Established in January 2003 with the purpose to produce and globally market flywheel based energy storage systems.

The largest UPS independent flywheel energy storage company in the world

OEM Supplier to all Major UPS suppliers for “battery-free” solutions.

Also supplier to electric rail market with first project to capture regenerative energy from braking trains in LACMTA.

Over 1000 systems installed over 12 million field cycles of operation, 13 major patents for the design of the flywheel systems

100% acquired by Calnetix Technologies in 2014
• Founded in 1997 in Cerritos, Ca. The four founders are still with the company today

• Comprised of 4 Business Units, each with a Business Unit Leader/GM reporting to single CEO / President

• Private, closely held company
  – 120 Employees
  – 60,000 square feet manufacturing and office space in own building
  – $80M in revenue

• 3 Strategic Sales Executed
  – Direct Drive Systems – to FMC  $140+M
  – Access Energy for combustion engines – to GE  $50+M
  – Waste Heat Recover Systems in Japan – to Daiichi Japan $40M
Calnetix – Core Technologies and Products

Calnetix Electric Motor Generators
- Magnaforce™ Permanent Magnet Motor Generators

Calnetix Power Electronics
- Vericycle™ Bidirectional Drives
- Vericycle™ Modules

Calnetix Active Magnetic Bearings
- Powerflux™ Magnetic Bearings
- Xcelflux™ High Performance Magnetic Bearings
- Insight™ Magnetic Bearing Controllers

Calnetix Custom Integrated Subsystems
Custom designs:
- Housing
- Cooling systems
- Couplings
- Other interfaces

Products are based on IP from our core technologies developed over 15 years.
Technology Focused....
Industry Agnostic.
**Calnetix - Services**

**Product Development**
- Electromagnetic Analysis and Design
- Mechanical, Rotordynamic and Stress Analyses
- Embedded Control System Design
- Power Electronics and Motor Controller Design

**System Integration**
- Full System Integration
- Preliminary Design Review
- Detailed Design Review
- Fabrication and Testing

**Manufacturing**
- High-Performance Stators and Permanent Magnet Rotors
- Motor Assembly and Test
- Electronic Assembly and Test
- Inspection and Quality Control
Focused approach to developing, producing and servicing products that meet customer expectations and further advancing our technology in line with customer demand and market trends.

### Business Units

<table>
<thead>
<tr>
<th>Energy Storage</th>
<th>Heat Recovery</th>
<th>Electric Turbo</th>
<th>Industrial</th>
</tr>
</thead>
</table>

[Images of Energy Storage, Heat Recovery, Electric Turbo, and Industrial units]
Higher Operating Temperature Requirements – In order to reduce cooling cost (electricity consumption) companies are looking at pushing the operating temperature of the data center higher, thus equipment, including energy storage must be tolerant of these environments

Higher Efficiency in the Power Chain – Utilization of higher efficiency UPS and server power supplies to reduce electrical consumption. New generation of UPS providing 97% efficiency in double conversion mode. Line-Interactive modes delivering 99% efficiencies. 400Vac distribution and 380Vdc distribution are now considerations.

Higher Power Density – High performance servers utilizing virtualization is increasing power usage per rack. This is driving need to fit more power in the same physical space.

Scalability – Day one requirements are often far below total capacity of the data center design. Ability to scale infrastructure to optimize performance and save capital expense is desirable.
**Focus On Continuous Power, not a set amount of Run Time** – Requirement for 10-15 minutes of battery has changed. Most clients understand the most important back-up time is the transition from utility failure to generator back-up which occurs in seconds instead of minutes. What they seek is a more reliable, predictable energy storage during this transition. Alternative energy also being deployed or incorporated into designs. (Wind, solar, fuel cell). Even some consideration being given to removal of back-up gensets for some data center applications.

**Greening of the Data Center** – Data Center operators under pressure to reduce carbon footprint leading to solutions that are best in class in efficiency and sustainability. Removal of toxic materials from the work environment.
Flywheel DC Energy Storage

- A flywheel stores energy by spinning a mass (flywheel).
- Reliable DC power is delivered utilizing the kinetic energy stored in the high speed flywheel.
- Is a mechanical battery.
A Typical UPS System Block Diagram is shown. The diagram includes the following components:

- **Utility AC**: 480 VAC
- **Genset AC**: Long-term AC alternate source
- **Rectifier AC/DC**
- **Inverter DC/AC**: 540 VDC (flywheel and power converter)
- **Automatic Transfer Switch**

The diagram illustrates the flow of power from the Utility AC through the Automatic Transfer Switch, Rectifier AC/DC, and Inverter DC/AC to provide critical AC output. The 540 VDC is indicated as the power source for the Inverter.
## Flywheel Battery Comparison

<table>
<thead>
<tr>
<th>Feature</th>
<th>VYCON Flywheel</th>
<th>Lead Acid Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance</td>
<td>Minimal / Annual</td>
<td>Frequent / Quarterly</td>
</tr>
<tr>
<td>HVAC costs</td>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td>Availability (MTBF)</td>
<td>&gt;50,000 hrs</td>
<td>&gt;2,200 hrs</td>
</tr>
<tr>
<td>Life expectation</td>
<td>20 years</td>
<td>3-4 years</td>
</tr>
<tr>
<td>Installation cost</td>
<td>Low</td>
<td>Med to High</td>
</tr>
<tr>
<td>Hazardous materials</td>
<td>None</td>
<td>Lead &amp; Acid</td>
</tr>
<tr>
<td>Toxic, explosive gas emissions</td>
<td>None</td>
<td>Hydrogen</td>
</tr>
<tr>
<td>Footprint</td>
<td>Small</td>
<td>Large to very large</td>
</tr>
<tr>
<td>Diagnostics / monitoring</td>
<td>Accurate</td>
<td>Speculative</td>
</tr>
<tr>
<td>Disposal requirements</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>Fire hazard permitting</td>
<td>None</td>
<td>Often</td>
</tr>
</tbody>
</table>
**Max Power Rating:**
- 300kW

**Max Energy Storage Rating:**
- VDC-XE: 4000kW secs
- VDC-XXE: 6000kW secs

**Footprint / Weight:**
- 6.25 sq ft (.58m²)
- 1783 lbs (794kg)
- Rolls on Casters

**Standard Features Include:**
- DC Breaker
- 4 line display
- Top or bottom cable entry

**Options Include:**
- Touch Screen GUI
- MOD Bus
- Customer Interface Board
Next Generation In Flywheel Design

- “Mechanical battery” – stores energy by spinning a mass, produces high power output for short duration (10-30 seconds)
- Dual Mode Motor / Generator – converts kinetic energy into electricity when needed, quickly charges (converts electricity into kinetic energy) to be ready for next event
- Five-axis active magnetic levitation – eliminates any bearing maintenance, no fiction losses.
- Efficient – high speed permanent magnet motor/generator in a low friction environment
- Key Benefit – 20 year operating life with no flywheel maintenance
VDC – Simplified One Line

To UPS Battery Input

Soft Start

IGBT Power Converter

DC Monitoring

Motor Generator Controls

Power Conversion Module Controller

Magnetic Levitation Controller

User GUI
Inside the VDC

- IGBT Bi-Directional Converter
- Magnetic Levitation Control Module (MBC)
- Redundant power supplies
- Flywheel Controller Module
- Top- or bottom- entry
- Redundant fans
- Flywheel module
- DC breaker
- Vacuum pump
Typical UPS System Block Diagram

- **Genset AC**
- **Utility AC**
- **Rectifier AC/DC**
- **Inverter DC/AC**
- **Automatic Transfer Switch**
- **480 VAC**
- **480 VDC**
- **Critical AC Output**
- **VDC** (flywheel and power converter)

- Long-term AC alternate source

Proprietary and Confidential
Typical UPS System Block Diagram

- **Genset AC**: Long-term AC alternate source
- **Utility AC**: 480 VAC
- **Rectifier AC/DC**: Genset Start Signal
- **Inverter DC/AC**: 540 VDC
- **Flywheel Module**: DC/AC
- **Critical AC Output**: Bi-directional IGBT converter
- **Auxiliary Power (Protected AC source for flywheel controls and vacuum pump)**
- **Graphical Control Interface**
- **Remote Monitoring**

**Key Components**:
- **Automatic Transfer Switch**
- **Graphical Control Interface**
- **Remote Monitoring**
- **VDC (flywheel and power converter)**
Basic Operational Sequence

- **Genset AC**
- **Utility AC**
- **Rectifier AC/DC**
- **Inverter DC/AC**
- **Flywheel Module DC/AC**
- **Critical AC Output**
- **Auxiliary Power (Protected AC source for flywheel controls and vacuum pump)**

**Long-term AC alternate source**

**Genset Start Signal**

**Automatic Transfer Switch**

**Time Line**

**480 VAC**

**Graphical Control Interface**

**Remote Monitoring**
Basic Operational Sequence

UPS System

- Rectifier AC/DC
- Inverter DC/AC
- Automatic Transfer Switch
- Genset AC
- Utility AC
- Critical AC Output

Graphical Control Interface
Remote Monitoring
Auxiliary Power (Protected AC source for flywheel controls and vacuum pump)

Time Line
- Utility Outage
- Genset Start
- 2 sec.
- 6 sec.
- 2 sec.
- 2 to 15 min

Auxiliary Power

VDC (flywheel and power converter)
Parallel Operation

- Parallel for either higher capacity (power), run time or redundancy
- No communication required for paralleling due to “droop” sharing methodology

Long-term AC alternate source

Genset AC

Automatic Transfer Switch

Utility AC

480 VAC

UPS System

Rectifier AC/DC

Inverter DC/AC

540 VDC

Critical AC Output

VDC (flywheel and power converter)
# VYCON Flywheel MTBF

| VDC Installed Base (as of April 2015) | 832 units |
| Date of 1st Installation             | 4Q2005    |
| Primary Application                  | UPS/Power Quality |
| Total System Field Operating Hours   | 16,959,520 |
| MTBF (hours) at 95% Confidence level | 67,522    |
| Unit Availability based on downtime  | 99.999%   |

![Global Consumption By Market Segment](image)

**Global Consumption By Market Segment**

- Medical/Healthcare: 57%
- Data Center: 3%
- Gaming: 10%
- Broadcasting: 5%
- Rail: 4%
- Crane: 3%

Confidence level: likelihood, expressed as a percentage, that the data is real and repeatable, and not just random.

Total operating hours are estimated based on unit start-up date.

Proprietary and Confidential.
# 15 Year Operating Costs

## SE EPS8000 / VYCON

<table>
<thead>
<tr>
<th>800kVA / 720kW UPS Module</th>
<th>2 Flywheels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>Year 2</td>
</tr>
<tr>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>2 x VDC XKE (680kW Max Power - 10 seconds)</td>
<td></td>
</tr>
<tr>
<td>Required Maintenance</td>
<td>$0</td>
</tr>
<tr>
<td>Air Filter Replacement</td>
<td>$190</td>
</tr>
<tr>
<td>Vacuum Service</td>
<td>$221</td>
</tr>
<tr>
<td>Bearing Replacement</td>
<td>N/A</td>
</tr>
<tr>
<td>Vacuum Pump Replacement</td>
<td>$4,350</td>
</tr>
<tr>
<td>Fan Replacement</td>
<td>$1,239</td>
</tr>
<tr>
<td>Energy Cost (Parasitic loses @ $.04 per kWhr)</td>
<td>$1,051</td>
</tr>
<tr>
<td>Total Cost Per Year</td>
<td>$1,463</td>
</tr>
<tr>
<td>Accumulated</td>
<td>$1,463</td>
</tr>
<tr>
<td>3 x VDC XE (720kW Max Power - 15 seconds)</td>
<td></td>
</tr>
<tr>
<td>Required Maintenance</td>
<td>$0</td>
</tr>
<tr>
<td>Air Filter Replacement</td>
<td>$286</td>
</tr>
<tr>
<td>Vacuum Service</td>
<td>$332</td>
</tr>
<tr>
<td>Bearing Replacement</td>
<td>N/A</td>
</tr>
<tr>
<td>Vacuum Pump Replacement</td>
<td>$6,525</td>
</tr>
<tr>
<td>Fan Replacement</td>
<td>$1,859</td>
</tr>
<tr>
<td>Energy Cost (Parasitic loses @ $.04 per kWhr)</td>
<td>$1,577</td>
</tr>
<tr>
<td>Total Cost Per Year</td>
<td>$2,194</td>
</tr>
<tr>
<td>Accumulated</td>
<td>$2,194</td>
</tr>
</tbody>
</table>

**Note:** The numbers in the table are indicative and subject to change based on actual operating conditions.
Mission Critical Protection For.....

**Data Centers**
- Web Hosting
- Corporate
- Financial / Banks
- Universities

**Healthcare**
- IT / Patient Records
- Imaging Suites
- Surgical Suites
- Labs / R&D

**Gaming & Automation**
- Data Center
- Gaming Machines
- Security Systems
- Software

**Broadcasting**
- TV / Radio
- Studios
- Transmitters
Medium System – Development Lab

Site Specifics:
- 500kVA UPS
- 3 x VDC XE’s
- Ride thru to generator

Decision Drivers:
- Green initiatives
- Simple installation
- Limited space
- Limited cooling capacity
Medium System
Proton Therapy Center

Site Specifics:
• 2 x 750KVA/675kW UPS
• 8 VDC XE flywheels
• No Batteries

Decision Drivers:
• Small footprint
• Reduced Maintenance Cost
Medium System
Education Data Center

Site Specifics:
- 4 x 825 kVA UPS systems
- 16 VYCON VDC XE flywheels

Decision Drivers:
- Easily expandable, scalable
- Reduced maintenance costs
- Size & weight
- Improved reliability
- Green solution
Large System – Cloud Data Center

Site Specifics:

- 24 x VDC XE’s (7.2MW)
- Ride thru to genset: capacity for 17 seconds runtime
- No added cooling systems required

Decision Drivers:

- Green initiatives
- Simple installation
- High power density
- Large space saving
Modular Solution

Site Specifics:
- 5 x 300 kW VDC XE’s
- 1100 kVA UPS
- Installed in container outside of building

Decision Drivers:
- Modular
- Minimal maintenance
- No bearing changes
- Small floor space
- Green solution
Mobile / Containerized Solutions
Summary

- Total Cost of Ownership (TCO) Savings
- No Bearing Maintenance or Bearing Replacements
- OSHPD Seismic Listed / Certified
- High Reliability / Predictability
- Green / Sustainability
- Minimal Maintenance
- High Efficiency 99.4%
- High Power Density
- Simple Installation
- 20 Year Lifespan
- Small Footprint