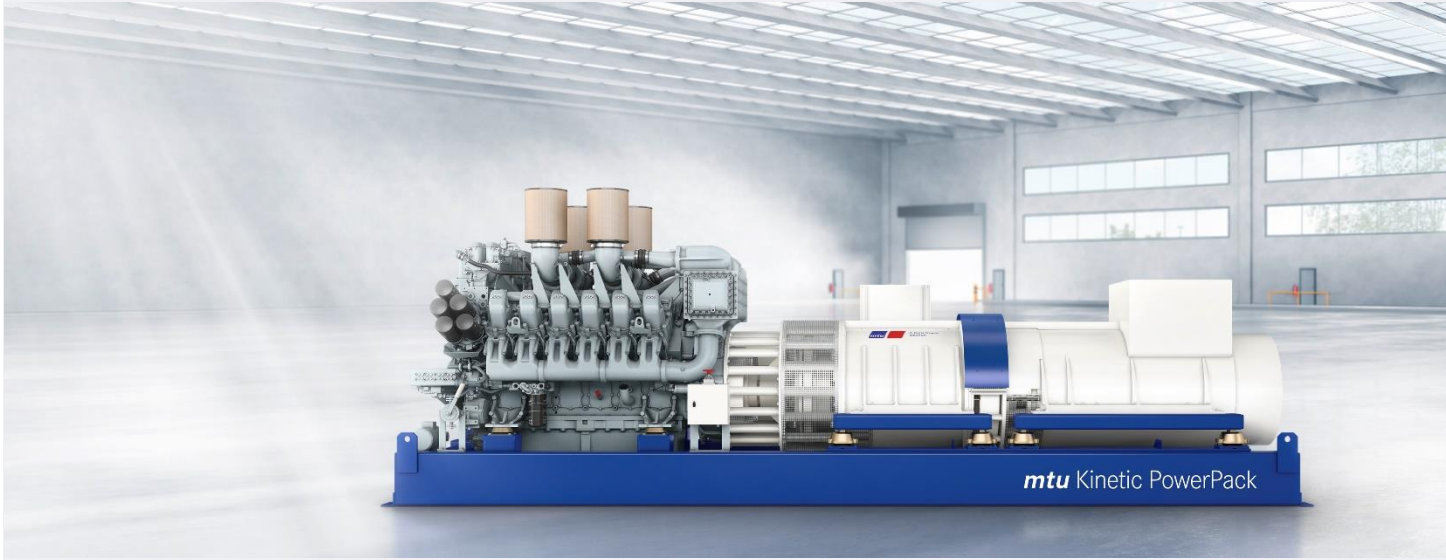


mtu Kinetic PowerPack

Big picture, application, technology, benefits, portfolio

A Rolls-Royce solution

Contents

A Rolls-Royce solution

01

Rolls-Royce Power Generation

Solutions at a Glance

A Rolls-Royce solution

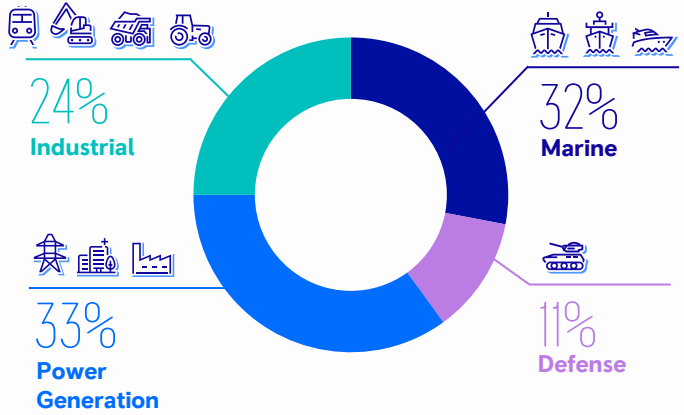
Power Systems at a glance

Revenue 2020

£2.745bn

Employees

≈ 9,000



A Rolls-Royce solution

02

mtu Kinetic PowerPack solutions

Our market segments

mtu Kinetic PowerPack

A Rolls-Royce solution

Data Centers & IT

Colocation Data Centers

Hyperscale Data Centers

Enterprise Data Centers

Supercomputers

Infrastructure + Logistics

Airports

Traffic Tunnels

Logistics + Distribution Centers

Healthcare

Casinos

Critical Process Manufacturing

Semiconductors

Pharmaceuticals

Refining + Petrochemical

Food

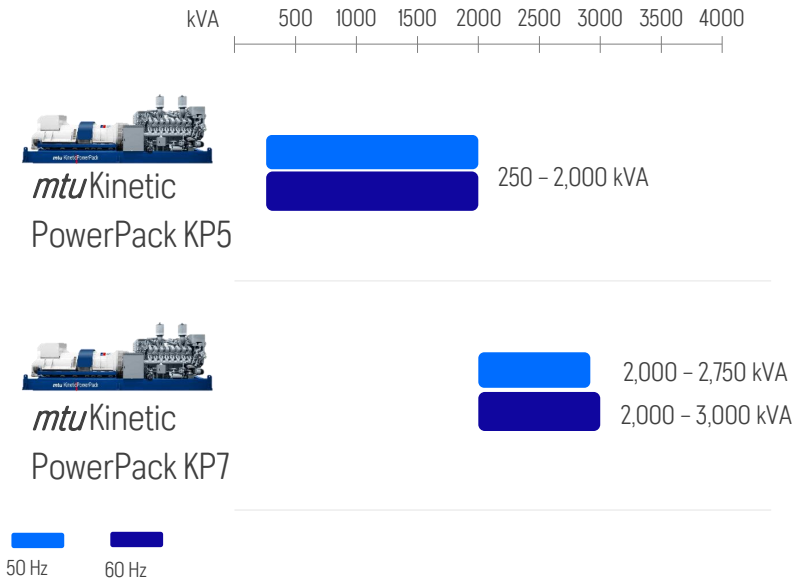
Textiles

Overview *mtu* Kinetic PowerPack business

Key facts

Member of Rolls-Royce since	July 2020
Offering	Customized turn-key solutions
Assembly & Testing	Belgium
Installed base	>1,400 units across 57 countries
1st unit installed	1984
Market Segments	Data Centers, Critical Process Manufacturing, Infrastructure, Healthcare, Airports

Product Portfolio



50Hz (Low voltage: 380-415V; Medium voltage: 6-36kV);
60 Hz (Low voltage: 208-480V; Medium voltage: 4-36kV)

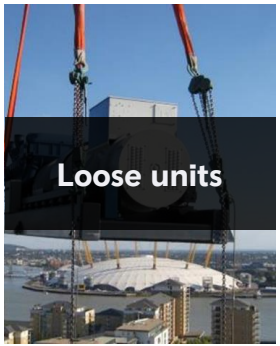
Rolls Royce Solutions Liege, Belgium

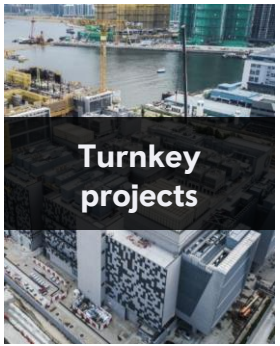
- 6300 M² Factory
  - ✓ Assembly
  - ✓ 16 units testing facility

A Rolls-Royce solution

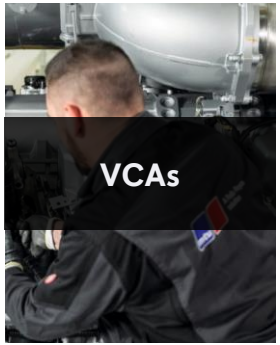
Our philosophy: We provide our customers with a complete solution

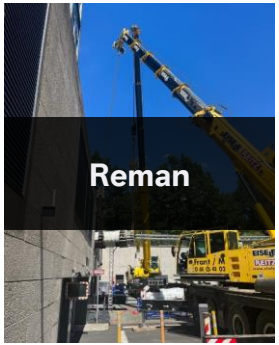
Our solution scope

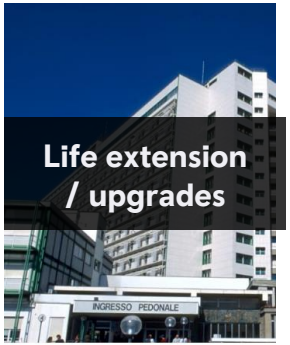




Our service scope

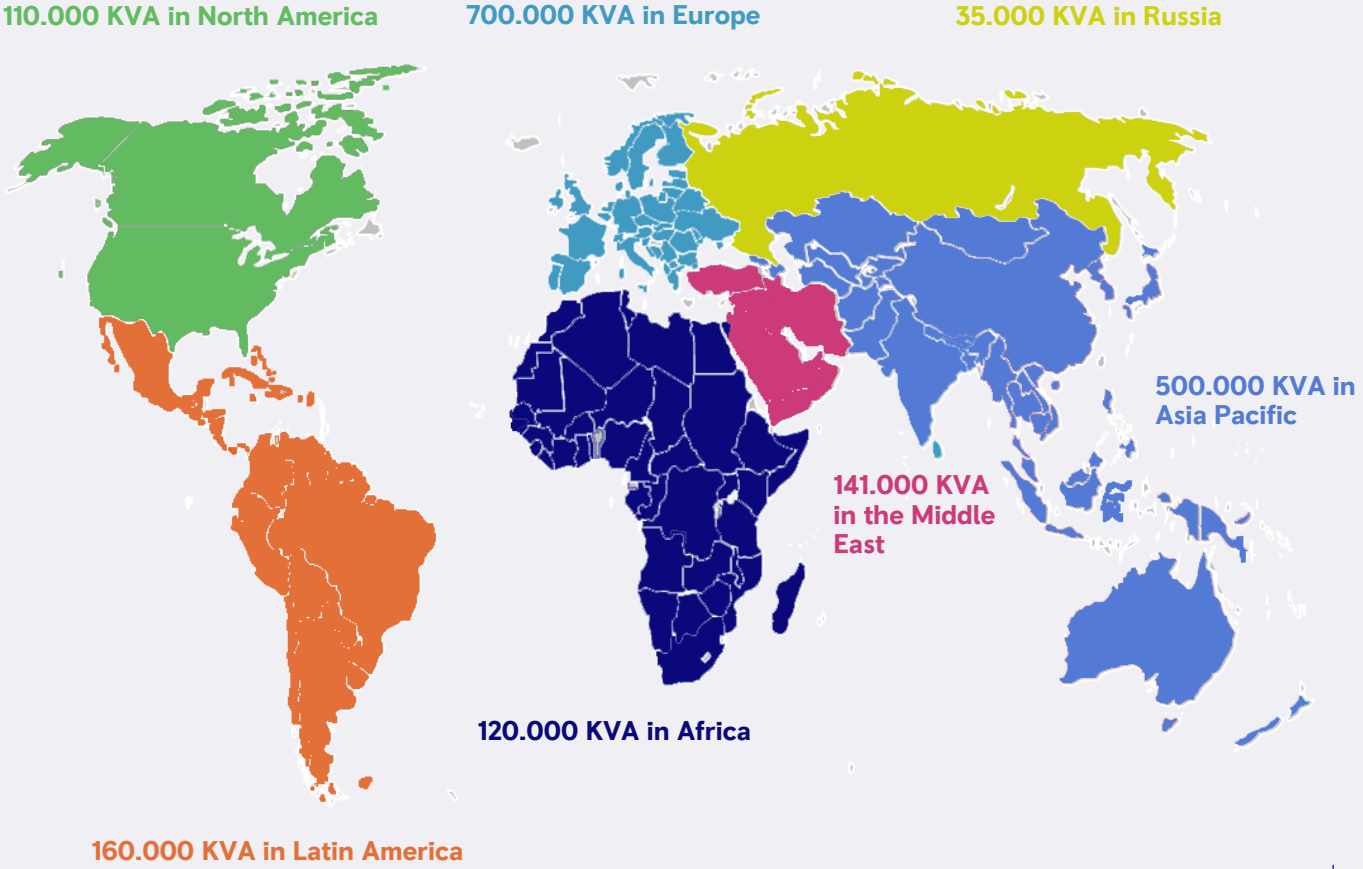






Global Presence

Installed Base > 2,000,000 kVA

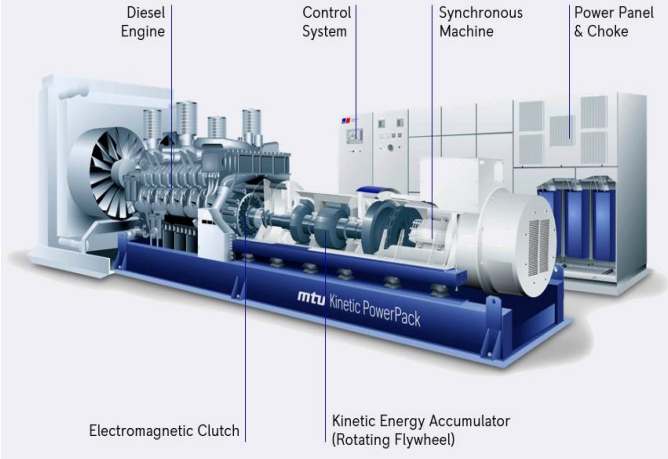


A Rolls-Royce solution

03

Design & Benefits of *mtu* Kinetic PowerPack solutions

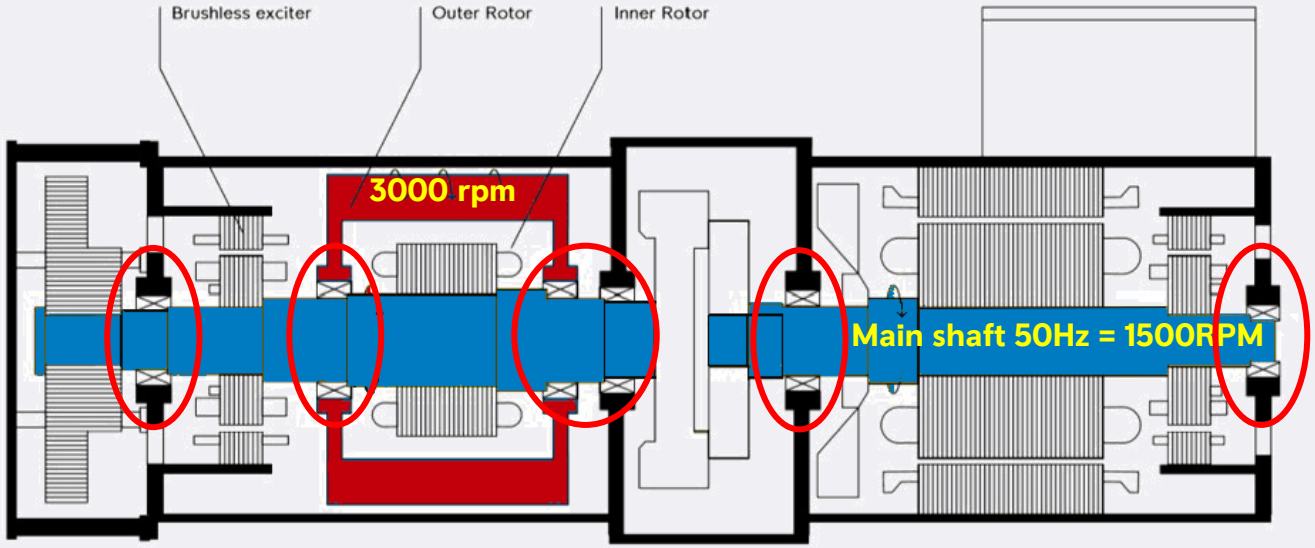
Design and fundamental of *mtu* Kinetic PowerPack



The mtu Kinetic PowerPack combines DUPS system and diesel backup generator in one single integrated and compact solution.

Design of a Kinetic Powerpack

Stato-Alternator Bearing Construction



Electromagnetic Clutch

Kinetic Energy Accu

Synchronous Machine

Unstressed Bearing Construction

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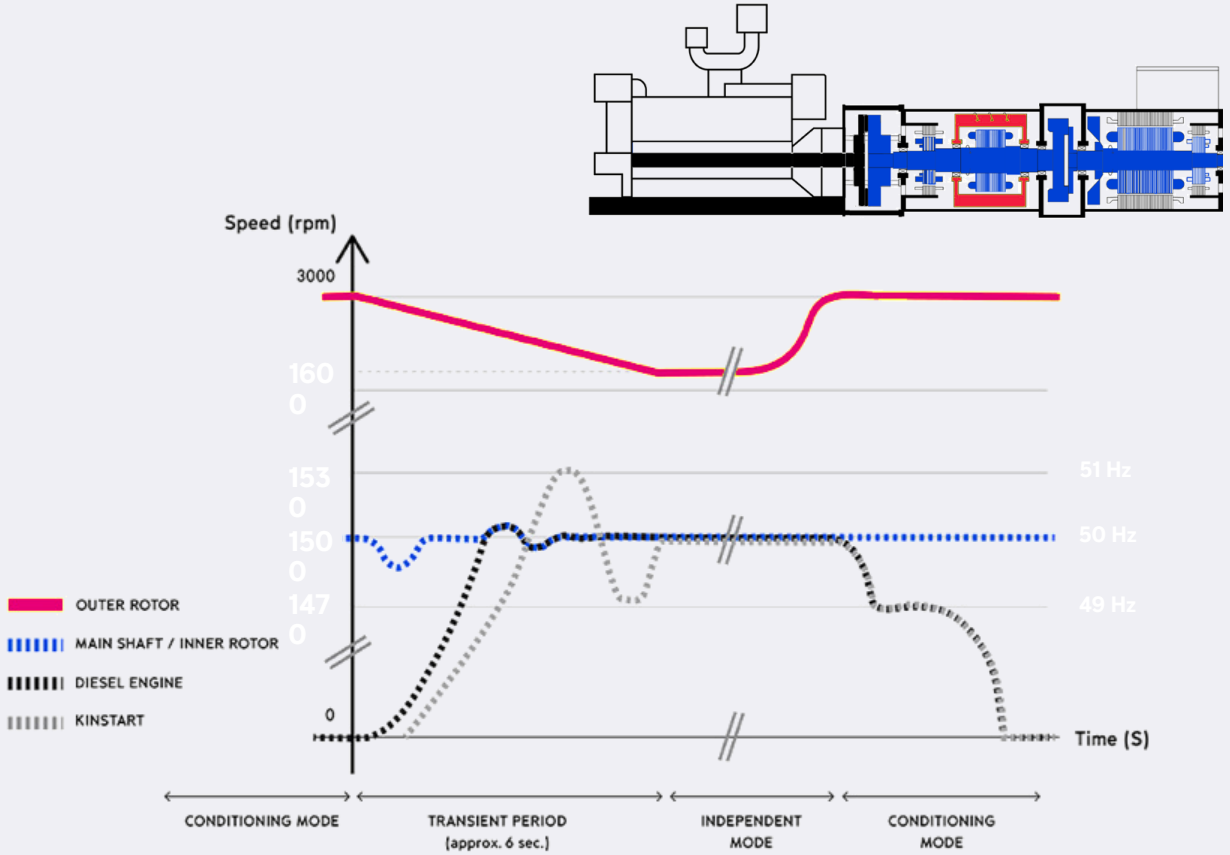
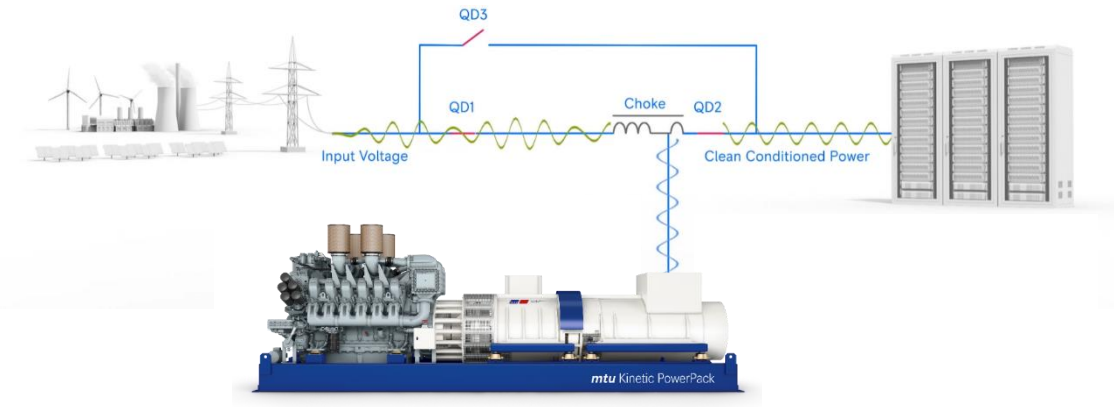
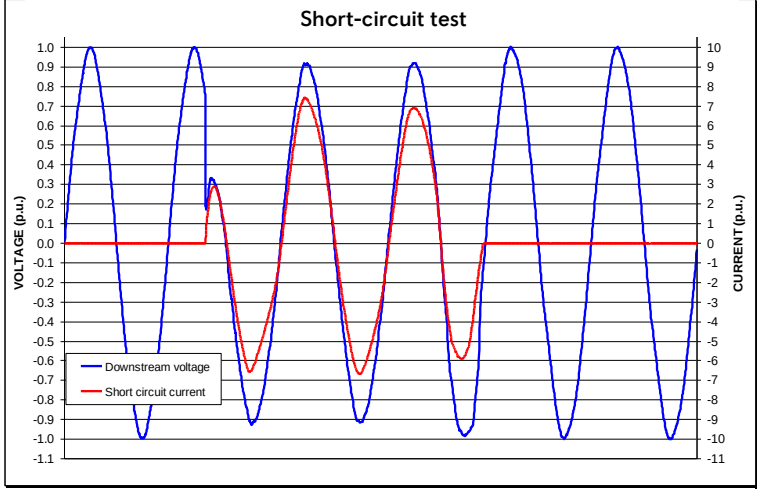
Function of *mtu* Kinetic PowerPack 50Hz



A Rolls-Royce solution

Maximum protection





Filtering and power factor improvement

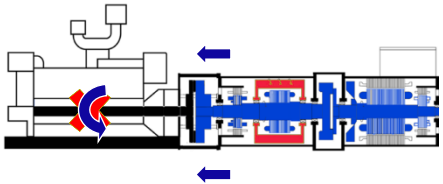
- Continuous filtering and conditioning of raw mains before it reaches the critical load
- Elimination of spikes, frequency deviations, sags, outages, harmonics and transients
- High system efficiency in conditioning mode results in low operating costs (> 96-97%)

Fast fault clearing capability

- Capability to provide up to 20x the rated current
- In case of short-circuit downstream, this allows for fast tripping of protection, good discrimination, minor voltage perturbation
- Instead, inverters in static UPS are limited to less than 3x the rated current

Maximum reliability

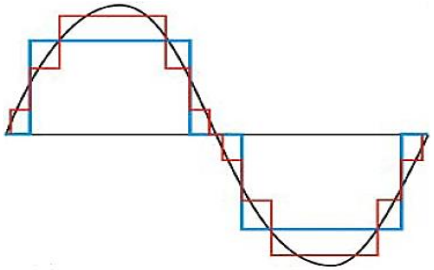
Guaranteed engine start



The ***mtu*** Kinetic PowerPack offers redundant and independent starting systems for the diesel engine:

1) the usual electric system
2) the KINSTART ⇦

Robust synchronous machine



- The synchronous machine generates a sine wave naturally and is robust due to its high rotational inertia.
- Instead, in static UPS, the voltage wave form is generated by comparatively fragile semiconductors with a low thermal inertia.
- Power electronics are highly susceptible to overloads

Less components

- Intrinsic reliability through low number of components
- The ***mtu*** Kinetic PowerPack combines DUPS system and diesel backup generator in one single integrated and compact solution
- Elimination of static UPS, batteries, additional switches and capacitor banks

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Best sustainability

Static UPS

- Battery replacement after 3-5 years increases TCO
- Several days of downtime during replacement
- Batteries lose capacity over lifetime

Dynamic UPS

- Typical design life 20+ years
- Bearing replacement at overhaul after 10 years of operation
- Minimal environmental impact
- No power degradation with use

Reduced carbon footprint with DUPS

- Elimination of batteries avoids tons of waste material and pollution during production and disposal
- Battery recycling is highly energy intensive and limited to certain battery types

Greatest flexibility

Low & medium voltage systems

50Hz:

- Low voltage: 380 – 415V
- Medium voltage: 6 – 36kV

60Hz:

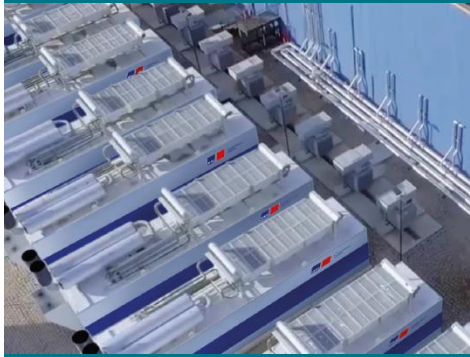
- Low voltage: 208 – 480V
- Medium voltage: 4 – 36kV

Specific voltage on demand

Single & dual output systems

- Single output systems to supply all loads with uninterruptible No-Break (NB) Power
- Dual output systems to supply critical loads with NB-power and non-critical loads with interruptible Short-Break (SB) power
- A dual output system reduces the component count and adds additional floor space savings

Modular & scalable



- Container or building layout specification
- Customized container & enclosure solutions
- Design of sound attenuation, ventilation systems, exhaust systems, exhaust aftertreatment, piping, etc.

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Highest power density

DUPS footprint is only

70% of static UPS + genset footprint.

30%

grey space[1] saving, more white space[2] available

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Static UPS + Genset installation layout

- Higher OPEX due to more components
- Battery replacement after 3-5 years
- Capacitor replacement after 7 years

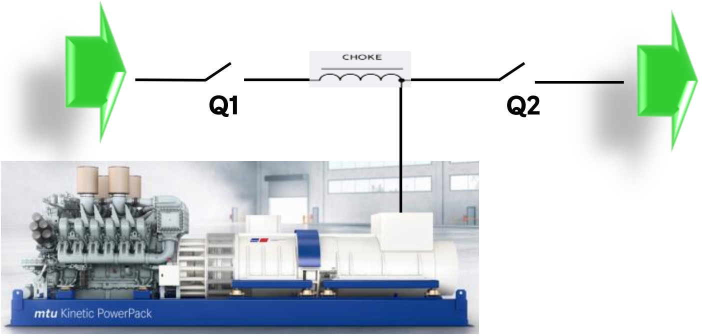
Dynamic UPS installation layout

- **More space…**
  - **…to save space and construction costs**
  - **…to expand IT floor and to generate revenues**

1 Grey space: Installation space for air conditioning, emergency power and other operating equipment → creating cost
2 White space: Installation space for servers, switches and data storage in data centers → creating revenue

Efficiency comparison

100%



>96-97%

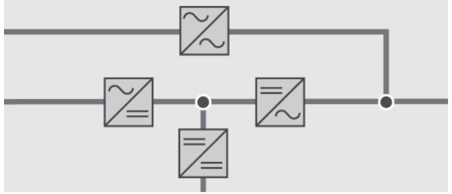
Total losses D-UPS < 3-4%

Always conditioned power

Energy Efficient by minimum 3%

Total losses S-UPS > 6-7% (3-4% system + 2-3% A/C)

Unconditioned in EcoMode/Standby/Lineinteractive mode



100%

Air Conditioning

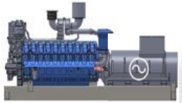
Standby Batteries

UPS

Filter & PFC

Busduct & Cabling

Spark-proof Lighting



GenSet

<93-94%

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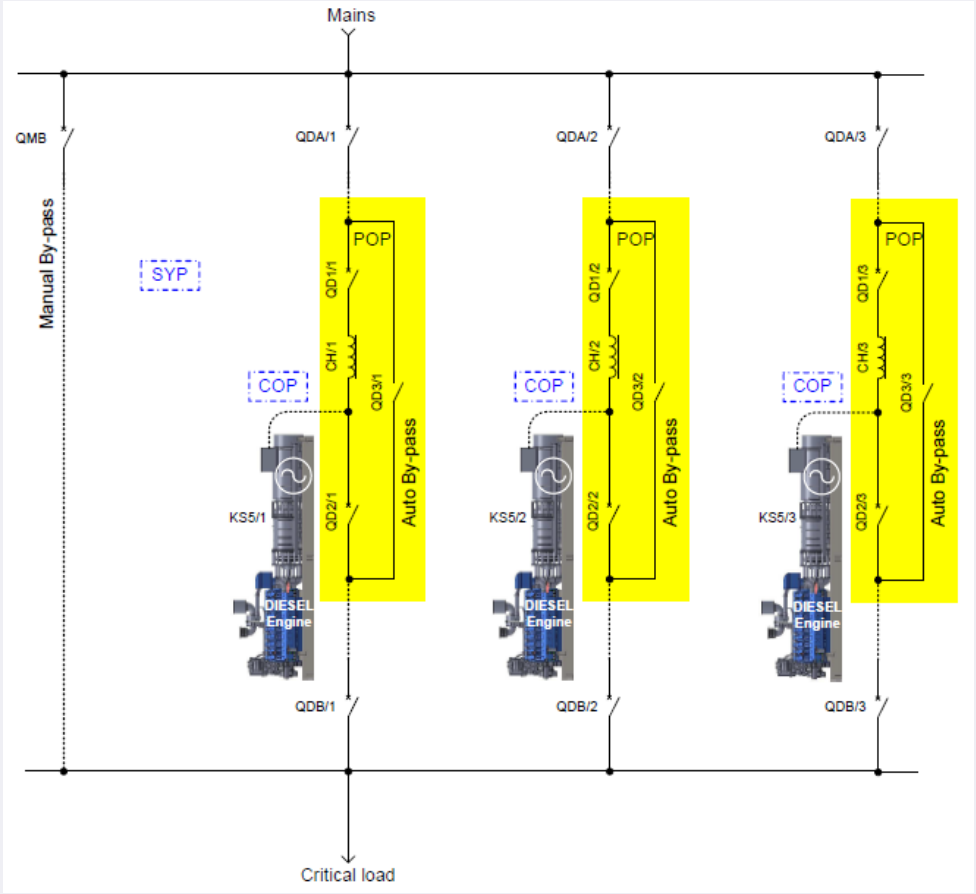
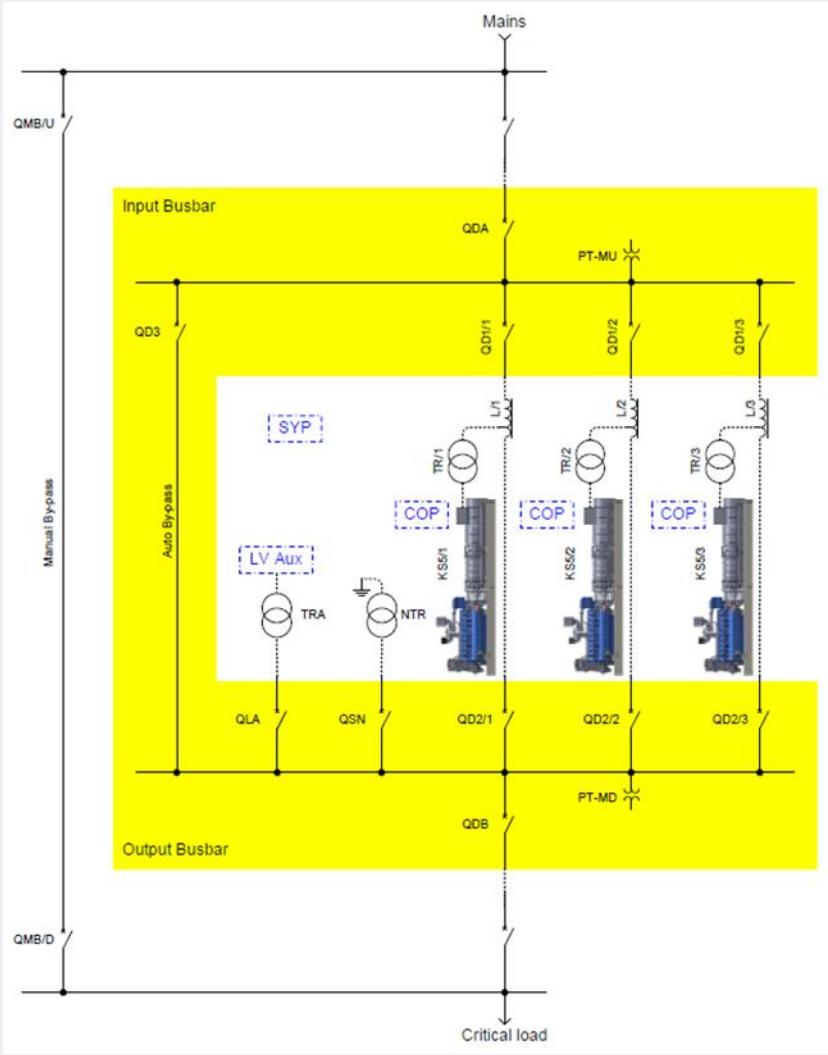
KP® LV Parallel System



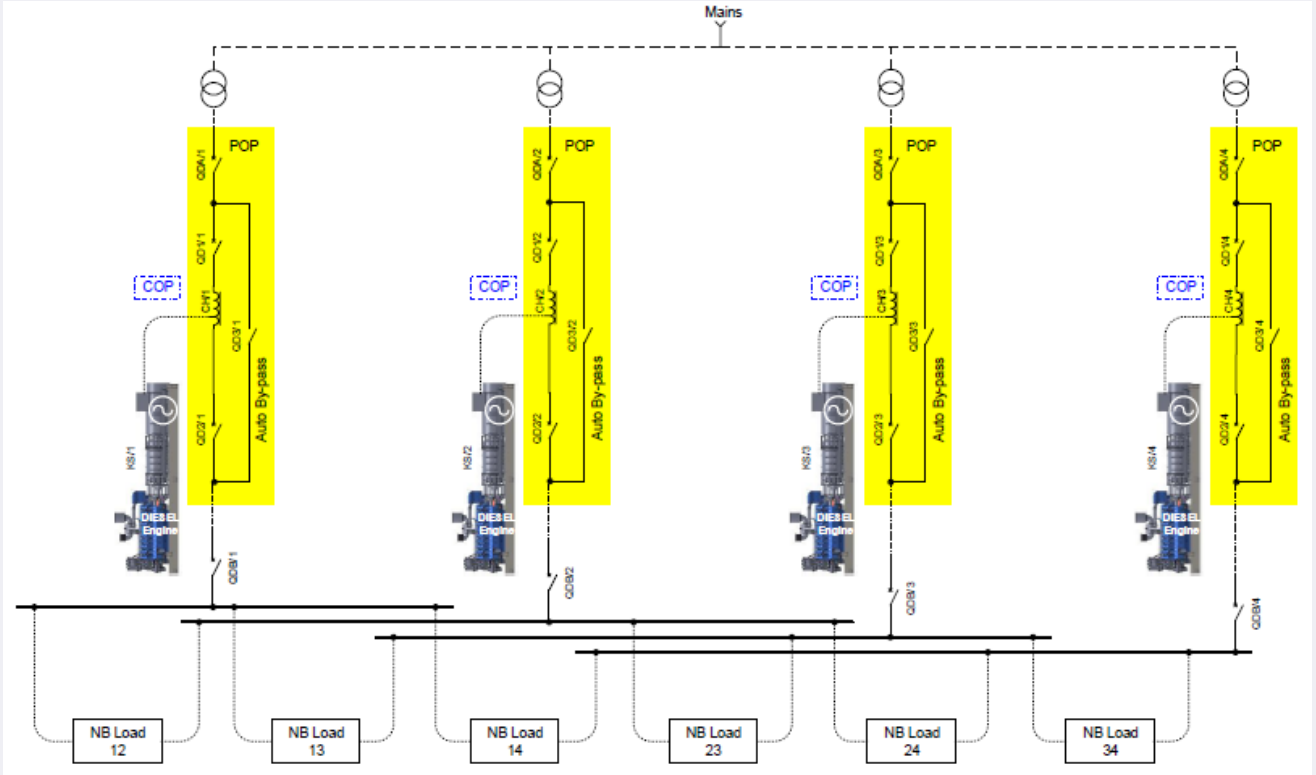
A Rolls-Royce solution

KP® MV Parallel System



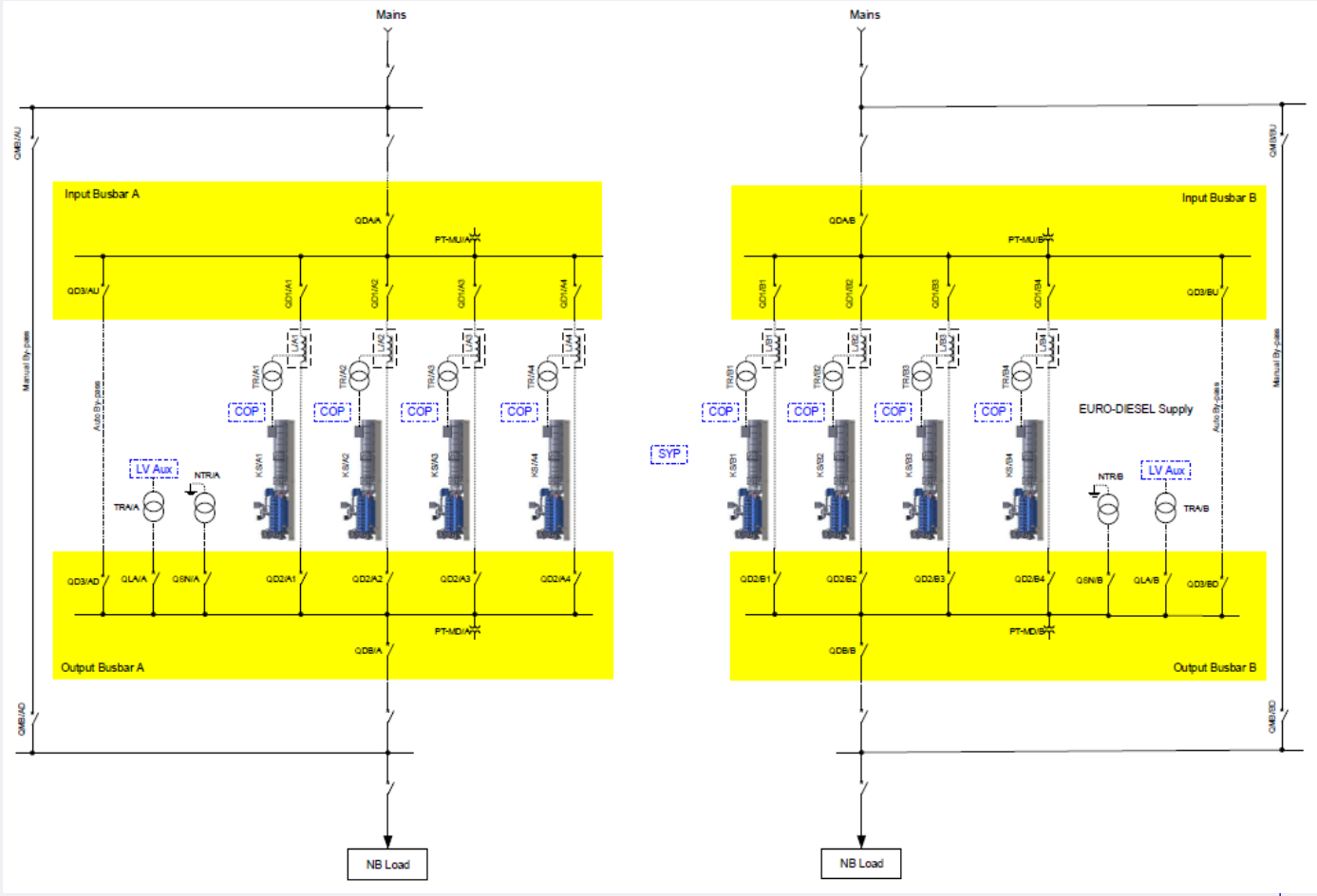
A Rolls-Royce solution

KP® Distributed Redundant System Tier III



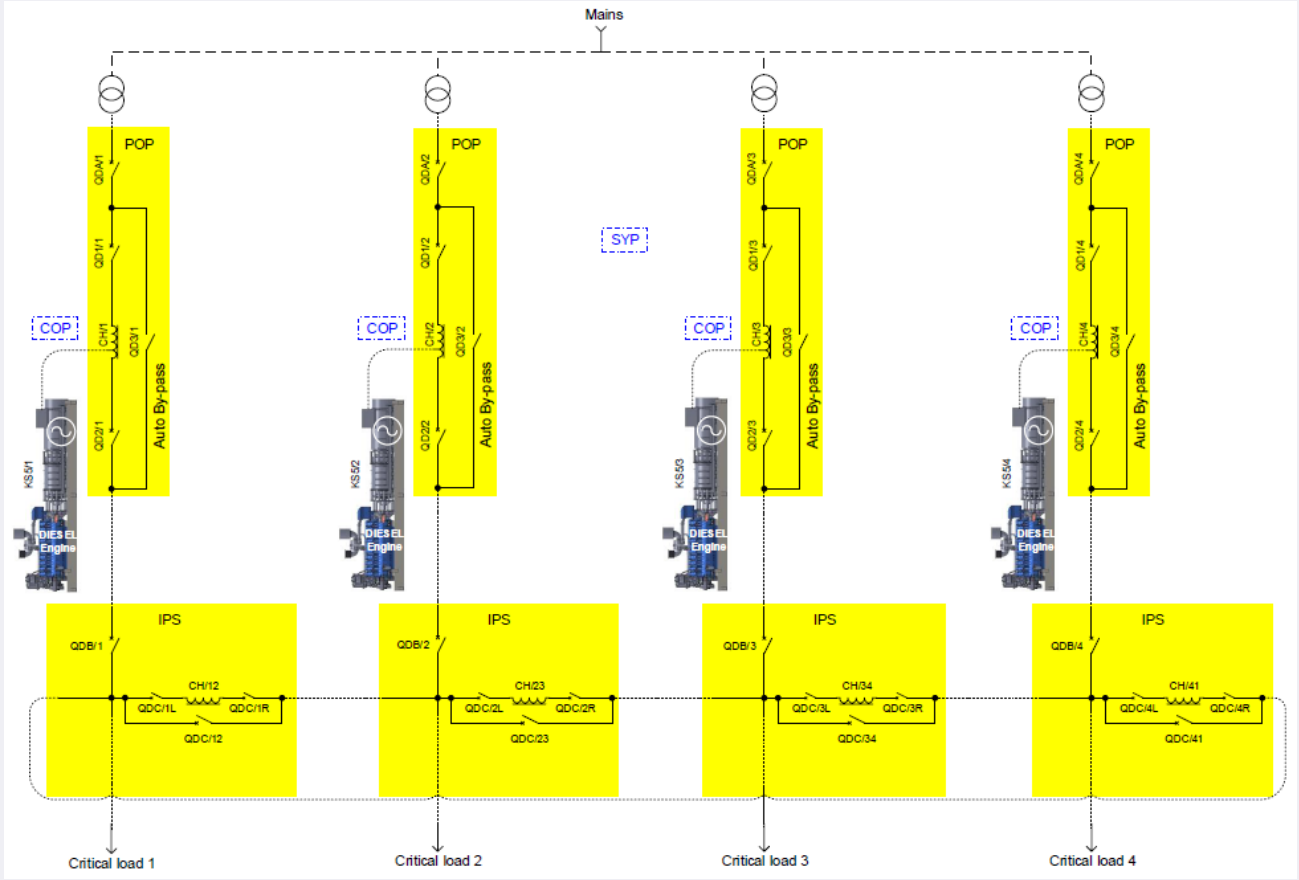
A Rolls-Royce solution

KP® MV Parallel 2 (N+1), Tier IV



A Rolls-Royce solution

KP®
Isolated Parallel System



A Rolls-Royce solution

04 Total Cost of Ownership

Comparison Table

CAPEX & OPEX Costs
Over 10 years

Option A - Static UPS

Static UPS: N x α kW + Gensets: N x β kW DCC/ESP/... rating

	Scope of supply	Quantity	Unit price	Total
CAPEX	Investment SUPS α kW + batteries (ex: VRLA 10 minutes)	N	€	€
	Investment Diesel Genset β kW in container	N	€	€
	Investment ATS "mains - genset" + mechanical load feeder	N	€	€
	Investment for SUPS input/output switchgear	N	€	€
	Investment HVAC SUPS room/Batteries room	N	€	€
	Investment for Fire suppression system for SUPS and battery rooms	N	€	€
	Installation costs SUPS, batteries and fire suppression system	N	€	€
	Installation costs Diesel Genset	N	€	€
			TOTAL CAPEX	**€**

	Scope of supply		Quantity	Yearly OPEX per unit	Total (10 years)
OPEX	Efficiency losses SUPS	(... kW)	N	€	€
	Power consumption HVAC SUPS room	(... kW)	N	€	€
	Power consumption HVAC Battery room	(... kW)	N	€	€
	Yearly preventive maintenance costs SUPS		N	€	€
	Yearly preventive maintenance costs Diesel Genset		N	€	€
				Additional OPEX per unit	
	Batteries replacement after 5 years		N	€	€
	SUPS capacitors replacement after 7 years		N	€	€
	Additional major maintenance on Diesel engine : same as DUPS				
				TOTAL OPEX	**€**
	Electricity costs, for losses, based on ... €/kWh and 8760 hours/year				

TCO	**Total cost of ownership - 10 years - for SUPS solution**	**TOTAL TCO**	**€**

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Comparison Table

CAPEX & OPEX Costs
Over 10 years

Option B - Dynamic UPS

Dynamic UPS: N x *mtu* Kinetic PowerPack γ kW (Engine @ DCC/ESP/... rating)

	Scope of supply	Quantity	Unit price	Total
CAPEX	Investment DUPS γ kW critical in container	N	€	€
	Investment DUPS Switchgear including: Choke, upstream/downstream and automatic bypass circuit-breakers		*Included in DUPS investment*	
	Installation costs DUPS system	N	€	€
			TOTAL CAPEX	**€**

	Scope of supply	Quantity	Yearly OPEX per unit	Total (10 years)
OPEX	Efficiency losses DUPS (... kW)	N	€	€
	Ventilation fans (... kW)	N	€	€
	Yearly preventive maintenance costs DUPS system	N	€	€
	Additional major maintenance on Diesel engine : same as SUPS genset			
			TOTAL OPEX	**€**
	Electricity costs, for losses, based on ...€/kWh and 8760 hours/year			

TCO	**Total cost of ownership - 10 years - for DUPS solution**	**TOTAL TCO**	**€**

A Rolls-Royce solution

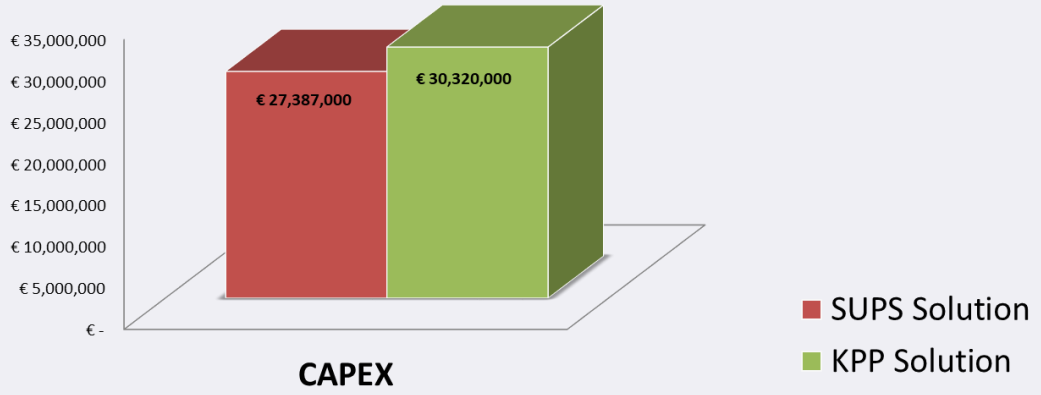
Example of a Data Center

Quantities and Load Demands comparison for both solution A & B

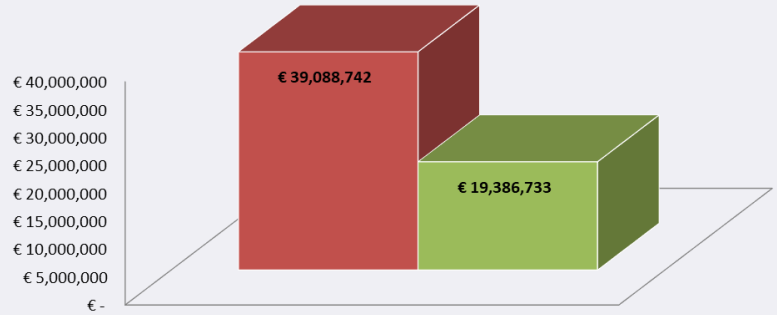
Item	Solution A (Static UPS + Gensets)		Solution B (Kinetic Power pack)	
	Power rating	Quantity	Power rating	Quantity
Critical Load	1.6 MW 2.0 MW	7 units 5 units	2.0 MW 2.0 MW	11 units 5 units
Gensets	2.4 MW	14 units	NA	NA
Total loads		26 units		16 units

Capex & Opex Analyses
SUPS vs KPP
Li-ion

	CAPEX	OPEX	TCO 10 YEARS
SUPS Solution	€ 27,387,000	€ 39,088,742	€ 66,475,742
KPP Solution	€ 30,320,000	€ 19,386,733	€ 49,706,733



CAPEX



OPEX

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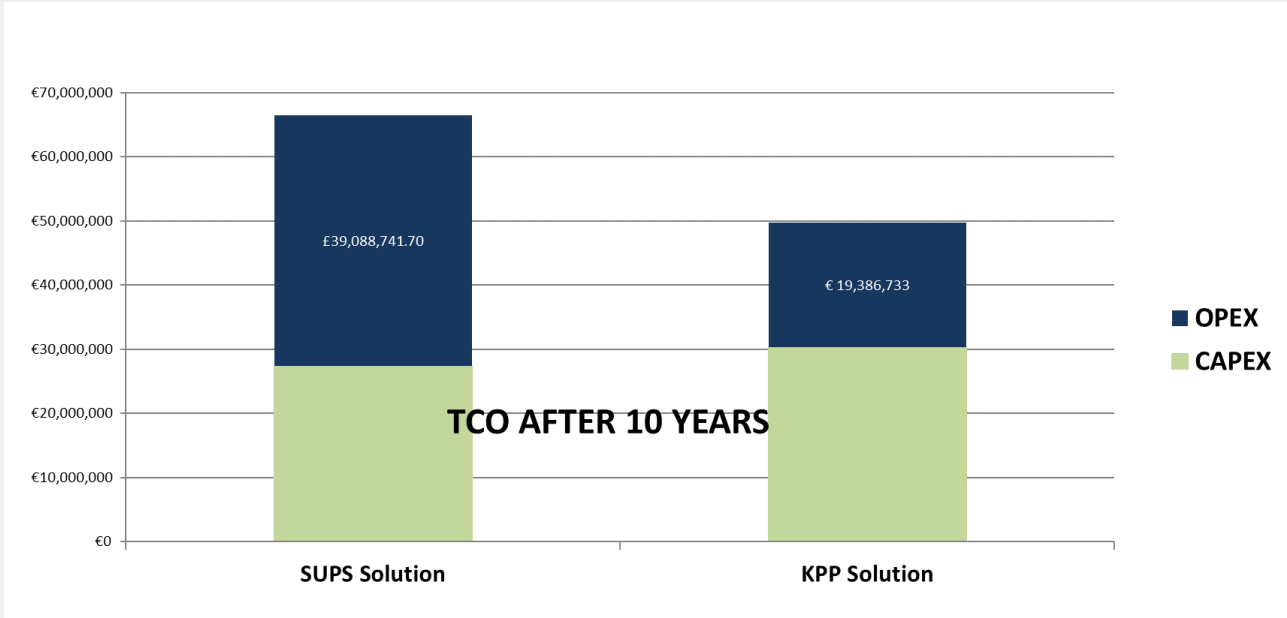
TCO Comparison
SUPS vs D-UPS
Li-ion

TCO Comparison over a 10-year period



SAVING USING KPP AFTER 10 YEARS	€ 16,769,008

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05

Maintenance

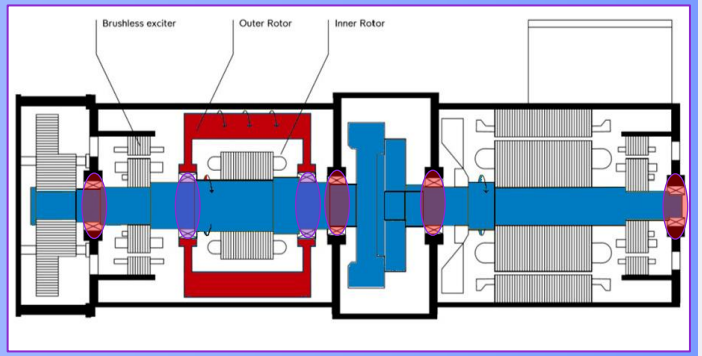
Overview of 20 y maintenance = life cycle

20 years life cycle preventive maintenance is key basis to support customers

Uptime improvement and lifetime extension opportunity from discipline and mutual trusted PM activities.

Yearly program	▪ Regular service visits and plant maintenance ▸ For 50 Hz systems – visits every 2 months ▸ For 60 Hz systems – visits every 6 weeks
2-yearly program	▪ Additional services include: ▸ Change of control panel batteries ▸ Change of engine air filters and engine crank breather filters
5-yearly program	▪ Additional services include: ▸ Change of coolant ▸ Change of engine batteries ▸ Service Inspection switchgear (some times outsourced)
10-yearly program (overhauls)	▪ Factory overhaul of alternator, accumulator and clutch at KINOLT's facility (or using exchange equipment ▪ Depending on the engine / environmental conditions / running hours, services include change of injector pockets, seals, flexible tubing, etc. ▪ Switchgear

Automatic greasing



Manual greasing

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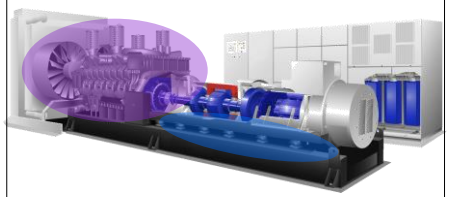
Scope of Works of an Overhaul

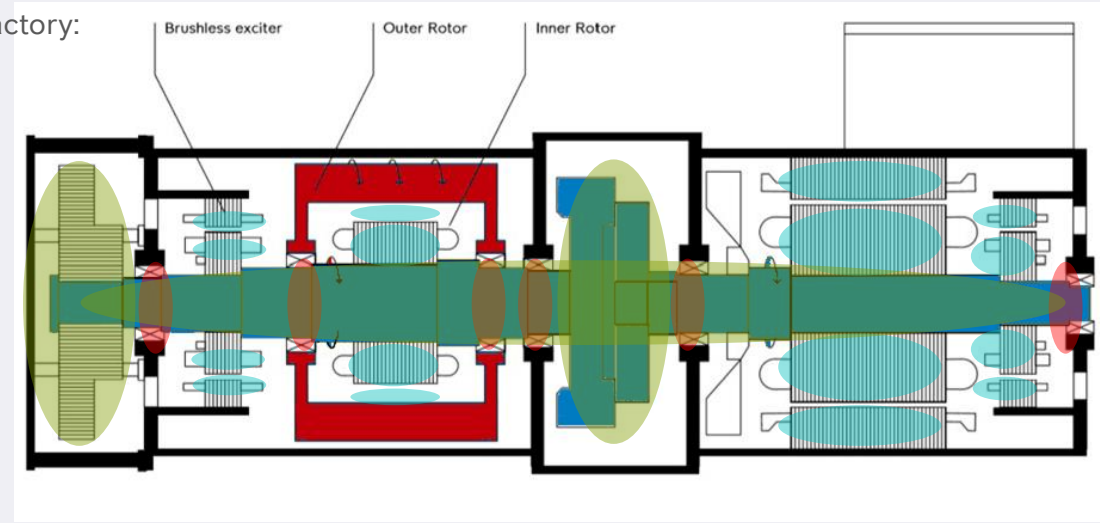
In general: 5 types of operations are performed

1. Bearings: Each bearing has a life expectancy; it must be replaced in due time.
2. Windings and diodes: Windings insulation is subjected to environmental conditions. The insulation must be checked and reinforced in due time. *Diodes of the accumulator will be exchanged.*
3. Mechanical Parts: must be checked and adjusted to maintain the reliability over the time.
4. Replacement of the vibration isolators (AVM's) of the Stato-Alternator.
5. Diesel engine heavy maintenance according OEM recommended program (LTBO)

In situ:



In factory:



Electromagnetic Clutch | Kinetic Energy Accu | Synchronous Machine

A Rolls-Royce solution

SERVICE LEVEL

3 CASE STUDIES

- Partnership agreements with key accounts
- Ensure continuous technical support
- Ensure over 99.982% availability of Data Center Power Supply

A Rolls-Royce solution

ASCENTY – BRAZIL

DATA CENTERS

- Over 100 D-UPS units
- 8 sites spread over Brazil
- Dedicated Rolls-Royce technicians on each site
- 24/7 Back office in Brazil & Belgium

SERVICE LEVEL

- Preventive, predictive and corrective maintenance

ETISALAT – UAE

DATA CENTERS

- 40 D-UPS units
- 2 sites in UAE
- Dedicated Rolls-Royce technicians on each site
- 24/7 Back office in Dubai & Belgium

SERVICE LEVEL

- Preventive, predictive and corrective maintenance
- Immediate response time during office hours. 30 minutes response time outside of office hours

Global Switch

DATA CENTERS

- 63 D-UPS units
- 4 sites in Asia and Europe
- Dedicated Rolls-Royce technicians on each site
- 24/7 Back office Support

SERVICE LEVEL

- Preventive, predictive and corrective maintenance
- Within 120 minutes at site
- Local spare parts

Benefits of *mtu* DUPS systems

Maximum reliability

Highest power density

Reduced footprint

Space provision on site

Superior robustness

High inrush currents

Handling of large loads

Maximum protection

Fast fault clearing capability

Filtering & power factor improvement

Best sustainability

Elimination of batteries

Reduced waste & carbon footprint

Greatest flexibility

Low & medium voltage systems

Modular & scalable

Single & dual output systems

Container solutions

Reduced total cost of ownership

CAPEX & OPEX

A Rolls-Royce solution

06

References

18 x *mtu* Kinetic PowerPack

Total power output: 45000 kVA (3 plants)

SEMI-CONDUCTOR

Location: Singapore

Project background:

Customer is a world market leader in computer memory and data storage. The company introduced a revolutionary 3D NAND storage technology, being at the forefront of the introduction of 5G and development of autonomous transportation technologies.

The plant is a highly precise and sensitive process nature, which manufactured several wafer products at the same time. MTU Kinetic PowerPack provide them with clean power quality energy oscillation and improve the performance of the sophisticate tools/machine during their production.

Key customer benefits:

- Reduced footprint
- medium voltage system
- Fast fault clearing capability
- Filtering & power factor improvement
- Less risk for financial losses
- Handling of large loads

A Rolls-Royce solution

CRITICAL MANUFACTURING

Customer:
X-FAB Sarawak

Location:
Sarawak, Malaysia

4 x mtu Kinetic PowerPack

Uninterruptible power output:
1600 kW

- X-FAB is one of the world's leading specialty foundry groups for analog/mixed-signal semiconductor technologies with a clear focus on automotive, industrial, and medical applications.
- Utility blackout will cause severe losses of wafer products and high production cost.
- Mtu Kinetic PowerPack was selected due to several technical benefits higher reliability, electrical efficiency, space saving, high inrush currents, eliminate batteries, medium voltage system.
- Mtu Kinetic PowerPack was selected due to financial benefits, i.e. lower Total Cost of Ownership (TCO) compared to Static UPS system.

CRITICAL MANUFACTURING

ams Osram

Location:
Malaysia

Kinetic Powerpack

KP-7

2 x 2200 kVA, 11kV

- **2 x 2200kVA @ 0.8pf KPP – 11kV, 50Hz**
- **ams OSRAM is a global leader in optical solutions expand to build a extension FAB in Malaysia.**

Key customer benefits:

- Reduced footprint
- medium voltage system
- Fast fault clearing capability
- Filtering & power factor improvement
- Less risk for financial losses
- Handling of large loads

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CRITICAL MANUFACTURING

Global Foundries

Location:
Singapore

Kinetic Powerpack

KP-5

2 x 2500 kVA, 6.6kV

- **2 x 2500kVA @ 0.8pf KPP – 6.6kV, 50Hz and MV equipment**
- **Chip giant Global Foundries expand to build a new FAB in Singapore.**

Key customer benefits:

- Reduced footprint
- medium voltage system
- Fast fault clearing capability
- Filtering & power factor improvement
- Less risk for financial losses
- Handling of large loads

DC SEGMENT

Customer:
Global Switch

Location:
London, UK

Kinetic Powerpack

KS-5

26 x 2000 kVA, 11 kV

- **1 Power station of 6 Dual output SB0 KINOLT KS of 2000 kVA for supporting Mechanical load and 2 Power stations each with 10 single output KINOLT KS of 2000 kVA for protecting the IT load.**
- **(Continuous power until diesel engines are started supporting critical load**

DC SEGMENT

Customer:
Global Switch

Location:
Singapore

Kinetic Powerpack

KS-5

3 x 2500 kVA, 400 V

- **Distributed Redundant System**
- **D-UPS in container**

DC SEGMENT

Customer:
Global Switch

Location:
Sydney, Australia

Phase 1:

5 X KS5 2250 kVA, 11kV

Phase 2:

3 X KS5 2250 kVA, 11kV

- **Isolated Parallel (IP) Configuration**
- **MV system, with low voltage alternators and step-up transformers**
- **D-UPS and MV Equipment/ MV Switchgear in room installation**

DC SEGMENT

Customer:
Global Switch

Location:
Hong Kong

Phase 1:

12 X KS7e 2625 kVA, 11kV

Phase 2:

8 X KS5 2625 kVA, 11kV

- **Isolated Parallel (IP) Configuration**
- **MV system, with low voltage alternators and step-up transformers**
- **D-UPS and MV Equipment/ MV Switchgear in Containerized installation**

DC SEGMENT

Customer:
Data Centre in East Singapore

Location:
Singapore

System 1:
Phase 1: 8 X KS7 2500 kVA, 22kV
Phase 2: 4 X KS7 2500 kVA, 22kV
Phase 3: 4 X KS7 2500 kVA, 22kV

System 2:
Phase 1: 8 X KS5 2500 kVA, 22kV

- **2N Configuration**
- **MV system, with low voltage alternators and step-up transformers**
- **D-UPS in Containerized installation**
- **MV Equipment/ MV Switchgear in room installation**

MISSION CRITICAL INDUSTRY SEGMENT

Customer:
LSP

Location:
Vietnam

Kinetic Powerpack

KS-5

20 X KS5 2250 kVA, 11.5kV

- **Parallel Medium with double bus bar configuration**
- **MV system, with MV alternators**
- **D-UPS in Containerized installation**

8 x *mtu* Kinetic PowerPack

Total power output: 16000 kVA (2 sites)

LOGISTICS

Customer: Top supermarket chain

Location: Australia

Project background:

Top Supermarket chain invested in state-of-the-art automated warehouses that require very little human involvement, lower supply chain costs, enhance overall business competitiveness and increase efficiencies in their supply chains.

The giant warehouse is installed with a highly automated shuttle and conveyer belt technology system. MTU Kinetic PowerPack provide clean power and protect the system from utility power failure which would take them many hours to restart the system.

Key customer benefits:

- Handling of large loads
- Reduced footprint
- Less risk for financial losses
- Fast fault clearing capability
- High inrush currents
- Filtering & power factor improvement

A Rolls-Royce solution

MISSION CRITICAL: DATA CENTER

Customer:
King Abdullah University of Science and Technology

Location:
Thuwal, Saudi Arabia

12 *x mtu* Kinetic PowerPack

Uninterruptible power output:
12x 1.600 kW

- Turnkey solution to provide the university's supercomputing facility and data center with clean, conditioned, uninterruptible power
- State-of-the-art facilities and one of the world's best supercomputing installations “Shaheen” and “Shaheen 2”
- 60Hz medium voltage system (13.8 MV) incl. switchgear, transformers and two control stations
- Custom-made enclosure designed for humid ambient conditions and up to 50 degrees Celsius
- Operational support and long term service support throughout the lifetime on the installation

A Rolls-Royce solution

CRITICAL MANUFACTURING

Customer:
Molyb

Location:
Antofagasta, Chile

2 x *mtu* Kinetic PowerPack

Uninterruptible power output:
3.600 KVA

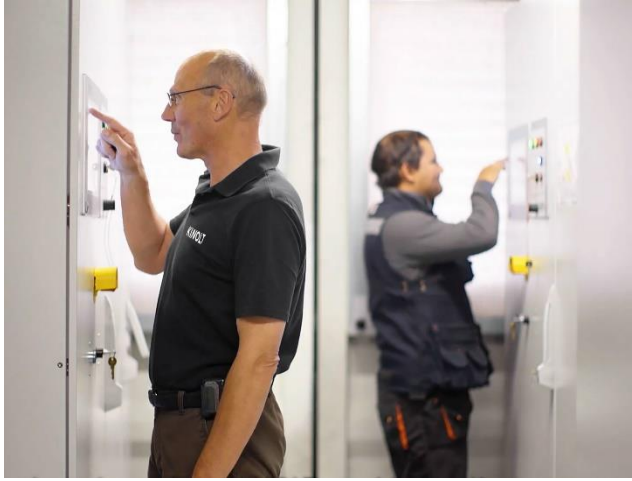
- One of the largest molybdenum (Mo) processors in the world (24.000 tons, 10% of global production)
- Molybdenum strengthens and hardens alloys
- Utility outage every 6 hours causes severe production losses
- High inrush currents, a hazardous environments and earthquake risk require robust, resilient and creative solutions
- Container meets strict noise requirement

A Rolls-Royce solution

INFRASTRUCTURE: TELE-COMMUNICATIONS

Customer:
ESO Paranal Observatory

Location:
Atacama Desert, Chile (2635m)



2 x *mtu* Kinetic PowerPack

Uninterruptible power output:
3.000 KVA

- One of the best astronomical observing sites in the world
- Telescopes have to be kept at a temperature of -200°C
- A small power failure is enough to stir the resting particles in the telescope's lenses
- The process to normalize the system takes 7 days
- Huge observatory losses because neiter the time or the sky can be the same than from the past

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HEALTHCARE & DATA CENTER

Customer:
Welcome Trust

Location:
London, U.K.

4 x *mtu* Kinetic PowerPack

Uninterruptible power output:
4.400 KVA

- One of the world's leading institutes and organisations in genomics and computational biology.
- One of the most advanced IT infrastructure containing data researches that have to be accessible at all times.
- Battery-free smaller footprint D-UPS Solution helps to manage energy cost.
- Include the facility to participate in peak shaving schemes

A Rolls-Royce solution

INFRASTRUCTURE TUNNEL

Project:
Belliard Tunnel

Location:
Brussels, Belgium

4 x *mtu* Kinetic PowerPack

Total power output:
1000 kVA

- Tunnels are equipped with critical equipment such as fire detection, lighting, traffic control, ventilation, …
- A short interruption on the electrical power supply of those equipment could result to catastrophic events such as accidents, fire, intoxication, ….
- After having secured the power supply of the Tunnel Belliard in Brussels for 27 years, the Brussels Region decided in 2019 to replace the 4 D-UPS by 4 ***mtu*** PowerPack of 600/1000 kVA

A Rolls-Royce solution

INFRASTRUCTURE LOGISTIC

Project:
REWE NZL MAG

Location:
Magdeburg, Germany

1 x *mtu* Kinetic PowerPack

Total power output:
2250 kVA

- The logistics centre will be used to store and handle slow-moving food / nearfood goods from the dry goods category
- In case of a power loss a fundamental damage in the logistic supply chain and in reputation would occur
- Due to the high automatization level of the warehouse it would take several shifts to restart and to recover the system and bring everything back to normal

mtu A Rolls-Royce solution

SEGMENT

Customer:
Ascenty – Sumaré 2 ph3

Location:
Sumaré, Brazil

3 x *mtu* Kinetic PowerPack

Uninterruptible power output:
1700/2313 kVA

- Established in 2010, Ascenty is Latin America's largest data center provider. The company currently has 27 units in operation or under construction in Brazil, Mexico and Chile; Sumaré 2 site build in 2018;
- Smaller footprint and lower CAPEX of the mtu Kinetic PowerPack were decision criteria for Ascenty
- Site designed to 20MW;
- 12.000 m² (130.000sqft)

A Rolls-Royce solution

Thank You for Listening

A Rolls-Royce solution