Renewable Energy Question 26: *Has Michigan, or have other jurisdictions, incentivized energy storage technologies or included energy storage in a renewable or clean energy standard? Why or why not?*

Executive Summary

1. Seven states, including Michigan, consider certain types of energy storage technologies eligible to meet their Renewable Portfolio Standard (RPS) requirements

2. None of the energy storage facilities are commercially viable except pumped storage hydro; even new development of pumped storage hydro is limited by siting, permitting and cost challenges

3. Upgrades to the existing Ludington pumped hydro storage facility in Michigan present a unique opportunity to achieve the benefits of a storage facility in the most cost effective way

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1. Seven states, including Michigan, consider certain types of energy storage technologies eligible to meet their Renewable Portfolio Standard (RPS) requirements

California, Maine, Massachusetts, Michigan, Montana, Ohio and Pennsylvania consider certain types of energy storage as eligible technologies to meet RPS requirements. Among the seven states, California, Maine, Michigan and Pennsylvania limit the eligible energy storage technology to pumped hydro storage; Massachusetts limits the eligible technology to flywheel storage[1]; Montana limits the technology to compressed air storage[2]; and Ohio permits any storage technology that promotes the better utilization of a renewable energy resource that primarily generates during off peak periods.

Details of energy storage eligibility by state are summarized in Table 1 below.

[1] Flywheel energy storage works by accelerating a rotor (flywheel) to a very high speed and maintaining the energy in the system as rotational energy. When energy is extracted from the system, the flywheel's rotational speed is reduced as a consequence of the principle of conservation of energy; adding energy to the system correspondingly results in an increase in the speed of the flywheel

[2] Compressed air storage facilities utilize large underground caverns to store air that is compressed during off-peak hours. The compressed air is then fed into a natural gas fired expander or combustion turbine to provide power back to the grid during peak demand periods.

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Table 1: Energy Storage Eligibility by State

State	Energy Storage Eligible	Details
CA	Yes	Pumped storage hydro may qualify if 1) the facility meets the eligibility requirements for small hydro facilities and 2) the energy used to pump the water qualifies as an RPS-eligible resource
ME	Yes	Pumped storage hydro may qualify if the energy used to pump the water qualifies as an RPS-eligible resource
MA	Yes	Flywheel energy storage is qualified for Alternative Energy Portfolio Standards (separate from RPS)
MI	Yes	Pumped storage hydro is qualified for Incentive Renewable Energy Credits: 0.2 credits awarded for 1 MWh generated during on peak hours
MT	Yes	Compressed air energy storage from eligible renewables
OH	Yes	Any storage facility may qualify if it promotes the better utilization of a renewable energy resource that primarily generates off peak
PA	Yes	Pumped storage hydro is qualified for Tier II of RPS requirements

States enumerate two primary reasons for including energy storage technologies in their RPS standards:

- Energy storage technologies help states manage integration of intermittent renewable resources. California identifies storage as "a key strategy for accommodating the intermittent nature of some renewables."[3] Similarly, Ohio explicitly points out in the state RPS that storage facilities can "promote the better utilization of a renewable energy resource that primarily generates off peak."
- Inclusion of energy storage technologies can support economic development in the state. For example, Beacon Power, the developer of flywheel-based energy storage solutions for electric grid, is based in Massachusetts. Gaelectric, the largest owner of wind development rights in Montana, is actively exploring compressed air energy storage opportunity to develop with its Montana wind projects.

[3] California Energy Commission. (2009). 2009 Integrated Energy Policy Report. http://www.energy.ca.gov/2009publications/CEC-100-2009-003/CEC-100-2009-003-CMF.PDF. Accessed Feb 26, 2013

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2. None of the energy storage facilities are commercially viable except pumped storage hydro; even new development of pumped storage hydro is limited by siting, permitting and cost challenges

Many new energy storage technologies are still in research and development or pre-commercial stages, as shown in Table 2. Pumped hydro is the only commercially viable energy storage technology that is able to provide a scaled contribution to the electric grid.[4]

Table 2: Development stage of select energy storage technologies

Commercial	Pre-commercial Prototype	Demonstration Stage	Developmental Stage
• Pumped Hydro	• Compressed Air • Lead-Acid Battery • Ni-Cad Battery • Sodium-Sulfur Battery Flywheel	• Zinc-Bromine Battery • Flywheel • Vanadium Redox Battery • Electrochemical capacitor	• NiMH Battery • Lithium-Ion Battery • Electrochemical capacitor

However, even the development of new pumped hydro storage faces significant permitting and siting challenges, which add to the costs. The high costs of storage technologies make it more difficult for them to attract financing or to compete with other technologies, such as natural gas-fired power plants, that can serve similar functions in the integration of intermittent renewable resources.[5]

The applicability of energy storage technologies in the electric grid is expected to be limited in the foreseeable future. The Annual Energy Outlook 2012 from the U.S. Energy Information Administration (EIA) projects that the total generating capacity of storage facilities in the United States will remain almost constant through 2035.[6]

[4] Hawaiian Electric Company. http://www.heco.com/portal/site/heco/menuitem.508576f78baa14340b4c0610c510b1ca/?vgnextoid=94600420af0db110VgnVCM1000005c011bacRCRD&vgnextchannel=ab020420af0db110VgnVCM1000005c011bacRCRD&vgnextfmt=default&vgnextrefresh=1&level=0&ct=article. Accessed Feb 26, 2013

[5] UC Berkeley Law, Center for Law, Energy & the Environment, and UCLA Law, Emmett Center on Climate Change and the Environment. 2010. The Power of Energy Storage: How to Increase Deployment in California to Reduce Greenhouse Gases. July 2010.

[6] EIA AEO 2012. Electric Power Projections for EMM Region, United States, Reference Case. http://www.eia.gov/forecasts/aeo/sector_electric_power.cfm. Accessed Feb 26, 2013.

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3. Upgrades to the existing Ludington pumped hydro storage facility in Michigan present a unique opportunity to achieve the benefits of a storage facility in the most cost effective way

Upgrades to the existing pumped hydro facility at Ludington are the most cost effective way to provide the energy storage benefits of accommodating increasing renewable generation while keeping greenhouse gas emission at the minimum level.

Michigan has benefited from the Ludington pumped hydro facility since the start of its commercial operation in 1973. The facility draws energy from the grid to pump water from the lower to the higher reservoir during off-peak hours, and supplies energy to the grid when the water runs back down to the lower reservoir during on-peak hours, effectively mitigating power prices when prices are high. Besides price mitigation, Ludington helps ensure system reliability by providing operating reserves and system balancing services to the grid, attributed to its fast response capability. Today, Ludington is able to produce 1,872 MW during peak hours, enough to power a community of 1.4 million customers. After the upgrades, the maximum output of the facility will be increased by 16% to 2,172 MW.

In summary, maximizing the use and capability of Ludington pumped hydro storage facility is important to ensuring reliability and affordable electric service in Michigan. It is the most cost effective way by far to capture the benefits of energy storage facilities in our electric grid.