MASSACHUSETTS ENERGY STORAGE INITIATIVE

STORAGE STUDY UPDATE

May 18, 2016
1. Reduce and **stabilize the rising cost** of energy for consumers

2. Continue the Commonwealth’s commitment to a **clean energy future**
   - GWSA GHG reductions: 25% by 2020 and 80% by 2050 (1990 baseline)

3. Ensure that we have a **safe, reliable, and resilient** energy infrastructure
ENERGY STORAGE INITIATIVE

- Storage is a game changer that can play a part in solving our energy challenges
- $10 million Energy Storage Initiative includes a study as well as funding for demonstration projects
- Robust stakeholder engagement

“Massachusetts will continue to lead the way on clean energy, energy efficiency and the adoption of innovative technologies such as energy storage.”
Governor Baker, Feb 2016, Accord for a New Energy Future Press Release

“Given the recent advances in energy storage technology and cost-effectiveness, it is hard to imagine a modern electric distribution system that does not include energy storage.” Utility stakeholder perspective
Pumped Hydro Storage is often referred to as a “conventional” storage technology.

More recent emerging forms of energy storage such as batteries, flywheels, and new compressed air energy technologies are often referred to as “advanced energy storage”.

Advanced Energy Storage Technologies

- **Mechanical**
  - Pumped Hydro (Conventional Storage)
  - CAES (Compressed Air Energy Storage)
  - Flywheel

- **Electrochemical**
  - Lead acid, Lithium Ion, Sodium Sulfur, and Sodium Nickel Chloride
  - Flow batteries - Vanadium redox, Zinc-bromine

- **Thermal**
  - Sensible - Molten salt, chilled water
  - Latent - Ice storage, Phase change materials
  - Thermochemical storage

- **Electrical**
  - Supercapacitors
  - SMES (Superconducting Magnetic Energy Storage)

- **Chemical (Hydrogen)**
  - Power-to-Power (Fuel Cells, etc)
  - Power-to-Gas
Advanced Energy Storage is Growing Rapidly in the US

US Market for Advanced Energy Storage technologies expected to grow by 500% in five years

The electricity market has a fast “speed of light” supply chain and the least amount of storage. This lack of storage creates a need for additional infrastructure to maintain market reliability.
Electric Grid is Sized for Highest Hour of Demand

Top 1% of Hours accounts for 8% of Massachusetts Spend on Electricity
Top 10% of Hours accounts for 40% of Electricity Spend
While Energy Efficiency has Decreased Average Energy Consumption, Peak Continues to Grow (1.5% per year)

Growing peak results in inefficient use of grid assets, including generation, transmission and distribution, increasing the cost to ratepayers.
Energy storage is the only technology that can use energy generated during low cost off-peak periods to serve load during expensive peak.
Increased Renewables Requires Grid Flexibility to Manage Intermittency

Typical Solar Output

- Variable Output Generators Requires Fast and Flexible Resources to Maintain Balance and Reliability
- Slow-ramping Generator
- Fast-responding Energy Storage
- Storage has near instantaneous response to grid changes

Renewable resources, such as solar, can have variable generation

According to ISO-NE “State of the Grid – 2016” fast and flexible resources will be needed to balance intermittent resources’ variable output. Storage can provide this flexibility.
As distributed generation increases, utilities are challenged to manage reverse power flow at substations. Distributed storage can manage and optimize power flows.

Amount of Distributed Generation has Skyrocketed

- There are over 40,000 distributed solar projects in Massachusetts
- Distributed generation is growing at rate of 400 installed projects per week

![Graph showing reverse power flow problem and energy storage solution.](image1.png)
Major Outages From Storm Events are More Common

- Although total weather days have decreased, the number of customer outages have increased due to an increase in severe storm events
- Major storm events increase costs for the utilities to maintain resiliency

Storage, especially when integrated with microgrids, can increase resiliency in storm events
Massachusetts businesses, especially those with high electricity use, could use storage to better manage their peak and reduce electricity costs.

- Massachusetts has one of the highest electricity rates in the nation.
- Commercial electricity customers pay utility demand charges based on customer’s peak hour.

High Electricity Costs Impact Massachusetts Businesses

Example Massachusetts C&I Daily Demand Profile

Storage Charging During Low Demand

Storage Discharging To Reduce Peak

ISO-NE Peak

Load (kW)

Hours in a Day

0:00 6:00 12:00 18:00 24:00

2000 200 400 600 800 1000 1200 1400 1600 1800 2000
Advanced Storage Optimization Model

Model Details
- Generators
- Nodes
- Trans. Lines
- Transformer
- Renewables

Benchmark
- Demand
- Price

BenchMark
- Cap. Factor
- Gen. Cap.
- Emission

Capacity Optimization
- Storage Technology Categories
  - Long Duration
  - Medium Duration
  - Medium-Long Duration
  - Short Duration
  - Where?
  - How much?
  - When?

Production Cost Model
- Hourly Day-ahead Market
- Sub-hourly Real-time Market
- Storage brings efficiency to Day-Ahead and Real Time markets and simultaneously advantages to distribution, transmission and generation.

Evaluation
- MA Ratepayer Benefits
- Emission
- Reliability
- Renewable Integration
- Reserves
- Peak Demand
- Use Cases
- T&D Deferral
- ISO-NE Production Cost

Uncertainties
- Load Growth
- Fuel Prices
- Regional System Plan
- Renewable Availability
Energy Storage has potential applications across the entire electricity value chain

Source: 2015 Electric Power Research Institute
Next Steps

• Storage Study is in it’s final stages – expect release in the coming weeks

• Following the release of the study, DOER and MassCEC will issue an RFP for demonstration projects