



Beacon Power, LLC
Response to the New York Energy Highway Request for Information (RFI)
May 30, 2012

RESPONDENT INFORMATION

Beacon Power, LLC (“Beacon Power” or the “Company”), a manufacturer and merchant developer of an innovative flywheel energy storage technology, is pleased to provide this response to the New York Energy Highway Request for Information (“RFI”). Beacon Power has developed and now operates a 20-megawatt (“MW”) flywheel energy storage plant located in Stephentown, New York, which currently provides Frequency Regulation service in NYISO’s Regulation market. Beacon Power’s flywheel energy storage technology is a clean, reliable, low-cost solution for improving reliability and reducing congestion on the power grid.

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ORGANIZATION OF RESPONSE

This response is organized into three sections. The first section discusses the use and benefits of flywheel energy storage for providing reliability services to the power grid, such as frequency regulation, through NYISO’s Ancillary Services markets. The second section discusses the use and benefits of flywheel energy storage for reducing congestion on the transmission

system. The last section discusses policy recommendations to increase the use of energy storage technologies on the grid in order to provide reliable, affordable power to New York's homes and businesses.

I. Storage Resources as Frequency Regulation Service Providers

A. Project Description

Since January 2011, Beacon Power has been operating its first 20 MW commercial-scale flywheel energy storage plant located in Stephentown, New York (Rensselaer County, NYISO Zone F). The plant provides frequency regulation service to the grid through the NYISO's Ancillary Service Regulation market. Beacon Power is interested in building additional flywheel energy storage plants in New York State.

B. Project Justification

In order to reliably deliver power to consumers, the grid must stay at a constant frequency of 60 Hertz per second. This requires that the supply of electricity by generators and the demand for electricity by consumers stay in perfect balance. However, supply and demand is constantly fluctuating and varies second by second. The NYISO maintains reliability and manages these fluctuations by buying Regulation Service through its wholesale power market. Today regulation service is typically provided by generators who increase or decrease their output. But this approach has limitations. Because generators operate most efficiently at a constant output, rapid changes in power delivery cause them to consume more fuel, require more maintenance and produce higher emissions. A better solution is to store energy for brief periods of time. This is what Beacon Power's flywheel technology can do. Our technology operates by using flywheels to rapidly recycle excess energy on the grid. When generated power exceeds load, Beacon Power's flywheels store this excess energy. When load increases, Beacon's flywheels return the energy to the grid. Beacon Power's technology can respond nearly instantaneously to NYISO's control signal. The ability of Beacon Power's flywheels to quickly and precisely respond to moment-by-moment system changes make this technology ideally suited to provide frequency regulation.

There are several benefits of using flywheel storage for frequency regulation that align with the Energy Highway Objectives:

1. As a new, fast, accurate resource for maintaining grid frequency, flywheel energy storage assures that long-term reliability of the electric system is cost-effectively maintained, benefiting system performance and operations.

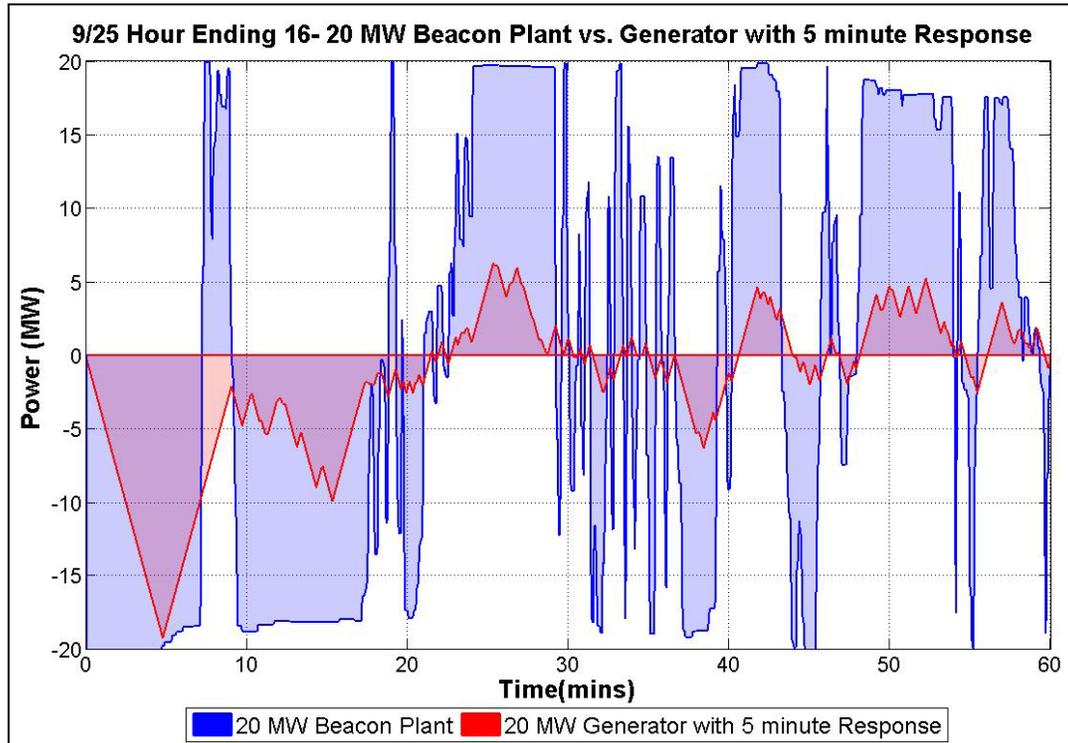
Beacon Power's technology provides a fast response solution for maintaining grid reliability. With a 25 kWh/100 kW flywheel system, Beacon's technology can respond to an ISO's control signal up to one hundred times faster than what is offered by traditional generators. Since fast regulation resources are significantly more effective at responding to system imbalances than slower-ramping generation resources, their use on the grid can lower the overall amount of Regulation that needs to be purchased to maintain system reliability.

The following example shows the greater effectiveness provided by using flywheel energy storage for frequency regulation. On September 25, 2011, at hour ending 16, Beacon's flywheel regulation plant in Stephentown, NY supplied 20 MW of Regulation capacity to the NYISO regulation market, or 11% of the total 175 MW of Regulation capacity procured during the hour.¹ Based upon data provided by NYISO, during that hour the total Area Control Error ("ACE"), which is a measurement of the frequency error and system imbalance on the grid, was 44.3 MWh (the sum of positive ACE MWh with the absolute value of negative ACE MWh).² In this hour, Beacon's 20 MW flywheel plant provided 14.2 MWh of energy to correct ACE or 32.2% of the total ACE Correction due its ability to respond in seconds to the error. For the same hour, Beacon Power modeled a traditional generator supplying 20 MW of Regulation capacity with the allowable 5-minute response time following NYISO's pro-rated control signal derived from ACE. Based on its models, the generator would be dispatched to provide 3.7 MWh of energy to correct ACE correction, or just 8.3% of the total ACE Correction needed. (See Figure 1). The blue line is the actual amount of regulation service provided by Beacon Power's 20 MW flywheel plant by responding every 6-seconds to the NYISO dispatch signal and the red line shows the amount of regulation service provided by a 20 MW resource with a 5-minute response time.

¹ NYISO Regulation Requirements, http://www.nyiso.com/public/webdocs/market_data/reports_info/nyiso_regulation_req.pdf, Accessed 9/26/11.

² Area Control Error ("ACE") is defined by NERC as "The instantaneous difference between a Balancing Authority's net actual and scheduled interchange, taking into account the effects of Frequency Bias and correction for meter error." ACE data provided by NYISO. System ACE data is telemetered to Stephentown plant in conjunction with the plant's specific dispatch signal.

Figure 1. Comparison of the amount of Frequency Regulation Service (ACE Correction) provided by Beacon’s flywheel plant versus a Traditional Generator



In this hour the fast-ramping flywheel provided almost four times the ACE Correction (or frequency regulation) as the slow-ramping resource with the same amount of capacity (20 MW). By providing a significantly greater amount of frequency regulation service per MW of capacity, flywheels provide a cost-effective solution for maintaining system reliability thus maximizing ratepayer value.

2. Contributes to an environmentally sustainable future for New York State and supports the development of utility-scale renewable generation resources throughout the state.

In October 2008, NYISO issued a paper entitled, “Integration of Wind into System Dispatch” wherein it notes that “wind plants may create a significant demand for increased regulation and reserves, thus making it imperative to look for new sources and new technologies for these services.”³ More recently, NYISO has reported that an increase of 54% in the Regulation requirement can be expected with the forecasted increase in intermittent renewable resources.⁴ Flywheel Energy Storage enables very fast and accurate response to

³ Integration of Wind into System Dispatch, A New York ISO White Paper, October 2008.

⁴ NYISO “Growing Wind Final Report of the NYISO 2010 Wind Generation Study” September 2010.

frequent and unpredictable wind and solar ramping events and hence can reduce the overall expense of regulation reserves required to integrate wind.

Flywheel energy storage technologies can provide Regulation Service a la carte. This reduces the need to run additional generation units at night in order compensate for over-generation by wind resources. When the wind blows during off-peak hours, few generators will be on-line to provide Regulation Service. Those generators that are operating are likely to be running at or near their minimum operating level, meaning that they would be unavailable to provide Regulation Down service. This over-generation situation is further exacerbated by needing to either move these units above their minimum operating level or bringing additional units on-line for Regulation service if those operating are not Regulation-capable. Conversely, advanced energy storage can provide Regulation *a la carte*. With Beacon Power's flywheel energy storage on the system, operators will not need to ramp up generators operating in off-peak hours, or bring on additional generation to provide Regulation Service.

Flywheel energy storage produces fewer emissions when providing Regulation than conventional generation. Unlike generators that consume fossil fuel, Beacon Power's flywheel technology recycles existing power, thereby lowering its operating costs to provide regulation and benefiting the environment by producing zero direct CO₂ greenhouse gas, particulates or other air emissions.⁵ A study by KEMA concluded that a 20 MW Flywheel Energy Storage System emits 56% less CO₂ than a natural gas power plant providing regulation and 26% less emissions than a pumped hydro power plant.⁶ KEMA notes that continued reliance on thermal generating units to meet increased regulation requirements could actually increase emissions of CO₂, NO_x and other pollutants, thereby defeating one of the main benefits of wind generation.⁷

3. Maximizes New York state ratepayer value in the operation of power grid.

As discussed above, by providing a significantly greater amount of frequency regulation service per MW of capacity, flywheel energy storage can provide a cost-effective solution for maintaining system reliability thus maximizing ratepayer value. In addition, flywheel energy storage has the potential to reduce Regulation costs for ratepayers by introducing new competition to NYISO's regulation market and displacing high cost conventional generation.

Beacon Power's flywheel technology is a lower cost alternative than conventional generation for regulation. Beacon Power has a fundamental operating cost advantage because

⁵ Some emissions from flywheels occur indirectly, because some electricity from the grid must be used to compensate for energy losses during operation.

⁶ KEMA, Emissions Comparison for a 20MW Flywheel-based Frequency Regulation Power Plant, May 18, 2007.

⁷ *Id.*

it does not consume fossil fuel. Instead flywheels recycle existing power. That coupled with its high operating efficiency and low maintenance makes Beacon Power a low cost regulation provider. The introduction of new competition to the market will displace high-cost regulation deployments by traditional generators.

4. Using flywheels on the grid can increase the efficiency of traditional power generation plants.

Existing fossil fuel-powered plants displaced by Beacon Power's flywheel-based frequency regulation can be shifted to provide a corresponding amount of added generation capacity. In doing so, these plants can run at their optimum capacity, improving their heat rate efficiency, reducing wear and tear on their equipment, thereby potentially lowering their cost to produce energy. The regained capacity from traditional generators does not require permitting or construction time, enabling regions to increase peak power generation without the need for new power plants.

5. Create jobs and opportunities for New Yorkers.

The construction and operation of our Stephentown project has provided job opportunities in New York. Beacon Power used LeChase Construction Services, LLC, a New York-based firm, to construct the Stephentown project. In addition, the plant utilizes local contractors to perform on-going plant maintenance.

C. Financial Information

The project received a DOE Loan Guarantee and a \$2 million NYSERDA grant.

D. Permit/Approval Process

The Stephentown project is currently operational, it has received all required permits and approvals and requires no further permits.

II. Storage Resources as Transmission System Resources

A. Project Description

Flywheel energy storage can be used to reduce local transmission congestion. This can be accomplished by locating the storage resource in the downstate area such that it provides

power at times when local demand would otherwise cause transmission congestion. Alleviating congestion is achieved by storing energy during times of low demand, and releasing it when increased local demand would otherwise cause an overload on the transmission line. In addition, co-locating the energy storage resource with an intermittent renewable resource such as wind can provide firming such that the renewable resource has reduced variability.

B. Project Justification

Using storage technologies to relieve transmission congestion meets the State's goal of applying advanced technologies such as energy storage that benefit system performance and operations. This is accomplished by locally reducing transmission congestion with energy storage alone or in combination with providing firming of intermittent resources such as wind. Both stand alone energy storage projects, and the combination with a renewable energy resource solve the problem of transmission congestion with zero direct emissions. The use of storage to improve the existing transmission capability will 1) reduce constraints on the flow of electricity, 2) expand the diversity of power generation sources, 3) assure long-term reliability, 4) contribute to an environmentally sustainable future for New York state.

C. Financial Information

The use of storage on the transmission and/or distribution system should be part of the utility's infrastructure and eligible for rate-based cost recovery. Companies, such as Beacon Power, can sell turnkey storage solutions to the utility.

D. Permit/Approval Process

Beacon Power's flywheels do not consume fuel nor produce particulates or other harmful emissions. This helps make it possible to rapidly permit and site a flywheel-based plant almost anywhere on the grid relatively close to a transmission or distribution line.

III. Policy Recommendations

Beacon Power suggests several policy recommendations increase the use of advanced energy storage technologies, such as flywheels, on the New York power grid.

➤ Include energy storage technologies in the State's Renewable Portfolio Standard.

As discussed above, storage has zero direct emissions and is an enabler of additional renewable energy generation from sources such as wind and solar. Therefore, we recommend that the New York RPS be revised to include flywheel energy storage, and other advanced storage technologies, as an eligible electric generation source. In Massachusetts, flywheel

energy storage has been eligible for Alternative Energy Certificates (AEC) that are used to meet the state's Alternative Energy Portfolio Standard ("APS") since 2009.⁸ In New York, existing RPS methodologies can be borrowed to recognize emission reductions from energy storage.

Furthermore, since July 2010 flywheel energy storage has been included in the definition of Alternate Energy Production Facility in NY Public Service Law.⁹ Alternate energy production facilities are excluded from the definition of "electric corporation" under NY PSL and therefore are exempt from New York Public Service Commission (PSC) jurisdiction and do not require a certificate of public convenience and necessity (CPCN) to begin construction. The definition of Alternate Energy Production facility includes the following types of resources, "solar, wind turbine, fuel cell, tidal, wave energy, waste management resource recovery, refuse-derived fuel, wood burning facility, or energy storage device utilizing batteries, flow batteries, flywheels or compressed air" (PSL Section 2-b). The technologies included in the alternate energy production facility definition, with the exception of energy storage resources, are eligible resources under the NY RPS. Therefore, we urge policy makers to consider adding advanced energy storage systems to the list of eligible resources under the NY RPS.

➤ **Include energy storage in transmission planning and procurement**

As discussed above, flywheels, and other advanced storage technologies, can be used to reduce transmission congestion. Utility and regional planning should evaluate energy storage as a transmission and distribution alternative. We recommend that policies allow utilities and transmission owners to recover investments in storage assets in their rate-base.

➤ **Allow storage to qualify as a Capacity resource**

Capacity procurement and markets should allow energy storage to participate in the process. Storage used for frequency regulation, and other ancillary services, enables existing fossil fuel-powered plants to dedicate greater capacity to energy production and produce power more efficiently. Traditional plants displaced by Beacon Power's flywheel-based frequency regulation can be shifted to provide a corresponding amount of added generation capacity. In addition, storage can be an effective resource for providing energy capacity at peak periods and firming the capacity from wind or other renewable resources.

⁸ Massachusetts Alternative Energy Portfolio Standard (APS), 225 CMR 16.00.

⁹ The addition of flywheels to this law was based on New York's Public Service Commission (PSC) departmental bills S.7145 Aubertine and A.10216 Cahill, which added kinetic energy storage devices -- specifically flywheels and compressed air storage -- to the alternate energy production facility definition. Governor David A. Paterson signed the legislation into law on July 21, 2010. On March 25, 2011 battery storage was added to the definition.