

UPS technologies

- ✓ static
- ✓ dynamic
- ✓ Diesel
- ✓ battery backed
- ✓ battery less



Piller – Company Profile



- ❑ Since 1909 Piller has developed, manufactured and supplied a wide range of power quality products
- ❑ More than 1000 employees and represented in more than 40 countries
- ❑ Every year Piller maintains over 5000 rotary UPS units with ratings up to 3600kVA using a Global Service network of 280 technicians
- ❑ Piller is one of the World's Top 5 brands in the 3Ph-UPS market and the largest Rotary UPS manufacturer*.
- ❑ The only existing company which is in the business of rotary- and static UPS technologies.



*Source: IHS / UPS-World-4Q2014

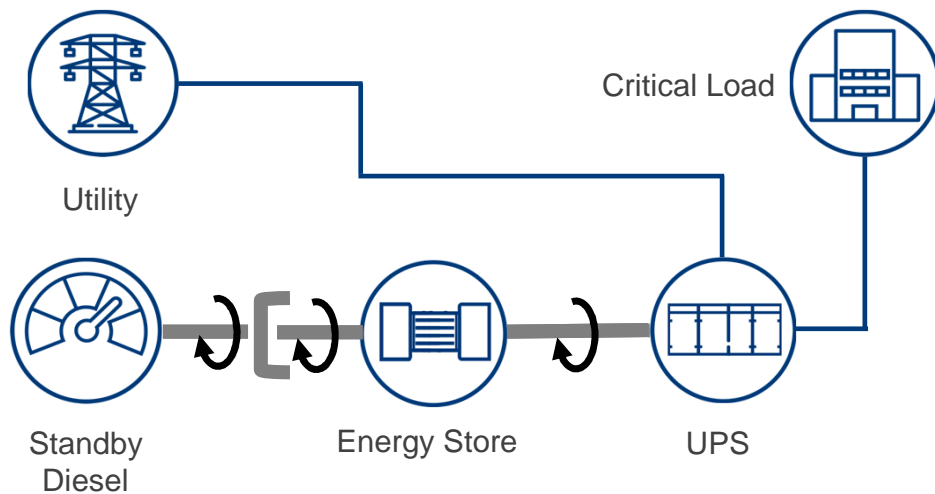


UPS technologies

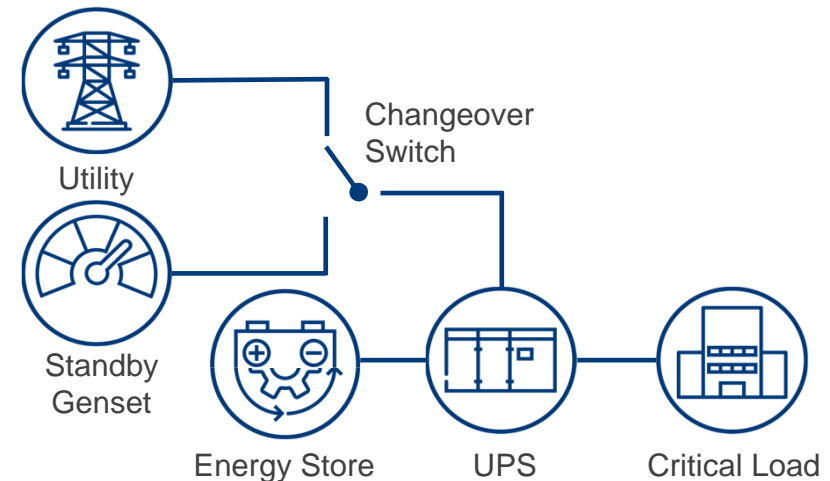
What are the two fundamental UPS topologies available?

UPS topology is best differentiated by the way in which the energy transfers between storage and UPS.

Mechanically Coupled (MC)



Electrically Coupled (EC)



The UPS performance, overhaul and maintenance requirements are largely determined by the method through which energy is transferred in and out of the energy store.

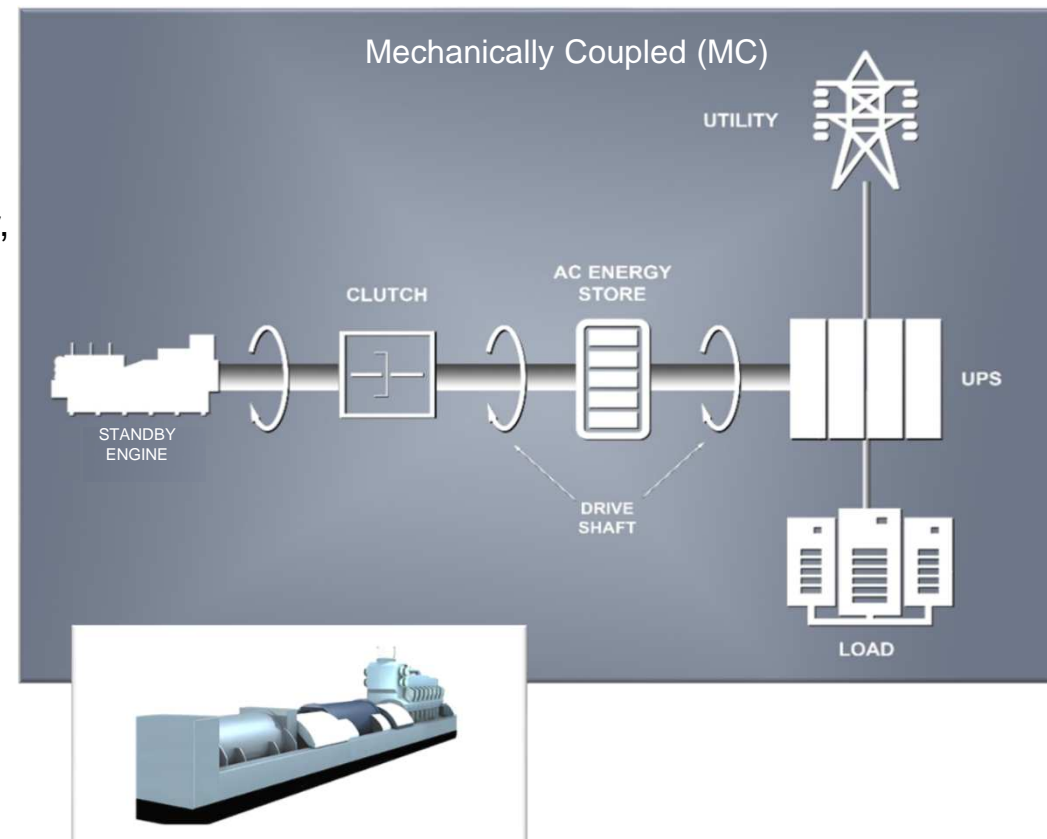
UPS technologies

Mechanically Coupled (MC) UPS

Mechanically coupled UPS (commonly DRUPS) **Also known as Rotary UPS and Dynamic Rotary UPS**

General industry definition:

- Mechanically Coupled (MC) energy store in-line with Generator, Diesel Engine and clutch mounted on the same shaft
- Energy store has limited ride through due to its complex mechanical design. No battery option.
- Non-standard fast start – high stress
- Extensive maintenance and overhauls with high downtime interventions
- No flexibility between engine and UPS arrangement.



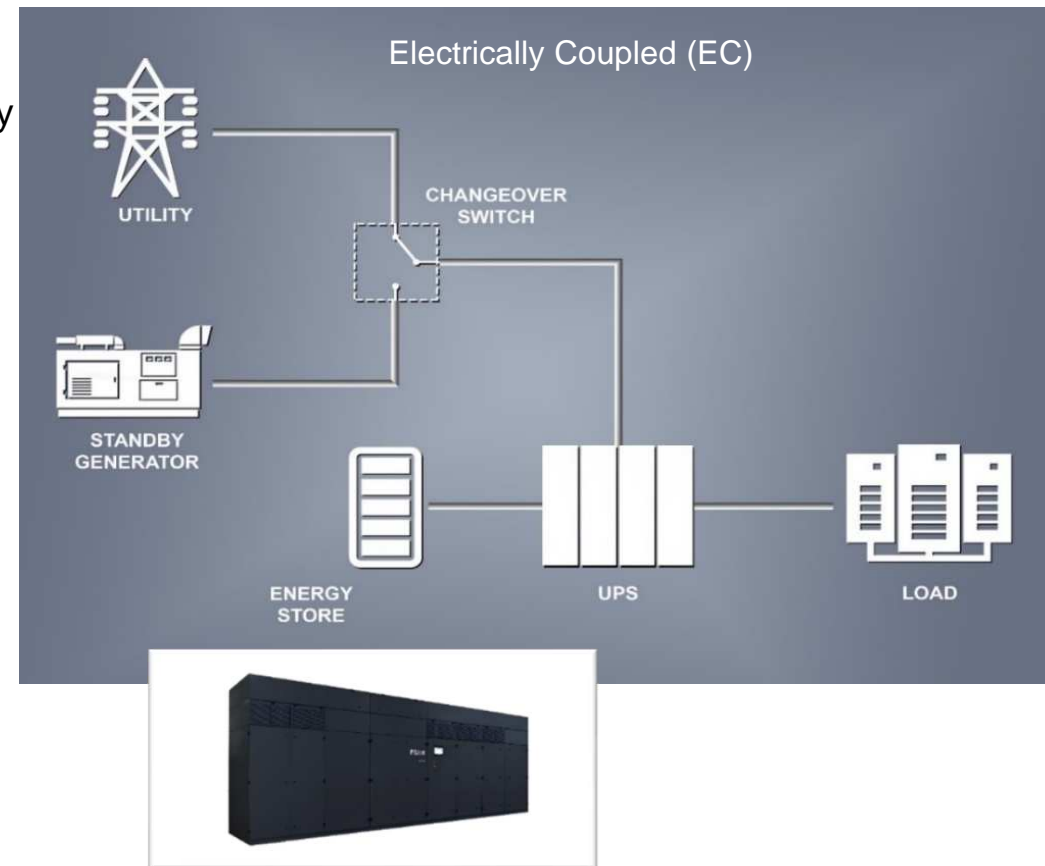
UPS technologies

Electrically Coupled UPS (EC) : UNIBLOCK UB-V or UBT(D)+



UB-V units up to 3.24MW/3.6 MVA without paralleling

- UB-V UPS uses power electronics to control the stored energy transfer across a DC link
- Battery and flywheel energy store options
- Uses an electrical machine for natural sinewave generation and cooling
- No power capacitors or electric fans
- Reduced component count significantly increases reliability
- Low intervention maintenance and overhaul requirements dramatically increases availability
- Direct connection to LV- or MV-utility grids
- Widest flexibility between engine and UPS arrangement
- Lowest cost per kW.



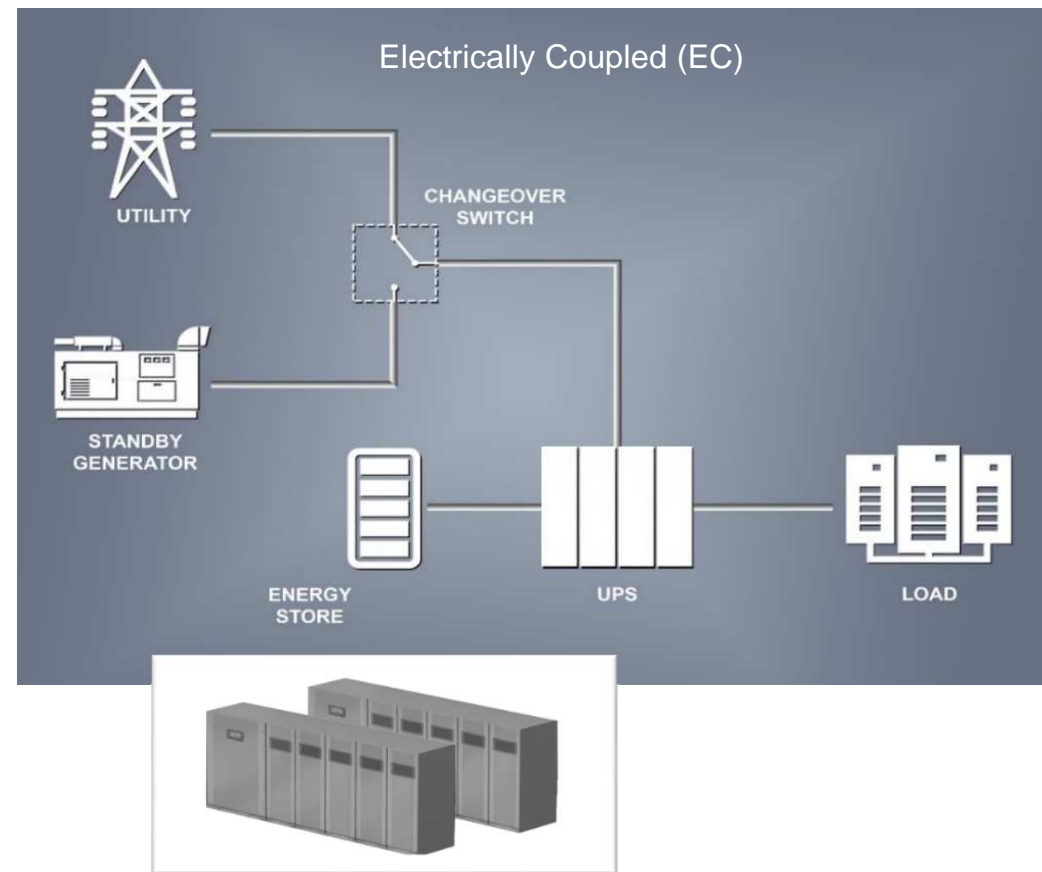
UPS technologies

Electrically Coupled UPS (EC) : Static

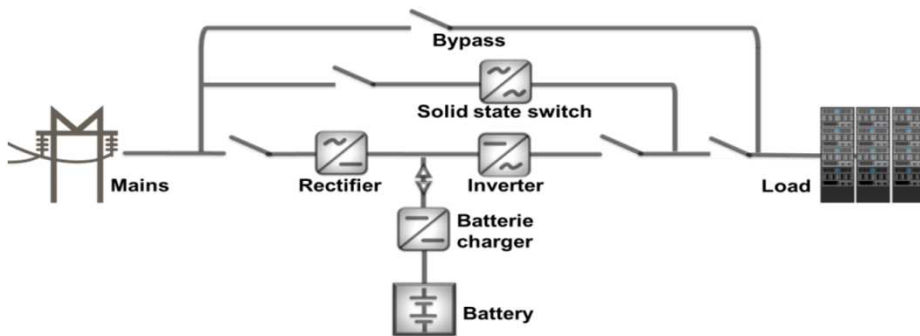
Static UPS - Electrically Coupled (EC) UPS

Typically, paralleled modules to achieve a high capacity

- Uses Power electronics
- Has many components in small modules
- Uses Power Capacitors to simulate Sine Wave
- Uses Electrical Fans for Cooling
- Ideal for smaller DC's i.e. <500KVA
- Increasingly more expensive above 1MW
- Limited to LV solutions
- Decreasing reliability with increasing capacity
- Higher maintenance, higher downtime that increases with capacity growth
- Compared to dynamic, larger footprint.

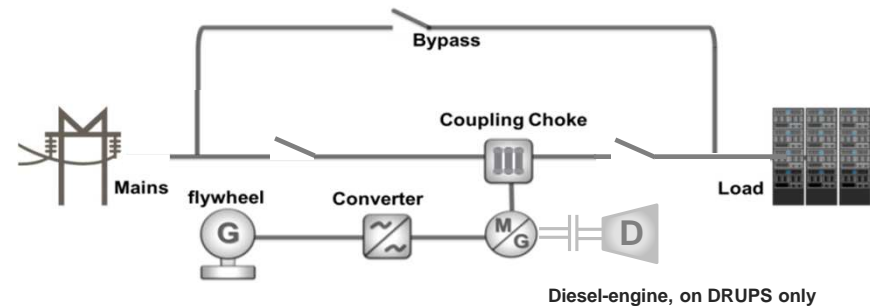


Static UPS [SUPS]



- ❑ A static UPS system works with power electronic components and can be equipped with a battery or small flywheels up to 6MJ, the output voltage is produced by means of an IGBT converter.
- ❑ Long term back-up can be achieved with external Diesel-Generators

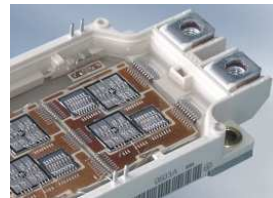
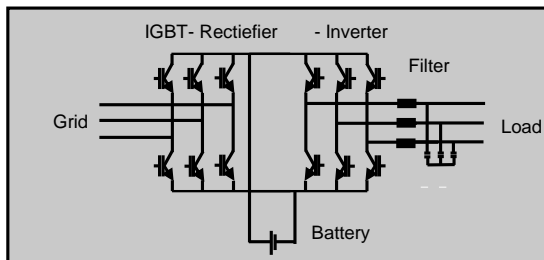
UNIBLOCK [DRUPS]



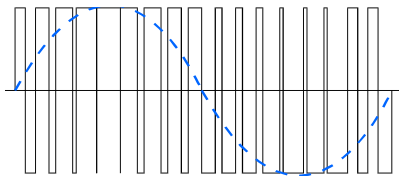
- ❑ In the case of a RUPS/DRUPS system, the output power is always generated by a synchronous alternator. Such UPS can be operated with batteries or large capacity flywheels (up to 60MJ).
- ❑ A Diesel back-up can be achieved by a direct mechanical coupling and by keeping the same basic technology

Different EC UPS-technologies

Static

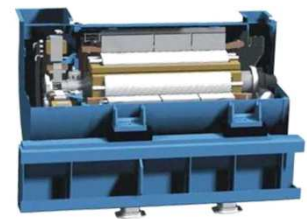
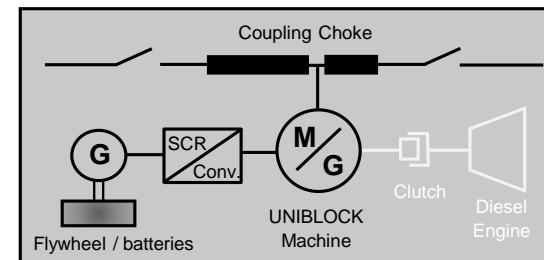


- ❑ The output voltage is generated by IGBT's in Puls Width Modulation (PWM). Current- and overload-limitations are given by the thermal behavior of power electronic components. Reasonable unit size up to approx. 500 kVA.

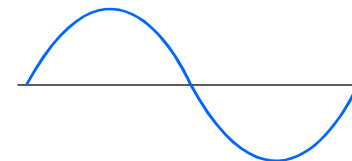


Artificial sine-wave

UNIBLOCK

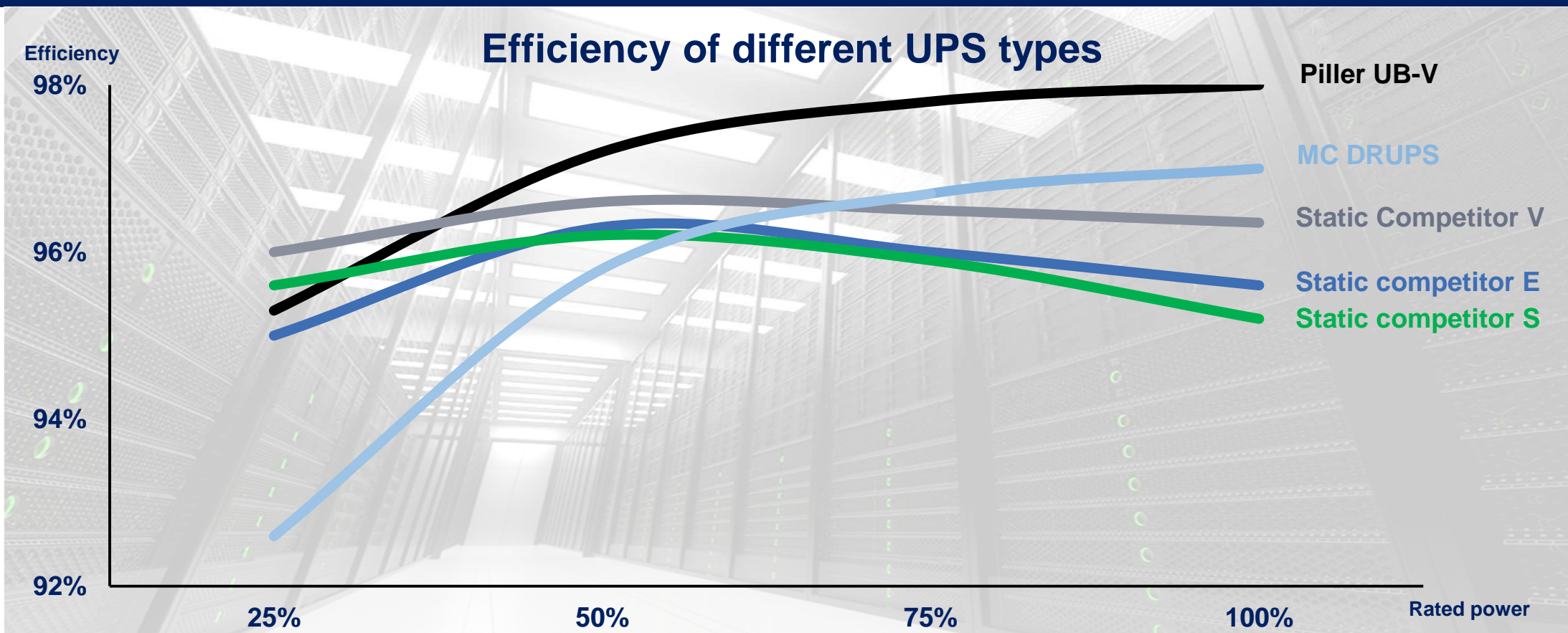


- ❑ In a RUPS/DRUPS system the output power is always generated by a synchronous alternator. Far less elements and more robust components ensure high load currents without any paralleling. Single unit size up to 3600 kVA.



Natural sine-wave

Efficiency of different UPS types in normal mode



Efficiency differences ranging up to almost 3% will have a huge impact to operating cost

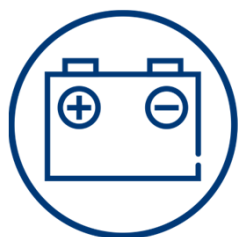
Life expectencies of UPS and essential components

<u>Criteria</u>	<u>Static UPS</u>	<u>UNIBLOCK UPS</u>
UPS itself	10 years	20 years +
Energy storage	8-10 years in average	20 years + with flywheel
Cooling device	4 – 6 years	20 years +
Power capacitors	5 – 7 years	Not applicable
Bearings	Not applicable	10-12 years
Air con	10 years	Mainly not required
MTBF	100.000 – 300.000h	1.300.000 - 3.200.000h



Energy Storages in comparison

<u>Lead Acid Battery (VRLA)</u>	<u>Li-Ion Battery</u>	<u>Flywheel</u>
Uni-directional energy flow	Uni-directional energy flow	Bi-directional energy flow
Typically, full charge within 10h	Typically, full charge within 1 -2h	Very fast recharge, max. < 1 min.
Toxic components	Highly toxic components	Non toxic components
Air conditioning cooling 20-25°C	Thermo-management	No requirements, 0-40°C (50°C)
2-3 % per annum capacity drop p.a.	Little aging effect	No capacity drop over lifespan
5-8 years, some 10-12 years life time	Up to 15 years estimated life time	20 years + lifetime
Poor frequency stabilisation	Limited frequency stabilisation	Excellent, 100% step load capability
Very high maintenance efforts	Low maintenance efforts	Very low maintenance efforts
Hardly flammable	Flammable	Not flammable



PLASTIC / LEAD / ACID



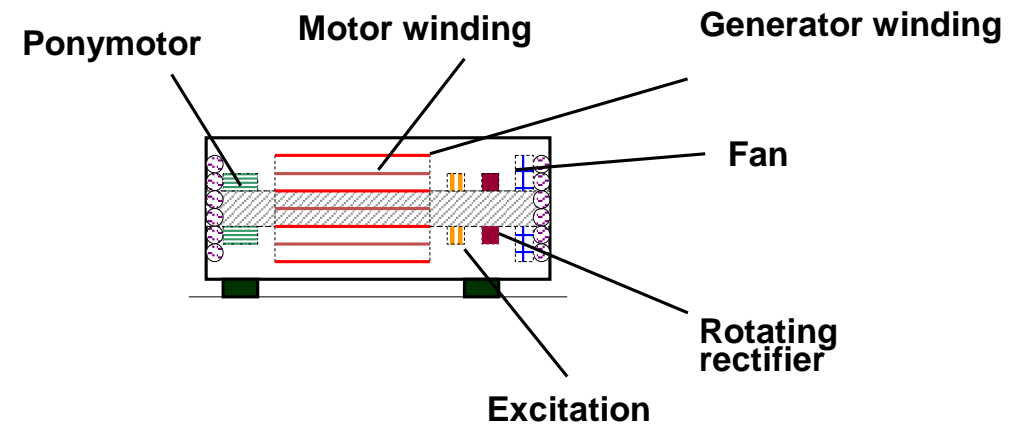
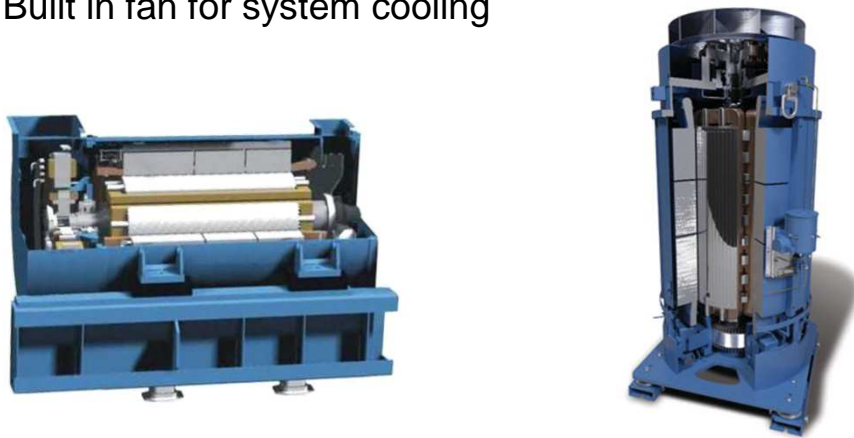
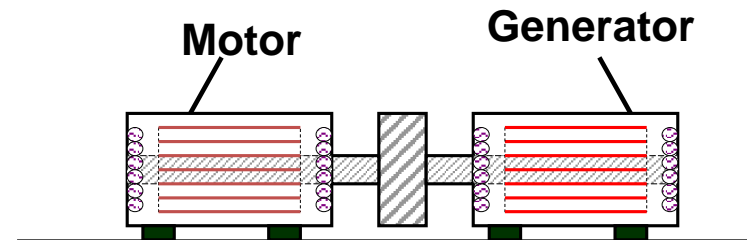
PLASTIC / ALUMINIUM /
COBALT + MANGAN / LITHIUM



STEEL / COPPER

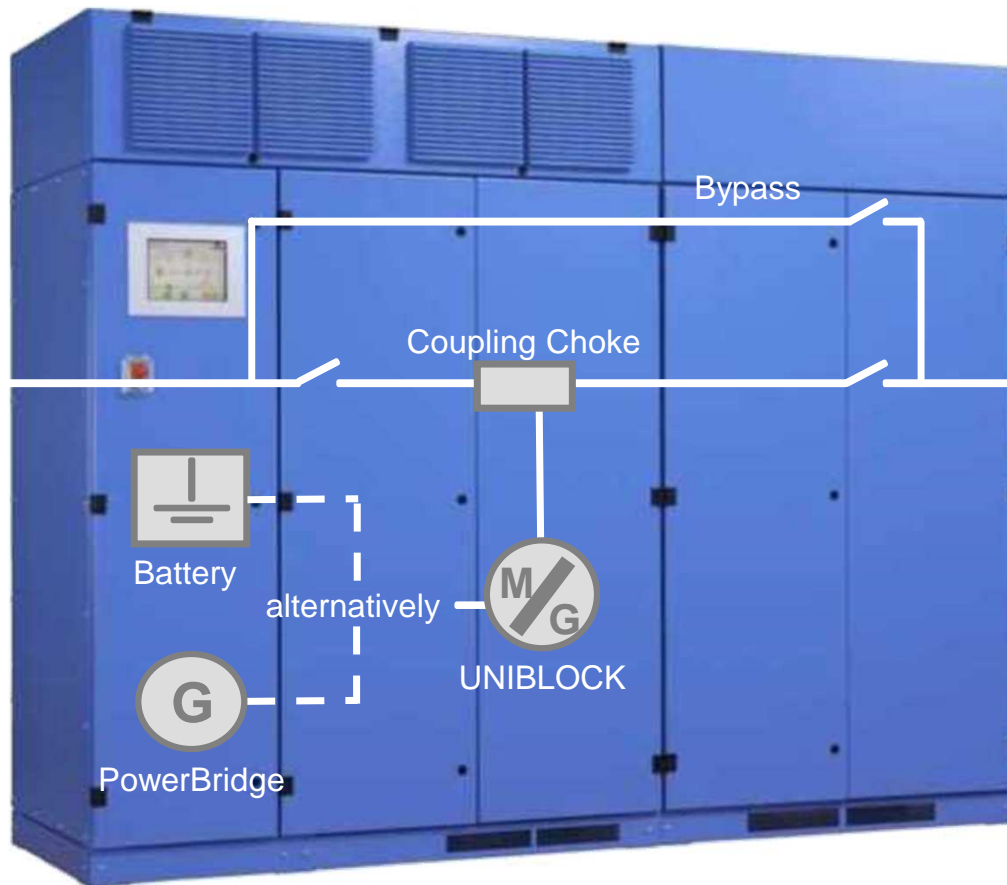
The UNIBLOCK MG set as a core component

- Unique high efficiency, common rotor MG.
- Low X_d'' affords high fault clearing capacity.
- Simple and highly reliable two bearing arrangement.
- Brushless excitation.
- Inherent harmonic suppression
- Built in fan for system cooling



UNIBLOCK UBT+ / UB-V

Single Line Diagram



UNIBLOCK power range

Ratings UB-V: 1100 kVA – 3,6 MVA

Ratings UB-V: 1000 kW – 3,24 MW

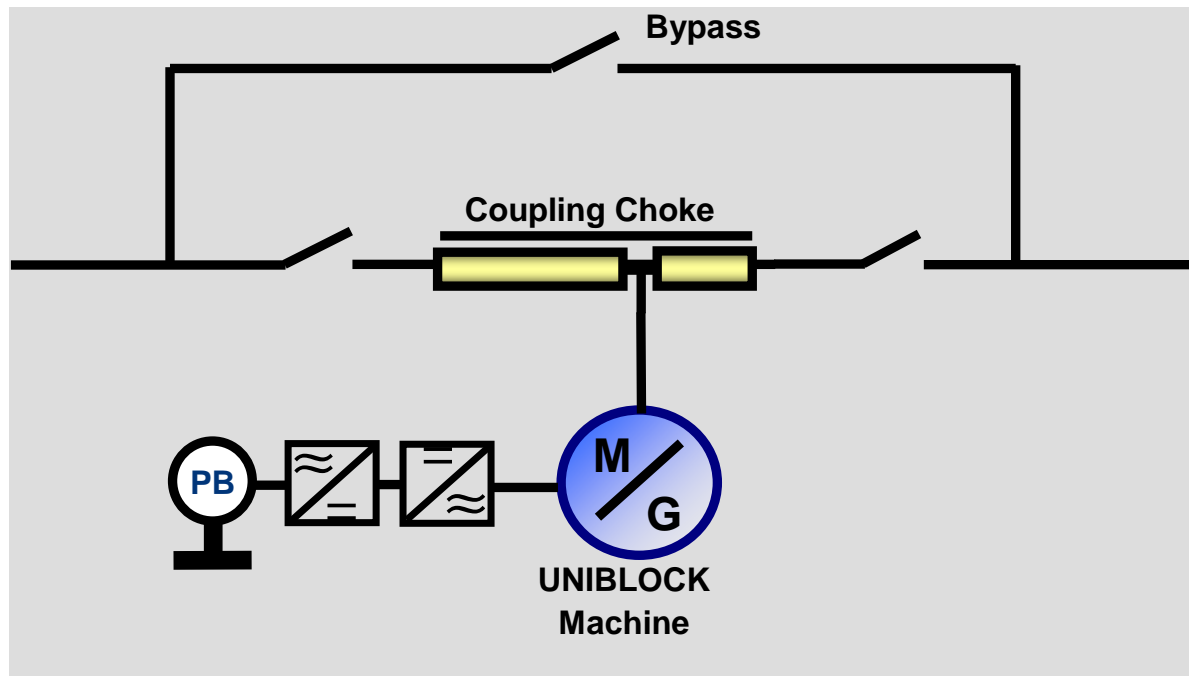
Ratings UBT+: 625 kVA – 2,5 MVA

Ratings UBT+: 500 kW – 2,25 MW

Voltage: 380 V up to 25kV

Frequency: 50 Hz

UB-concept, flywheel-version up to 3,6 MVA

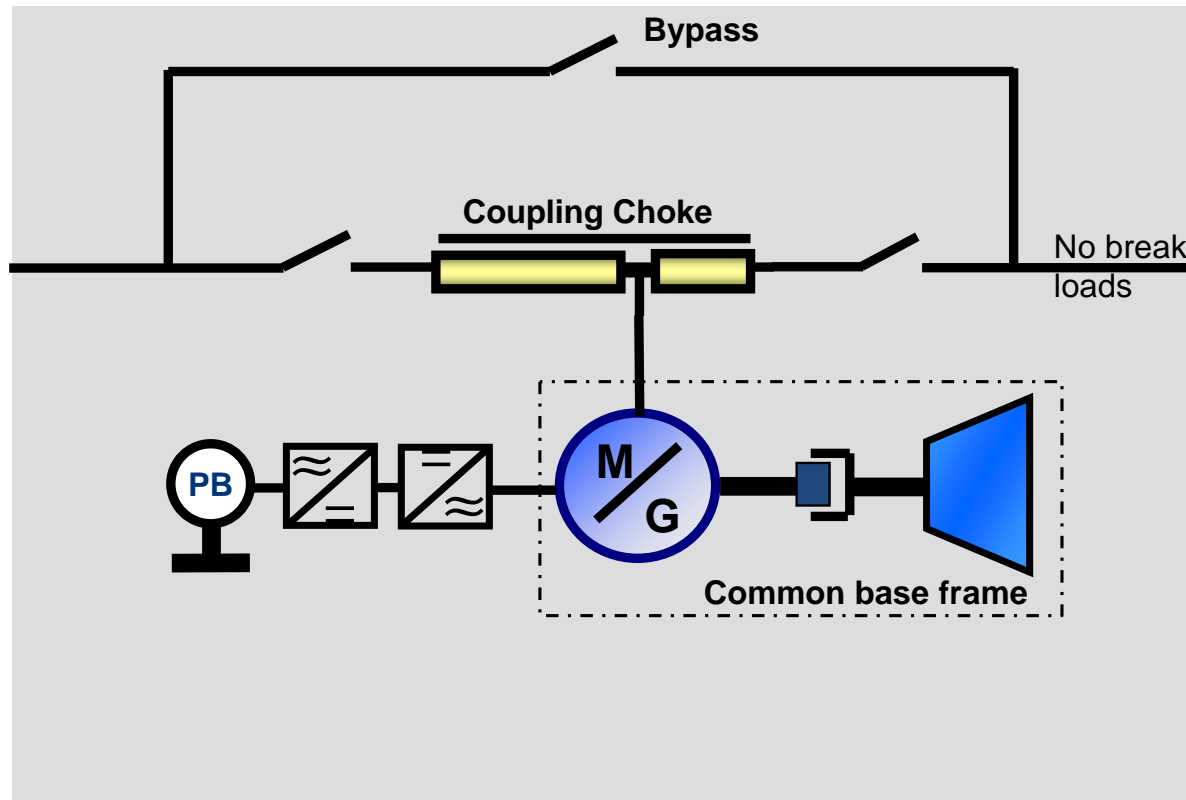


UB-V 1500, PB 21

WxDxH= 5300 x 1320 x 2700 mm, weight ca. 20 t

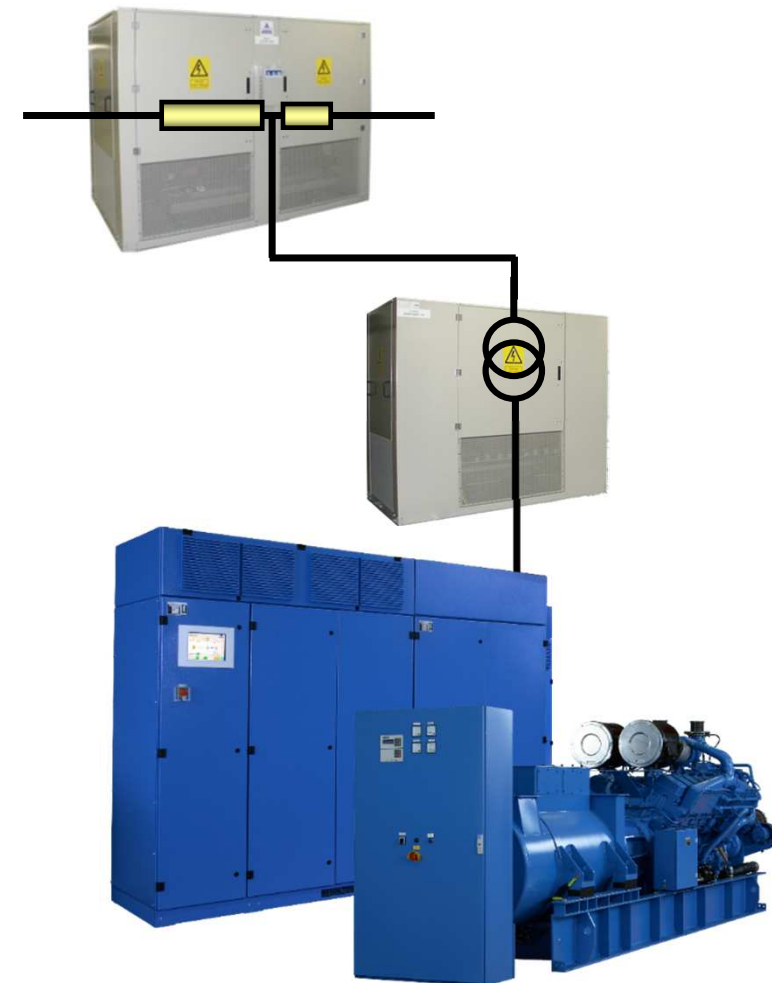
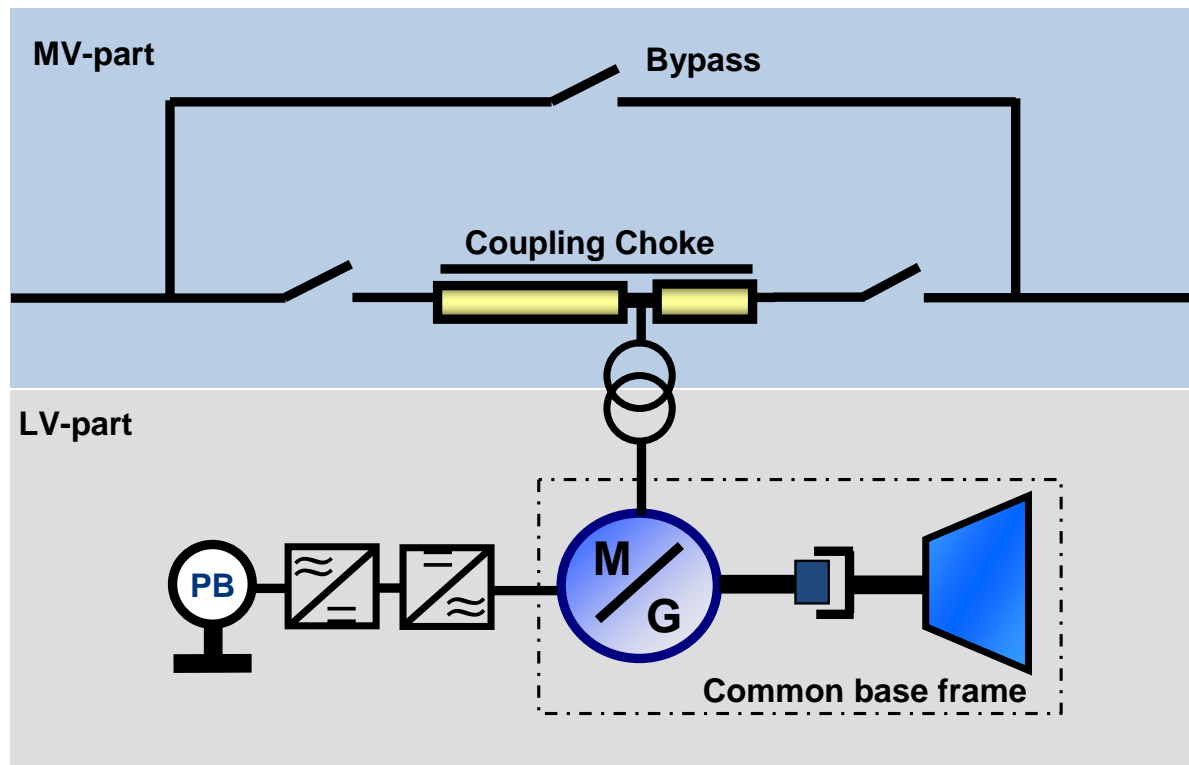
Unit ratings: 560, 1000, 1500, 1800, 2250, 2700, 3240 kW, at 400V/50Hz, p.f. 0.9
Energy storages: 16.5, 21 and 60 MJ (subject to units size)

UBTD-concept



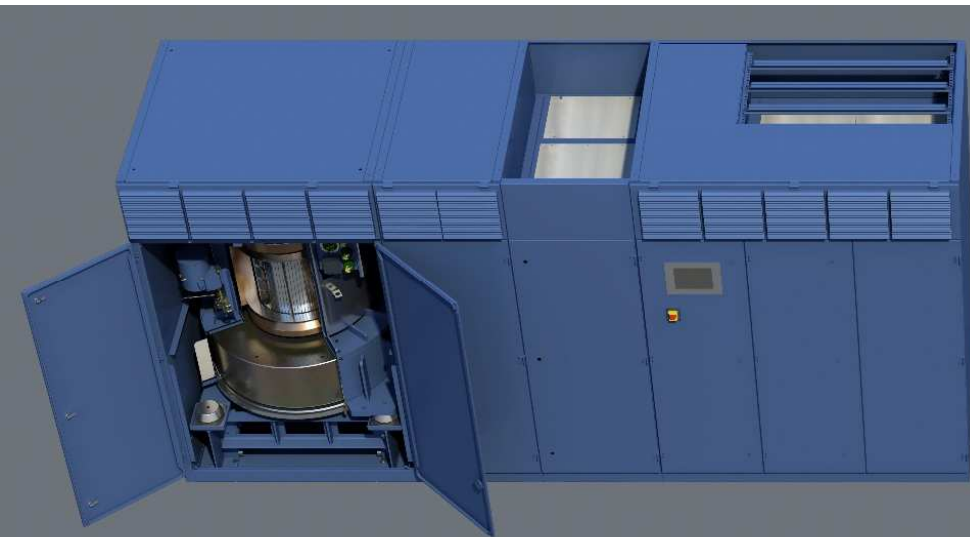
Unit ratings: 560, 1000, 1500, 1800, 2250 kW, at 400V/50Hz, p.f. 0.9
Energy storages: 16.5, 21 and 60 MJ (subject to units size)

UB-concept, Medium Voltage (MV) concept flywheel or battery

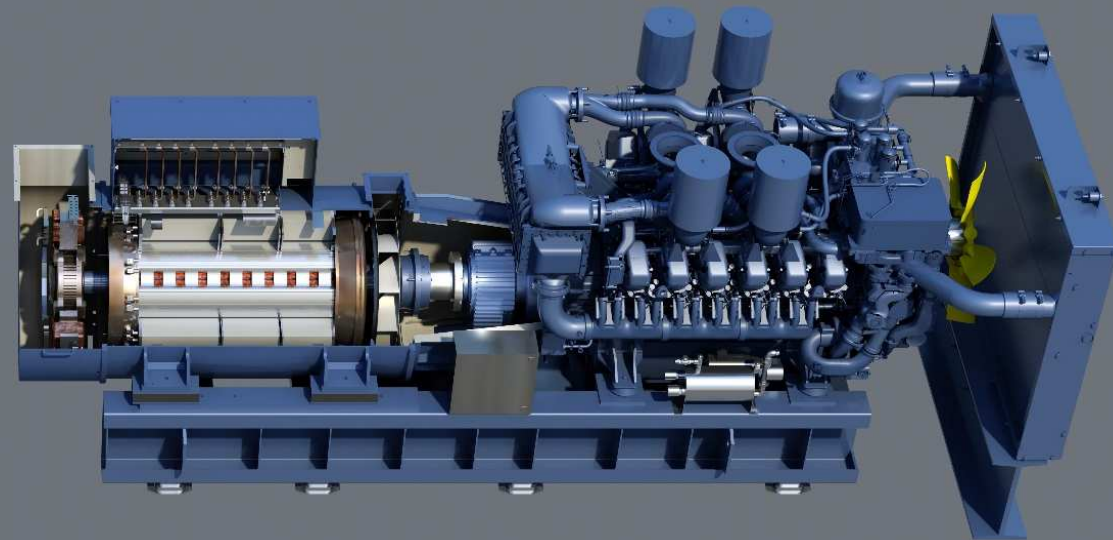


Unit ratings RUPS: 1500, 2000, 2700, 3240 kW, at MV-level, 50Hz
Unit ratings DRUPS: 1500, 1800, 2250, at MV-level, 50Hz
Energy storages: batteries or flywheels 21 and 60 MJ

UBT+ or UB-V concept, electrically coupled



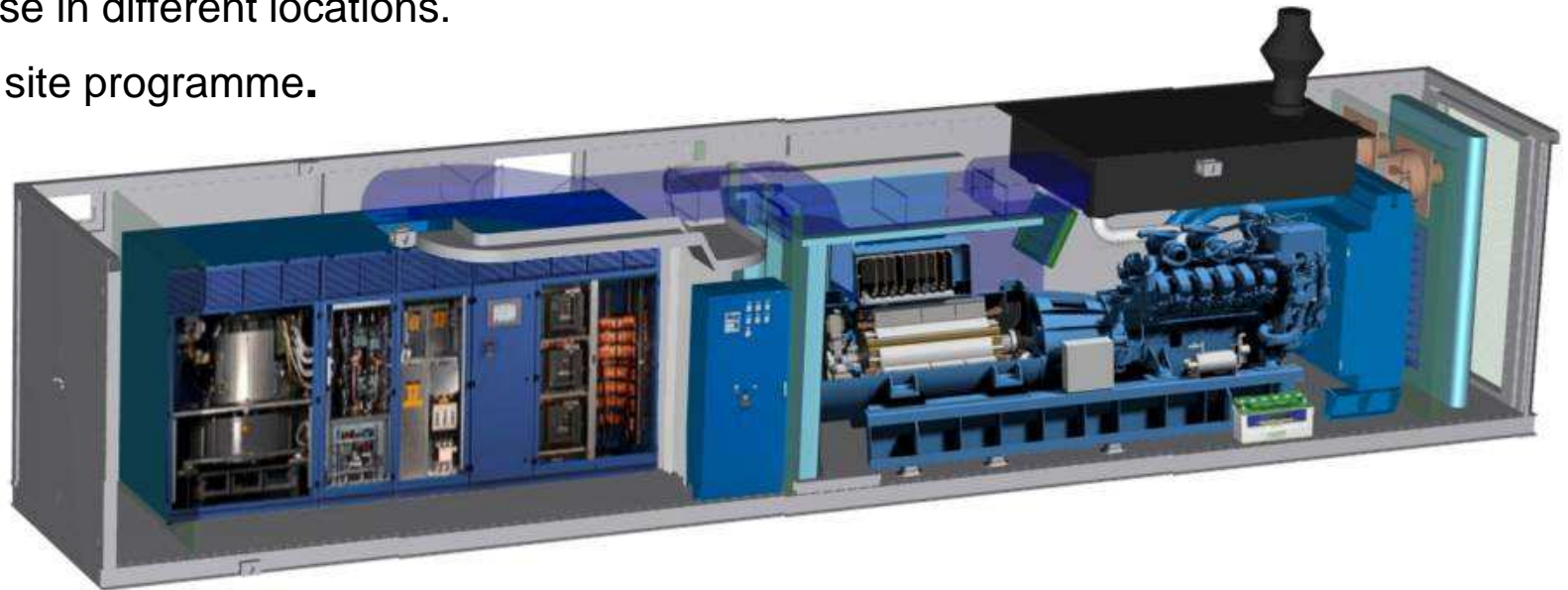
Switchboard part, incl. Energy storage,
electrically coupled



External Diesel-Gen set

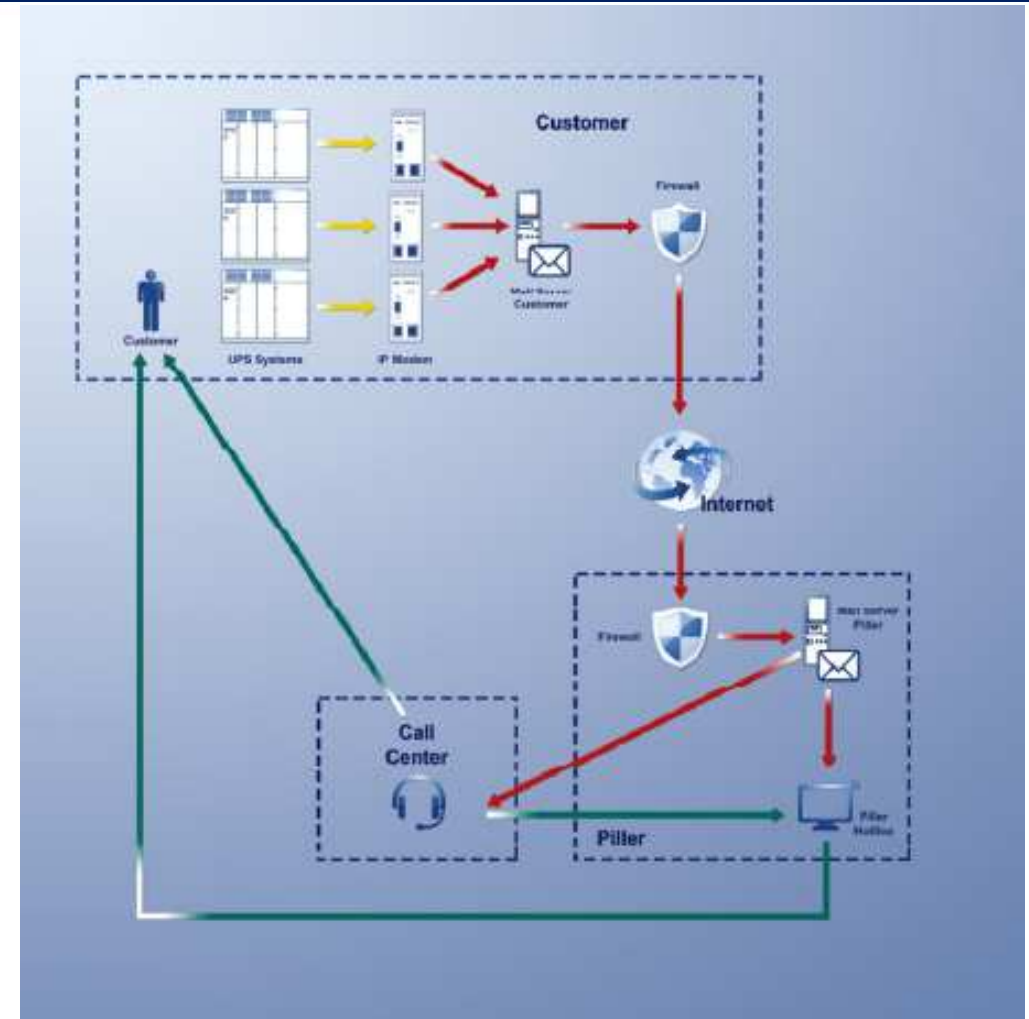
UNIBLOCK UBTD+, containerised version

- Operating readiness immediately on connecting to the mains.
- No structural measures for noise attenuation, ventilation or cabling.
- No expenditure for on-site testing and commissioning.
- No outlay on complex installation or plant room construction.
- Temporary use in different locations.
- Reduced on site programme.



APOCONNECT + IP-Modem

- ✓ Use of standard interfaces and protocols
- ✓ Monitoring in multiple UPS units
- ✓ Storage of history- and log-files
- ✓ Automatic release of notification by email to Piller HQ
- ✓ Worldwide transmission capability
- ✓ Individual support related to specific unit condition



Maintenance and Downtime



MC Diesel UPS (DRUPS)

- ❑ Energy storage overhaul – 5 days every 5 years
- ❑ Clutch – 2 days every 7 years
- ❑ Frequent Diesel engine maintenance
- ❑ UPS design life – 20 years

EC Static UPS with lithium ion battery

- ❑ Fans – 1 day every 5 years (discrete items)
- ❑ Capacitors – 2 days every 5 years (discrete items)
- ❑ UPS design life - 10 to 12 years

EC Diesel UPS (DRUPS) type UBTD+

- ❑ Reduced Service intervention
- ❑ Bearing change interval 100.000h
- ❑ 1 minor, 1 major inspection per annum
- ❑ UPS and energy storage design life time 25 years

EC UB-V

- ❑ Minimum Service intervention
- ❑ Offline maintenance interval every five years*
- ❑ UPS design life time 25 years

<i>Downtime (days) Over 10 years 2MW system</i>	MC DRUPS	EC Static UPS with Li-Ion	EC DRUPS UBTD/PB	EC UB-V* with Li-ion
Maintenance	15	10	10	2
Fans/Capacitors	0	2 x 3	0	0
Bearings	Incl in ES	0	0	0
ES overhaul	2 x 5	0	0	0
Clutch	2	0	0	0
Battery replacements	0	0	0	0
Total (days)	27	16	10	2

* Based on climate controlled Data Centre environment

** Battery maintenance not required.

Concept comparison

	Mechanically Coupled UPS	Electrically Coupled STATIC	Electrically Coupled UNIBLOCK
Energy transfer control	Electro-mechanical converter	Power Electronics/DC Link	Power Electronics/DC Link
Energy storage options	Flywheel	Battery (all types) & Flywheel	Battery (all types) & Flywheel
Backup generator flexibility	Direct Mechanical connection only.	Upstream Electrical connection only.	Upstream, Downstream or Direct Electrical connection.
Operating voltage flexibility	Low and Medium Voltage	Mainly Low Voltage	Low and Medium Voltage
Capacitive filtering (capacitors)	Not required.	Yes	Not required.
Grid service compatibility	Not possible.	Possible only when modified for bi-directional power flow.	Possible
Reliability (MTBF)	Medium	Low	High
Maintenance	High	Medium	Low
Power ratings – single unit	< 3MW	1MW	>3MW

Summary and Conclusion

