NESEA PRESENTATION
MASSACHUSETTS ENERGY STORAGE
ACCOMPLISHMENTS & NEXT STEPS

MARCH 15, 2019

AMY McGUIRE
INTRODUCTION

• Amy McGuire
  – MA DOER. Emerging Technology Division – Energy Storage and Resiliency Program Coordinator
  – Focused on:
    • Advancing Commonwealth Energy Storage (ACES)
    • Clean Peak Standard (CPS)
    • Community Clean Energy Resiliency Initiative (CCERI)
    • Various ongoing initiatives
Since launching our Energy Storage Initiative in 2015, Massachusetts has become a national leader for policies and programs for storage deployment.

2015

3 PROJECTS
1.4 MW / 0.45 MWh

January 2019

232 PROJECTS
190 MW / 470 MWh
(operating & in development)

National Ranking: #23

National Ranking*: #2

BENEFITS OF STORAGE

Recent advances in new storage technologies have made wide-scale storage of electricity possible

Historically the inability to store electricity (other than pumped hydro storage), required the power grid to be sized for the highest annual peak demand resulting in inefficiencies, underutilization of assets, and high cost.

Storage is “Game Changer”:

- Allows use of energy generated during low cost periods to serve load during expensive peak
- Defers investment in transmission and distribution “wires”, reduces need for “peaker” plants
- Enables wind and solar energy to be used when the sun isn’t shining and the wind isn’t blowing
- Provide resiliency during severe weather
- Benefits increase as we electrify transportation and thermal sectors

In 2015:
- The top 1% of Hours accounted for 8% of MA Spend on Electricity
- Top 10% of Hours accounted for 40% of Electricity Spend
Storage is a solution for interconnecting solar

Storage can assist with the PV “Duck Curve” load profile

Storage can assist with PV reverse power flows and substation overloading

- After SMART is completed, over 4,000 MW of solar in MA
- MA has peak load of approximately 12,000 MW and minimum daytime load of approximately 6,000 MW
  - By 2022/2023, solar may meet 1/3 of peak load and 2/3 of min daytime load

Storage is a flexible resource that can assist with interconnection of DERs
KEY POLICY ACTIONS AND MILESTONES TO PROMOTE STORAGE DEPLOYMENT

2016

• DOER and MassCEC published the “State of Charge” Energy Storage Study
• Storage included in Comprehensive Energy Legislation
  • Defined storage, clarified utilities may own storage, authorized DOER to set target

2016/2017

• Funded Grant and Demonstration opportunities
  • $20 million Advancing the Commonwealth Energy Storage (ACES) Program funded 26 storage projects to demonstrate multiple applications and use cases
  • $40 million Community Clean Energy Resiliency Initiative, includes storage
  • $4.6 million Peak Demand Reduction grants, includes storage
  • Utility demonstrations of storage in Energy Efficiency programs
  • Made eligible for Green Communities technical assistance grants

Sterling 2 MW / 3.9MWh ESS Community Resilience Grant
Holyoke 3 MW / 6 MWh ESS Peak Demand Grant
Braintree MLP 2 MW / 4.2 MWh ESS ESI-ACES Grant
DOER set 200 MWh Target for Storage in MA by Jan 1, 2020
  • 3rd state in nation to set a target for storage deployment
• DPU approved electric distribution companies proposals for utility storage
  • National Grid Owned Solar approved to pair with storage
  • Eversource rate case approved $45 million for storage on Cape Cod & Martha’s Vineyard
  • National Grid announces “non wires” solution to peak demand on Nantucket

DOER launched SMART solar incentive program with 1st in nation incentive “adder” for storage paired with solar
  • 135 projects with 70 MW/150 MWh of storage have submitted applications to date
• Legislation increased Storage Target to 1,000 MWh by 2025
• 1st in nation Clean Peak Standard announced
• Storage included in Next Three Year Statewide Energy Efficiency Plan 2019 – 2021, including specific goals for Active Demand reduction in Summer and Winter
• Eight standalone storage projects totaling 956MW submitted applications in the ISO-NE interconnection queue
### MA Storage Economic Development Landscape

#### Large corporations basing storage business in MA
- **Enel Green Power**  
  € 3B Revenue  
  North American HQ  
  *Andover*
- **Lockheed Martin**  
  $51B Revenue  
  Energy Storage Division  
  *Cambridge*
- **NEC**  
  $24B Revenue  
  Energy Solutions HQ  
  *Westborough*
- **Schneider Electric**  
  € 25B Revenue  
  North American HQ  
  *Andover*

#### Project Developers and Installers
- BlueWave
- Borrego
- Lodestar
- Nexamp
- NextEra
- Solect
- SunBug
- Sunrun
- Syncarpha
- Tesla

#### MA-based Storage Start-ups
- 24M Technologies
- Acumentrics
- Ambri
- Beacon Power
- Boston Power
- Exponent
- FastCap Systems
- General Compression
- IHI Energy
- Kinetic Battery
- Levisys
- Lithio Storage
- Mosaic Power
- Pellion
- Protonex
- SiEnergy Systems
- SparkCharge
- Sparkplug Power
- SolidEnergy Systems
- Solvus Global
- Vionx
- Titan Advanced Energy
- Xilectric
- WattJoule

#### Universities with Storage Research
- BC
- BU
- Harvard
- MIT
- NEU
- Tufts
- Umass
- WPI
PRIORITIES & NEXT STEPS

- **DOER/MassCEC Storage Stakeholder discussion series**
  - Focus on project development issues: Interconnection, metering/telemetry, permitting and inspections, financing

- **Potential working group (DOER/EEA/DPU/EDCs) to standardize distribution interconnection process**

- **Continue to promote the pairing of Renewables with Storage**
  - Implement Clean Peak Standard
  - Evaluate incentives for adding storage to pre-SMART solar projects
  - Evaluate stronger requirements for pairing Solar and Storage in future SMART program
  - Analyze ways to encourage storage + Off-shore Wind in DOER’s OSW study

- **Review results of ISO-NE Capacity Auction**
PRIORITIES & NEXT STEPS

- Work with ISO-NE on rules for storage paired with renewables in the wholesale market
  - Define process for adding storage to existing renewable generation
  - Interconnection study methodology for storage paired with renewables

- Continue to promote use of storage in Distribution System Planning as “non-wires” alternative
  - Participate in National Grid’s Rate Case

- Evaluate price signals/rate structures to align storage charging/discharging with policy goals to reduce system peak and improve system utilization
  - Explore EV time-of-use rate structures to promote charging off-peak

- Promote co-location of standalone storage with electric vehicle (EV) charging infrastructure

- Study long-term potential of new long-duration storage technologies, such as hydrogen “power-to-gas”, breakthrough battery technology
Energy Storage as an Energy Efficiency Measure

Valuing storage for cost/benefit calculations
The Massachusetts EE Plan

3/15/19

Todd Olinsky-Paul
Project Director
Clean Energy Group
State Policy Tools for Energy Storage

1. Studies and planning
2. Grants (demonstration projects)
3. Longer-term policy and programs
   • Utility mandates/procurement targets/portfolio standards
   • Incorporating storage into existing incentive programs (storage adders, storage as an efficiency measure)
   • Rebates/performance incentives
   • Tax incentives
   • Financing, clean energy financial institutions
   • Market-based tools and regulatory reform
   • Removal of barriers/soft costs
   • Technical assistance, tools, and resources
States Policy Landscape

• Studies/Roadmaps
  • CA, NY, MA, NM, RI, OR, VT, NJ, MN, MD, others
• Grants/Demonstration projects
  • NY, NJ, MA, CA, WA, OR, VT, CT, Others
• Longer-term programs
  • Utility procurement targets
    • CA, OR, MA, NY, NJ
  • Rebates/Other incentives
    • Rebates (CA, NJ, NY)
    • State tax incentives (MD)
    • Storage adder in solar incentive program (MA)
    • IRP reform (NM, WA)
### Massachusetts Energy Efficiency Plan

- 3-year plan
- Budget > $2 Billion
- First in the nation to include energy storage

<table>
<thead>
<tr>
<th>State</th>
<th>2017 energy efficiency spending ($ million)</th>
<th>$ per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vermont</td>
<td>64.0</td>
<td>102.42</td>
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<tr>
<td>Massachusetts</td>
<td>820.8</td>
<td>81.11</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>83.4</td>
<td>78.95</td>
</tr>
<tr>
<td>Connecticut</td>
<td>153.9</td>
<td>43.03</td>
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<tr>
<td>Oregon</td>
<td>158.6</td>
<td>38.75</td>
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<tr>
<td>Washington</td>
<td>241.8</td>
<td>38.87</td>
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<tr>
<td>Idaho</td>
<td>84.8</td>
<td>38.35</td>
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<tr>
<td>California</td>
<td>1,412.1</td>
<td>35.88</td>
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<tr>
<td>Iowa</td>
<td>112.3</td>
<td>35.42</td>
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<tr>
<td>Maryland</td>
<td>201.5</td>
<td>33.50</td>
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<td>Minnesota</td>
<td>185.0</td>
<td>28.49</td>
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<tr>
<td>Illinois</td>
<td>348.1</td>
<td>27.27</td>
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<tr>
<td>Maine</td>
<td>31.1</td>
<td>23.38</td>
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<tr>
<td>Arkansas</td>
<td>68.8</td>
<td>22.96</td>
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<tr>
<td>New York</td>
<td>450.1</td>
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<td>Michigan</td>
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<td>22.20</td>
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<td>District of Columbia</td>
<td>13.9</td>
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<tr>
<td>New Hampshire</td>
<td>28.1</td>
<td>19.55</td>
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<tr>
<td>Kentucky</td>
<td>84.7</td>
<td>19.09</td>
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<tr>
<td>Delaware</td>
<td>18.2</td>
<td>19.08</td>
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<td>New Mexico</td>
<td>38.7</td>
<td>18.80</td>
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<td>Wyoming</td>
<td>10.5</td>
<td>17.88</td>
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<td>North Carolina</td>
<td>180.9</td>
<td>17.82</td>
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<td>Colorado</td>
<td>98.2</td>
<td>17.38</td>
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<td>Nevada</td>
<td>51.0</td>
<td>17.34</td>
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<tr>
<td>Utah</td>
<td>51.4</td>
<td>18.45</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>89.0</td>
<td>18.62</td>
</tr>
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</table>
In Massachusetts, two conditions needed to be met before storage could be included in the efficiency plan:

1. **Redefining efficiency.** In order to include storage within the energy efficiency plan, Massachusetts first had to include demand reduction, a major application of battery storage, within the efficiency plan. This underlying expansion of the Commonwealth’s efficiency efforts to include demand reduction was formalized as early as 2008 with the Massachusetts Green Communities Act.

2. **Showing that storage is cost-effective.** In order for energy storage to qualify for the efficiency plan, it first had to be shown to be cost-effective. This meant that storage had to be able to pass a Total Resource Cost (TRC) test with a benefit-cost ratio (BCR) equal to or greater than 1. This was demonstrated in our July, 2018 white paper (see *A cost/benefit analysis for energy storage*, below).
1. Redefining efficiency

- Traditionally, electrical efficiency is defined as “using fewer electrons”
  - Storage does not normally qualify due to round trip losses
- Massachusetts expanded the traditional definition of efficiency to include peak demand reduction
  - Storage is well-suited to shifting peak demand, something traditional passive efficiency measures don’t do

**Key concept: Not all load hours should be valued the same**

Traditional efficiency reduces overall consumption, but does not shift peaks

Peak demand reduction reduces peaks, but does not reduce net consumption
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
Case: Boston Medical Center

Project goals:
• Resiliency
• Cost savings
• Power quality

Project Economics

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

Total: Hospital is currently paying annual demand costs of $1,247,000
Redefining efficiency

Massachusetts *Green Communities Act of 2008* requires that efficiency program administrators seek “…all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply.”

-Massachusetts state law, M.G.L. c.25, §21

Massachusetts *State of Charge* report of 2016 notes that “Storage and other measures that shift load are firmly covered by the intent of the [Green Communities] Act” and adds, “The 2016-2018 Statewide Energy Efficiency Investment Plan ("Three Year Plan") identifies peak demand reduction as an area of particular interest in the term sheet and in the EEAC resolution supporting the Three Year Plan…. Energy storage, used to shift and manage load as part of peak demand reduction programs, can be deployed through this existing process.”
To qualify for state energy efficiency plans, storage must pass a cost/benefit test.

CEG published independent economic analysis – July, 2018
Storage BCRs from Massachusetts EE plan PAs

*NOTE: These numbers do not include non-energy benefits!*

<table>
<thead>
<tr>
<th>BCRs</th>
<th>Cape Light</th>
<th>Eversource</th>
<th>National Grid</th>
<th>Unitil</th>
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<tbody>
<tr>
<td>Residential Advanced Demand Management Program (A2o)</td>
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<tr>
<td>Program BCRs</td>
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<td>2.4</td>
<td>1.5</td>
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<td>Direct Load Control</td>
<td>4.9</td>
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<td>7.4</td>
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<td>Behavioral DR</td>
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<td>Storage System and Performance</td>
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<td>Storage Dally Dispatch</td>
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<td>1.5</td>
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<td>4.9</td>
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<tr>
<td>Storage Targeted Dispatch</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
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<td>EV Load Management</td>
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<td>0.8</td>
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<td>Income-Eligle Advanced Demand Management Program (B1b)</td>
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<td>EV Load Management</td>
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<tr>
<td>Commercial/Industrial Advanced Demand Management Program (C2c)</td>
<td>7.5</td>
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<tr>
<td>Program BCRs</td>
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<tr>
<td>Interruptible Load</td>
<td>9.7</td>
<td>9.8</td>
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<td>7.5</td>
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<td>Winter Interruptible Load</td>
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<td>Storage System and Performance</td>
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<tr>
<td>Storage Dally Dispatch</td>
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<td>1.7</td>
<td>1.7</td>
<td>4.9</td>
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<td>Custom</td>
<td>8.3</td>
<td>8.3</td>
<td>8.3</td>
<td>2.0</td>
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</table>
Massachusetts Energy Efficiency Plan
Incentive Structure

• Three year plan > $2 Billion (electric and gas)
• Storage measures are in new Active Demand Reduction program
• Incentive is for performance (load reduction), not installation
• New BTM storage is eligible (with or without renewable generation)
• Residential and commercial customers may participate
• Two programs offered:
  • Daily discharge - $200/kWh (demonstration program)
  • Targeted discharge - $100/kWh (full program offering)
• Incentive payment based on *average load reduction* during hours called by utility
• Discharges will be called in *three hour blocks*
• Incentive paid at end of each year
• Utilities execute 5-year contract with customers
• HEAT loans available for storage
Anticipated Results (Deployment)

- Massachusetts 2019-2021 Energy Efficiency Plan includes BTM storage as a demand reduction measure
- Incentive payments = $13 million over three years
- Expected results = 34 MW new behind-the-meter storage

Shortcomings:
- No enhanced incentive, financing or carve-out for low-income customers
- No up-front rebate
- Daily discharge proposal downgraded to demonstration program
- Cape Light Compact proposal was NOT approved as proposed
- Numerous omissions mean storage BCRs are likely too low
Project Economics Example

A commercial customer participating in the targeted dispatch program installs a 30 kW battery. Assuming perfect call response:

30 kW battery = 10 kw/hr load reduction averaged over 3-hour calls

Incentive payment calculation: 10 kW x $100 = $1,000 annual incentive payment

Note: a customer installing new solar+storage could qualify for energy efficiency performance incentive and the SMART solar rebate with storage adder

Customers can participate in these programs while engaging in net metering and demand charge management
Upcoming Report

New report to be published April 2019 by Clean Energy Group

New report does four things:

1. Revises **battery storage BCR** for Massachusetts
2. Reviews and critiques **new storage incentive** in MA efficiency plan
3. Identifies issues and makes **recommendations for other states** to incorporate storage in efficiency plans
4. Assigns, for the first time, dollar values to **seven non-energy benefits of storage**
   a) Avoided power outages (combines value to customer and value to grid)
   b) Higher property values
   c) avoided fines
   d) Avoided collections and terminations
   e) Avoided safety-related emergency calls
   f) Job creation
   g) Less land used for power plants (expressed in acres)
## PRELIMINARY RESULTS

<table>
<thead>
<tr>
<th>1) Avoided power outages</th>
<th>Non-Energy Benefit (2018$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery storage measure participants avoid outages, and all of the costs that come with outages for both families and businesses</td>
<td>Residential: $1.72/kWh</td>
</tr>
<tr>
<td></td>
<td>Commercial/Industrial: $15.64/kWh</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2) Higher property values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installing battery storage in buildings increases property values for storage measure participants by: (1) increasing leasable space; (2) increasing thermal comfort; (3) increasing marketability of leasable space; and (4) reducing energy costs</td>
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</tbody>
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<table>
<thead>
<tr>
<th>3) Avoided fines</th>
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</thead>
<tbody>
<tr>
<td>Increasing battery storage will result in fewer power outages and fewer potential fines for utilities</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4) Avoided collections and terminations</th>
</tr>
</thead>
<tbody>
<tr>
<td>More battery storage reduces the need for costly new power plants, thereby lowering ratepayer bills, and making it easier for ratepayers to consistently pay their bills on time. This reduces the need for utilities to initiate collections and terminations</td>
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<thead>
<tr>
<th>5) Avoided safety-related emergency calls</th>
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<tbody>
<tr>
<td>Increasing battery storage results in fewer power outages, which reduces the risk of emergencies and the need for utilities to make safety-related emergency calls</td>
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<table>
<thead>
<tr>
<th>6) Job creation</th>
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<tbody>
<tr>
<td>More battery storage benefits society at large by creating jobs in manufacturing, research and development, engineering, and installation</td>
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<table>
<thead>
<tr>
<th>7) Less land used for power plants</th>
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<tbody>
<tr>
<td>More battery storage reduces the need for peaker plants, which are more land-intensive than storage installations—benefitting society by allowing more land to be used for other purposes</td>
</tr>
</tbody>
</table>
Thank You

Todd Olinsky-Paul
Project Director
CEG/CESA

Email for new report: Todd@cleanegroup.org

CEG webinar on new report: April 4, 12:30 p.m. Webinar is free, register at http://bit.ly/CESA-Webinar-4-4-19

Website: www.resilient-power.org
Utility markets: capacity and transmission cost reductions

Increased solar production is reducing midday demand for grid power.
Result:
Electricity demand = flat or decreasing
Capacity demand = increasing
Behind the Meter Markets

- Demand Charge Management
- Resiliency

Demand Charge Management:

Commercial customers pay as much as **50%** of their monthly electric bill for demand charges.

Energy storage can reduce demand charges by managing peak demand.
State policy example: Massachusetts Energy Storage Initiative

• Current Policy/Programs
  • CCERI $40M resiliency grants (2014-2017)
  • Energy Diversity Act (2016)
    • Utilities can own storage
    • DOER to assess need for utility procurement target
  • State of Charge report (2016)
    • State energy storage roadmap and analysis; recommendations for energy storage policy and program development
  • ACES $20M Energy Storage Demonstration Grants (2017)
  • SMART Solar Incentives with storage adders
  • Procurement Target – 1,000 MWhs by 2025
  • Storage added to EE plan (2019-2021)

• Policy/programs in development
  • Clean Peak Standard
  • Microgrids program
  • Resilient fueling stations program
  • Grid modernization
  • Storage inclusion in Alternative Portfolio Standard

With federal and foundation support, CEG/CESA is providing free technical assistance to DOER awardees for project implementation, as well as to DOER and MassCEC for policy and program development; and we are extending this policy support to the other New England states.
First National Survey of Demand Charge Rates

Based on a survey of more than 10,000 utility tariffs, Nearly 5 million commercial customers may be paying more than $15/kW in demand charges.

Darker areas on map = more customers paying high demand charges

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

1,060 kW / 2,120 kWh battery connected to existing CHP

Project goals:
• Resiliency
• Cost savings
• Power quality

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

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

Project Economics:

• Project Installed Cost: $1.9 M
• MassCEC Grant: $402,500
• Annual Savings: $200,000

Simple Payback: 6.5 years