



# Intelligent Flywheel Technology

High Power Storage Systems

**Gerotor**<sup>®</sup>

## Background

### Unique Success Story

#### Flywheels in General

Flywheels are well known to be an energy storage technology offering high power density, millions of charging and discharging cycles, high reliability, no capacity decrease, and very long lifetimes, while using non-flammable and non-toxic materials. However, there is no flywheel today that can serve a wide range of industrial applications. Gerotor is filling this gap.

#### Flywheel advantages:

- High power density
- High efficiency
- Minimal maintenance effort
- 20-year lifespan
- Unlimited number of cycles
- No dangerous or harmful substances
- Recyclable materials used

#### About Gerotor

The Gerotor flywheel technology is rooted in the Kinetic Energy Recovery System (KERS) that the Formula 1 introduced back in 2008. The Gerotor founding team was part of this development and set out to create one of the smallest and most powerful flywheels that ever existed to regenerate braking energy. Based on this know-how, the Gerotor team developed a flywheel to meet industrial requirements.

Over the past five years, Gerotor has been developing its flywheel technology, optimising its sub-systems and identifying crucial steps that need to be taken in order to become a world leader in flywheel energy storage systems.

Gerotor has built a flywheel solution that offers scalability and serial reproducibility. When designing our flywheel, our engineers were guided by principles of automotive product design facilitating automated mass production through the use of standard components and smart engineering. Due to numerous improvements, our High Power

Storage (HPS®) flywheel represents one of the largest technological advancement in the flywheel industry in the last few decades. The HPS excels where other flywheel storage technologies are not suitable. This gives us the opportunity to support a wide range of companies, which otherwise might not be able to increase the energy efficiency within their operations.

#### A unique innovation - Gerotor HPS flywheel:

- Life cycles proven with more than 35 million cycles in one application
- Smallest flywheel storage unit available on the global market today
- Up to 50.000 rpm, providing up to 50 kW peak power per HPS unit
- Very fast reaction time in few ms thanks to specific high-power electronic converters
- Self-tuning efficiency (StEff-Control) software to apply HPS unit to various applications automatically

## Global Technology Leader

Breakthrough Flywheel Energy Storage Systems / FESS

For organisations looking to enhance energy efficiency, high power storage offer some of the best opportunities for game-changing advancement. Whether you are developing a sustainable machine, operating a production plant or an isolated microgrid, storage technologies from Gerotor deliver new levels of flexibility and reliability to help you meet your energy goals.



**Intelligent  
Control Software  
with Self Tuning  
Efficiency**

+



+

**Latest High  
Power Converter  
Technology**

### HPS® High Power Storage

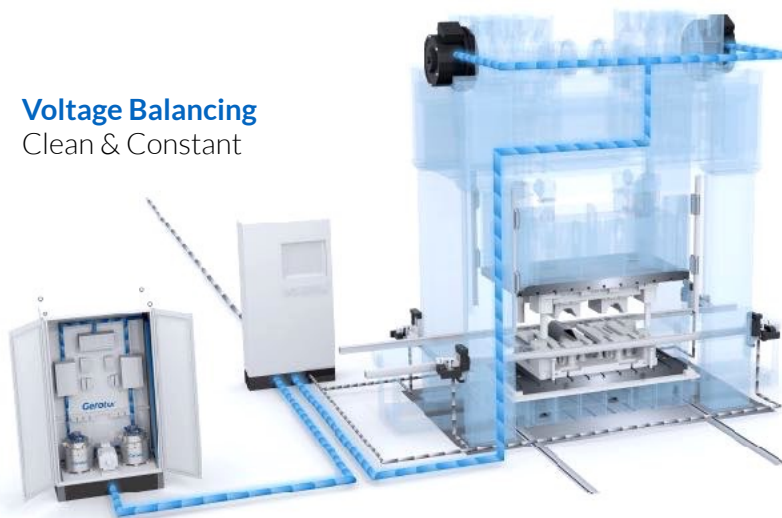
The compact single flywheel with 50 kW enables Gerotor to offer the lowest cost of ownership solution for a high power storage system in the market. Gerotor's approach is to supply a fully-fledged energy storage system to industrial applications based on smart, adaptable and standardized flywheels.

### HPB® High Power Block

The combination of multiple HPS modules into a swarm solution with our leading artificial control intelligence is our innovative cutting-edge and versatile high power block technology. Due to the modular approach, we can offer MW dimensions to meet your requirements.



**Voltage Balancing**  
Clean & Constant



**Energy Consumption**  
Less CO2 & Costs



**Cloud Services**  
Predict, Measure & Analyse

*Example: 100 kW Gerotor  
HPS® system integrated (DC)  
into a modern servo press*

## Functions, Applications & Benefits

### The Gerotor Effect

As part of a holistic energy strategy, the Gerotor system is a flexible energy storage that increases the efficiency of your application with multiple functions:

#### Power Management



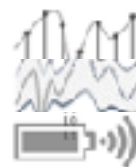
Load Shifting  
- Recuperation  
- Peak Shaving  
Reactive Power

#### Power Quality



Dip  
Swell  
Impulse / Spike  
Flicker  
Frequency  
Unbalance  
Harmonics  
Interruptions (< 3 sec)

#### Power Monitoring



Behavior Tracking  
Load Prediction  
Cloud Services

Our high power storage solutions can be used for a wide variety of applications and functions:

Applications	Functions			Main Benefits
	Power Management	Power Quality	Power Monitoring	
<b>System Integrated*</b> <ul style="list-style-type: none"> <li>• Machines</li> <li>• Batteries</li> <li>• Fuel Cells</li> <li>• Generators</li> </ul>	+++ +++ +++ +++	++ n.a. n.a. ++	++ n.a. n.a. ++	Lower total costs of ownership (TCO), Reduction of consumption and emissions; Extended system lifetime;
<b>Grid Integrated**</b> <ul style="list-style-type: none"> <li>• AC Plant Grids</li> <li>• DC Plant Grids</li> <li>• Off- &amp; Island Grids</li> </ul>	+ +++ +++	+++ ++ +++	+++ + ++	Production interruption prevention (PIP); Improved overall equipment efficiency (OEE); Effective exploration of renewables; Increased grid efficiency;

\* Mostly DC networks

\*\* Mostly AC networks

## Storage Solutions & Support Services

A Successful Collaboration - Right from the Start

To be reliable, safe and future-proof, our energy storage solutions are designed with the end-user in mind. Gerotor high power storage solutions include both, the technologies and the services needed to ensure smooth long-term operation. Our solutions are built upon a rock-solid foundation of several years of lessons learned in design, deployment and operation of complete energy storage systems.

### Full Service for Maximum Customer Satisfaction

Gerotor is the right partner to help you take advantage of the many benefits of power solutions. As a leader in high power storages and a strong energy advisor, we understand modern energy markets and the technologies as well as strategies that drive them. We put this knowledge to work to help you solve energy challenges and achieve your energy goals.

We have developed solutions and services for commercial, industrial and institutional customers of all kinds. With our wide range of

competencies, we are able to support our customers along the whole value chain.



Our comprehensive approach is based on three pillars:

#### Evaluation

- Power demand analysis
- Electrical measurements on customer site
- Independent evaluation & solution modelling

#### Development

- Power solution conception & manufacturing
- Development & implementation of control system
- Integration & Commissioning

#### Operation

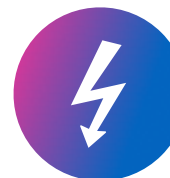
- Maintenance
- Power-as-a-Service models
- Digital services



Evaluation



Development



Operation

*We accompany every project with suitable service and maintenance plans. An annual maintenance can be carried out by the customer's trained staff, and detailed inspections should be carried out by authorized partners or by Gerotor. A continuous system diagnosis in real time can be analyzed via our Gerotor Cloud.*



## Modularity

Get your perfect fit

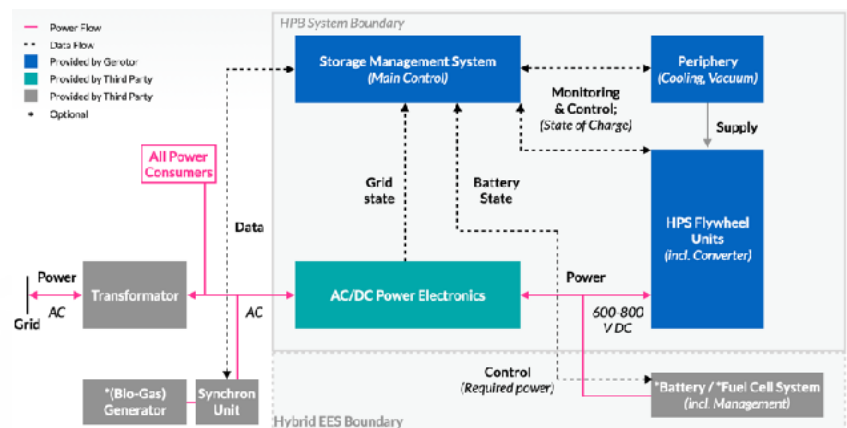
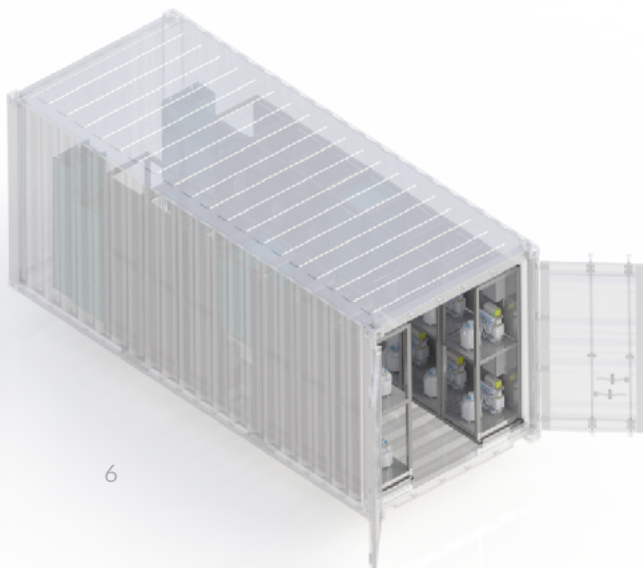
A power storage solution from Gerotor is designed, built and supported according to your needs. Based on our HPS technology, we offer technologies and services that can be tailored to fit to your application and infrastructure.

Systems		HPS 50	HPS 100	HPB 200	HPB 1000
Flywheel Units (Stacked)		1	2	4	20
Power Nominal (Max.)	kW	50	100	200	1.000
Capacity	kJ	95 - 235	190 - 470	380 - 940	1,900 - 4,700
Voltage (AC / DC Integratable)	DC	560 - 850			
	AC	400 / country specific requirements			
Frequency	Hz	50 / 60			
HPS System Efficiency**	%	85			
Full Cycle Stability***		Infinite			
Communication		EtherCAT, PROFINET, PROFIBUS (More protocols on request)			
Dimensions (L*W*H)	mm	600x600x500	600x600x1.000	600x600x2.000	20 ft. Container
Weight	kg	80	160	320	3.000

\* Depends on system configuration

\*\* For flywheel and its DC power electronics

\*\*\* 35 Millions of charging and discharging cycles proven



## Competencies, Awards & Partnerships

Transform Your Energy Strategy with Gerotor

With long term industry know-how, insights, and experience our team and network is ready to make your project a success.

### 11 team members (Ø-age 39)

- 2 Business Administration
- 8 Engineers & Scientists
- 1 External Specialists

### Advisors

- 2 Scientific Advisors
- 1 Financial Advisors
- 1 Market Advisor

*We take on all relevant project management and engineering services to offer you the "turnkey solution".*

### Awarded Innovation



### Existing Partnerships & StEff-Control Research Alliance



*StEff: Self-Tuning Efficiency Control is a world leading innovation for energy storage control with artificial intelligence based algorithms, enabling us to apply our systems to applications in a smart way.*

## Leading Edge Technology!

*"Gerotor has extensive expertise and all the prerequisites needed to become the hidden champion for energy efficiency in the global industry."*

**Prof. Dr.-Ing. Walter Kunerth**

Siemens AG

Former Member of the Executive Board

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The information in this document contains general descriptions of technical options available, which do not always have to be present in individual cases. The required features should therefore be specified in each individual case at the time of closing the contract. The document contains a general product overview. Availability can vary by country. For detailed product information, please contact the company office or authorized partners.

**Gerotor®**
















## Appendix

### Use Cases & Key Advantages




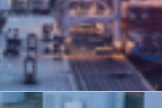

In the following is an extract of use cases and customer applications. The applications displayed are divided into two segments: system integrated and grid integrated. All applications benefit from:

- Increased energy efficiency with positive environmental impact
- Digitalized energy behaviour

#### System Integrated

	<b>Servo Presses</b>	Reduction of connected load up to 60%; Regeneration of waste energy up to 50%;
	<b>CNC Machines</b>	UPS in unstable grids; Downsizing of electrical periphery up to 40%; Increased energy utilization up to 25%;
	<b>Automation &amp; Robotics</b>	Optimization of energy distribution between electrical consumers; Minimization of power failures & down-times;
	<b>Elevators</b> (Category 4-6, Linear)	Reduction of energy cost; Downsizing of electrical periphery; Backup power for safety mode of elevator system;
	<b>Intralogistics</b>	Reduction of energy cost; Downsizing of electrical periphery; Backup power for safety mode of lifting system;
	<b>Port Cranes</b> (STS, RGTs)	Recuperation while lowering the weight; Decrease of CO <sub>2</sub> emissions and significant savings of energy costs;
	<b>Fuel Cells</b>	Smooth rating of fuel cell power output for higher availability; Fast response time to load changes;
	<b>Batteries</b> (Redox Flow, Li-Ion)	Higher ROI due to increasing lifetime by factor 3; Minimization of charging stress; peak shaving enables system down-sizing;
	<b>Generator Sets</b>	Smooth load balancing leads to significant fuel savings, less CO <sub>2</sub> emissions and increase in lifetime; Down-sizing possible;
	<b>Wind Power</b>	Improved wind harvesting through better pitching / load management; Balanced power grid infeed;
	<b>Wave Power</b>	Higher overall power deployment through balanced power grid infeed due to instant load shifting;
	<b>Offshore-Stabilizing Systems</b>	Optimized load profile for efficient smoothing of wave motion; Better industrial offshore operation & higher customer comfort;
	<b>Amusement Rides</b>	Increased system efficiency with less energy consumption; Lower connected power needed; Ideally suited for linear drives;

## Grid Integrated

	<b>AC Industry Plant Grids</b>	Reliable power supply for uninterrupted productivity; Optimizing energy ownership from integration of renewable;
	<b>DC Industry Plant Grids</b>	Reduced peak loads and immediate power balancing; Enhanced security of power supply; intermediate for energy flexibility;
	<b>Off- &amp; Island Grids</b>	Voltage stabilization and improved grid availability; Minimization of grid failures; Higher degree of energy utilization;
	<b>Port Grids</b>	Higher power reliability and energy flexibility; Optimized integration of sustainable energy solutions (e.g. Power-to-X);
	<b>Rail Substation</b> ( <i>Light Rail, Maglevs</i> )	Energy savings due to regeneration of braking energy; Reduction train weight due to less braking resistors on-board;

Your application is not listed? Please contact us, we are looking forward to it.

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