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FLYWHEEL ENERGY STORAGE



PRODUCT BROCHURE

Beijing Honghui International Energy Technology Development Co., Ltd.

World-Leading Provider of Flywheel Energy Storage Equipment

CE Certified 2026 Edition



Introduction

In a world prioritizing sustainability and efficiency, Honghui Energy Technology Co., Ltd. stands out with its advanced flywheel energy storage solutions. As a leading innovator in China, Honghui provides high-power vacuum magnetic levitation flywheels energy storage system and supports a wide range of applications, including frequency regulation, microgrids, data centers, and high-power industries. Partner with us to drive a sustainable future through cutting-edge energy technology.

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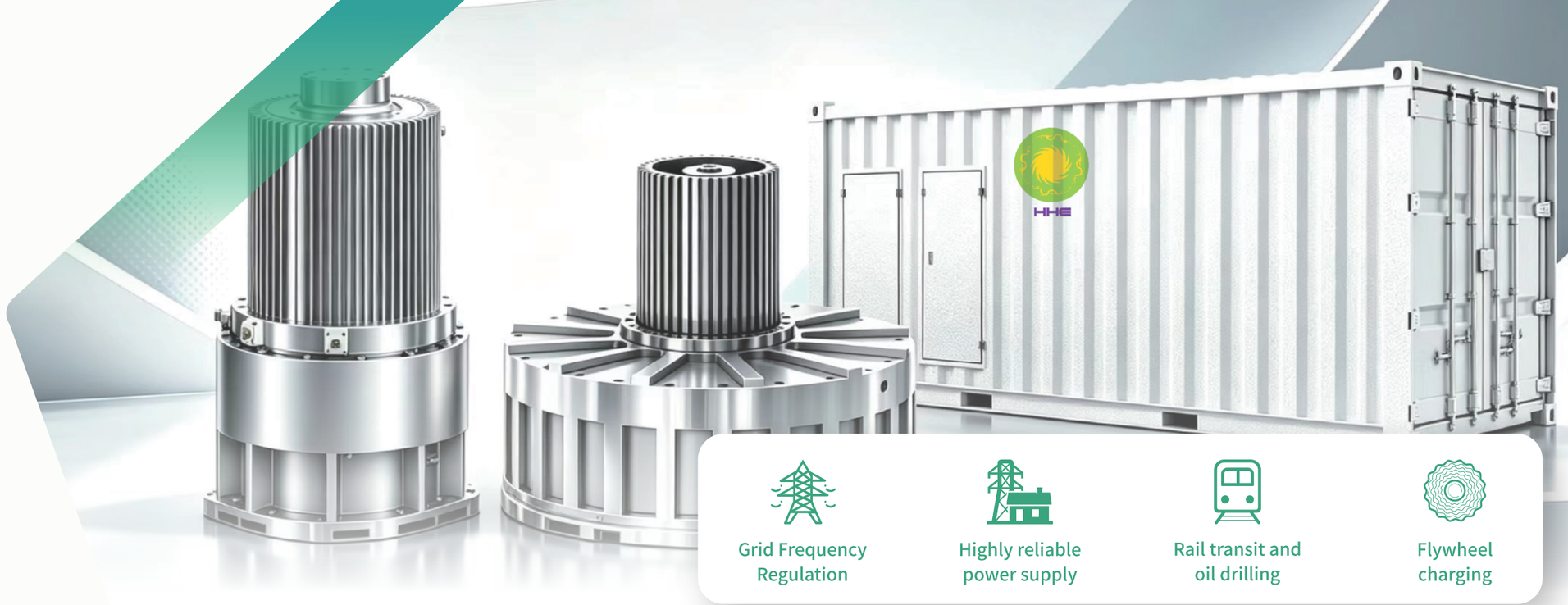
COMPANY PROFILE



Grid Frequency Regulation

Highly reliable power supply

Rail transit and oil drilling

Flywheel charging

The Company is dedicated to the R&D, manufacturing, sales and full life-cycle service of high-power vacuum magnetic-levitation flywheel energy storage equipment, delivering integrated solutions in energy-storage frequency regulation, intelligent computing centers, energy conservation and consumption reduction, and power-quality management for customers across industries. Honghui Energy's flywheel technology derives from aerospace heritage. Through sustained focus on the flywheel energy storage sector, the Company has continuously overcome core technical challenges in magnetic-levitation flywheel energy storage, achieved multi-tier breakthroughs including single-unit equipment array integration, and has fully mastered the core independent intellectual property rights of magnetic-levitation flywheel energy storage systems. Its technology has been engineering-validated across multiple application scenarios and successfully deployed to serve customers across numerous fields worldwide.

The Company holds more than one hundred authorized intellectual property rights in aggregate and has been recognized as a National Intellectual Property Advantage Demonstration Unit. It also leads a national-level R&D program and has taken the lead in drafting a national standard, driving the standardized development of the industry through technical strength.



Beijing Headquarters & R&D Center



Guangdong Zhongshan Power Electronics R&D & Manufacturing Base



Hebei Tangshan Production Base



Jiangsu Qidong Production Base

DEVELOPMENT MILESTONES

2015

Company founded; strategic positioning established as a flywheel energy storage technology provider.

2016

Independently developed high-power flywheel magnetic bearings and control technology.

2017

Won a wafer-fab order in Chengdu.

2018

Successfully delivered a customized 16 MW, 10 kV flywheel critical power supply system.

Successfully delivered a flywheel energy-recovery system for a CNPC drilling-platform microgrid. Successfully developed an application for an edge-computing modular data center.

2019

Successfully delivered a flywheel UPS mobile power vehicle to State Grid Shunyi. Successfully developed a single-unit 5 MW flywheel energy storage device.

2020

Led the drafting of China's first flywheel energy storage industry group standard.

Obtained CRCC certification and Zhongguancun "First Set" (first unit) product recognition.

Undertook an Inner Mongolia MW-class flywheel energy storage major science and technology program.

2021

Designated a Beijing Municipal Intellectual Property Pilot Unit.

Awarded Beijing Municipal Enterprise Science & Technology R&D Institution certification.

Delivered a single 5 MW ultra-high-power flywheel unit.

2022

Delivered the Carbon-Neutral Power Substation and Zhengzhou Metro projects.

Received dual intellectual-property qualifications together with industry science & technology awards.

Launched the 160 kWh flywheel unit, completing the product portfolio matrix.

2023

Won the bid for a CNOOC energy storage project and was rated an AAA-Credit Enterprise.

Achieved successful grid connection for the Zhengzhou Metro project and delivered the China Huadian Jiangxi primary frequency-regulation project.

A single-unit MW-class flywheel energy storage array achieved successful grid connection at an Inner Mongolia wind farm.

2024

Established three production bases in Qidong (Jiangsu), Zhongshan (Guangdong) and Tangshan (Hebei).

Delivered the world's first offshore oil-drilling-rig energy-recovery system.

Delivered Xinjiang's first hybrid energy storage demonstration project.

Completed the Inner Mongolia MW-class flywheel energy storage system major science and technology program.

2025

Led the drafting of the national flywheel energy storage standard (as first drafting unit); the standard was formally implemented.

Successfully delivered flywheel frequency-regulation projects at thermal power plants in Yuncheng and Shaanxi.

Broke ground on three 100 MW flywheel-plus-lithium-battery independent frequency-regulation power stations in Taigu and Liaozhong.

2026

Delivered the Shenyang Liaozhong Jinghe 100 MW grid-forming hybrid energy storage power station project.

Broke ground on the Liaoning Fuxin High-Tech Zone 100 MW flywheel-plus-electrochemical hybrid energy storage frequency-regulation project.

Broke ground on the Liaoning Chaoyang 200 MW/333 MWh flywheel energy storage system project.

Honghui Energy and Delta jointly launched the industry's first "SST + Flywheel Energy Storage" 10 kV medium-voltage UPS.

CERTIFICATIONS

Honghui Energy's flywheel energy storage systems are designed, manufactured, and serviced under internationally recognized management frameworks, certified by CNAS-accredited bodies that are signatories of the IAF Multilateral Recognition Arrangement (MLA).

Our Jupiter, Saturn, and Venus product families carry the CE Mark, independently assessed against the EU Low Voltage Directive and EMC Directive — ensuring seamless integration into data centers, manufacturing plants, renewable facilities, and metro networks across the European Economic Area.

Four management systems govern our operations: Information Security, Environmental, Occupational Health & Safety, and Five-Star After-Sales Service — the highest rating under China's national service evaluation standard. Together, they reflect a single conviction: flywheel reliability is built not only in the rotor, but in the processes and people behind it.

The certificates that follow are the current, valid credentials for the systems and products described above.



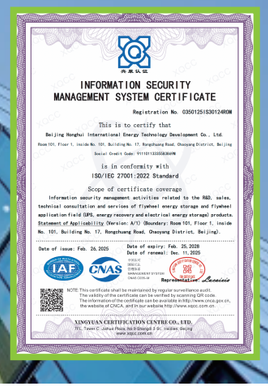












FESS PROFILE/ PRODUCT LINE

Flywheel Energy Storage System

Flywheel Overview & Product Line

Converter Cabinet

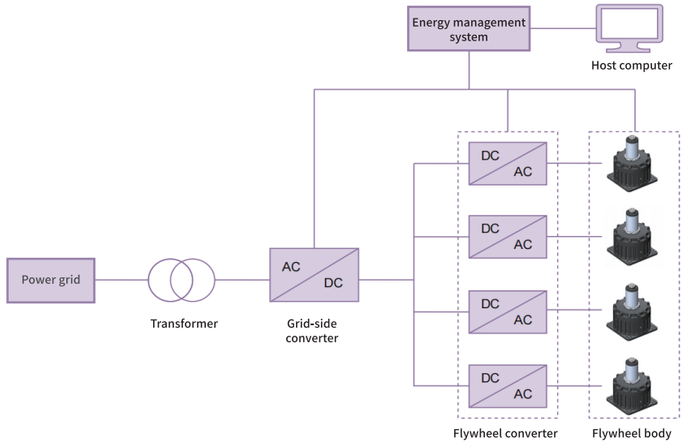
Product Configuration Table

Intelligent Cloud Platform

FLYWHEEL ENERGY STORAGE SYSTEM

System Architecture

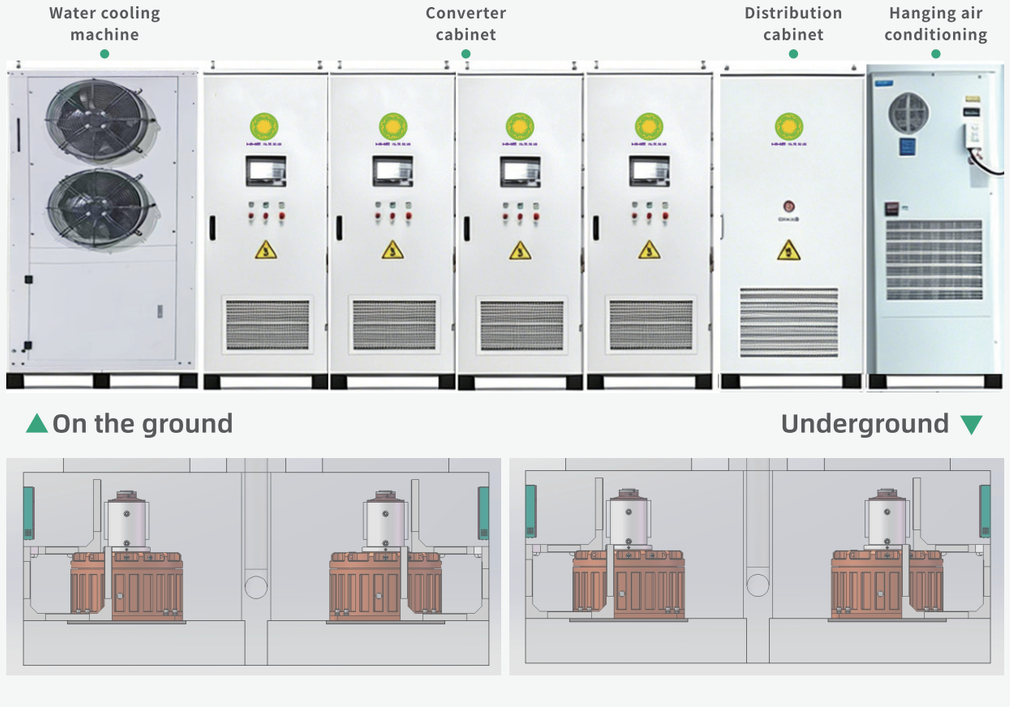
The flywheel energy storage system consists of three principal subsystems: the power-conversion unit, the energy-storage unit and the energy-management unit. During charging, grid AC power is rectified to DC by the grid-side converter; the DC bus then distributes power to each flywheel converter, which inverts it back to AC to drive the flywheel and accelerate it, storing energy as kinetic energy. During discharging, energy flows back to the grid in the reverse direction, centrally dispatched by the energy-management system, enabling coordinated multi-unit operation and fast response.



System Advantages

- Ultra-high conversion efficiency — system efficiency ⩾ 95%
- Millisecond-level response — seamless, smooth power switching
- Modular design — supports multi-unit parallel expansion
- Centralized dispatch — coordinated multi-unit response
- Multi-voltage-level adaptability — flexible compatibility with diverse grid conditions

System Integration Diagram





Internal view

FLYWHEEL
OVERVIEW & PRODUCT LINE

Introduction to Flywheel Energy Storage Technology

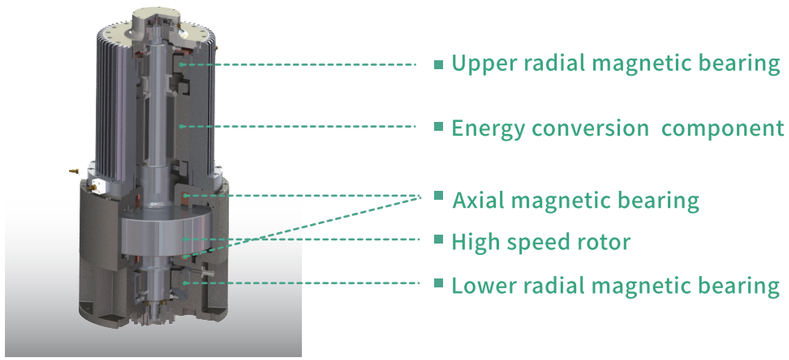
Flywheel energy storage is a physical energy-storage method that uses a flywheel as the energy carrier: under vacuum, magnetically-levitated conditions, energy is stored and released through the mutual conversion of kinetic and electrical energy.

Principle

$$E_k = \frac{1}{2} J \omega^2$$

Radial magnetic bearings and axial magnetic bearings support the flywheel rotor in a fully levitated, near-frictionless state.

Electrical energy kinetic energy: an integrated motor/generator drives the flywheel rotor to high rotational speed, converting electrical energy into stored kinetic energy (charging); when the motor/generator operates in generating mode, the flywheel rotor decelerates, converting kinetic energy back into electrical energy for release (discharging).



Advantages of Flywheel Energy Storage

01. Ultra-high reliability

No risk of thermal runaway or fire; magnetic-levitation, near-zero-friction operation ensures long-term stable performance.

02. Wide operating temperature range

Stable performance across a broad ambient-temperaturewindow.

03. Ultra-long service life

Unaffected by charge/discharge cycling in the way electrochemical batteries are; service life of 20 years or more.

04. Low losses, low maintenance

Magnetic-levitation bearings minimize mechanical wear, reducing maintenance requirements and losses.

05. Ultra-fast response

Suited to high-power, high-frequency charge/discharge cycling with millisecond-level charge/discharge response.

06. Precise state-of-charge measurement

Rotational speed can be precisely measured to accurately calculate remaining energy.

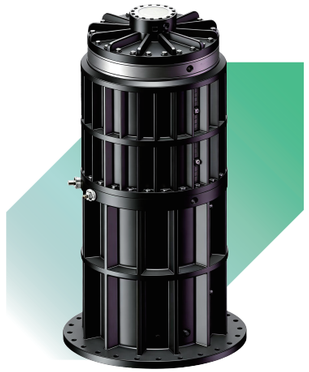
07. High conversion efficiency

DC-side conversion efficiency exceeds 92%.

08. High residual value

Decommissioned flywheels can be directly recycled and reused, retaining high residual value.

Star-Series Flywheel Technical Specifications



Jupiter 1 - FW1M50

Rated charging/discharging power (kW): 1000
Rated Voltage (Vac): 690
Maximum working speed (rpm): 9500
Overall dimensions (mm): Φ1380 x 2549
Rated charging/discharging energy (kWh): 35
Weight (kg): 13500

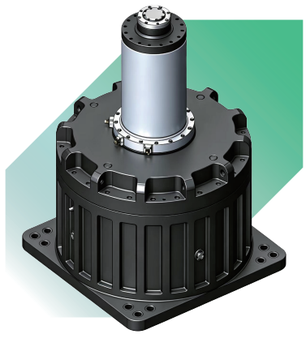


Jupiter 3 - FW32M04

Rated charging/discharging power (kW): 3200
Rated Voltage (Vac): 690
Maximum working speed (rpm): 20000
Overall dimensions (mm): Φ800 x 1430
Rated charging/discharging energy (kWh): 3
Weight (kg): 2800

Saturn 1 - FW2550C/D

Rated charging/discharging power (kW): 250
Rated Voltage (Vac): 480/690
Maximum working speed (rpm): 6500
Overall dimensions (mm): Φ1506 x 1769
Rated charging/discharging energy (kWh): 31.25
Weight (kg): 10000



Venus 4/5/6 - FW3303A/B/C

Rated charging/discharging power (kW): 330
Rated Voltage (Vac): 690/690/980
Maximum working speed (rpm): 9500/9500/10000
Overall dimensions (mm): Φ720 x 1596
Rated charging/discharging energy (kWh): 2.7/2.7/3
Weight (kg): 2340





Saturn 2 - FW50160

Rated charging/discharging power (kW): 500
Rated Voltage (Vac): 690
Maximum working speed (rpm): 5000
Overall dimensions (mm): Φ2150 x 2751
Rated charging/discharging energy (kWh): 134
Weight (kg): 27690



Venus 7 - FW1M12

Rated charging/discharging power (kW): 1000
Rated Voltage (Vac): 1500
Maximum working speed (rpm): 10000
Overall dimensions (mm): Φ1180 x 2100
Rated charging/discharging energy (kWh): 9
Weight (kg): 7230

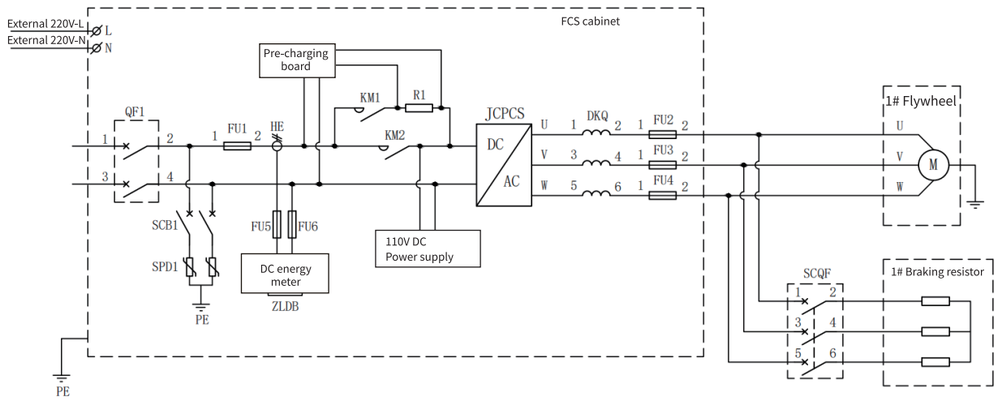
Flywheel Selection Guide by Application

Application Segment	Typical Use Cases	Applicable Models
Power grid energy storage &frequency regulation	Source/grid-side primary FR & AGC;independent ESS stations;wind-solar-storage; microgrids; thermal/renewable energyancillary services	Jupiter-1-FW1M50 (primary frequency regulation) Saturn-1-FW2550B (AGC regulation) Saturn-2-FW50160 (AGC regulation)
AIDC (AI Data Centers)	Large/hyperscale/cloud/super computing centers; IDC/EDC critical loads; MV UPS; PQ management	Jupiter-3 -FW32M04 Venus-4-FW3303A
Rail transit & oil drilling	Metro/LRT energy recovery; heavy-haul traction supply;	Venus-4-FW3303A
Power grid energy storage &frequency regulation	regen-braking recovery; traction voltage support; rail microgrids; catenary PQ	Venus-7 – FW1M12
Megawatt flywheel fast-charging	MW-class fast-charging; expressway/urban flash-charging;bus/ride-hail/HD-truck stations; PV-storage-charging; power compensation	Jupiter-1 – FW1M50 Saturn-1 – FW2550C/D Saturn-2 – FW50160

**Note: model numbers and configurations may be non-standard and custom-engineered to actual project requirements.*

CONVERTER CABINET

Product Schematic Diagram



Product Naming Convention

Format: RL-YYY-XXXXK-VVV/A(-G/-LN/-LW)-x1(X)

RL - YYY - XXXXk - VVV / A (-G/-LN/-LW)-x1(X)

- "x1" denotes the number of converter units per cabinet; an appended letter (e.g. "G", "p") denotes afurther sub-variant
- Configuration suffix:
  A = standard configuration;
  G3 = grid-forming, three-level topology;
  LN = natural (fan-forced) air cooling;
  LW = external liquid/water-cooled pump unit
- Voltage class, e.g. "480" = 480 V; "690" = 690 V
- Converter power rating, e.g. "250K" = 250 kW; "1000K" = 1000 kW
- Cabinet type:
  FCS = flywheel-side converter cabinet;
  NCS = grid-side converter cabinet;
  FES = integrated flywheel energy storage cabinet;
  PCS = integrated machine-side/grid-side converter cabinet
- RL — Company internal identification code

Product Features

High-efficiency energy conversion
converter peak efficiency ⩾ 98%

Wide voltage adaptability
compatible with multiple DC-bus voltage ranges

Millisecond-level response
power response time < 20 ms

Modular, flexible expansion
supports multi-unit parallel output

Strong short-time overload capability
withstands 3× rated current impulse for up to 10 s

Converter Cabinet Technical Specifications

Product model	RL-FCS-250K-480/A-x1	RL-FCS-250K-690/A-x1	RL-FCS-250K-690/LW-x1 RL-FCS-250K-690/LW-x1(G)
Appearance			
Rated power (kW)	250	250	250
Rated voltage (Vdc)	700	1100	1100V
Voltage range (Vdc)	600-800	900-1200	900-1200
AC voltage (Vac)	480	690	690
Overall dimensions (mm)	W800*D790*H2000	W800*D790*H2000	W800*D790*H2000
Heat dissipation method	Air-cooled	Air-cooled	Air-cooled
IP rating	IP21	IP21	IP21
Overload capacity	——	——	3 times @ 10 seconds
Communication interface	RS485、CAN、TCP-IP		

Product model	RL-FCS-250K-690/LN-x1 RL-FCS-250K-690/LN-x1(G)	RL-FCS-330K-690/A-x1 RL-FES-330K-690/A-x1	RL-FCS-500K-690/L-x1
Appearance			
Rated power (kW)	250	330	500
Rated voltage (Vdc)	1100	1100	1100
Voltage range (Vdc)	900-1200	900-1200	900-1200
AC voltage (Vac)	690	690	690
Overall dimensions (mm)	W800*D790*H2000	W800*D790*H2000	W1806*D903*H2200
Heat dissipation method	Air-cooled	Air-cooled	Air-cooled
IP rating	IP54	IP21	IP54
Overload capacity	3 times @ 10 seconds	——	——
Communication interface	RS485、CAN、TCP-IP		

Product model	RL-FCS-1000K-690/A-x1	RL-FCS-1000K-690/LN-x1 RL-FCS-1000K-690/LW-x1 RL-FCS-1000K-690/LW-x1(P)	RL-PCS-1000K-690/LW-x1
Appearance			
Rated power (kW)	1000	1000	1000
Rated voltage (Vdc)	1100	1100	1100
Voltage range (Vdc)	900-1200	900-1200	**900-1200**
AC voltage (Vac)	690	690	690
Overall dimensions (mm)	W1806*D903*H2200	W1806*D903*H2200	**W1806*D903*H2200**
Heat dissipation method	Air-cooled	Water cooling	Water cooling
IP rating	IP54	IP54	**IP54**
Overload capacity	——	3 times @ 10 seconds	——
Communication interface	**RS485、CAN、TCP-IP**		

Converter Cabinet Technical Specifications

Note: the source layout presents this specification set as a dense multi-column matrix; cabinet-to-column alignment abovereflects best-effort reconstruction from the original artwork. Please verifyexact figures against the original for procurement or engineering purposes.

PRODUCT CONFIGURATION TABLE

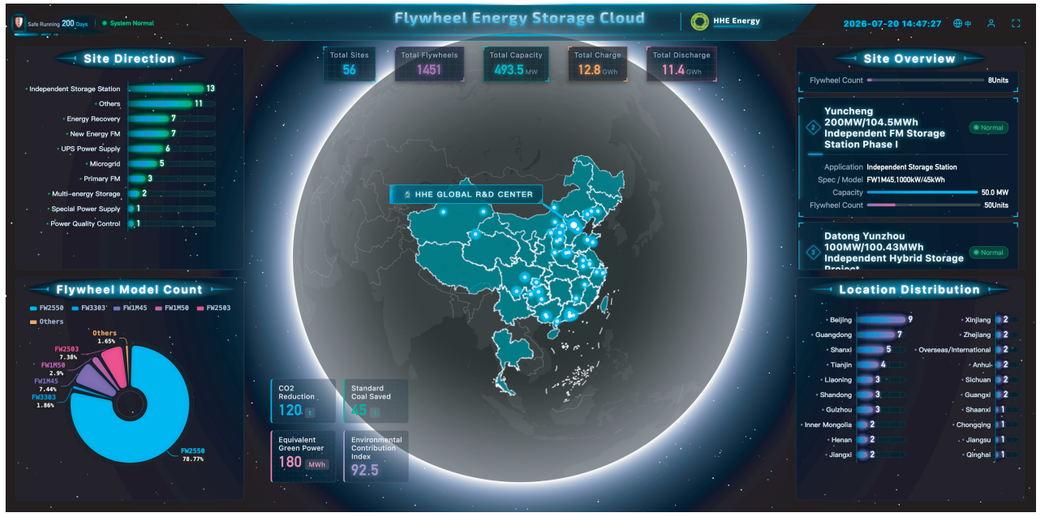
Flywheel & Converter Configuration Table

Converter Model	Compatible Flywheel Model(s)
RL-FCS-250K-480/A-x1	FW2550C,FW2503
RL-FCS-250K-690/A-x1 / RL-FCS-250K-690/LW-x1(-G) / RL-FCS-250K-690/LN-x1(-G)	FW2550D
RL-FCS-330K-690/A-x1 / RL-FES-330K-690/A-x1 (SST-integrated cabinet)	FW3303
RL-FCS-1000K-690/A-x1 / RL-FCS-1000K-690/LN-x1 / RL-FCS-1000K-690/LW-x1	FW1M50
RL-FCS-500K-690/L-x1	FW50160 (four flywheels per converter); FW2550D (four flywheels per converter)
RL-FCS-1000K-690/LW-x1(P)	FW50160 (two flywheels per converter); FW1M50

INTELLIGENT CLOUD PLATFORM

Platform Overview

The Honghui Energy Flywheel Energy Storage Intelligent Cloud Platform is a comprehensive industrial-internet management system purpose-built for flywheel energy storage systems. Through digital means, it delivers domain-wide, centralized monitoring, intelligent operations & maintenance (O&M), and data-value extraction for distributed energy-storage assets. The platform comprises three core modules - a main dashboard,energy-storage-unit monitoring, and back-office management - helping asset owners transition from "reactive O&M" to "proactive, intelligent control", comprehensively improving efficiency, safety and returns.



Key Capabilities

Site overview — unified access for all equipment units at a given site; the main dashboard provides an at-a-glance view of energy-storage-unit operating status, with real-time refresh of charge/discharge quantities and grid waveforms.

Digital twin / topology view — graphical visualization of energy flow and system topology; dynamic capture of key parameters such as flywheel speed, power and temperature, with instantaneous anomaly detection.

Project-location mapping — an intuitive, user-friendly interface with clearly zoned displays, key data surfaced up front, and integration of geographic mapping with micro-scale 3D equipment simulation for immersive viewing and operation.

Alarm management — real-time alarm refresh, precise fault localization, rapid handling of abnormal conditions, and full historical traceability, significantly improving O&M response efficiency.

APPLICATIONS SOLUTIONS CASE STUDY

Frequency Regulation

AIDC

Rail Transit & Oil Drilling

Megawatt Flywheel Fast-Charging

FREQUENCY REGULATION

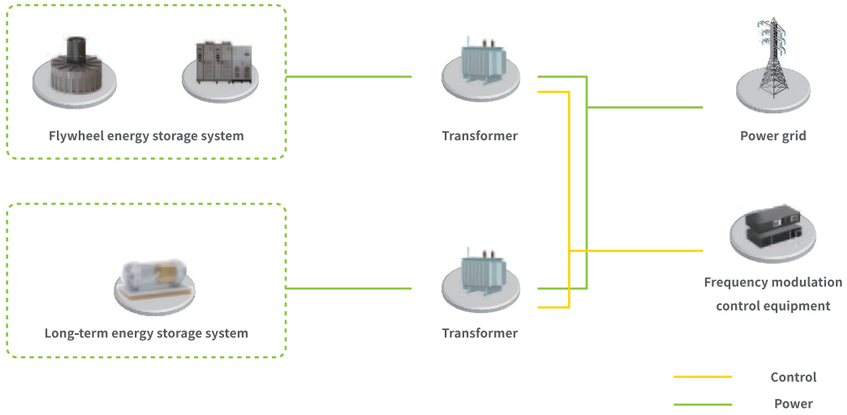
Flywheel Energy Storage for Frequency Regulation

Model	Rated Charge/Discharge Power (kW)	Rated Voltage (Vac)	Max. Speed (rpm)	Dimensions (mm)	Rated Energy (kWh)	Discharge Duration at Rated Power	Weight (kg)
Saturn-1 - FW2550C/D	250	480/690	6,500	Φ1506×1769	31.25	≈ 7.5 min	10,000
Saturn-2 – FW50160	500	690	5,000	Φ2150×2751	134	≈ 16 min	27,690
Jupiter-1 - FW1M50	1000	1600	9,500	Φ1380×2549	35	≈ 2 min	13,500

Grid-Side Independent Hybrid Energy Storage Station



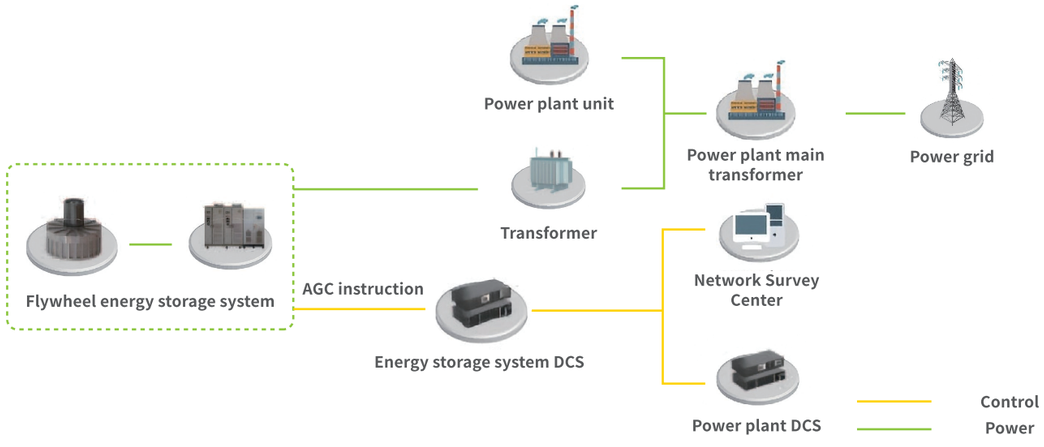
A hybrid energy-storage configuration combines a flywheel energy storage system with a long-duration energy storage system in a defined ratio. The flywheel system handles the bulk of high-frequency grid-side frequency-regulation duty; when the flywheel system alone cannot meet power or energy requirements, the long-duration storage system provides supplementary power or energy, and can also perform peak-shaving duty as required by policy. This arrangement minimizes the number of duty cycles imposed on the long-duration storage system, improving overall system service life and safety (for example, in lithium-iron-phosphate electrochemical storage systems), while optimizing the overall economics of the combined energy-storage system.



Power Generation-side Flywheel Energy Storage for Frequency Regulation

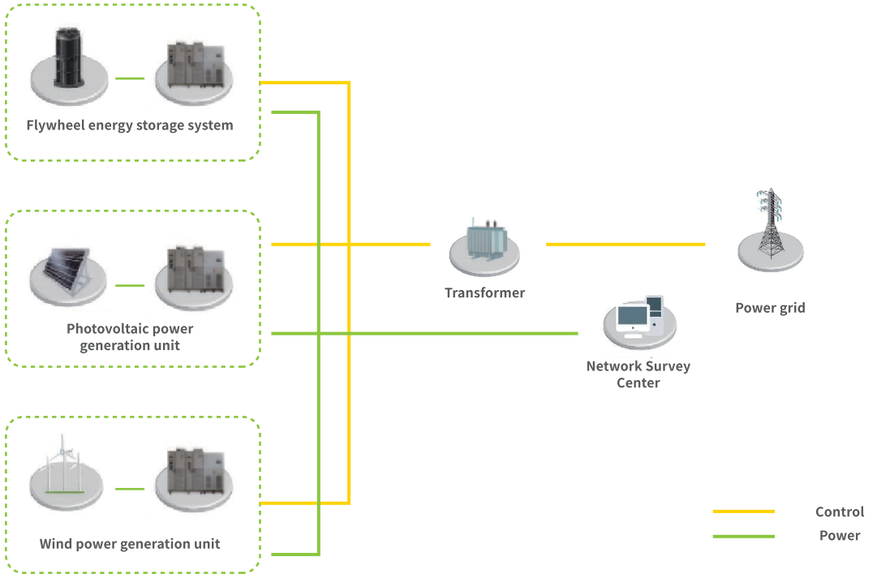
Thermal Power Plant Energy Storage Solution

As the share of new-energy generation capacity and grid-connected capacity increases, grid frequency-regulation requirements have risen accordingly. Traditional thermal-power-unit frequency regulation suffers from long response delays and poor regulation performance; furthermore, units participating in AGC regulation duty incur additional generation costs and equipment wear. Flywheel energy storage offers high regulation precision, fast response speed and bidirectional regulation capability. Combining thermal power generation with flywheel energy storage for joint frequency regulation can effectively improve the composite performance index (K-value), increase plant revenue, and relieve frequency-regulation pressure on thermal units.



Renewable Energy Side Energy Storage

Renewable generation based primarily on wind and photovoltaic power is inherently variable and intermittent,and is prone to significant curtailment. As the share of new-energy generation in the power mix continues torise, pairing new-energy generation with energy storage to enhance system flexibility becomes critical - notonly to improve renewable-energy absorption, but also to directly safeguard grid operating safety and reliability.



Application Scenario

- Primary frequency regulation
- AGC frequency regulation
- Ramping ancillary service
- Inertia support (potential application)

Representative Projects

Empowering Northeast China's Grid Modernization with Standalone Energy Storage



Liaozhong Jinghe 100 MW flywheel + lithium-battery grid-forming independent frequency-regulation station (Liaoning)

20 MW/2.5 MWh flywheel (250 kW/31.25kWh × 80) + 80MW/160 MW helectrochemical



Fuxin High-Tech Zone 100 MW flywheel + electrochemical hybrid independent frequency-regulation station (Liaoning)

20 MW/2.5 MWh flywheel (250 kW/31.25kWh × 80) + 80 MW/160 MWh electrochemical

Supporting Shanxi's Energy Transition with Standalone Energy Storage



Datong Yunzhou100 MW independent energy storage frequency-regulation station (Shanxi)

20 MW/2.5 MWh flywheel (250 kW/31.25kWh × 80) + 80MW/160 MWh electrochemical



Taigu 100 MW flywheel + lithium-battery independent frequency-regulation station (Shanxi)

20 MW/2.5 MWh flywheel (250 kW/31.25kWh × 80) + 80 MW/160 MWh electrochemical

Xinjiang Next-Generation Hybrid Standalone Energy Storage Demonstration Project, China





Xinjiang first hybrid energy storage demonstration project (China Huadian open-bid program)

8 × 250 kW/31.25 kWh units

Honghui Energy Power Transformation and Upgrading of Shanxi Energy (Energy Storage)



Yuncheng 200 MW independent frequency-regulation energy storage station (Shanxi)

50 MW/1.75 MWh flywheel (1 MW/35 kWh × 50) + 150 MW/300 MWh electrochemical

Honghui Energy Supports Energy Transformation in Jiangxi (Independent Energy Storage)



Zhoutie Energy new independent energy storage project (Jiangxi)

20 MW/2.5 MWh flywheel (250 kW/31.25kWh × 80) + 80 MW/160 MWh electrochemical

Jiangxi Huadian 100 MW Photovoltaic Power Generation Project (Primary Frequency Regulation)



Jiangxi Huadian 100 MW PV project — primary frequency regulation

2 MW flywheel + 6 MW electrochemical storage

Shenzhen Smart Energy 150 MWSolar-PV Hybrid Project (Primary Frequency Regulation)



Shenzhen Zhihui Energy 150 MW agrivoltaic project — primary frequency regulation

Single-unit 1 MW/50 kWh flywheel system

The 200MW Wind Power Plant Project of Zhongheun Energy inErlianhot (Primary Frequency Regulation)



CNNC Huineng Erenhot 200 MW wind farm — primary frequency regulation (Inner Mongolia)

3 MW flywheel (3 × 1 MW/45 kWh)

Shaanxi Thermal Power Plant Project (Thermal-Fire Storage Frequency Regulation)



Shaanxi thermal power plant (Yanghuopan Coal Power) — thermal-storage frequency regulation

8 × 1 MW/35 kWh flywheel units

AIDC

AIDC - Flywheel Energy Storage Medium-Voltage UPS System

This system is an advanced dynamic uninterruptible power supply that integrates solid-state transformer (SST) and flywheel energy storage technology, purpose-built for critical loads such as data centers and precisionmanufacturing. The system's rated power spans 1 MW to 20 MW at a 10 kV voltage class. When a voltage sagor interruption occurs on the mains supply, the system achieves seamless transfer, with the flywheel energystorage independently supplying full-load backup power and smoothly coordinating hand-off with the backuppower source. The system also integrates comprehensive power-quality management, fundamentally eliminating grid power-quality issues and providing ultra-reliable power support for critical facilities.

The system deeply integrates multiple functions - uninterruptible power supply (UPS), dynamic voltagerestoration (DVR), and a power-conversion system (PCS) - enabling uninterrupted backup and joint powersupply, and incorporates active power filtering (APF) and reactive-power compensation (SVG) capability to safeguard grid power quality.Compared with conventional UPS solutions, this system delivers marked advantages: system operating efficiency of up to 99%, versus a typical operating efficiency of 96% for conventional online UPS - yielding substantial annual electricity-cost savings. For impact, fluctuating and harmonic loads typical of industrial sites, AIDC facilities and large supply installations, and for regenerative (energy-feedback) loads, the required configured-capacity coefficient is lower than that needed by conventional online UPS in the same applications, improving investment. The equipment offers outstanding reliability, with a system service life of up to 20 years and simplified maintenance. The system sets a new industry benchmark for efficiency, load adaptability, service life and total lifecycle cost.

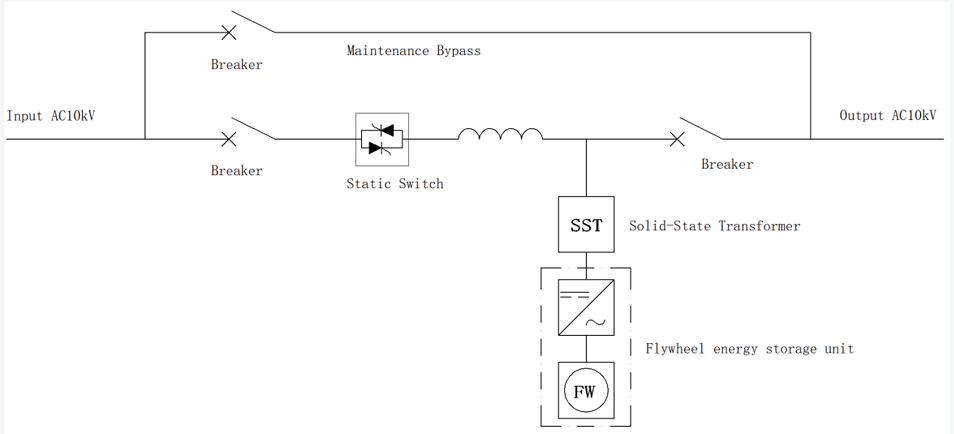


Typical Industries Served

- Data centers
- Renewable energy
- Semiconductor / chip manufacturing
- Ports
- Metallurgy & non-ferrous metals
- Petrochemicals

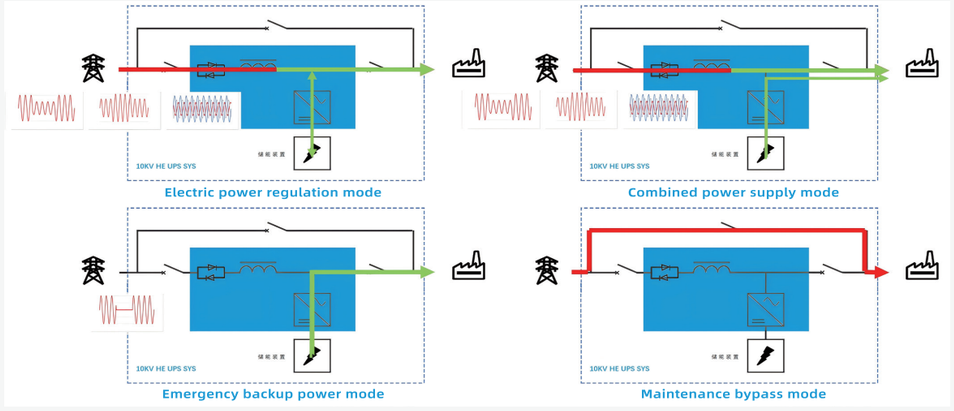
Working Principle – Operating Modes

- Mains mode: Input AC 10 kV → breaker → static switch → output AC 10 kV
- Inverter mode: solid-state transformer (SST) → flywheel energy-storage unit → output AC 10 k
- Maintenance-bypass mode: input AC 10 kV → breaker → maintenance bypass → output AC 10 kV



▲Electrical principle

Working condition ▼



Product Features

Reliability

Strong load-matching capability, suited to complex operating conditions such as industrial sites

- Superior fault-clearing and overload capability, matched to impact and harmonic loads: mains mode capacitive complex loads 400% rated current for 2 s, 120% for 10 min; inverter mode 150% rated current for 2 s, 125% for 25 s
- Wider output power-factor range: 0.1 lagging to 0.7 leading, matching inductive, resistive and capacitive complex loads
- Four-quadrant operating capability, matching energy-feedback loads such as elevators, hoists and cable cars

A unique system topology delivers 100% load coverage within a highly reliable supply architecture

-The SST adopts a modular design with no single point of failure; each phase of each cabinet includes one redundant module

-The flywheel energy storage cabinet adopts a modular design with no single point of failure

- Multiple redundant auxiliary power paths; redundant cooling fans

Unique flywheel energy storage method: no fire risk, insensitive to ambient temperature, 20-year service life, low maintenance

Efficiency

Average whole-system operating efficiency of up to 99%

- Lower losses at the 10 kV medium-voltage system level
- Unique topology minimizes power-conversion losses; mains-mode efficiency exceeds 99%

-SST converter efficiency up to 98%, further reducing overall charge/discharge and power-regulation energy consumption

Scalability

Capacity expansion of 1—2 MW within a system

Parallel capacity expansion of 2–20 MW across systems

Flexible, elastic expansion in step with customer load growth

Power Quality

SST + flywheel energy storage transfer time < 5 ms, ensuring uninterrupted supply to critical loads Output voltage stability ±1%; output distortion THDu < 2%; input power factor > 0.98 — excellent power quality

Multi-Function, One Machine

- APF/SVG — provides active power while performing harmonic and reactive-power treatment
- UPS/PCS — provides backup power while supporting mains/storage joint supply in any ratio
- DVR/UPS — addresses voltage sags and short interruptions

Maintainability & Availability

Long mean time between failures: MTBF > 150,000 hours

- Redundant system design, no single point of failure

Lower mean time to repair: MTTR < 10 minutes

- Consumable wear parts such as fans and dust filters support online replacement
- Flywheel cabinets are redundant and support online maintenance
- SST cabinets are modular and support online maintenance; maintenance cycle
- SST modules are redundant per phase (one redundant module per phase); a faulty module automatically bypasses and the system continues running until the next scheduled maintenance

System availability of up to 99.99%

Centralized medium-voltage installation, compact footprint, flexible deployment

Applicable Standards

· **IEC 62040 — Uninterruptible power systems (UPS)**

· **IEC 62477 — Safety requirements for power electronic converter systems and equipment**

· **GB/T 7260.3-2024 — Uninterruptible power systems, Part 3: Method of specifying the performance and test requirements**

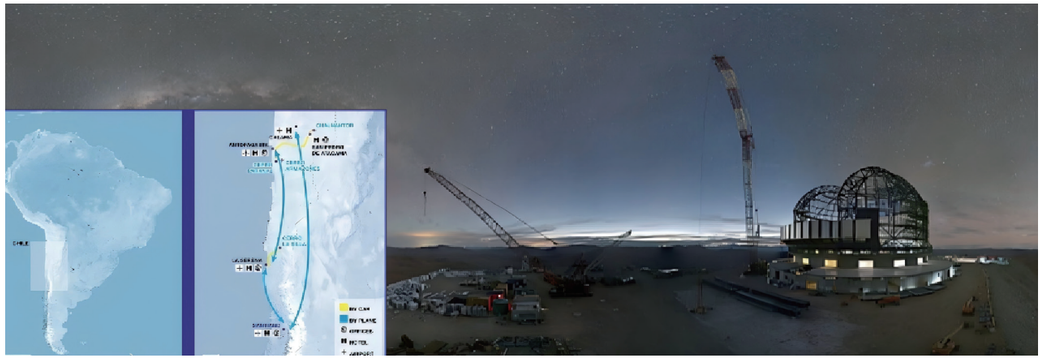
Comparison with Conventional Low-Voltage Online UPS

Comparison Item	Conventional Low-Voltage Online UPS	Flywheel Energy Storage Medium-Voltage High-Efficiency UPS
Functional coverage	UPS function only	Multi-function, one machine: DVR / UPS /PCS + APF / SVG
Energy-storage medium	Lead-acid / lithium battery	Flywheel energy storage
Capacity coverage & scalability	0.5–2 MW	1–20 MW
Footprint / integration	May occupy load-side equipment space	Centralized medium-voltage installation; does not change the distribution architecture; no load-side footprint required
Single-unit end-to-end efficiency	96%	99%
System efficiency	94%	98%
Service life	8–10 years	20 years
Load suitability	Online mode 120% for 10 s; bypass mode 300% for 2 s	Impact / fluctuating / energy-feedback loads, 0.1 lagging – 0.7 leading power factor Industrial or mixed loads typically require only 1–1.5 units of redundant UPS capacity
Overload capability	Stable loads, 0.6 lagging – 0.9 leading power factor Industrial or mixed loads typically require 2–3 units of redundant UPS capacity	Mains mode 400% for 2 s; independent mode 150% for 2 s

Application Case

ESO Chile Project

A 6 MW flywheel energy storage medium-voltage UPS system provides high-quality, uninterrupted power supply for critical loads at the European Southern Observatory (ESO) and its associated data center. This marks the technology's first application to astronomical telescope facilities, meeting the power-quality demands of high-precision optical instrumentation and ultra-precise data computation — supporting scientists in deep-space exploration and providing outstanding support for humanity's deep-space and astronomical research endeavors.











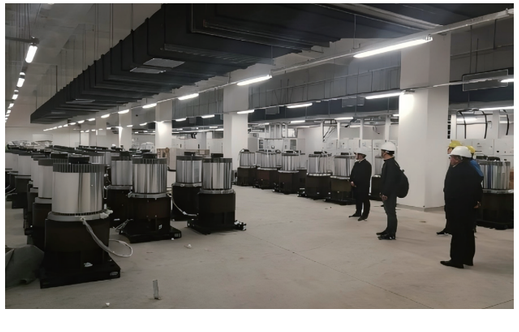
GlobalFoundries Wafer Fabrication Facility

GlobalFoundries Semiconductor Co., Ltd., the world's second-largest wafer foundry, invested a cumulative total exceeding USD 10 billion to build a 12-inch wafer production line. The facility deployed a 16 MW flywheel energy storage medium-voltage UPS system together with a 16 MW diesel-generator automatic-start system, forming a reliable power-supply system covering the extensive array of precision equipment across the entirefab - providing a solid guarantee for the enterprise's continuous, reliable operation.







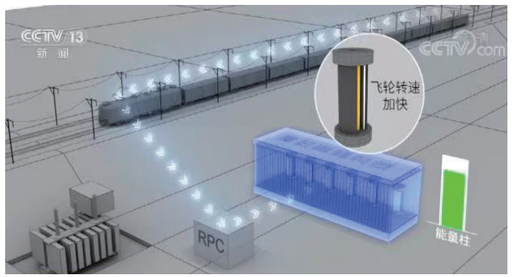


RAIL TRANSIT & OIL DRILLING

Flywheel Energy Storage for Rail Applications

First Application of Flywheel Energy Storage System in Electrified Railways







Installing flywheel energy storage in the traction power-supply systems of long, heavy-haul railway lines delivers the following benefits:

- Improves power quality and raises the peak supply capacity of the power-supply system
- Improves power performance and reduces the impact on new-energy grid connections along the route
- Smooths load fluctuations, making it well suited to traction power-supply systems under new-type power-system architectures
- Absorbs and reuses regenerative braking energy generated by rolling stock
- Peak-shaves the traction load, reducing the maximum demand imposed on traction transformers

Industry Pain Points Addressed



Severe traction-load fluctuation:
Frequent load fluctuation is an inherent characteristic of traction power-supply systems. To ensure normal railway operation, traction-transformer design capacity tends to be oversized, requiring railway operators to pay higher basic demand charges to power utilities over the long term.

Power-quality issues:
Traction power-supply systems using single-phase, single-side supply arrangements experience persistent power-quality issues dominated by negative-sequence current, reactive power and harmonics, affecting the safe, stable operation of the traction network and rolling stock.

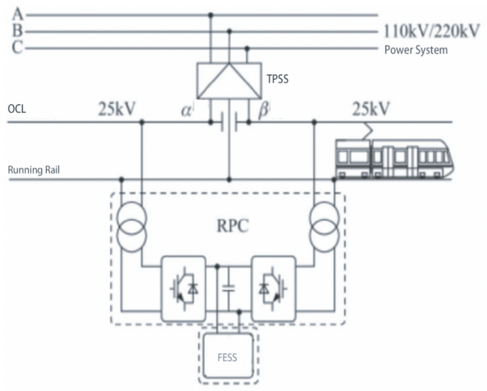
Wasted regenerative-braking energy:
Electric locomotives use regenerative braking; when trains feed braking energy back to the grid, power utilities do not compensate railway operators for this energy, resulting in wasted power-quality value with no economic benefit to the railway operator.

Impact on new-type power systems:
New-type power systems built predominantly on renewable energy have inherently weaker grid architectures, making them more susceptible to the impact of impulse loads such as train traction and braking.

Connection Method and Application Principle

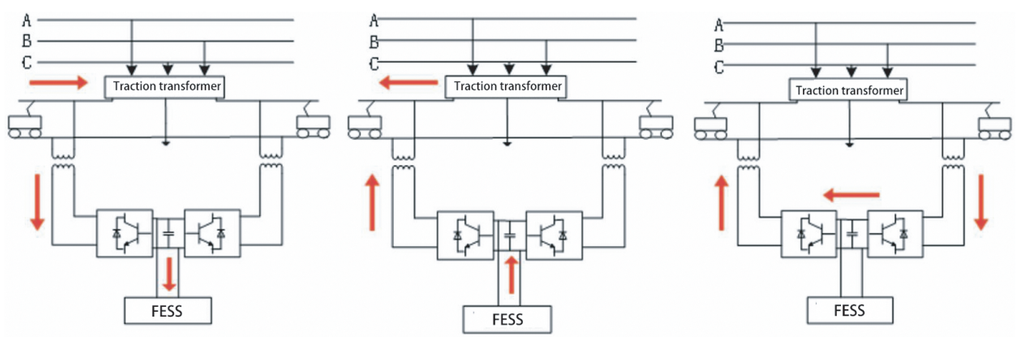
Connection method

A railway power quality compensator (RPC) device connects the two differently-phased power-supply arms (α/β) at a traction substation via an AC/DC/AC conversion, enabling the two supply arms to interconnect. The DC interface of the flywheel energy storage device connects to the DC side of the RPC device; the RPC's AC side connects to the traction power-supply system through a step-up transformer and switching devices.



Working principle

An energy-management system (EMS) monitors energy flow on the line. When braking occurs on the line, braking energy is stored in the flywheel energy storage device via the traction network; when acceleration is required elsewhere on the line, energy stored in the flywheel is released back into the traction network for use by trains. When multiple trains are running simultaneously and the traction load is heavy, the flywheel storage system discharges to assist the traction transformer, thereby reducing the transformer's maximum demand.
This mode of energy flow management can also help address negative-sequence and reactive-power quality issues in the traction power-supply system.

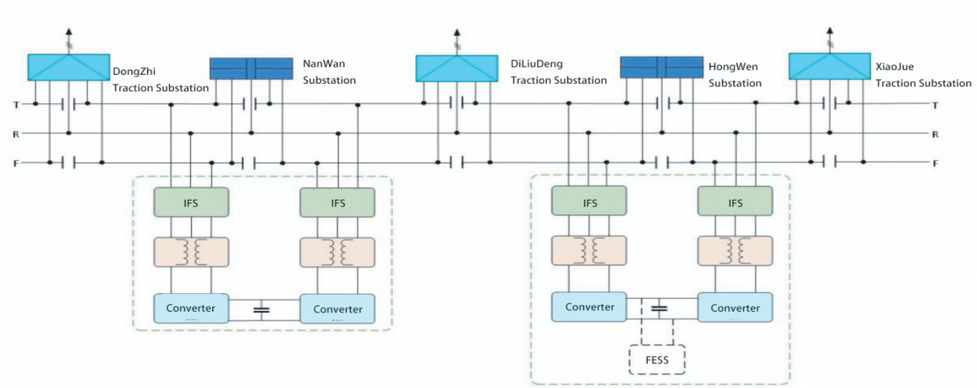


Project Case

Guoneng Shuo-Huang Railway flexible power supply project

On the Shuohuang Railway flexible power-supply project, flexible power-supply devices installed within the traction power-supply system provide an energy-flow pathway between different busbars at traction substations and between different supply arms at sectioning posts. By adding a flywheel energy storage device on the DC side of the flexible power-supply device, the project effectively adds an “energy-storage cell” to the existing traction power-supply system, increasing system flexibility and enabling more flexible allocation of regenerative-braking energy, substantially improving the utilization rate of regenerative-braking energy.

The flywheel energy storage system for this project has been formally commissioned. Following installation, traction network voltage fluctuation has been effectively smoothed, with continuous stable operation. Field data show the system performs approximately 3,000 charge/discharge cycles per day, saving over 3,000 kWh of electricity per day on average, with an investment payback period of approximately three years — delivering strong safety and economic benefits. The China Academy of Railway Sciences has issued a formal type-test report for this project.



Model	Rated Charge /Discharge Power (kW)	Rated Voltage (Vac)	Max. Speed (rpm)	Dimensions (mm)	Rated Energy (kWh)	Weight (kg)
Saturn-2 – FW50160	500	690	5,000	Φ2150×2751	134	27,690
Jupiter-1 – FW1M50	1000	690	9,500	Φ1380×2549	35	13,500

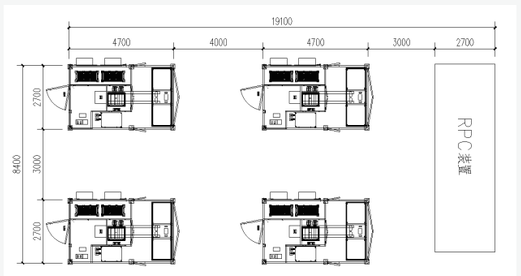
Domestic Heavy-Haul Railway Application Case

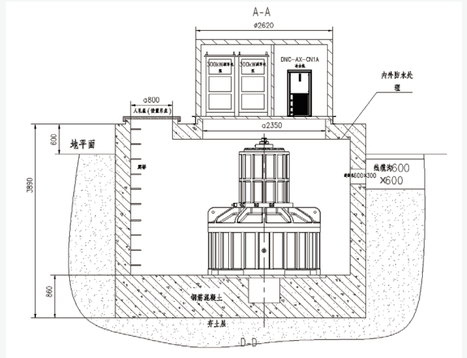
Simulation Calculation

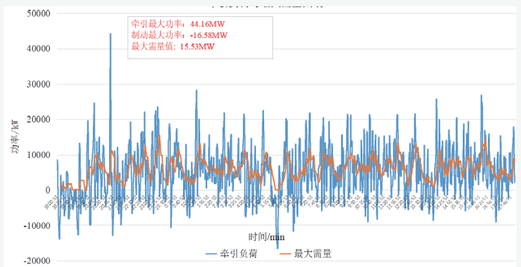
On a domestic ten-thousand-tonne heavy-haul freight line, characterized by a long, steep downhill grade during heavy-load operation, a 2 MW large-capacity flywheel energy storage installation is proposed for the relevant line section. Total equipment investment is approximately RMB 10 million, with an estimated project payback period of approximately five years.

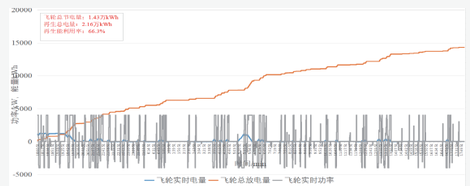
Near-Term Scheme

A 2 MW flywheel energy storage traction-substation energy-saving unit comprising four 500 kW / 160 kWh single-unit, high-power, large-capacity flywheel energy storage devices together with one 2 MW RPC system.
Field data indicate a regenerative-energy utilization rate that rises with flywheel power capacity, reaching roughly 90–96% across the tested range of flywheel power configurations, together with clear peak-shaving effects on traction-load maximum demand.









Flywheel Energy Storage for Metro Applications

Deploying flywheel energy storage devices in the subway traction power supply system has the following important functions



Improves the power-supply capability of the traction power-supply system

Supplements instantaneous output power, supports traction-network voltage, and improves the reliability and safety of the power-supply system, providing more comfortable and efficient journeys for passengers

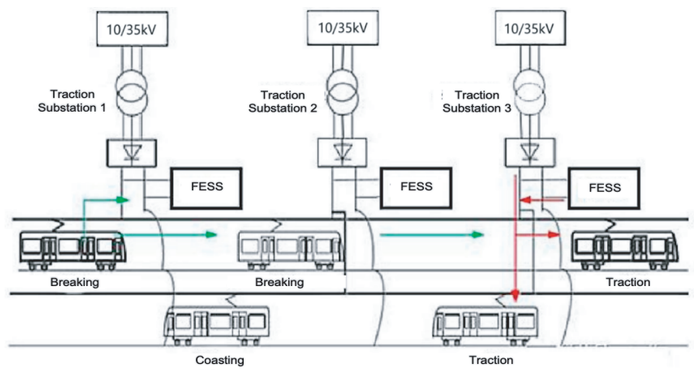
Recovers and reuses vehicle braking energy, reducing brake-pad wear, saving energy and cutting emissions — supporting national carbon-peaking and carbon-neutrality goals

Can serve as a backup power source, rapidly engaging critical equipment in the event of a traction power-supply fault, providing robust support for safe and orderly passenger evacuation

Flywheel Energy Storage in Subway Applications Principle

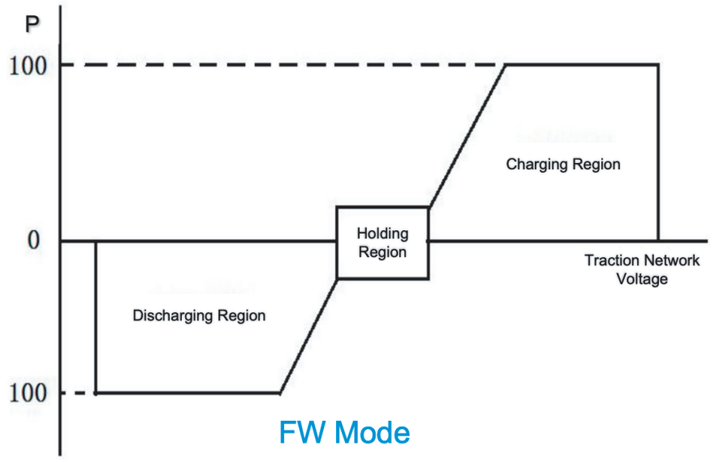
Connection Method

The DC interface of the flywheel energy storage device is connected directly in parallel to the positive/negative busbars of the metro traction DC power-supply system.



Working Principle

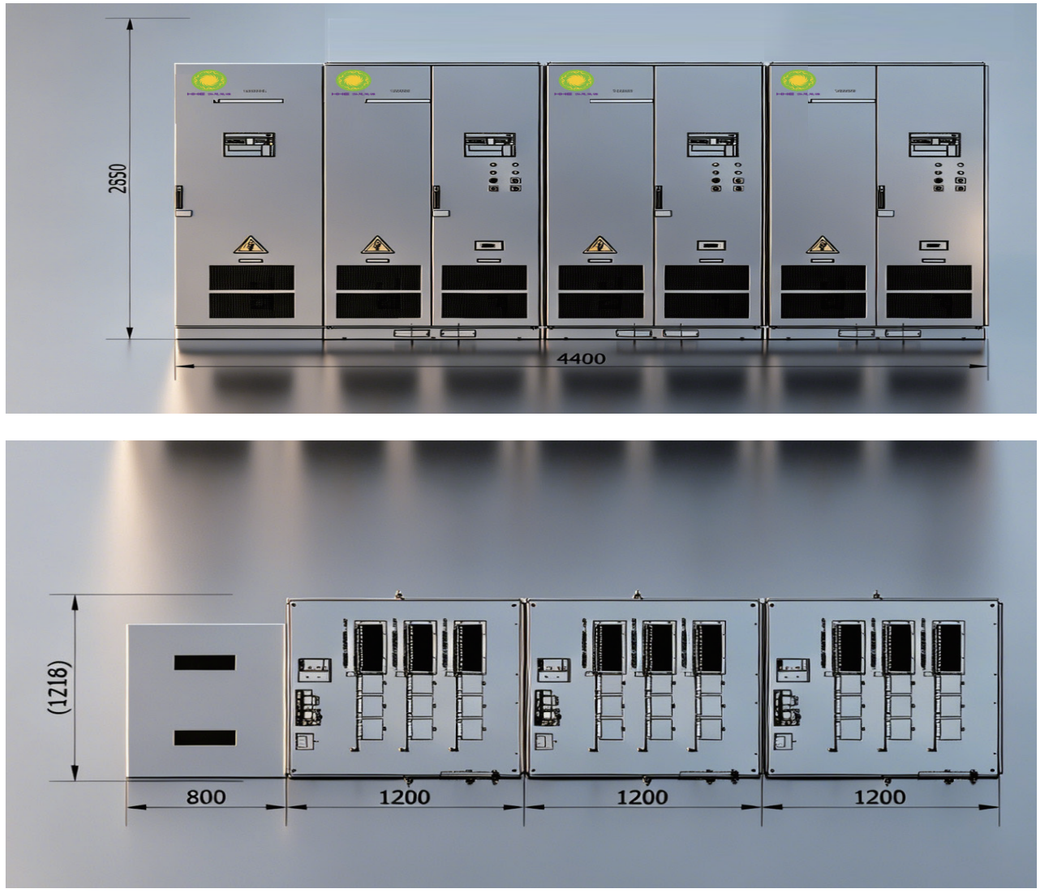
the flywheel energy storage device monitors the DC traction-network voltage to determine charge/discharge action — when traction-network voltage rises, the flywheel device charges; when traction-network voltage falls, the flywheel device discharges. Where the power-supply section is long and voltage at the mid-point of the line is lower, the flywheel energy storage device can assist the traction power-supply system by discharging to support traction-network voltage, ensuring safe, stable train operation.



Metro Application – Product Configuration

Model	Rated Charge /Discharge Power (kW)	Rated Voltage (Vac)	Max. Speed (rpm)	Dimensions (mm)	Rated Energy (kWh)	Weight (kg)
Venus-4/5/6 – FW3303series	330	690/690/ 980 Vac	9,500/9,500 / 10,000	Φ720×1596	2.7 /2.7 /3	2,340
Venus-7 – FW1 M12	1000	1,500 Vdc	10,000	Φ1180×2100	9	7,230





1 MW flywheel energy storage regenerative-braking energy-recovery system – front and plan-view schematic (see original artwork).

Type	Access Method	Integration Complexity	AC-Grid Harmonic Impact	Energy-Saving Effect	Reliability	Traction-Network Voltage Support	Emergency Power Function
Flywheel energy storage	DC-side connection	Simple	None	High	Good	Yes	Yes
Regenerative / bidirectional converter type	AC-side connection	Complex	Present	Moderate	Moderate	NO	NO

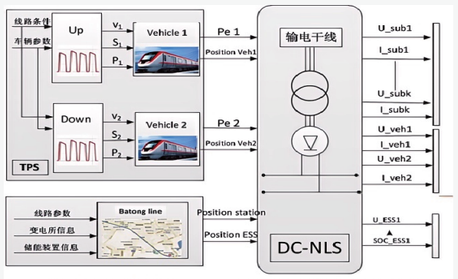
Metro Case Study

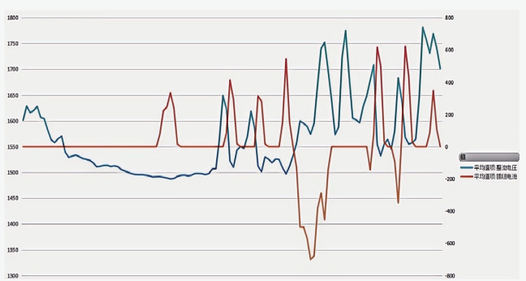
Zhengzhou Metro Flywheel Energy Storage Feedback System

Flywheel energy storage products deployed in the rail-transit sector: at Huanancheng Station, a DC energy meter records the electrical energy absorbed and released by the flywheel system. Data show the station absorbs approximately 1,000 kWh of braking energy per day on average, with an energy-utilization efficiency of approximately 93%, saving approximately 930 kWh per day on average. Average daily traction-network electricity consumption at Huanancheng Station is approximately 5,000 KWh, giving the flywheel system a braking-energy recovery rate of approximately 18.69% relative to total consumption.







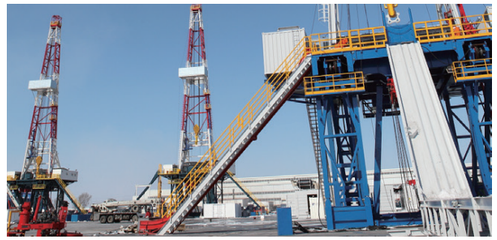


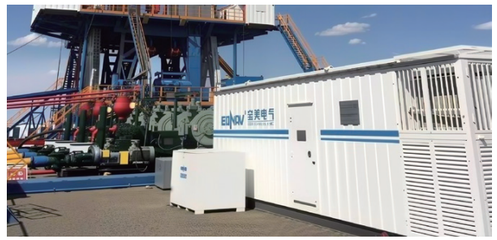
Applications in Oil Drilling, Ports and Steel Manufacturing

Oil Drilling

When an oil-drilling rig's hoisting drum descends, the flywheel energy storage system absorbs the braking energy generated by the winch, stabilizing DC-bus voltage. The system's ability to rapidly release large amounts of power on an instantaneous basis improves the dynamic performance of diesel or gas generator sets, increasing drilling-operation efficiency. It also effectively reduces wear and fatigue on diesel or gas generator sets, extending their overall service life.

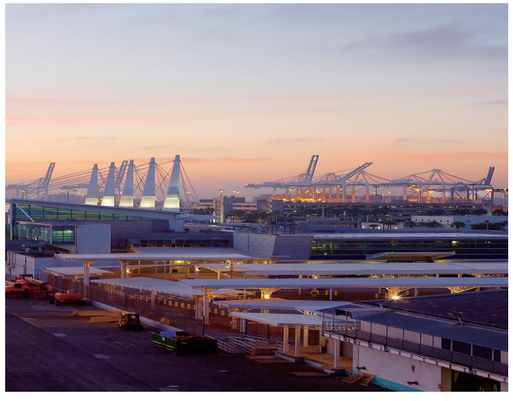






Port Applications

Energy savings and energy recovery for port equipment such as container gantry cranes and quay cranes: when a spreader lowers, the flywheel rapidly absorbs the regenerated electrical energy, smoothing voltage fluctuation and protecting the converter and motor; when the spreader lifts, the flywheel discharges instantaneously to supplement peak power demand, reducing the required diesel-generator capacity and fuel consumption.
When a port microgrid operates in island mode, the flywheel energy storage system serves as a millisecond-response uninterruptible power source, ensuring continuous operation of critical equipment.





Steel Manufacturing Applications

Flywheel energy storage systems applied in steel manufacturing address the problem of high maximum-demand charges caused by impact loads from equipment such as electric-arc furnaces and rolling mills. The operating principle: before a load spike exceeds a defined threshold, the flywheel rapidly discharges to shave the peak; once load power returns to the normal range, the flywheel automatically draws power from the grid to recharge — effectively lowering maximum demand and reducing basic demand charges.





MEGAWATT FLYWHEEL FAST-CHARGING

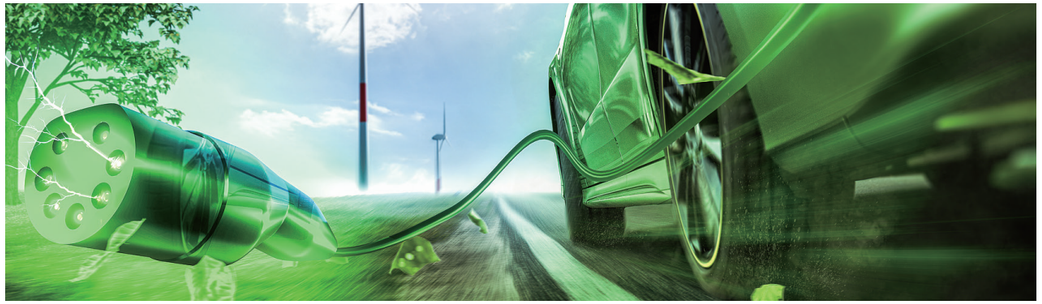
Solution Overview & Market Value



With the explosive growth of the new-energy-vehicle market and rising consumer demand for a “refueling-equivalent” charging experience, vehicle-side fast-charging technology is rapidly evolving toward megawatt-class power platforms. However, the instantaneous high-power impact of megawatt-class flash-charging significantly increases pressure on grid capacity expansion; traditional grid-upgrade approaches suffer from high investment cost, long construction cycles and poor expansion flexibility, making complementary energy-storage technology essential to achieve coordinated planning and flexible support between charging infrastructure and the grid.

Leveraging millisecond-level high-power response, a service life supporting tens of millions of charge/discharge cycles, high-rate tolerance, and wide-temperature-range adaptability, flywheel energy storage can work in coordination with the grid to deliver megawatt-class power output — effectively addressing core pain points at charging stations such as grid-capacity bottlenecks, charging-speed limitations and equipment-cycling-life constraints, ensuring efficient, robust operation of charging infrastructure while reducing stations' dependence on grid upgrades and associated capacity-expansion costs.

Technical Features & Core Advantages



1. Instant high-power response, faster charging.
With millisecond-level power response, the system sustains high-power output demands and matches diverse fast-charging equipment, enabling minute-level EV charging — greatly improving efficiency and user experience.

2. Broad adaptability across scenarios.
The equipment handles a wide range of operating conditions, fitting urban charging stations, expressway service areas, and heavy-truck stations, while remaining compatible with integrated PV-storage-charging architectures — supporting large-scale network rollout.

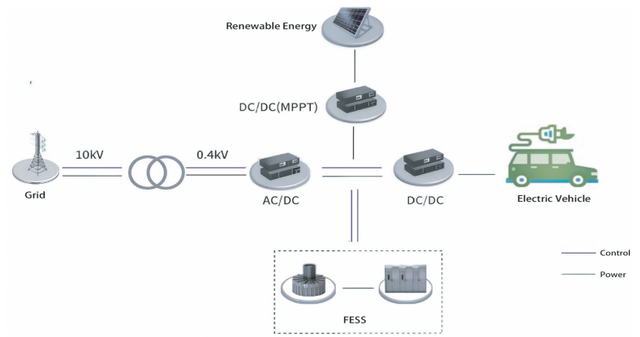
3. Ultra-long cycle life, stable operation.
Rated for tens of millions of charge/discharge cycles, the system avoids the capacity fade typical of chemical batteries and suits the high-frequency, high-power demands of fast charging — extending equipment lifespan and ensuring long-term station stability.

4. Smart peak-valley arbitrage, lower costs.
By storing energy during off-peak periods and discharging at peak times, the system optimizes station load profiles, cuts electricity costs, and boosts operating economics and overall returns.

5. Safe, reliable, and low-carbon.
Built on a purely physical energy-storage architecture, the system eliminates risks like thermal runaway and fire, involves no chemical contamination, and uses recyclable core components — aligning with green, low-carbon development goals in the new-energy sector.

System Structure Diagram

The Solution



Applicable Scenarios



Electric Heavy-Truck Charging Station



The Highway Service-Area Charging Station



Bus Supercharging Station



Urban Core Area Fast-Charging Station

Recommended Product Models

Model	Rated Charge /Discharge Power (kW)	Rated Voltage (Vac)	Max. Speed (rpm)	Dimensions (mm)	Rated Energy (kWh)	Weight (kg)
Jupiter-1 – FW1M50	1000	690	9,500	Φ1380×2549	35	13,500
Saturn-1 – FW2550C/D	250	480/690	6,500	Φ1506×1769	31.25	10,000
Saturn-2 - FW50160	500	690	5,000	Φ2150×2751	134	27,690