peak	Summer	-	\$0.0000	\$0
	Winter	-	\$0.0000	\$0
Off-peak	Summer	176,967	\$0.0925	\$16,369
	Winter	773,548	\$0.0925	\$71,553
TOTAL, /yr		1,512,124		\$139,871



Energy

DEMAND				
		Avg Peak, kW	Cost, \$/kW	Total Cost, \$
Max	Summer	153	\$29.80	\$18,221
	Winter	352	\$21.35	\$60,096
Peak	Summer	0	\$0.00	\$0
	Winter	0	\$0.00	\$0
Part-Peak	Summer	0	\$0.00	\$0
	Winter	0	\$0.00	\$0
TOTAL, /yr				\$78,317
Meter Charge, \$/yr				\$2,000
TOTAL, \$/yr				\$220,188



Demand

Hassan Apartments payback comparison

	Size	Capital cost	Federal ITC	Depreciation	Net cost	Year 1 savings		Estimated payback
						Energy charge	Demand charge	
Solar system	150 kW PV	\$375,000	\$112,500	\$144,713	\$117,787	\$18,204	\$5,374	5.7 years
Energy Storage system	30 kW/45 kWh battery	\$88,604	\$26,581	\$34,192	\$27,831	\$0	\$7,645	4.4 years
Combined system	150 kW PV + 30 kW/45 kWh battery	\$463,604	\$139,081	\$178,905	\$145,618	\$18,204	\$13,019	5.3 years

Solar+Storage payback = 5.3 years

What the analysis includes:

- Federal ITC
- Federal accelerated depreciation

What it doesn't include:

- SMART solar incentives (with storage adder)
- Income from Alternative Energy Certificates
- Other market programs (demand response)

Jewish Community Housing for the Elderly

Coleman House:

146-unit affordable senior
housing facility
Newton, MA

System modeled:

116 kW solar
55 kW/226 kWh Li-Ion Battery

Demand charge:

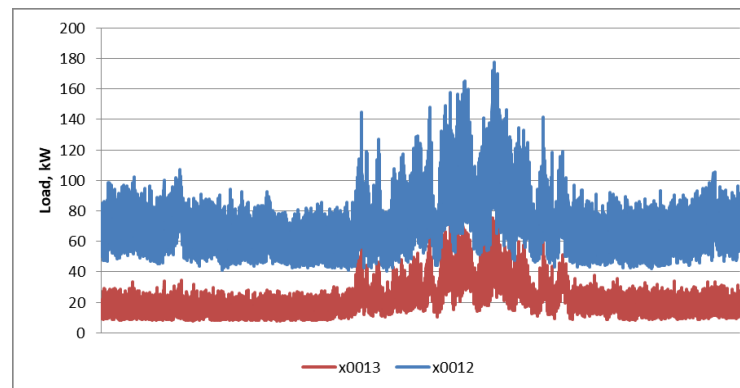
\$28.92 / kW June – September
\$20.47 / kW October – May

Modeling:

System modeled over 25 years,
with battery replacement at 10
years

IRR > 18%

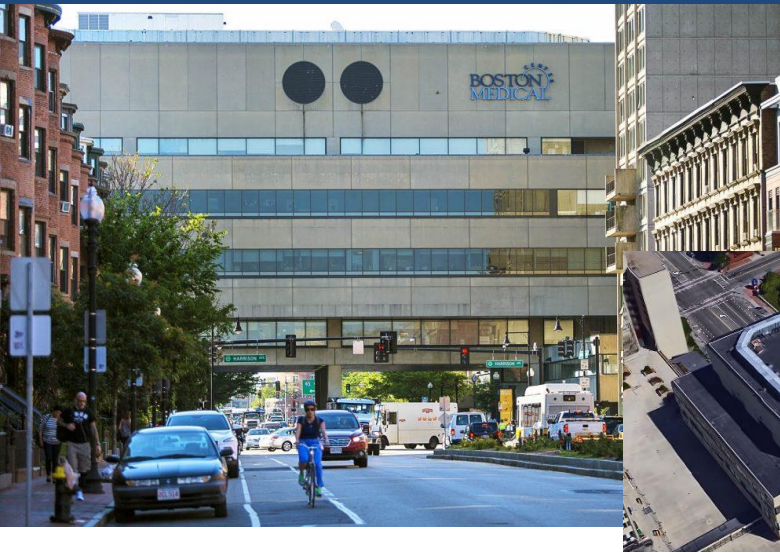
Assumes SMART incentive and ITC



Annual load
profile (two
meters)

Payback reached in year 5

Boston Medical Center



1,060 kW / 2,120 kWh battery to be located on the roof of the Yawkey Ambulatory Care Center, next to existing CHP

Project Installed Cost:
\$1,500,000

MassCEC Grant: \$402,500

Baseline Capacity Charges

Eversource T&D charge:

Summer = \$24.82/kW

Winter = \$18.86/kW

ISO-NE Capacity Cost (icap) charge:

\$9.96/kW-month

Result: Hospital is currently paying
annual demand costs of \$1,247,000

Project Economics:

Annual Savings: \$200,000

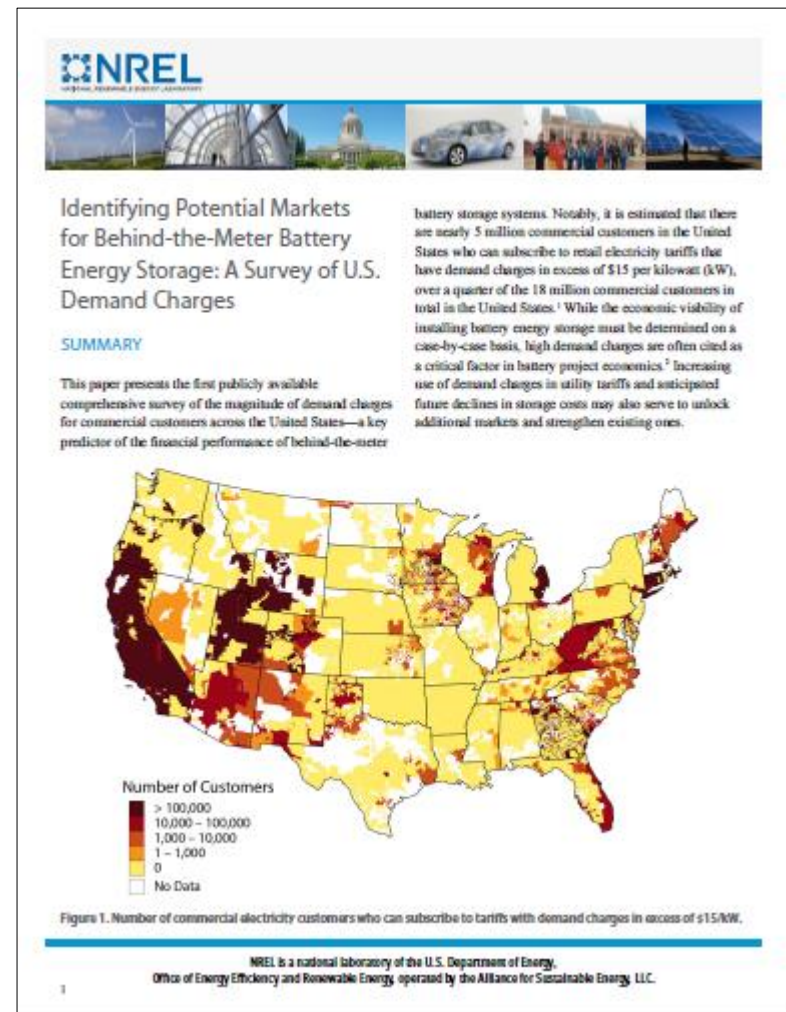
Simple Payback: 7.5 years (without grant)
5.5 years (with grant)*

Note: This installation is costly due to rooftop location, and high hospital load factor. Ground installation, or a lower load factor, would result in lower installed cost and lower simple payback.

First National Survey of Demand Charge Rates

Identifying Potential Markets for Behind-the-Meter Battery Energy Storage: A Survey of U.S. Demand Charges

- Based on a survey of more than 10,000 utility tariffs
- Applies to approximately 70% of commercial buildings in the United States
- **Result: Nearly 5 million commercial customers may be paying more than**



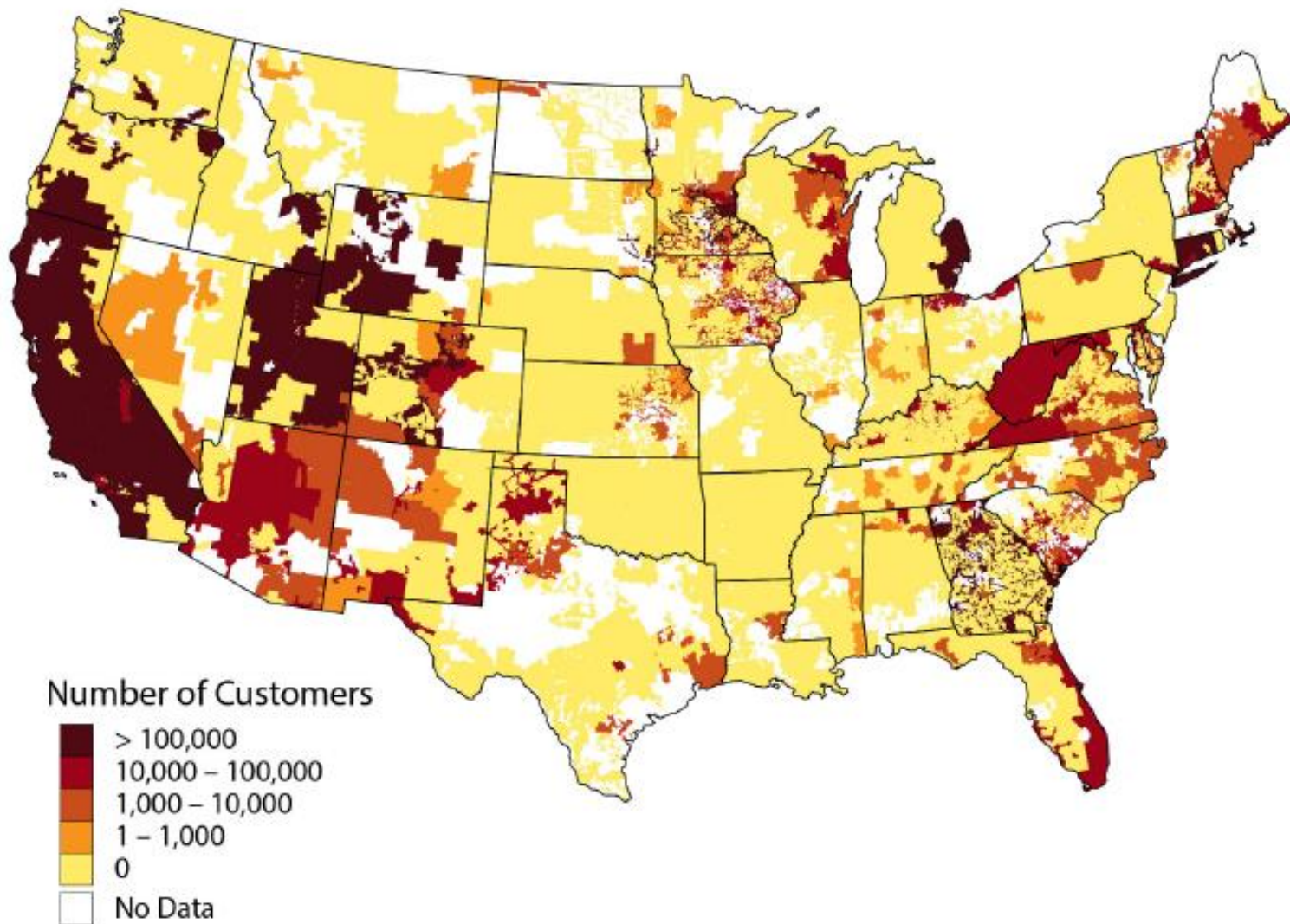


Figure 1. Number of commercial electricity customers who can subscribe to tariffs with demand charges in excess of \$15/kW.

Darker areas on map = more customers paying high demand charges

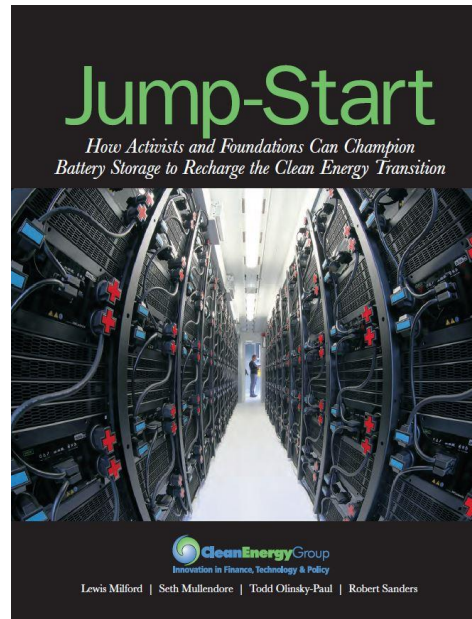
New England Demand Charge Rates

- Connecticut (Eversource)
 - Small General Electric Service = \$20.82/kW
 - Intermediate General Electric Service = \$17.34/kW
 - Large Church and School = \$18.17/kW
- New Hampshire (Eversource)
 - Small Commercial = \$15.25/kW
 - Medium Commercial = \$14.10/kW
- Maine (Central Maine Power)
 - Small General Service = \$12.18-\$13.57/kW
 - Intermediate General Service = \$13.95/kW
 - Large General Service = \$15.38-\$15.71/kW
- Vermont (Green Mountain Power)
 - Small General Service = \$14.30
 - Large General Service = \$14.67
- Rhode Island (National Grid)
 - Small Commercial = \$9.17/kW
 - Medium Commercial = \$8.41/kW
 - Large Commercial = \$7.03/kW



Generally, energy storage for demand charge management is economical (without subsidies) if the customer is paying at least \$15/kW for demand charges.

Thank You



Please check out our new report –*Jump-Start: How Activists and Foundations Can Champion Battery Storage to Recharge the Clean Energy Transition*

bit.ly/CEG-JumpStart

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