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Power Systems

THE FUTURE OF SUSTAINABLE & SCALABLE DATA CENTER UPS POWER

Introduction Pointers

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Sustainability
Decarbonize
Green

UPS
Technologies

Electrical
Architecture

Total Cost
of
Ownership

What is Sustainability?

“Making only such use of natural, renewable resources that people can continue to rely on their yields in the long term”

- As we demand more - more power, more natural resources, for more people, homes & cities, we must all strive to achieve this with less waste, fewer emissions, less energy consumption and wider sustainable thinking and action - in every aspect of our lives.

- In the data center ecosystem, this places greater emphasis on technology design and choice…..
  - materials used – recyclable and reusable
  - Efficiencies and carbon footprint
  - Complexity, components, (electrical) infrastructure
  - Economic sustainability – must be cost effective

Source - Wikipedia

UPS & Energy Storage – The New Power Triangle

Supply & Demand

Demand

Supply & Demand

The UPS / Energy Store needs to do more!

Demand Response
- FCAS (Frequency Control Ancillary Services)
- FFR (Fast Frequency Response)

Inertia - Synchronous / Asynchronous generation

BESS - Battery Energy Storage Systems

FESS - Flywheel Energy Storage Systems

UPS Technologies

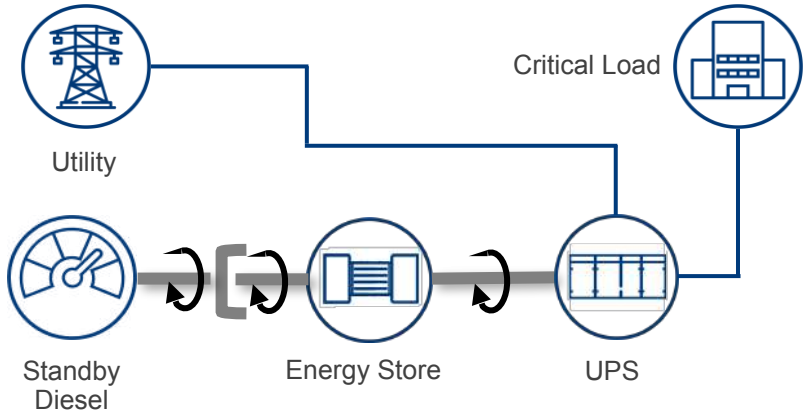
What UPS topology is available in the market for Data Centres?

What are the two fundamental UPS topologies available?

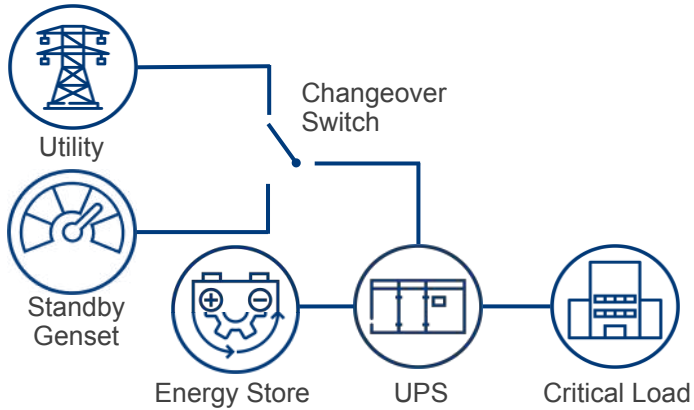
UPS topology is best differentiated by the way in which the energy transfers between storage and UPS

A UPS topology is not defined by the type of energy storage (battery, flywheel, capacitor,...)

Mechanically Coupled (MC)



Electrically Coupled (EC)



UPS Technologies

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	Mechanically Coupled UPS	Electrically Coupled STATIC	Electrically Coupled UB-V
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.
BESS 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

Energy Storage Options

The power required by UPS systems for bridging mains failures can be provided in different ways:

- **Battery**
- **Flywheel**
- Capacitor
- Compressed air
- Superconducting coil (SMES)

Amazon (Bezos) Flywheel

A flywheel… “Keep pushing and eventually it starts to help turn itself and generate its own momentum – and that's when a company goes from good to great”

Environmental Impact

Lead Acid Battery	Li-Ion Battery	Flywheel
Material = plastic, acid, lead recyclable	Material must be recycled - unclear	Material=copper, steel 100% recyclable
Toxic components	Highly toxic components	Non toxic components
Limited transport – battery-dependent	Transport of dangerous goods	Standard transport without any restrictions
Air conditioning cooling	Thermo-management	No requirements
Hardly flammable	Flammable	Not flammable
5-8 years, some10-12 years life time	Up to15 years estimated life time	20+ years life time

PLASTIC / LEAD / ACID

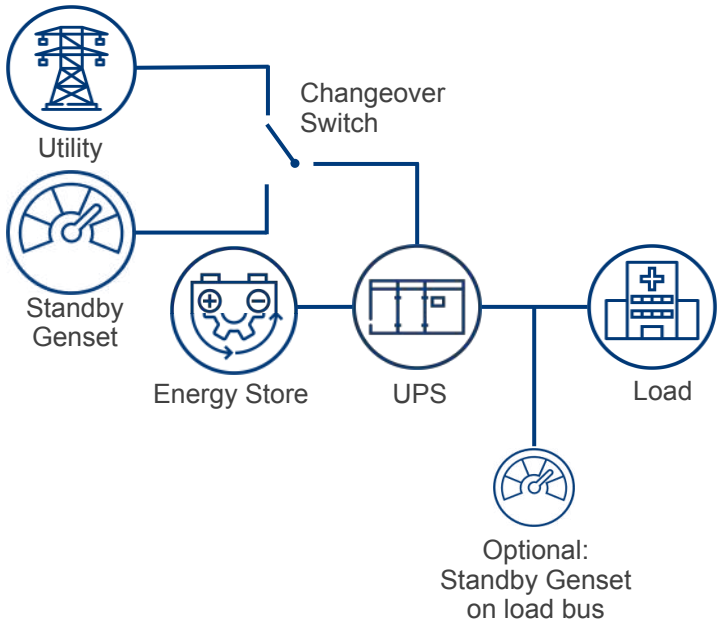
PLASTIC / ALUMINIUM /
COBALT + MANGAN / LITHIUM

STEEL / COPPER

UPS Technologies - Electrically Coupled UPS (EC) UB-V

UNIBLOCK UB-V units up to 3.24MW 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
- Widest flexibility between engine and UPS arrangement



Benefiting from High Voltage

As data centres continue to get bigger, the future of Power at Scale is High Voltage. And this is how Piller does it….

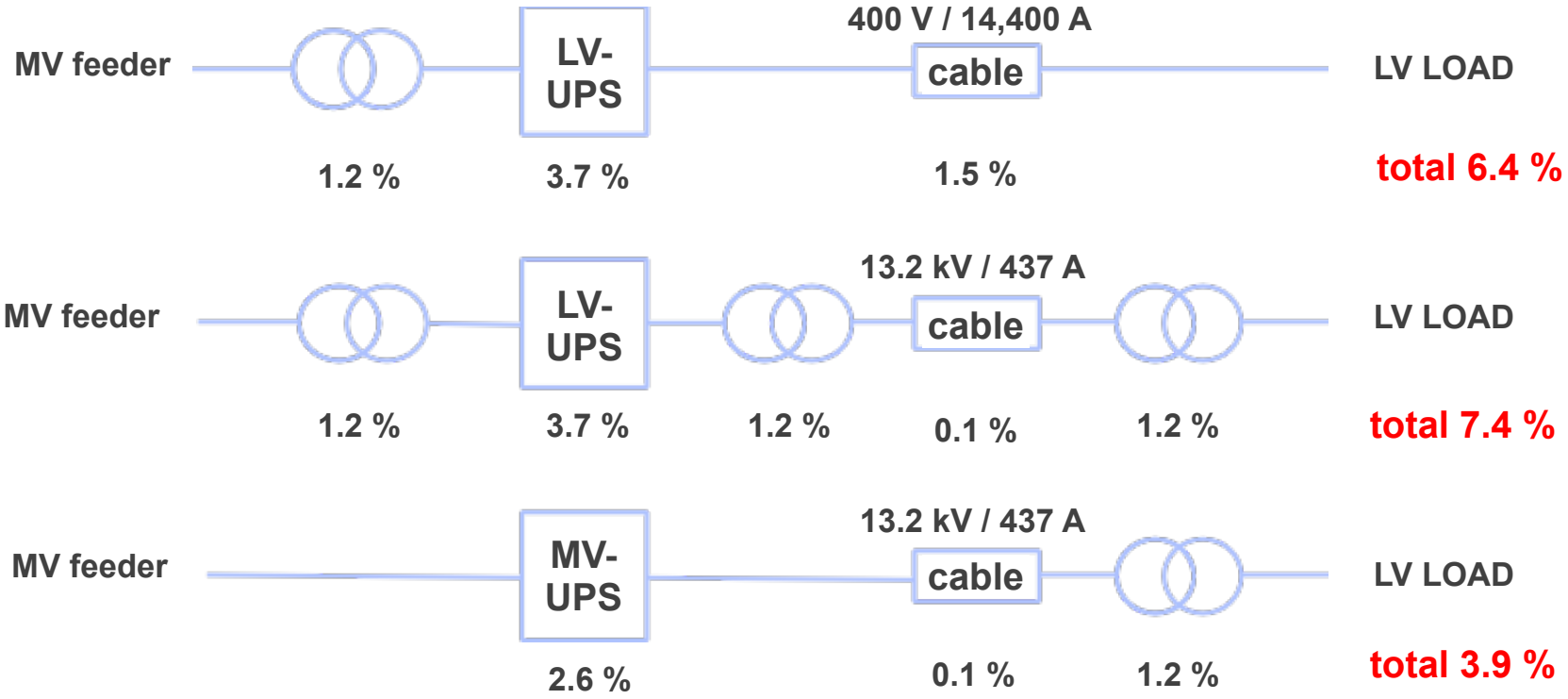
- Cut power losses – adds to green credentials
- Save infrastructure Capex
- MV achieves this without compromising reliability
- There is a limit beyond which Low Voltage cannot practically be used
- More systems means more infrastructure, more failures, more cost
- This limitation does not apply to Medium Voltage
- Renewables typically connected at MV thus a MV UPS & Energy Store fits naturally and optimises the entire system.

> **“We would suggest that the use of UPS at high voltage will become more and more prevalent in the coming years.”**

Robert Thorogood – Hurley Palmer Flatt

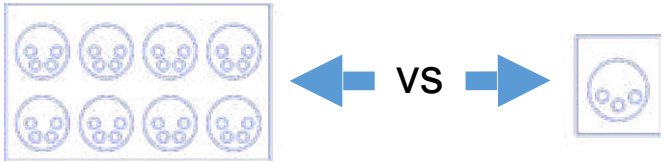
Comparison of Losses - LV solution Vs MV solution

The schemes are showing the typical losses of 3 different configurations for a 10 MVA distribution.



Sustainable HV – Less Material

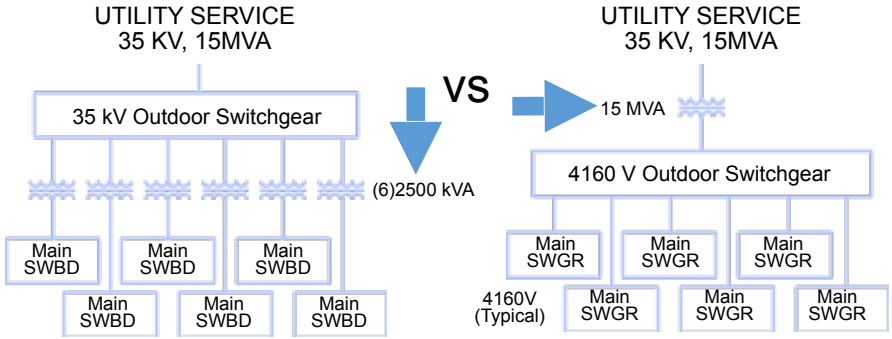
Feeder rationalisation



Up to 80% less Copper and PVC

Less Steel in armour and ladder rack

Large systems allow transformer consolidation



25% Reduction in plant room space

Less real estate building materials

Sustainable MV – Less Concerns Too

Breaker Reliability

600 Volt Insulated Case Breaker
Squared D Masterpact NW

VS

MV Mag-Actuated Vacuum
Breaker ABB VM-1

Endurance Test Results:

- The best 480 V breaker performed nearly 25,000 operations before failure
- The best 4160 V breaker went over 70,000 operations before testing was stopped

Reliability Increases with MV Breakers

Can have lower arc flash than equivalent LV system

Maintenance is less

Heat-related Switchboard issues are less

Terminations are fewer

Costs can be less

And MV has to be on the site of large scale facilities anyway – no issues with Approved Persons.

Direct Comparison between Key Technology Factors

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Footprint

Reliability and Availability

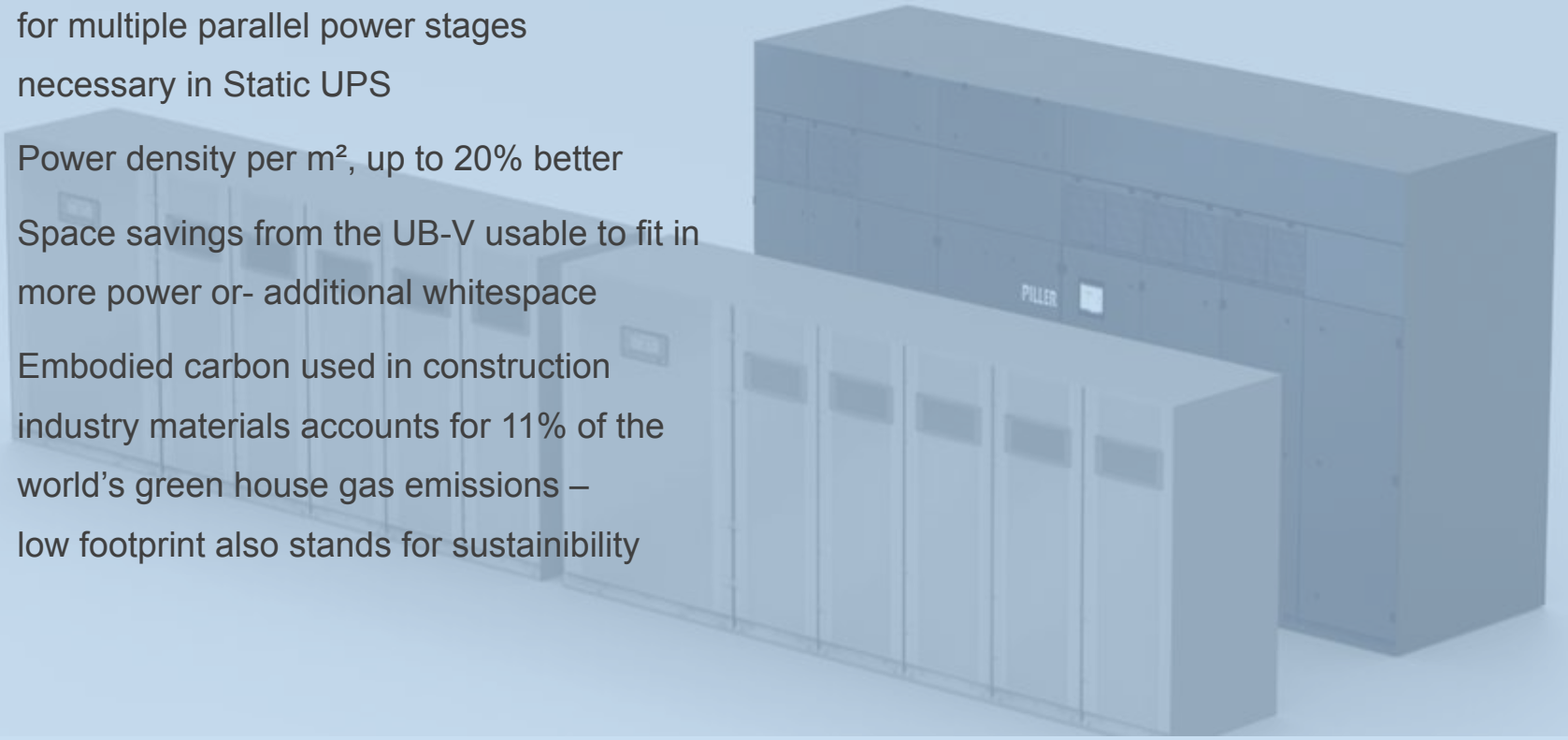
Maintenance and Downtime

Efficiency

Total Cost of Ownership

Footprint

- Single entity UB-V eliminates the need for multiple parallel power stages necessary in Static UPS
- Power density per m², up to 20% better
- Space savings from the UB-V usable to fit in more power or- additional whitespace
- Embodied carbon used in construction industry materials accounts for 11% of the world's green house gas emissions – low footprint also stands for sustainibility

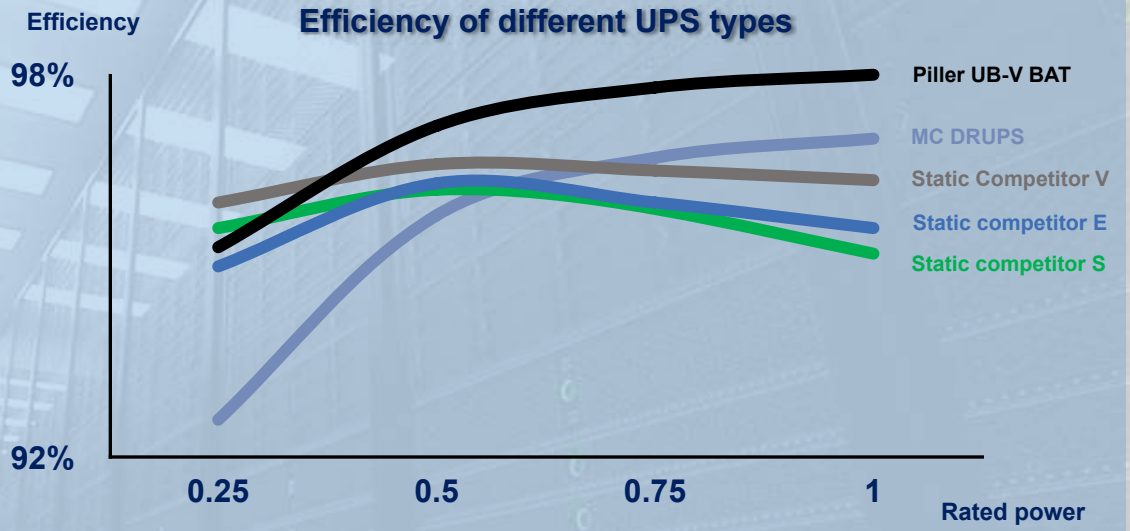


Efficiencies – (= Sustainability)

Efficiency

Modern Static UPS have good online efficiencies

- UB-V efficiency is better across the majority of nearly all load level
- UB-V has no internal paralleling
- Higher Static UPS efficiency possible;
  - by switching between alternate modes (e.g. ECO), but this introduces risk and is not normally adopted, or
  - By ramping down converter stages to maintain a high percentage of load but this reduces short circuit capability, that could affect sub-circuit discrimination



Maintenance and Downtime

MC UPS

- Energy Store overhaul – 5 days every 5 years
- Clutch – 2 days every 7 years
- Frequent diesel engine maintenance
- UPS design life – 20 years

Static with Li-Ion

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

UB-V with Li-Ion

- Largely Maintenance Free
- Offline maintenance interval every 5 years
- Design life 25-years

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

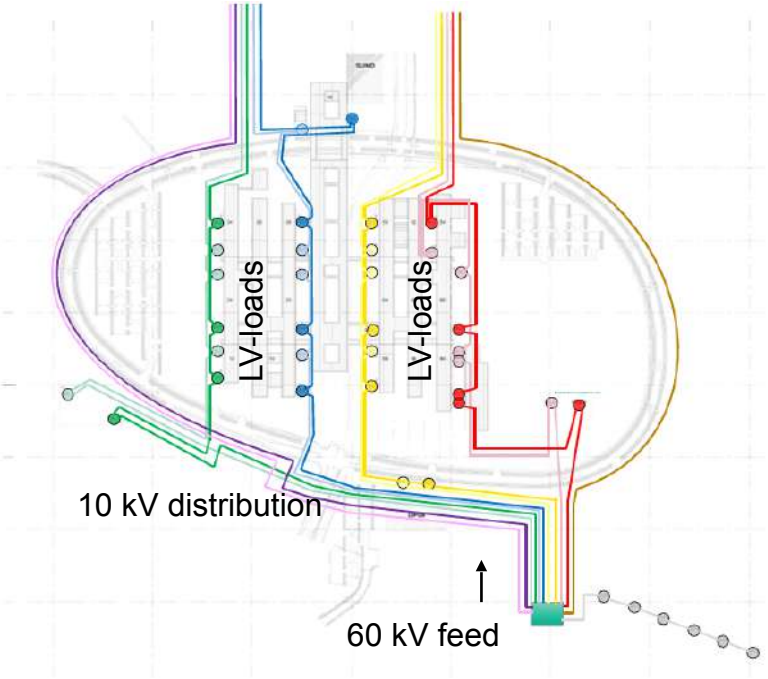
* Based on climate controlled Data Centre environment

Total Cost of Ownership Factors

- 40MW Installation - 32MW duty capacity - 24MW operational load (60%) - over 10 year period	**Distributed Redundant Static (40 x 1MW)**	**Distributed Redundant UB-V (20 x 2MW)**
Footprint	246 sqm	200 sqm
Relative Capex (inc. Install and Li-Ion Battery)	100%	92%
Efficiency % (60% load)	96.2	96.9
Energy Loss Cost (60% Load @ 0,2 €/kWh)	16.608.960 €	13.451.856 €
Maintenance (incl. Fan / Caps & Batteries)	2.914.000 €	1.722.000 €
UB-V Energy + Maintenance cost savings over Static UPS = 4.349.104 €		

Regular Maintenance regime for Static UPS and comprehensive for UB-V
Batteries generally the same for each system
Currency is €uro

Danish reference project for 10 MW DRUPS



Key-points:

- ✓ Total power demand of 10MW Diesel backed UPS
- ✓ 10 kV MV power supply as an internal transmission voltage
- ✓ 5 different H.Q. power supply rings on the complete campus
- ✓ Step down transformer to 400V inside the hospital buildgings
- ✓ Full hospital supply with a central Diesel UPS installation
- ✓ 2 load groups with a common N+1 redundacy as a swing unit
- ✓ All power supply equipment installed in a central building
- ✓ Designe for a product lifetime of 25 years+
- ✓ Significant advantages in TCO to other UPS concepts
- ✓ Maximum reliability, by responsibility to protect human life.

Conclusion

- Historic labels are insufficient in indicating the differences of
  - performance, downtime & TCO
  - reliability and flexibility,
  in the context of the modern Data Centre.
- Smart power networks require client & UPS technology ready for demand response.
- Sustainability is more than just efficiency, it is a **must have** related to the entire UPS concept.

Sustainability is key for the future!


Q&A