



# Flywheel Energy Storage System

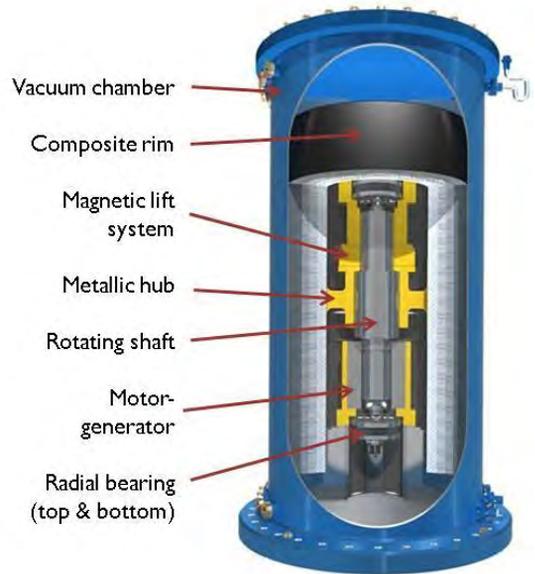
## Features

- Beacon’s proven Gen 4 flywheel energy storage technology
- Modular FESS implementation to meet specific needs
- High cycle life. 100,000 cycles at full depth of discharge
- Four quadrant inverter can deliver real and reactive power

## Primary Applications

- Frequency regulation
- Frequency response
- Solar PV & wind output smoothing
- Power quality and voltage support
- Peak shaving

## Generation 4 Flywheel



FESS Ratings*		
Configuration	Power & Energy	High Power
Capacity per flywheel	100 kW	150 kW
Energy delivery per flywheel	25 kWh	12.5 kWh
Discharge time at rated capacity	15 minutes	5 minutes

\* Can be configured for any power and energy value in between

Advantages	Benefits
<b>High performance:</b> Less regulation needs to be purchased. Existing resources can operate more efficiently. Enhances renewable integration	<ul style="list-style-type: none"> <li>• Lower cost to load for regulation and energy</li> <li>• Less emissions to the environment</li> <li>• Lower existing unit maintenance costs</li> </ul>
<b>High cycle life:</b> 100,000 equivalent full charge/discharge cycles over a 20 year design life	<ul style="list-style-type: none"> <li>• Low cost: \$/MW per full charge-discharge cycle</li> <li>• High availability and limited O&amp;M scope and cost</li> <li>• Reduced life cycle costs</li> </ul>
<b>No degradation:</b> Energy storage capacity and performance does not degrade with cycle duty, depth of discharge, charging rate, time or temperature	<ul style="list-style-type: none"> <li>• No decrease in performance over asset life</li> <li>• No need to oversize the system</li> </ul>
<b>Flexible:</b> Capable of charging as fast as it discharges and switching power direction almost instantaneously	<ul style="list-style-type: none"> <li>• Increased system availability</li> <li>• More frequency regulation mileage available</li> </ul>
State-of-charge is accurately known at all times	<ul style="list-style-type: none"> <li>• Predictable operation</li> </ul>
State-of-health monitoring system	<ul style="list-style-type: none"> <li>• Key parameters continuously monitored</li> <li>• Condition-based maintenance</li> </ul>
No direct air emissions, no air permits or water use. NEPA evaluation: “Findings of No Significant Impact”	<ul style="list-style-type: none"> <li>• Rapid siting</li> </ul>

Specification	Value
<b>Design Life</b>	20 years or 100,000 full depth of discharge cycles
<b>Electrical Interface</b>	
Input / Output Voltage	480 VAC
Input / Output Real & Reactive Power	Up to 150 kVA continuous power at any power angle
Frequency	50 Hz or 60 Hz
Standby Loss	0.03 MWh / MW / hour
Round Trip Efficiency	85 %
Response Time	<1 second to full power
<b>Mechanical</b>	
Flywheel Rim Material	Comingled carbon and E-glass fiber composite (patented)
Flywheel Motor / Generator	Permanent magnet synchronous
Flywheel Magnetic Lift System	Combination of permanent and electro magnets
Flywheel Vacuum Level	<1 Millitorr
Flywheel Operating Rotational Speed	8,000 to 16,000 RPM
Flywheel Dimensions	82 in (208 cm) height x 47 in (120 cm) diameter
Modular Electronics & Cooling Dimensions	40 in (101 cm) x 40 in (101 cm) x 60 in (152 cm)
<b>Environmental</b>	
Temperature Range	-35C to +40 C
Humidity	Up to 95% (non-condensing)
Flywheel Installation	Below ground in concrete housing
Seismic Capability	Sds 2.0g Per IBC 2012
Noise Level	45 dBA standard and Ldn of 50 dBA
<b>Communications and Monitoring</b>	
Driving Signal	Receives DNP3 (or other standard protocols) signal from the operator. Or self managed based on frequency
Monitoring	Internet based in compliance with NERC Standards
Data Storage	Full trending and analysis. Data stored locally and offsite
<b>U.S. Patents</b>	
6,710,489; 6,747,378; 6,817,266; 6,824,861; 6,852,401; 6,884,039; 6,959,756; 7,034,420; 7,174,806; 7,365,461; 7,679,247; 8,008,804; 8,314,527 (other U.S. and international patents pending)	



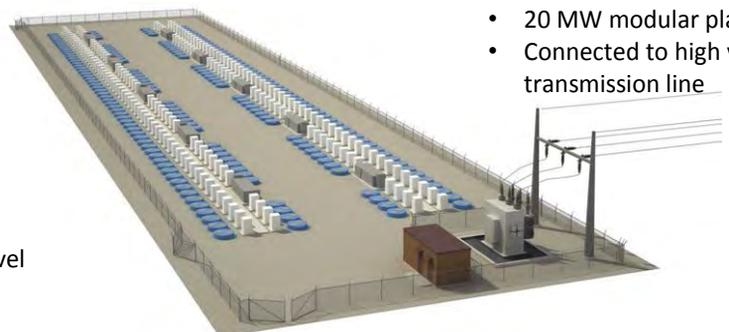
**Flywheel assemblies arriving at a plant site**



**Integrated power and control electronics and ancillary equipment**

## System Characteristics

- No direct fuel or emissions – typically permitted locally like a substation
- Unmanned installation, remotely operated
- Modular design results in high availability
- Can be sized from 100 kW to any power level



## Typical Installation

- 20 MW modular plant
- Connected to high voltage transmission line