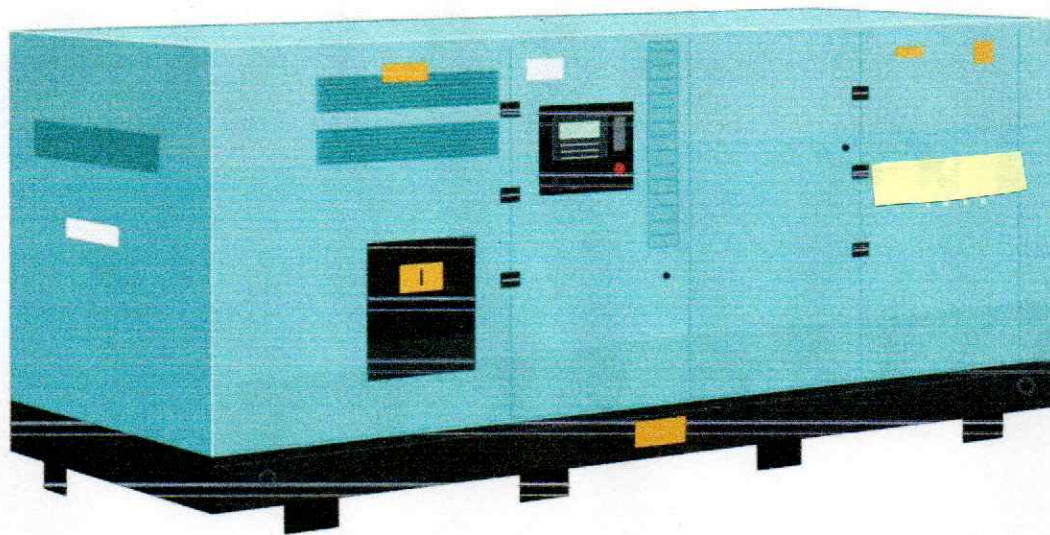


Advanced Flywheel Energy System

WHITE PAPER



The Next Generation of Energy Starts Here

Forget everything you know about power generation.

NO FOSSIL FUELS

NO WIND TURBINES

NO SOLAR PANELS

One intelligent energy platform.

Technical Specifications & Engineering Overview

Engineering the Future of Continuous Power

Why does industry still depend on fuel, weather and the grid?

For more than a century, industrial electrical power has rested on two foundations: fuel that must be purchased, transported and burned, or renewable resources that depend on weather and daylight. Both work. Neither is unconditional.

For a factory, a hospital or a data centre, the cost of energy is rarely the whole story. The real exposure is continuity — what happens in the seconds and hours when supply is not there.

Fuel dependency

Diesel and gas generation ties operating cost to a commodity price and a delivery schedule. At remote sites, fuel logistics can exceed the cost of the fuel itself.

Weather dependency

Solar and wind deliver excellent energy economics, but output follows conditions rather than demand. Firming is a separate investment.

Grid instability

Voltage dips, frequency excursions and outages damage equipment and interrupt processes long before a full blackout occurs.

Maintenance burden

Combustion machinery carries service intervals measured in hundreds of running hours, with consumables, emissions duties and noise limits attached.

Site constraints

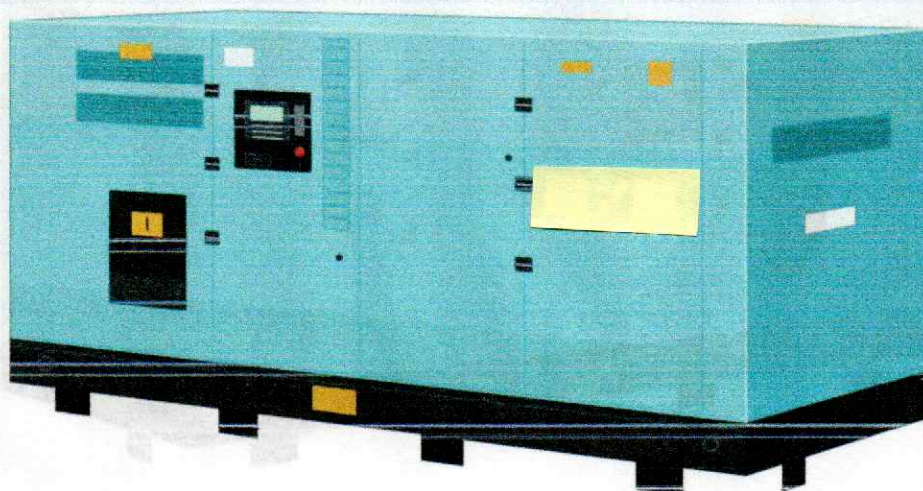
Fuel storage, exhaust routing, acoustic treatment and permitting shape what can physically be installed and where.

Response time

Standby generation needs time to start and stabilise. Sensitive loads often cannot tolerate that window.

THERE IS ANOTHER WAY.

introduces an alternative engineering approach based on advanced flywheel energy storage, intelligent power management and scalable system architecture.



A rotating-mass energy platform engineered for industrial duty.

combines a lithium iron phosphate (LiFePO₄) energy store, a parallel inverter group, a high-inertia flywheel stage, a reduction gearbox and a synchronous alternator into a single skid-mounted platform. Every element is selected for industrial duty rather than adapted from consumer hardware.

The architecture is modular. The same engineering approach scales across the product family, so a pilot installation and a full plant deployment share components, controls, spare parts and service procedures.

Engineering

Industrial-grade mechanical design, machined shaft line, precision-balanced rotating assemblies.

Energy store

Custom LiFePO₄ bank with integrated BMS and thyristor-controlled rectifier management.

Alternator

Synchronous generator at 1500 rpm, three-phase 380/400 V, regulated output.

Flywheel

Two-stage inertial mass providing torque stabilisation and instantaneous response.

Smart control

Motor driver control, grid synchronisation and remote monitoring as standard.

Industrial

IP-rated enclosure, S1 continuous-duty machinery, designed for 24/7 plant environments.

Engineered for

- Industrial and manufacturing applications
- Critical infrastructure
- Military and defence systems
- Data centres and telecommunications
- Remote and off-grid locations
- Emergency and standby power



Designed and engineered by MXB Energy

From stored charge to regulated three-phase output.

X GEN™ — SYSTEM ARCHITECTURE

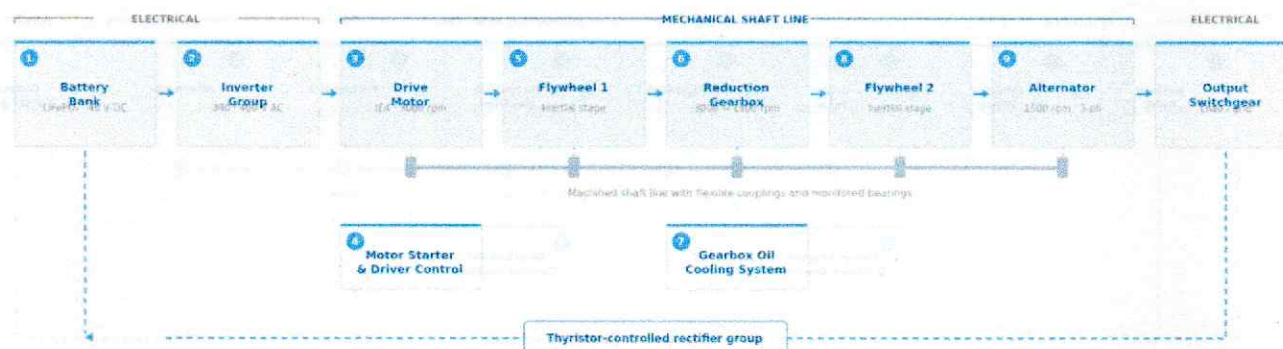


Figure 1 system architecture. Numbers correspond to the component list in section 5.

01 Energy store

A custom-designed LiFePO₄ battery bank supplies 48 V DC. The bank is engineered for the application rather than assembled from standard commercial cells, and is divided into banks sized to the platform rating.

02 DC/AC conversion

Parallel-connected inverters convert the DC supply to 380/400 V AC three-phase, feeding the drive motor through the motor starter and driver control.

03 Drive motor

An IE4-class three-phase induction motor receives the AC supply and initiates rotation of the shaft line at approximately 3000 rpm.

04 Flywheel stage 1

Rotational energy is transferred to the first flywheel. The inertial mass stabilises torque and buffers transient load variation on the shaft line.

05 Reduction gearbox

The gearbox reduces shaft speed from 3000 rpm to the alternator's 1500 rpm synchronous speed, converting speed into torque. A dedicated oil cooling circuit holds lubrication within its optimal temperature band.

06 Flywheel stage 2

A second inertial stage on the alternator side further smooths torque delivery and supports stable output under changing load.

07 Alternator output

The synchronous alternator operates at 1500 rpm, producing regulated three-phase 380/400 V at 50/60 Hz. Output can be consumed directly, stored, or synchronised to the grid.

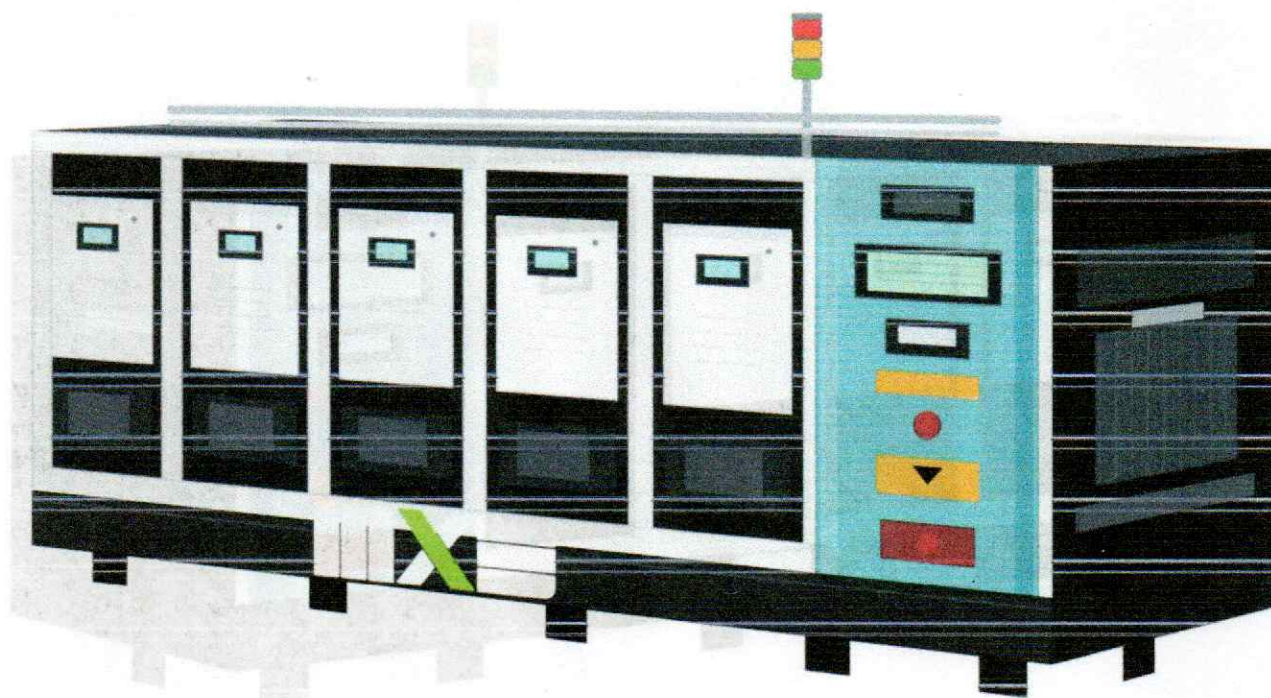
A thyristor-controlled rectifier system is integrated and synchronised with the battery bank to manage charge conditions, extend battery service life and reduce duty on the starter motor.

Figure 2 — Power conversion stages through the platform, with the rectifier charge-management path.

MEASURED PERFORMANCE — TO BE COMPLETED FROM FACTORY ACCEPTANCE TEST DATA

The figures below define the performance envelope of the platform and must be entered from the Factory Acceptance Test report for the specific unit before this document is issued externally.

- Measured electrical input to the drive motor, kW
- Measured electrical output at the alternator terminals, kW
- Measured round-trip efficiency of the complete chain, %
- Continuous runtime at rated load, hours
- Battery state of charge at test start and test end, %
- Test duration, load type and instrumentation used



What the architecture delivers in practice.

No combustion at the point of use

No exhaust routing, no on-site fuel storage, no local emissions or combustion noise. Installation constraints reduce accordingly.

Location independence

Operation does not depend on solar irradiance, wind conditions or daylight hours. Performance is the same in every season and at every latitude.

Instantaneous response

Rotating inertia responds to load change mechanically, without the start-up and stabilisation window required by combustion machinery.

Long-life energy store

LiFePO₄ chemistry rated at 8000 cycles with a 10-year estimated service life, managed by an integrated thyristor-controlled rectifier system.

Modular scalability

A common architecture across the product family. Units can be deployed individually or in parallel to match the required plant capacity.

Low maintenance burden

Specialist maintenance at two-year intervals with a short service window, against the hundreds-of-hours service cycle typical of combustion plant.

Remote monitoring

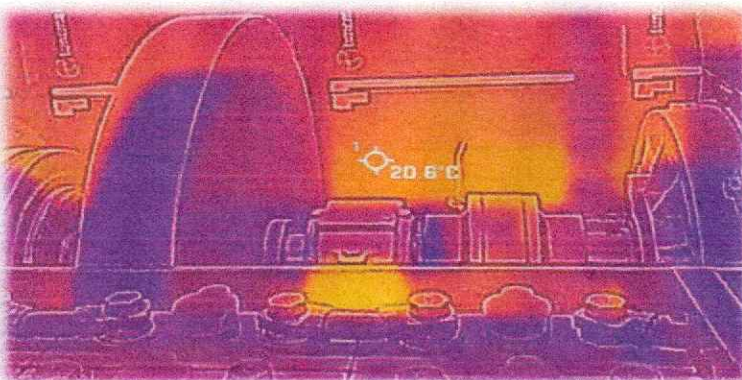
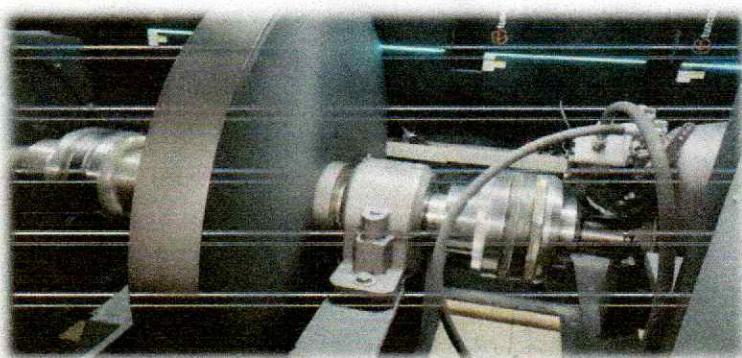
Remote access for monitoring, diagnostics and control is provided as standard, supporting unmanned and remote installations.

Extended warranty cover

Five-year platform warranty with ten-year spare parts availability and a design life in excess of thirty years.

Industrial component base

IE4 motors, machined shaft line, industrial gearbox with dedicated oil cooling, and IP-rated enclosures throughout.



Core Components

The nine assemblies that make up an ... platform.

No.	Assembly	Function
1	LiFePO ₄ battery group	Custom-engineered lithium iron phosphate energy store with integrated battery management, divided into banks sized to the platform rating.
2	Inverter group	Parallel-connected DC/AC inverters converting the 48 V DC bank supply to 380/400 V three-phase AC.
3	Drive motor	IE4-class three-phase induction motor, S1 continuous duty, IP65, driving the shaft line.
4	Drive motor starter	AC/DC motor starter and driver control managing start sequence, ramp and protection.
5	Flywheel 1	First inertial stage on the motor side, providing torque stabilisation and transient buffering.
6	Gearbox	Reduction gearbox converting shaft speed to the alternator's 1500 rpm synchronous speed.
7	Gearbox oil cooling system	Dedicated forced-cooling circuit maintaining lubrication temperature within the specified band.
8	Flywheel 2	Second inertial stage on the alternator side, smoothing torque delivery under varying load.
9	Generator / alternator	Synchronous alternator at 1500 rpm producing regulated three-phase output at 380/400 V, 50/60 Hz.

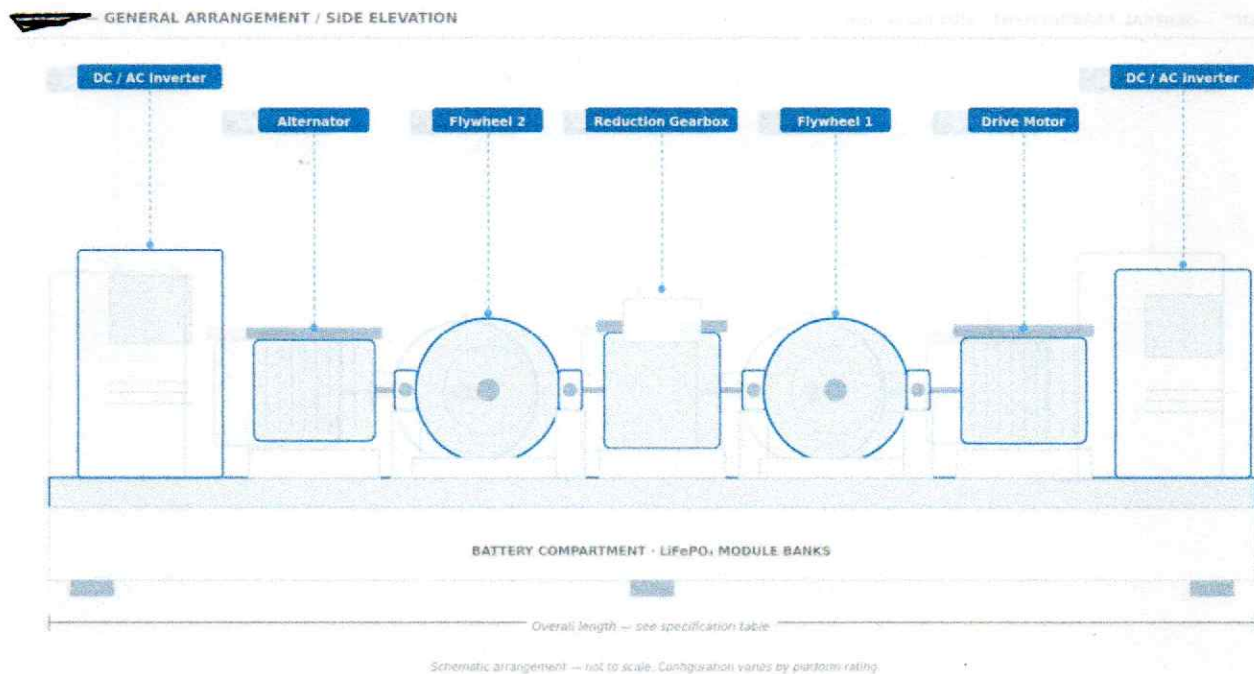


Figure 3 — General arrangement, side elevation. Schematic; configuration varies by platform rating.

Technical Specifications

Platform family — 20 kW to 5 MW, configured to project requirements.

1 Basic identification

Parameter	1000 kW	1500 kW	2000 kW	5000 kW
Model	X GEN 1000	X GEN 1500	X GEN 2000	X GEN 5000
System type	Flywheel hybrid	Flywheel hybrid	Flywheel hybrid	Flywheel hybrid
Rated power output	1000 kW / 1100 kVA	1500 kW / 1650 kVA	2000 kW / 2200 kVA	5000 kW / 5500 kVA
Output voltage range	380 / 400 V	380 / 400 V	380 / 400 V	380 / 400 V
Frequency	50 / 60 Hz	50 / 60 Hz	50 / 60 Hz	50 / 60 Hz
Number of phases	3	3	3	3
Insulation class	Class A	Class A	Class A	Class A
Excitation system	380 V / 50 Hz	380 V / 50 Hz	380 V / 50 Hz	380 V / 50 Hz
Voltage regulation	Regulated	Regulated	Regulated	Regulated
Noise level	74 dB	81 dB	81 dB	96 dB
System efficiency	[FAT]	[FAT]	[FAT]	[FAT]
Continuous runtime at rated load	[FAT]	[FAT]	[FAT]	[FAT]
Total harmonic distortion	[FAT]	[FAT]	[FAT]	[FAT]

2 Drive motor

Parameter	1000 kW	1500 kW	2000 kW	5000 kW
Rated power	90 kW / 125 HP	110 kW / 147 HP	140 kW / 198 HP	170 kW / 290 HP
Rated voltage	380 V	380 V	380 V	400 V
Rated current	280 A	310 A	345 A	410 A
Frequency	50 / 60 Hz	50 / 60 Hz	60 Hz	60 Hz
Efficiency class	IE4	IE4	IE4	IE4
Insulation class	Class A	Class A	Class A	Class A
Connection type	Star / delta	Star / delta	Star / delta	Delta
Rated speed	3100 rpm	3100 rpm	2980 rpm	2980 rpm
Number of poles	2	2	2	3
Duty type	S1 continuous	S1 continuous	S1 continuous	S1 continuous
Enclosure rating	IP65	IP65	IP65	IP65
Noise level	74 dB	74 dB	81 dB	98 dB

3 Energy storage system

Parameter	1000 kW	1500 kW	2000 kW	5000 kW
Battery type	LiFePO ₄	LiFePO ₄	LiFePO ₄	LiFePO ₄
Module capacity	51.2 V / 100 Ah — 5120 Wh	51.2 V / 100 Ah — 5120 Wh	51.2 V / 100 Ah — 5120 Wh	51.2 V / 100 Ah — 5120 Wh
Total module quantity	16	18	22	30
Total stored energy	81.9 kWh	92.2 kWh	112.6 kWh	153.6 kWh
Cycle life	8000 cycles	8000 cycles	8000 cycles	8000 cycles
Estimated battery life	10 years	10 years	10 years	10 years
Inverter AC output voltage	380 V	380 V	380 V	380 V
Inverter AC output frequency	50 Hz	50 Hz	50 Hz	50 Hz
Inverter group capacity	[FAT]	[FAT]	[FAT]	[FAT]

4 Physical and environmental

Parameter	1000 kW	1500 kW	2000 kW	5000 kW
Dimensions (L × W × H)	600 × 200 × 180 cm	600 × 200 × 180 cm	650 × 250 × 200 cm	750 × 300 × 250 cm
Dry weight	14 500 kg	16 150 kg	18 100 kg	24 000 kg
Ambient operating temperature	−40 °C to +75 °C	−40 °C to +75 °C	−40 °C to +75 °C	−40 °C to +75 °C
Ingress protection	IP44	IP44	IP65	IP65
Power density	69 kW/t	93 kW/t	110 kW/t	208 kW/t

5 Compliance and certification

Parameter	1000 kW	1500 kW	2000 kW	5000 kW
Industry standards	CE / ISO 9001	CE / ISO 9001	CE / ISO 9001	CE / ISO 9001
Grid compliance	Synchronisable	Synchronisable	Synchronisable	Synchronisable
Certification scope	IAF code 19	IAF code 19	IAF code 19	IAF code 19
Type test / third-party report	[to be added]	[to be added]	[to be added]	[to be added]

A note on performance data

Fields marked [FAT] are to be populated from the Factory Acceptance Test report for the specific unit and configuration. Power density figures above are calculated directly from the rated output and dry weight stated in the same column. Where a third-party verification report exists, it should be referenced in section 5 and appended to this document.

Applications

Where continuity of supply is not optional.

Manufacturing

Process industries where an interruption costs a full production batch, and where voltage quality directly affects machine tolerances and product yield.

Mining

Remote sites where fuel logistics dominate operating cost, and where haulage, ventilation and processing plant require continuous, high-quality supply.

Healthcare

Hospitals and diagnostic facilities where imaging, surgical and life-support systems require uninterrupted, clean power with no local exhaust.

Defence

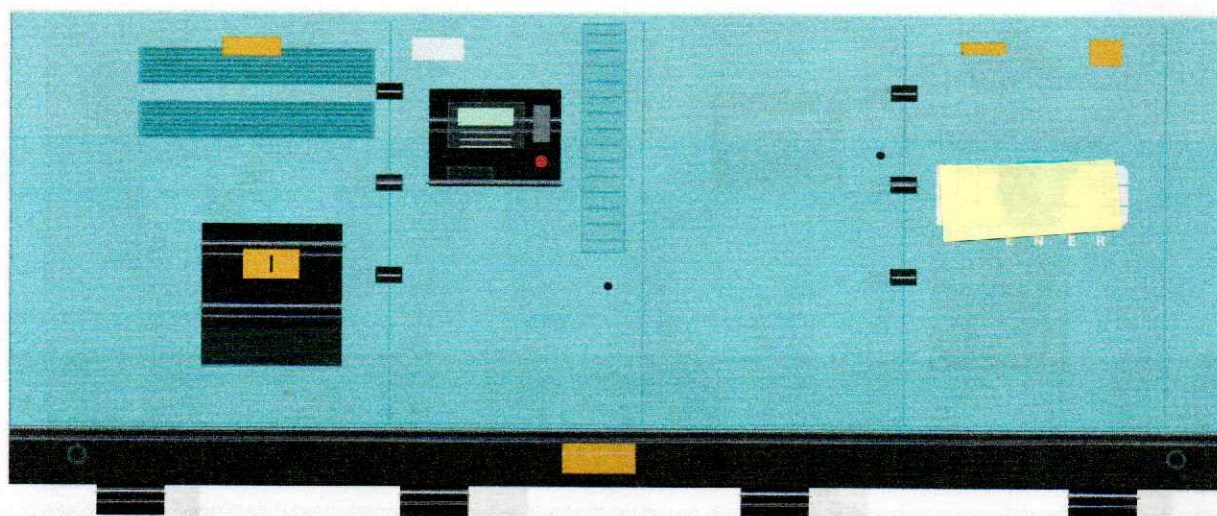
Forward and fixed installations where fuel resupply is a strategic vulnerability, and where acoustic and thermal signature are operational considerations.

Data centres

Facilities where power quality events, not just outages, are the primary threat to uptime, and where rotating inertia bridges transfer events.

Marine and offshore

Vessels and platforms with constrained space, restricted fuel bunkering and stringent emissions requirements in controlled waters.



Each deployment is configured to the site: platform rating, number of parallel units, enclosure specification, integration with existing switchgear, and grid synchronisation requirements are defined during the engineering review.

How the platform compares on the criteria that shape an investment decision.

Criterion		Diesel	Solar PV	Wind	Grid
On-site fuel required	No	Yes	No	No	No
Weather dependent	No	No	Yes	Yes	No
Local emissions	None	Yes	None	None	None
Local combustion noise	None	High	None	Moderate	None
Response to load change	Immediate	Delayed	Inverter-limited	Inverter-limited	Immediate
Independent of external supply	Yes	Fuel supply	No	No	No
Site footprint per MW	Compact	Compact	Large	Large	Minimal
Service interval	24 months	250–500 h	12 months	6–12 months	n/a
Exposed to energy price	No	Yes	No	No	Yes
Continuous output duration	[FAT]	Fuel-limited	Daylight-limited	Wind-limited	Unlimited
Capital cost per kW	[to be added]	Low	Moderate	Moderate	Lowest
Levelised cost of energy	[to be added]	High	Low	Low	Variable

A complete commercial comparison requires the capital cost, the measured continuous output duration and the levelised cost of energy for the specific configuration. These are shown as open fields above and should be completed before the document is issued to investors or customers.

Safety

High-inertia rotating machinery, engineered accordingly.

..... stores significant kinetic energy in rotating masses and significant chemical energy in its battery bank. Both are addressed by design, not by procedure alone.

Mechanical

- Rotating assemblies are precision-balanced and mounted on an engineered shaft line with monitored bearings.
- Flywheel assemblies are enclosed within the platform structure; containment design is verified for the rated operating speed of each platform.
- Vibration and bearing temperature are monitored continuously, with defined alarm and trip thresholds.
- Guarding prevents access to rotating parts during operation; interlocks prevent enclosure access above defined shaft speeds.

Electrical

- Overcurrent, earth fault and overvoltage protection on both DC and AC sides.
- Emergency stop with controlled shutdown and monitored rundown of the rotating assembly.
- Grid synchronisation with anti-islanding protection where the platform is connected to an external network.
- IP-rated enclosures across the platform, with restricted access to live compartments.

Energy store

- Integrated battery management system with cell-level voltage and temperature monitoring.
- LiFePO₄ chemistry selected for its thermal stability relative to other lithium chemistries.
- Thyristor-controlled rectifier management limits charge conditions outside the specified envelope.
- Defined isolation and lock-out procedure for all maintenance work on the DC side.

Commissioning requirement

Every platform is commissioned by MXB Energy personnel. Site acceptance includes verification of protection settings, emergency stop function, containment integrity and monitored shutdown behaviour before the unit is released to the customer.

Maintenance

Designed for long intervals and short service windows.

Activity	Interval	Duration	Performed by
Remote monitoring and diagnostics	Continuous	—	MXB Energy
Visual inspection and log review	Quarterly	30 minutes	Site personnel
Gearbox oil condition check	Annual	1 hour	Site personnel
Specialist maintenance service	24 months	2 hours	MXB Energy
Battery capacity verification	24 months	Within service	MXB Energy
Bearing and vibration survey	24 months	Within service	MXB Energy

Coverage

- Five-year platform warranty from commissioning.
- Ten-year spare parts availability guarantee.
- Design life in excess of thirty years with the specified maintenance schedule observed.
- Remote access for monitoring, diagnostics and control included as standard.
- Technical support available throughout the warranty period.
- Factory Acceptance Test carried out on every unit prior to shipment; site acceptance test carried out at commissioning.

Each unit undergoes a Factory Acceptance Test before release. After successful FAT the system is installed and commissioned on site, and the warranty period begins at handover.

Frequently Asked Questions

What is the operating principle of

A LiFePO₄ battery bank feeds a parallel inverter group, which drives an IE4 induction motor. The motor turns a shaft line carrying two flywheel stages and a reduction gearbox, which drives a synchronous alternator at 1500 rpm. The alternator produces regulated three-phase output, and a thyristor-controlled rectifier system manages the battery bank.

What power ratings are available?

The platform family is offered from 20 kW to 5 MW. Standard configurations are 1000, 1500, 2000 and 5000 kW; intermediate ratings are configured to project requirements, and units can be operated in parallel.

How long does the platform run at rated load?

Continuous runtime at rated load is stated in the Factory Acceptance Test report for the specific configuration. This figure should be requested for the platform rating under consideration and confirmed against the FAT instrumentation record.

What is the measured round-trip efficiency?

Efficiency of the complete chain — inverter, motor, gearbox, alternator and rectifier — is recorded during the Factory Acceptance Test and stated in the FAT report for the specific unit.

Can the system be connected to the grid?

Yes. The platform is designed to synchronise with an external network. Grid connection requires approval from the network operator and the applicable protection settings, both of which are addressed during the engineering review.

What are the site requirements?

A level foundation sized to the platform mass, clearance for maintenance access, ventilation for the gearbox cooling circuit and the enclosure, and connection to the site distribution board. No fuel storage, exhaust routing or acoustic enclosure for combustion is required.

What maintenance does it need?

Specialist maintenance every 24 months with a service window of approximately two hours, supported by continuous remote monitoring and routine site inspections. There are no combustion consumables.

What is the expected service life?

The platform is designed for a service life in excess of thirty years. The battery bank carries an 8000-cycle rating with a 10-year estimated service life and is a planned replacement item within that period.

What testing is carried out before delivery?

Every unit undergoes a Factory Acceptance Test prior to shipment, covering electrical performance, protection functions, thermal behaviour and mechanical condition. A site acceptance test is carried out at commissioning.

Is independent verification available?

Customers and partners may request third-party witnessed testing. MXB Energy supports independent verification of platform performance under an agreed test protocol.