Commission To Study the Economic, Environmental and Energy Benefits of Energy Storage to the Maine Electricity Industry

November 6, 2019

Work Session Handouts

- Overview of Storage Barriers, Uses, Benefits and Policies
- Energy Storage Applications and Economic Value Streams
- Classification of Energy Storage Technologies
- Overview of Energy Storage Provisions in Maine Law

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Overview of the Storage Barriers, Uses, Benefits and Policies from the Report - State of Charge: Massachusetts Energy Storage Initiative

Stakeholder Identified Barriers and Challenges

- Uncertainty regarding regulatory treatment of storage
- Barriers in wholesale market rules
- Limitation in the ability for project developers to monetize the value of their energy storage project
- Lack of specific policies to encourage the use of innovative storage technologies

Storage Uses

Storage can be used to:

- Address a gap left by the retirement of generation in the New England Region by operating as local peak generation in highly populated areas to mitigate the impact of these generation retirements.
- Provide electricity in place of natural gas “peaker” plants during times of high electricity and fuel prices.
- Balance the variable output from intermittent generation resources.
- Help in the management of power flows and alleviate reliability issues caused by reverse power flows[1] when located at substations.
- Increase the resiliency of the grid, especially where there are more frequent and intense storm events.
- Manage peak electric consumption, integrate any on-site generation, and to reduce electricity bills at commercial and industrial facilities.

Storage Benefits

- Reduces the price paid for electricity.
- Lowers peak demand.
- Defers transmission and distribution investments.
- Reduces greenhouse gas emissions.
- Reduces the cost to integrate renewable generation.
- Defers capital investments in new capacity.
- Increases the grid’s overall flexibility, reliability and resiliency.
- Storage projects typically have smaller footprints and can be constructed more quickly than conventional generation.

Policies to Encourage Storage

- Provide grants, loans, incentives and rebate programs.
- Set storage mandates or targets – ex. including storage in state portfolio standards.
- Establish /clarify regulatory treatment of utility owned/operated storage.
- Include options to enable storage to be part of clean energy procurements.
- Address interconnection, safety and performance codes and standards.
- Perform customer marketing and education about storage opportunities.

[1] Reverse power flow or backfeeding is a flow of electrical energy in the reverse direction from its normal flow. For example, reverse power flow may occur when there is an excess of solar power flowing from a solar generator into the grid.

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Energy Storage Applications and Economic Value Streams

Application	Value Streams
Electricity Customer	
Demand Charge Reduction	Energy storage can be used to reduce electricity demand charges by shifting the profile of building-level energy loads. By charging an energy storage system during off-peak periods and discharging at key times throughout the day, a customer can prevent its load profile from exceeding a demand charge threshold.
Time-of-Use Bill Management	Energy storage can be used to reduce customer's electricity purchases made when time-of-use rates are high (peak electricity-consumption hours) by relying on stored power and shifting purchases to periods when time-of-use rates are lower (off-peak periods).
Backup Power/ Resiliency	Energy storage paired with a generator can provide backup power when a power outage or grid failure occurs. This can be done at multiple scales, ranging from backup for residential customers to second-to-second power quality maintenance for industrial customers.
Increased Self-Consumption	Energy storage can be used to increase customer self-consumption of behind-the-meter generation and reduce export of that generation to the grid. The degree of benefit depends on how exported distributed generation is treated in the utility rate structure.
Energy Supply and Generation	
Resource Adequacy (Asset Deferral)	Energy storage can serve as a resource to meet system requirements during peak electricity-consumption hours (peak demand periods). This can defer or reduce the need for investment in new generation assets and minimize the risk of overinvestment in generation.
Renewables Integration	Energy storage can smooth out the delivery of energy from variable or intermittent resources such as wind and solar, by storing excess energy when the resource is active (e.g. windy or sunny) and delivering stored energy when the resource is inactive (e.g. lack of wind or sun).
Transmission and Distribution System	
Transmission and Distribution System Upgrade Deferral	Energy storage can shave the peak of the projected system load and reallocate demand on the system to non-peak periods. This can provide a means to defer, reduce the size of, or avoid the need for investments in transmission and distribution system upgrades.
Transmission Congestion Relief	Energy storage installed downstream of congested transmission corridors can be discharged during congestion periods to reduce congestion, creating value because grid operators (ISOs/RTOs) charge utilities to use transmission corridors during congested periods.
Wholesale Market and Grid Operation	
Wholesale Market Arbitrage	Energy storage can be used to purchase wholesale electricity at times when the locational marginal price is low (typically during the night) and sell electricity back to the wholesale market at times when the locational marginal price is high (buy low, sell high).
Spinning and Non-spinning Reserves	Energy storage can provide supply reserves to serve load on the grid in response to a contingency event, such as a generation outage. Spinning reserves are online and able to serve load immediately. Non-spinning reserves can respond to events and serve load within a short period of time (<10 minutes) but not instantaneously.
Frequency Regulation	Energy storage can be charged or discharged in response to a change in grid frequency in order to maintain the alternating current frequency on the grid within an acceptable range. Frequency regulation is necessary to ensure that system-wide generation is matched with system-wide demand to avoid spikes or dips in frequency, which create grid instability.
Voltage Regulation	Energy storage can be used to address variations in voltage on the grid by providing a means to insert or absorb "reactive power." Using storage this way helps resolve voltage variations and ensure voltage remains within allowed limits. (Reactive power is the portion of electricity that establishes/sustains electric and magnetic fields required by alternating current equipment; it exists in a circuit when the current and voltage are not in phase.)
Black Start Asset	Energy storage can serve as a black start asset during a grid outage. Black start refers to the ability to restore generation at a facility without relying on external resources; generation at the facility can then restore operation to larger power stations to bring the grid back online.

Prepared by the Office of Policy and Legal Analysis (11/6/19)

Sources: Developed from "The Economics of Battery Energy Storage," Rocky Mountain Institute (2015), and other Internet resources.

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Classification of Energy Storage Technologies

Mechanical Storage	Battery Storage	Thermal Storage	Electrical Storage	Hydrogen Storage
Stores energy using kinetic or gravitational forces.	Stores energy in a chemical form that can be converted to electricity. (Also called electrochemical storage.)	Stores energy produced in the form of heat (or cold) energy.	Stores energy in electric and and electromagnetic fields.	Stores energy in hydrogen created by electrolysis, a process that splits water into hydrogen and oxygen.
Pumped Hydro: Stores electrical energy as potential energy of water. Electricity is used to pump water from a lower level to a higher level. When electricity is needed, water is released to generate power through a hydraulic turbine. **Compressed Air Energy Storage (CAES):** Converts electricity to compressed air, which is stored in an underground cavern or above ground containers. When electricity is needed, compressed air is released to generate power through an expansion turbine. **Flywheel:** Stores electrical energy as kinetic rotational energy by accelerating a flywheel. When energy is needed, the spinning of the flywheel turns a generator.	**Solid Rechargeable Battery:** Stores chemical energy in solid-based electrodes. (Examples: lead acid, lithium ion, sodium sulfur and sodium nickel chloride.) **Flow Battery:** Stores chemical energy in flowing liquid electrolytes kept in tanks separate from the actual electrochemical cells. (Examples: vanadium redox and zinc-bromine.)	**Sensible Heat Storage:** Stores thermal energy in a material by changing the temperature of the material. (Examples: water, molten salt, sand or rocks.) **Latent Heat Storage:** Stores thermal energy created when a material goes through a phase change, such as melting, boiling or freezing. **Thermochemical Storage:** Stores thermal energy as chemical energy; energy is absorbed and released in a reversible chemical reaction (breaking and reforming of molecular bonds).	**Supercapacitor:** Uses static electricity to stores electrical charge. This technology consists of two metal plates coated with a porous substance, soaked in an electrolyte and separated by a thin insulator; it can be charged and discharged quickly and recharged almost indefinitely. **Superconducting Magnetic Energy Storage (SMES):** Stores electricity within the magnetic field of a superconducting wire coil, with near zero loss of energy.	**Power-to-Power:** Uses electrolysis to produce produce hydrogen which is then converted to electricity via fuel cells or engines. **Power-to-Gas:** Uses electrolysis to produce hydrogen which is then injected into natural gas pipelines or used as transportation fuel, or put through a second process to produce methane for use in a natural gas pipeline or converted to liquified petroleum gas (LPG).

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Sources: Developed from the "State of Charge, Massachusetts Energy Storage Initiative," State of Massachusetts (2016), and other internet resources.

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Overview of Energy Storage Provisions in Maine Law

Definition of Energy Storage

The term “energy storage system” was added and defined in Title 35-A in the first regular session of the 129th Legislature (2019). The definition, which appears in two sections of statute, is as follows:

> “Energy storage system means a commercially available technology that uses mechanical, chemical or thermal processes for absorbing energy and storing it for a period of time for use at a later time.”
>
> (35-A MRSA section 3210-G, subsection 1; 35-A MRSA section 3481, subsection 6).

Renewable Portfolio Standard (RPS)

Public Law 2019, chapter 477 (LD 1494) “An Act to Reform Maine’s Renewable Portfolio Standard” includes language regarding energy storage systems in the provisions regarding procurement of Class 1A resources.

This law requires the Public Utilities Commission (PUC) to allow energy storage systems to participate in competitive solicitations for contracts for renewable resources classified as Class 1A under the renewable portfolio standard (RPS). The law provides that:

- An energy storage system may be included in a bid for or enter into contracts for Class 1A resources, if the energy storage system is connected to the State’s electricity grid, paired as a complementary resource with a Class 1A resource and either:
    - Co-located with the Class 1A resource (whether metered jointly or separately), or
    - Located separately from the Class 1A resource provided that the PUC finds the inclusion of the energy storage system would result in a reduction in greenhouse gas emissions
- A bid for a Class 1A resource contract that includes an energy storage system must include two separate bid proposals, one including the storage system and one not including it
- A paired energy storage system that is not co-located with a Class 1A resource may receive renewable energy credits (RECs) only for stored energy generated from a Class 1A resource
- If an energy storage system enters a Class 1A resource contract, the storage system must remain stationary and under the same ownership throughout the contract term
- The PUC may permit an energy storage system to be paired with and added to a Class 1A resource after the Class 1A resource has been awarded a contract

Solar Energy and Distributed Generation

Public Law 2019, chapter 478 (LD 1711) "An Act to Promote Solar Energy Projects and Distributed Generation Resources in Maine" includes language regarding energy storage systems in the provisions regarding procurement of distributed generation resources.

For the purposes of this law, *distributed generation resource* means an electric generating facility with a nameplate capacity of less than 5 MW that uses a renewable fuel or technology (wind power, solar power, fuel cells, tidal power, geothermal, hydroelectric, biomass, anaerobic digestion of animal or agricultural waste) and is located in the service territory of a transmission and distribution utility in the State.

The law requires the PUC to procure certain quantities of distributed generation resources in shared distributed generation (output owned by or allocated to subscribers) and in commercial or institutional distributed generation (non-residential) market segments.

This law authorizes, but does not require, the PUC to establish by rule incentives in the procurement of distributed generation resources and specifically mentions that these incentives may include *incentives to support distributed generation resources that pair with energy storage systems*.