

# Grid-Scale Flywheel Energy Storage Plant

Demonstrating frequency regulation using flywheels to improve grid performance

Energy Storage Program

Hazle Spindle LLC

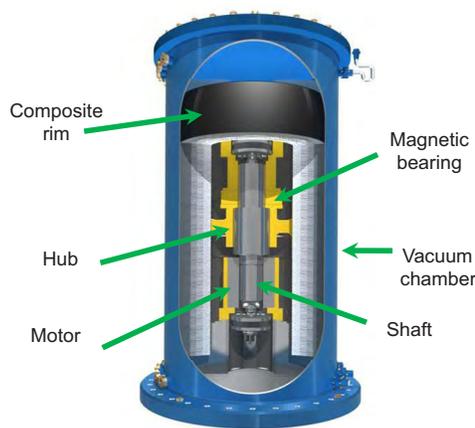
Beacon Power will design, build, and operate a utility-scale 20 MW flywheel energy storage plant at the Humboldt Industrial Park in Hazle Township, Pennsylvania for Hazle Spindle LLC, the Recipient of the ARRA Cooperative Agreement. The plant will provide frequency regulation services to grid operator PJM Interconnection.

Flywheel systems are kinetic energy storage devices that react instantly when needed. By accelerating a cylindrical rotor (flywheel) to a very high speed and maintaining the energy in the system as rotational energy, flywheel energy storage systems can moderate fluctuations in grid demand. When generated power exceeds load, the flywheel speeds up; when load exceeds generation, the flywheel is slowed to convert the energy for distribution.

The plant will provide a response time of less than four seconds to frequency changes. With availability of more than 97%, as demonstrated in earlier small-scale pilots, this technology exceeds the average availability for conventional generators performing frequency regulation.

## More About the Technology:

At the heart of Beacon Power's flywheel design is a patented high-strength carbon fiber composite rim, supported by a metal hub and shaft with a motor/generator on the shaft. Together, the rim, hub, shaft, and motor/generator assembly form the rotor. The rotor is sealed in a strong vacuum chamber and levitated magnetically, which nearly eliminates frictional losses. This technology was developed with the assistance of the Advanced Research Projects Agency-Energy.



## Benefits

- Reduces frequency swings caused by load and generation changes
- Improves grid reliability
- Increases applicability of intermittent photovoltaic and wind energy
- Responds to a control signal 100 times faster than traditional generation resources
- Produces zero emissions
- Operates at 100% depth of discharge and can operate more than 150,000 full discharge cycles
- Does not degrade over time
- Durable—system lifetime expected to exceed 20 years

## Budget

**Total Project Value:**

\$52,415,000

**DOE/Non-DOE Share:**

\$24,063,978/\$28,351,022

## Equipment

Beacon Power will install and operate 200 Gen4 flywheels at the Hazle Township facility. The flywheels are rated at 0.1 MW and 0.025 MWh, for a plant total of 20.0 MW and 5.0 MWh of frequency response.

The image to the right shows a plant in Stephentown, New York, which provides 20 MW of power to the New York Independent System Operator (NYISO) grid. This plant came online in January 2011, and has been operating at full capacity since June 2011. Each of the blue cylinders in the picture contains one flywheel.



## Timeline

- May 2011:**  
Complete construction bid documents  
Complete PJM facility study
- July 2011:**  
Complete engineering and design drawings
- November 2011:**  
Execute interconnection agreements with PJM
- December 2012:**  
Complete building permits
- January 2013:**  
Complete site clearing
- September 2013:**  
Begin operation of 4 MW of flywheel storage
- December 2013:**  
100 flywheels delivered to site
- May 2014:**  
Remaining 100 flywheels delivered to site
- June 2014:**  
20 MW of flywheel storage operational
- September 2015:**  
Complete demonstration (monitoring period)

## Goals

- Demonstrate and speed the deployment of fast-response flywheel-based frequency regulation
- Stimulate the international market demand for flywheel energy storage
- Quantify and verify the commercial viability and scalability of this Smart Grid energy storage technology
- Increase transmission capacity and reduce congestion

## Project Partners

- Beacon Power  
<http://www.beaconpower.com>
- PJM Interconnection  
[www.pjm.com](http://www.pjm.com)
- PPL Electric Utilities  
[www.pplelectric.com](http://www.pplelectric.com)

## For More Information

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## Related Reading

Sandia National Laboratories, "Energy Storage Systems Program (ESS)," <http://www.sandia.gov/ess/>.

Beacon Power, Reports and Papers,  
<http://www.beaconpower.com/products/presentations-reports.asp>.

## Importance of Energy Storage

Large-scale, low-cost energy storage is needed to improve the reliability, resiliency, and efficiency of next-generation power grids. Energy storage can reduce power fluctuations, enhance system flexibility, and enable the storage and dispatch of electricity generated by variable renewable energy sources such as wind, solar, and water power. The Office of Electricity Delivery and Energy Reliability Energy Storage Program funds applied research, device development, bench and field testing, and analysis to help improve the performance and reduce the cost of energy storage technologies.

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