September 22, 2010

Secretariat
Entso-e

Re: Comments provided for ERGEG Public Consultation for Pilot Framework Guidelines for Electricity Grid Interconnection

Dear Sirs or Mesdames:

Introduction – Purpose of Beacon Power Corporations Submitting Comments

Beacon Power Corporation (BPC) www.beaconpower.com is a developer, manufacturer and seller of flywheel based energy storage systems for grid operation and stability. They can be interconnected at either transmission or distribution voltage. It is marketing and providing its technology in Europe and therefore is strongly interested in having as much harmonization and standardization in interconnection requirements across Europe as possible, as well as, a correct definition of its technology as a regulation resource. The former minimizes, or preferably eliminates, customization from country to country and latter assures that the technology is treated on a level playing field with existing and new resources providing frequency response, primary reserve, secondary reserve and other forms of ancillary services.

As described below BPC's flywheel energy storage technology acts as both a generator and demand. It functions as a device for grid operation and stability. It provides frequency regulation and response and voltage control and quality.

Technology Description

A 20 MWe Smart Energy Matrix (SEM) consists of 20, 1 MWe modules each consisting of 10 flywheels and associated electronics. Of course an installation can be made as large or as small as required by continuing to add or subtract modules. The flywheels feed power into or take power from the grid, thereby controlling the frequency at a very fast response rate, less than 4 seconds. The electronics control the flywheels and the interface between the flywheels and AC power are a series of inverters and sophisticated power electronics. A 3 MW system in New England has been operating for over a year, generating revenue and performing over 6000 equivalent full charge-discharge cycles per year. A 20 MWe system is under construction at the NY ISO and two more are planned to get underway next year in the mid-West. The SEM is particularly suited to systems with a large component of wind and/or solar generation, because of their rapid response time they can counter the short term fluctuations in wind and solar generation.

The flywheels operate between 8,000 and 16,000 rpm and an individual flywheel can provide 25 kWh of energy at 100 kw for 15 minutes. So a 20 MWe system provides 5 MWh for 15 minutes. The system can be operated in a number of ways and provide different services simultaneously.

For instance, in New England and New York they provide frequency regulation. The state of charge is managed so that the flywheels are never fully charged or discharged, but provides constant frequency regulation. This is an application that is very appropriate for the short term frequency and voltage fluctuations produced by the intermittent nature of wind and solar. There are also recent studies that show the systems effectiveness as primary reserve. It was shown that for a sudden step loss of capacity, one MWe of an SEM system (because of its fast response time) is equivalent to two or more MWe of conventional generation.

Economic Benefits

A summary list of the economic benefits the technology provides follows:

- Improves frequency response and regulation performance
- Reduces amount of regulation resources required
- Improves overall system generation efficiency
- Mitigates renewable fluctuation characteristic
- Lowers electricity cost to ratepayers
- Available alone, without base load generation
- Zero direct CO_2 emissions (no fossil fuel)
- Very low operating cost
- High reliability; 20-year life, no degradation
- Frees other regulatory generation capacity (1- 3%)

Demonstration Programs

Beacon Power Corporations flywheel energy storage technology for frequency regulation, primary reserve and secondary reserve has been operated and demonstrated in three rigorous programs supervised and monitored by expert third parties.

Beacon's flywheel technology has been successfully tested on live grids at a scale power in New York and California. The technology achieved system availability of over 97 percent, higher than the fleet average for conventional generators performing frequency regulation. Subsequent to these pilots, BPC technology has been successfully deployed at a multi-megawatt scale under ISO New England's Alternative Technologies Pilot Program. The first 1 MW system started operation in November 2008, a second 1 MW system was added in June 2009 and a third in December 2009. All resources are working very successfully and earning revenue under the Pilot Program.

The core building block of the 20 MW plant is the same design as the three 1 MW modules that are operating successfully in ISO New England's Alternative Technologies Pilot Program

In 2006, Beacon Power successfully demonstrated its ability to provide regulation to the California ISO (CAISO) through an 18-month trial sponsored by the California Energy Commission. Starting in March 2006 and continuing over a 12-month period, Beacon Power

successfully tested its flywheel energy storage technology on the New York power grid. These tests were carefully monitored by the DOE through Sandia National Laboratories and the New York State Energy Research and Development Authority (NYSERDA) and confirmed the ability of flywheels to perform frequency regulation on a very reliable and effective basis. Beacon's flywheel is a mechanical battery designed for a minimum 20-year life, capable of over 125,000 equivalent full charge/discharge cycles at a 4C (15-minute) rate, with zero degradation in energy storage capacity over time. Round-trip efficiency is high: 85 percent, and there is virtually no maintenance required in the mechanical portion of the flywheel system.

Based on the year-long test, Michael Calimano, then Vice President of Operations, New York ISO, stated: "We find the Beacon flywheel technology to be acceptable and viable for use in the New York ISO grid. We look forward to working with Beacon Power to implement this important new technology." The 20 MWe plant under construction in Stephentown is a direct consequence of this successful program.

Similarly, following the 18-month test of BPC technology on a live grid in California, John Geesman, Commissioner, California Energy Commission, was quoted as saying: "The Energy Commission is pleased at the results of Beacon's testing and the potential for use of this technology in California." The company also received a letter from Jim McIntosh, Director of Grid Operations, at the California ISO stating "The California ISO is pleased to certify that the 100kW high speed flywheel technology demonstrated by Beacon Power is an acceptable technology for potential use as a regulation resource for the power grid".

Specific Responses to the Issues Raised by ERGEG

General Issues

Answers are vitalized.

1. Are there additional major problem areas or further policy issues that should be addressed within the Grid Connection Framework Guideline?

Yes, for limited energy storage devices, such as flywheels and battery systems a separate category of regulation resource which acts as both a generator and demand and which has limited energy storage capability needs to be defined.

These technologies have operating characteristics which are different form either generation resources or demand resources. They provide regulation resources at a very high response rate (less than 4 seconds in the case of BPC's flywheels), but because of their limited energy storage the state of charge needs to be managed.

For instance, when supplying primary or secondary regulation the state of charge needs to be managed over time. This can be done by following a smoothed average of the frequency signal

and periodically adjusting the set point. If fully dispatched as primary reserve in response to an event, additional secondary regulation needs to be dispatched to recharge the device.

2. What timescale is needed to implement the provisions after the network code is adopted? Is 12 months appropriate or should it be shorter or longer?

12 months is likely appropriate, but it should occur as quickly as practicable.

3. Should harmonization of identified issues be across the EU or, perhaps as an interim, by synchronous area?

The first priority should be to harmonize them across the EU.

Grid Users related Aspects

4. Should the requirements apply to existing grid users?

In principle yes, but it needs to be recognized that some users will possibly need to be retrofitted. In some cases that may be economically unfeasible, e.g. for older wind turbines. In that case specific older designs could be grandfathered on a limited basis.

How should it be decided?

Independent studies could be carried out (at their expense) upon the application of owners of resources seeking to be grandfathered. The final decision would be made by ACER or similar authority based on the studies. Owners would have six months from the publication of the harmonized requirements to carry out the studies and then one year from a decision by ACER to implement compliance unless they were grandfathered.

To which users should the requirements apply?

See previous answer.

How should timelines for transitional periods be set?

See previous answer.

Who should bear any costs of compliance?

The entities seeking grandfathering of their equipment should bear compliance costs.

5. The framework guideline identifies intermittent generation, distributed generation and responsive demand as requiring specific grid connection guidelines.

The framework guidelines do not address limited energy storage devices which act as both generation and demand and whose purpose is to assist grid operation and stability. They should be modified to do so. In addition, at the moment, storage devices are not permitted to be owned by TSO's. However limited energy storage devices which are directed at controlling grid operation (frequency, primary reserve, secondary reserve, voltage control and quality) should be permitted to be owned and operated by TSOs and should have specific grid connection guidelines. For instance, in the US, in areas where there is no competitive market for regulation services limited energy storage devices have been defined as transmission equipment.

Is it appropriate to target these different grid users?

Yes.

How should the requirements for intermittent generation, distributed generation and responsive demand differ from the minimum requirements?

They need to take into account the specific character of the resources.

Is there a need for more detailed definition / differentiation of grid users?

Yes, see answer to the first part of this question.

Implementation

6. Is it necessary to be more specific regarding verification, compliance and reinforcement?

Yes

7. What are the key benefits and types of costs (possibly with quantification from your view) of compliance with these requirements?

No comment.

8. How should significant generation and consumption units be defined?

Limited energy storage devices like flywheels and batteries should be defined as a separate class of resource from generators and demand resources, as they have special characteristics. They have very fast response rates and are able to switch between providing up or down regulation very rapidly. They can act as both generation and demand by recycling energy form the grid.

9. For what real-time information is it essential to improve provisioning between grid users and system operators?

No comment.

Do you envisage any problems such greater transparency?

No comment.

What are the costs (or types of costs) and benefits you would see associated with this?

No comment.

Specific comments on individual grid requirements are given below.

As to BPC's present investigation of interconnection requirements: outliers seem to be: continuous 117% of nominal voltage (Denmark); 130% high-voltage ride-thru (Denmark, Spain); and 8% voltage Total Harmonic Distortion (Germany, Ireland).

As to suggestions for the future: consider any unique requirements which may be applicable to "Limited Energy Storage Resources." E.g., would low-voltage ride-thru capability really be desired if you cannot be certain whether the storage is injecting or absorbing power at the instant of the fault?

Supplemental Information

For ERGEG's and ACER's information comments provided to the California Independent System Operator (CAISO) and US Federal Energy Regulatory Agency regarding the characteristics and treatment of limited energy storage resources are are appended.

Sincerely,

William A. Franks
Director International Business Development