

## FLYWHEEL ENERGY STORAGE FOR A MORE RELIABLE ELECTRICITY GRID AND A REDUCTION IN CO<sub>2</sub> EMISSIONS

To ensure reliability, the nation’s power grid must maintain a grid frequency of 60 Hertz (cycles/second) at all times by constantly balancing the fluctuating demand for electricity with the supply generated by power plants. This function is referred to as “frequency regulation.” Grid operators accomplish this by requiring about one percent of their generating capacity – mostly from fossil fuel-powered plants – to increase or decrease output in response to frequency deviations. Not all generators can reliably operate in such a variable way. Generators that are capable of such operation suffer a significant loss in efficiency and incur higher costs due to increased fuel consumption and maintenance. They also emit much higher levels of CO<sub>2</sub> greenhouse gas and other unwanted emissions when performing frequency regulation services.

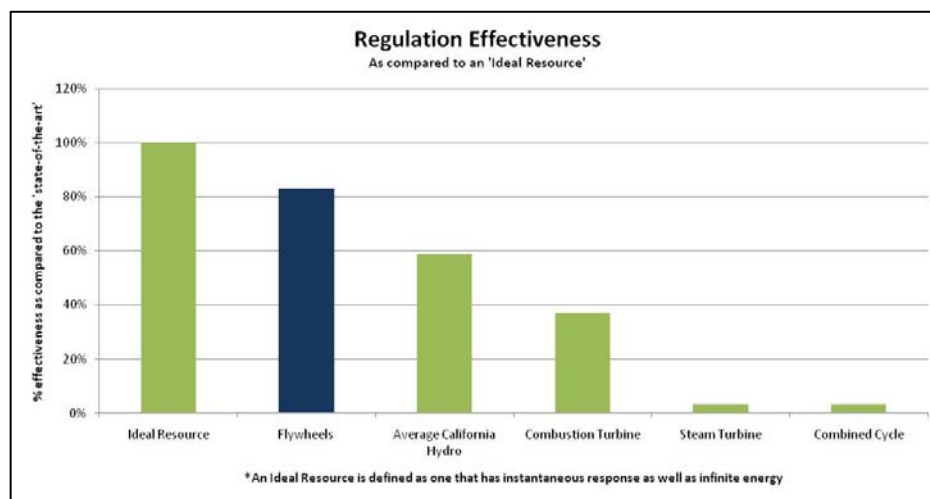
Over the last decade – and with an investment of more than \$160 million – Beacon Power Corporation in collaboration with the U.S Department of Energy (DOE), California Energy Commission, the New York State Energy Research and Development Authority, and various grid operators, has developed a flywheel-based energy storage technology to perform frequency regulation with the first 1MW going “live” in 2008.

A flywheel is a mechanical device that converts electrical energy into rotational energy, and vice versa. It consists of a large, heavy cylinder that spins inside a vacuum-sealed housing. Flywheels recycle electricity from the grid by absorbing it when the supply is greater than demand, then injecting it back when needed to meet demand, thereby stabilizing the frequency of the grid. This technology has a number of performance advantages including low operating costs, fast response, and zero direct greenhouse gas emissions.

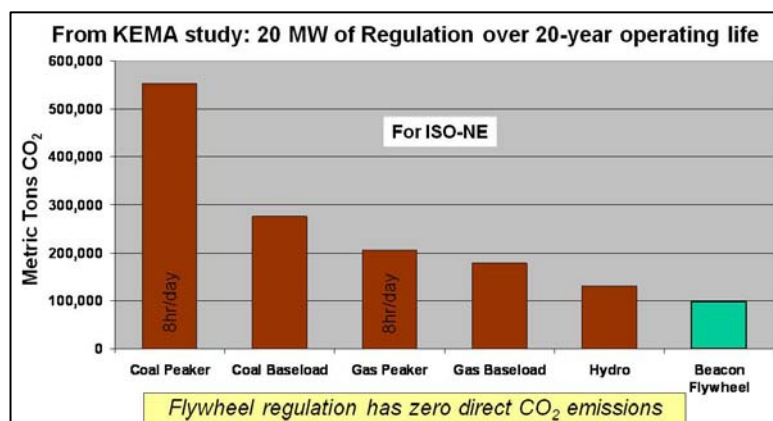


### *Benefits of flywheel technology for the U.S. power grid*

**Faster response:** Because flywheels respond much faster than conventional generators, a recent study by the Pacific Northwest National Laboratory (PNNL) shows that fast regulation may be as much as 17 times more effective than ramp limited technologies. This fast-response regulation will be especially supportive in integrating renewable energy technologies (especially wind) into the power grid, since the intermittent nature of those supplies requires an increase in regulation resources to balance energy supply with demand.



Green technology: The primary method used today for frequency regulation is to ramp fossil fuel power plants up and down, producing significant emissions. Flywheels will provide more reliable regulation, while generating zero direct emissions. This would dramatically reduce CO<sub>2</sub> emissions, as shown in the chart at right, based on a study funded by the DOE.



### ***Federal support of flywheel technology***

Beacon’s flywheel technology has already gained official recognition by the U.S. Department of Energy (DOE). Beacon’s proposed 20MW flywheel-based frequency regulation plant is among 16 finalists selected by the DOE (out of 143 pre-applications) to submit a full application to the Loan Guarantee Program authorized by Title XVII of the Energy Policy Act of 2005 (<http://www.lgprogram.energy.gov/>).

- To be eligible for selection, a project or technology must be able “...to achieve substantial environmental benefits...” and “... avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases...”
- Flywheel technology, specifically Beacon’s, was the only project selected in the category of “Electricity Delivery and Energy Reliability.”

In a letter supporting flywheel technology to Secretary Bodman of the DOE, the Massachusetts congressional delegation wrote, “We applaud your efforts to identify and carefully cultivate advanced energy technology that can benefit our energy infrastructure ...”

### ***Industrial approvals of Beacon’s flywheel technology***

Andrew Ott, Vice President of Markets at the PJM Interconnection (the nation’s largest grid operator) stated, “In approving this new technology, we recognize there are a number of important benefits. These include increased market competitiveness, technology diversity and the potential for reducing CO<sub>2</sub> greenhouse gas emissions.”

Jim McIntosh, Director of Grid Operations for CAISO stated, “We are excited about the commercial deployment of high-speed flywheel technology in California and believe it will provide better regulation services and improve grid reliability.”

Peter Smith, former President and CEO of New York State Energy Research and Development Authority stated, “NYSERDA is pleased with the successful outcome of Beacon’s frequency regulation field trial that was performed in New York, in cooperation with our partners at the U.S. Department of Energy. We look forward to continuing our role in facilitating the commercial deployment of this innovative technology within New York’s electricity grid.”