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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

Sustainability Statements

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Sustainability First: Digital Realty's
Global Commitment to Reducing Our Carbon Footprint ..
Bill Stein, CEO, December 3, 2020

FUTURE FIRST
SUSTAINABILITY @ EQUINIX

SUSTAINABLE DEVELOPMENT GOALS

NTT,Data Center Sustainability: It's More than Just Power

COMMON OBJECTIVES.... MANY SIGNATORIES ....

Energy Efficiency
Clean Energy
Water
Circular Economy
Circular Energy System

SUSTAINABLE DEVELOPMENT GOALS

- **ST Telemedia Global Data Centres** Launches Group ESG Plan, Pledges to Become Carbon-Neutral by 2030

Sustainability in the Cloud
Amazon Web Services (AWS) is committed to
running our business
in the most environmentally friendly way possible

Our commitment to a planet-sized challenge - **Microsoft**
And... "plan to be carbon negative by 2030"

https://www.climateneutraldatacentre.net/signatories/

Cloud Infrastructure Providers in Europe (CISPE) European Data Centre Association (EUDCA)

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

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

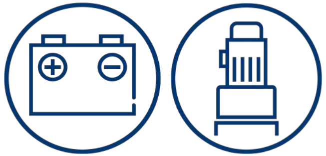
FESS - Flywheel Energy Storage Systems

UPS & Energy Storage – Integrating with Renewables

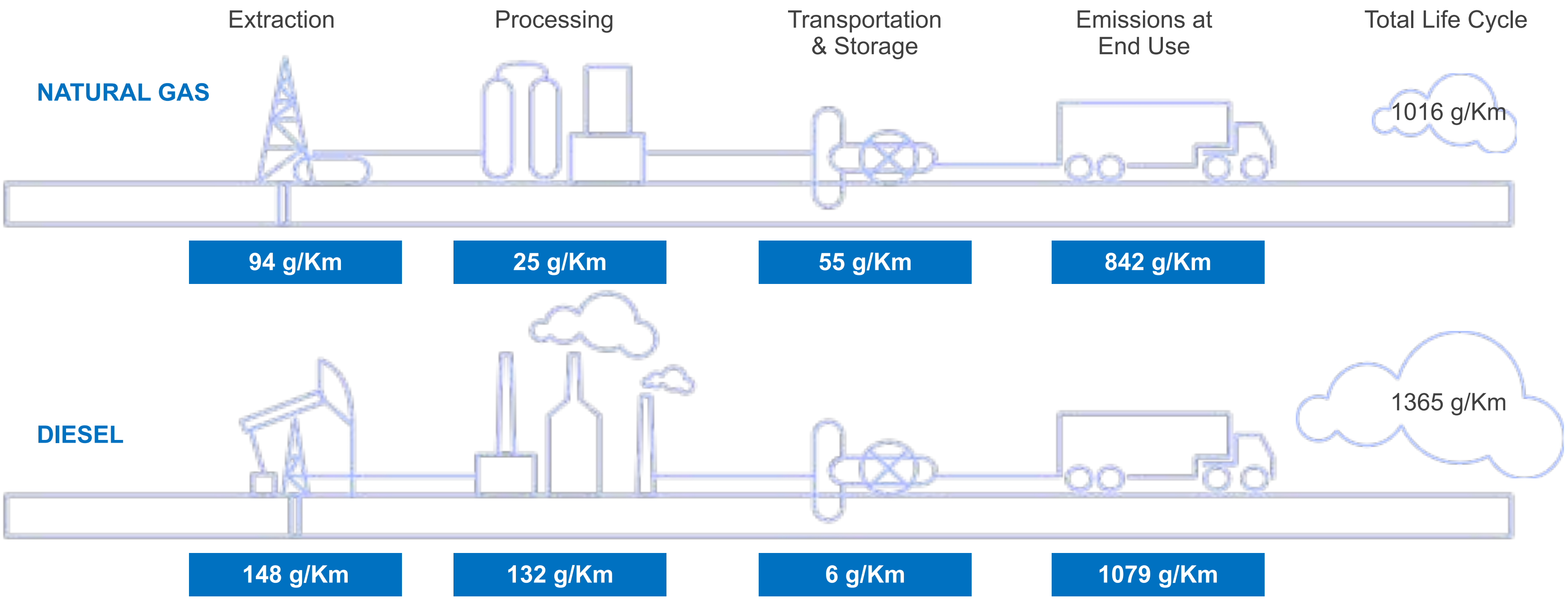
Customer supported sustainable energy solutions – reduces carbon footprint and generates revenue.

- Reduce the cost of powering the facility by creating additional revenue streams from power protection assets.
- UPS Operator & Client in control of stored energy – can choose how much capacity to offer and when
- Optimise power usage through the power triangle using BESS or FESS <u>or both,</u> integrated with the UPS system
- Bi-directional power flow via a synchronous interface allows grid stability with inertia (FFR)
- Critical load takes priority and is protected simultaneously.
- Demand Response (FCAS) can be catered for with simple set-up and control
- Renewables typically connected at HV thus a HV UPS & Energy Store fits naturally and optimises the entire system.

UPS operators can add value by helping energy providers balance power generation and consumption.



Source of Power: Grid Plus Diesel, Self Generated Gas or a Combination



Source: CleanEnergyFuels.com

UPS Technologies

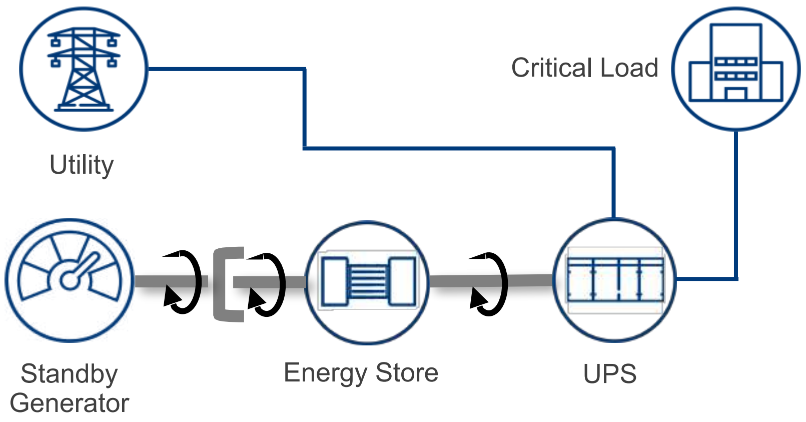
What UPS topology is available in the market for Data Centres?

What are the two fundamental UPS topologies available?

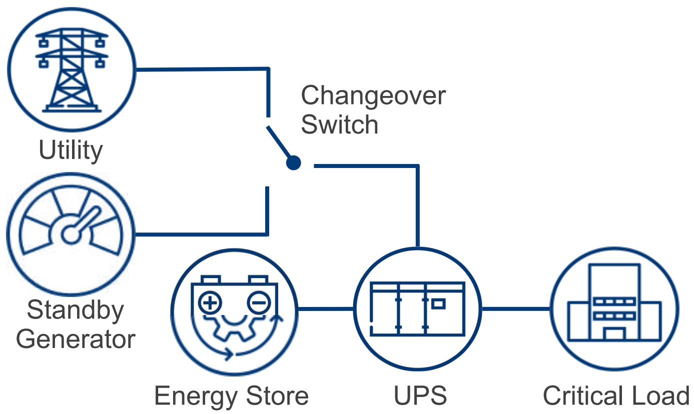
UPS topology is best differentiated by the way in which the energy transfers between storage and UPS

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 High Voltage	Low Voltage	Low and High Voltage
Capacitive filtering (capacitors)	Not required.	Yes	Not required.
BESS compatibility	Not possible.	Possible only when modified for bi-directional power flow.	Possible
Reliability	Medium	Low	High
Maintenance	High	Medium	Low
Power ratings – single unit	> 3MW	300kW	>3MW

Energy Storage Options

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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

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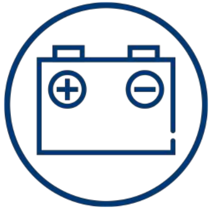
Lead Acid Battery	Li-Ion Battery	Flywheel
Material = plastic, acid, lead recyclable	Material must be recycled - unclear	Material=copper, steel 100% recyclable
Toxic components	Highly toxic components	Non toxic components
Limited transport – battery-dependent	Transport of dangerous goods	Standard transport without any restrictions
Air conditioning cooling	Thermo-management	No requirements
Hardly flammable	Flammable	Not flammable
5-8 years life time	Up to15 yrs estimated life time	over 15 years life time



PLASTIC / LEAD / ACID

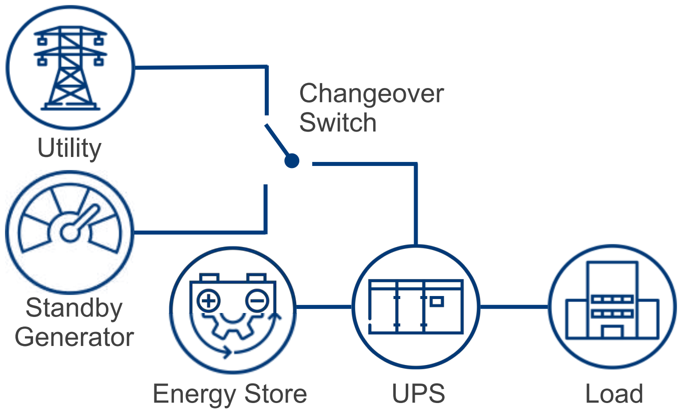
PLASTIC / ALUMINIUM / COBALT + MANGAN / LITHIUM

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



Characteristics - UNIBLOCK™ UB-V

Bi-directional power flow manages UPS and ESS functions simultaneously for optimised operation

Totally flexible configurations, High or Low Voltage and paralleling up to 50 MW making the UB-V ideal for large scale deployments

Kinetic Energy Storage for more than 60s short backup at 1MW load

Customised Li-ion or VRLA batteries for short backup

Benefiting from High Voltage

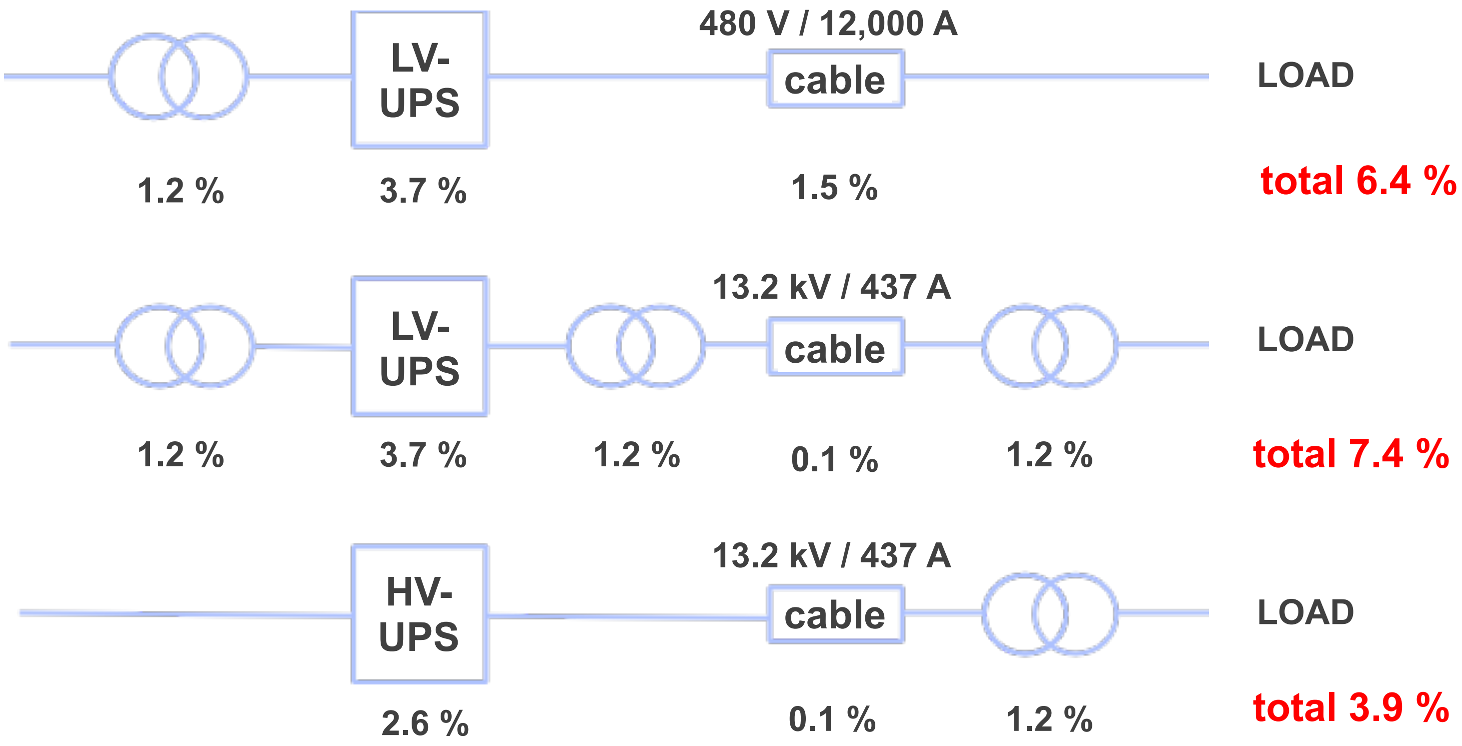
As data centres continue to get bigger, the future of Power at Scale is High Voltage. And this is how Piller does it….

- Cut power losses – adds to green credentials
- Save infrastructure Capex
- HV 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 High Voltage
- Renewables typically connected at HV thus a HV 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

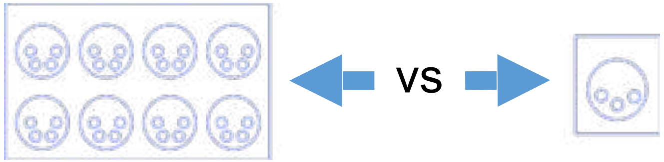
Comparison of Losses - LV solution Vs HV solution

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



Sustainable HV – Less Material

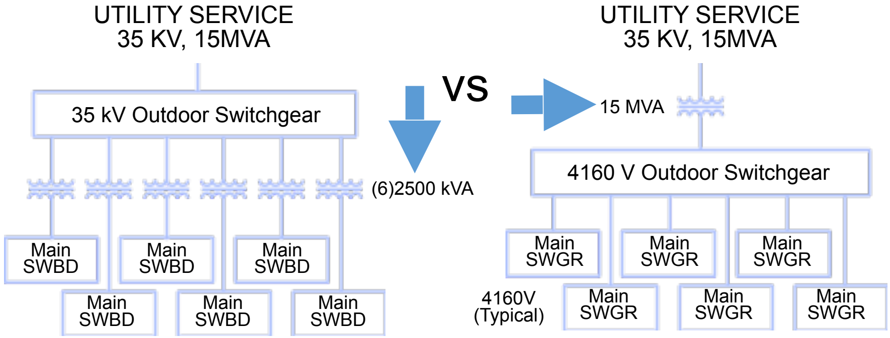
Feeder rationalisation



Up to 80% less Copper and PVC

Less Steel in armour and ladder rack

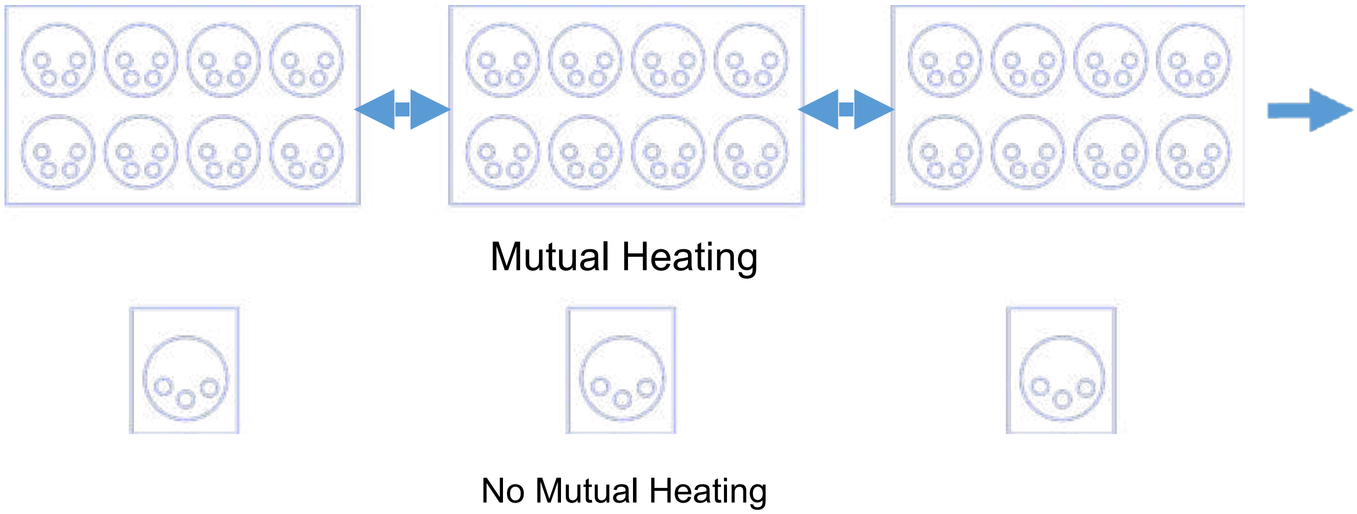
Large systems allow transformer consolidation



25% Reduction in plant room space

Less real estate building materials

Sustainable HV – Less Energy



Cable grouping and mutual heating lead to higher losses

Transformer losses cut by 60%

Feeder losses reduced by a factor of 50

‘Grid to rack’ losses reduced significantly

Sustainable HV – 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 HV 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 HV 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

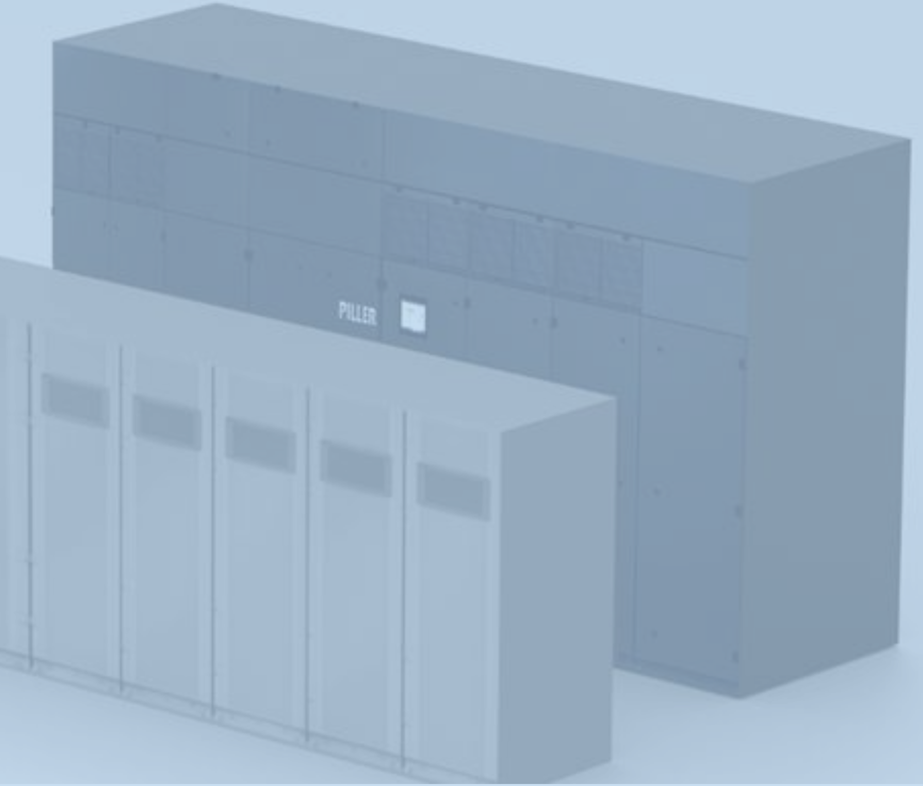
Maintenance and Downtime

Efficiency

Total Cost of Ownership

Footprint

- Single entity UB-V eliminates the need for multiple parallel power stages necessary in Static UPS
- Power per square metre up to 20% better
- Embodied carbon used in construction industry materials accounts for 11% of the world’s green house gas emissions
- If a 20% reduction could be achieved throughout construction, then carbon dioxide emissions could be reduced by 750 Million Metric tons pa.

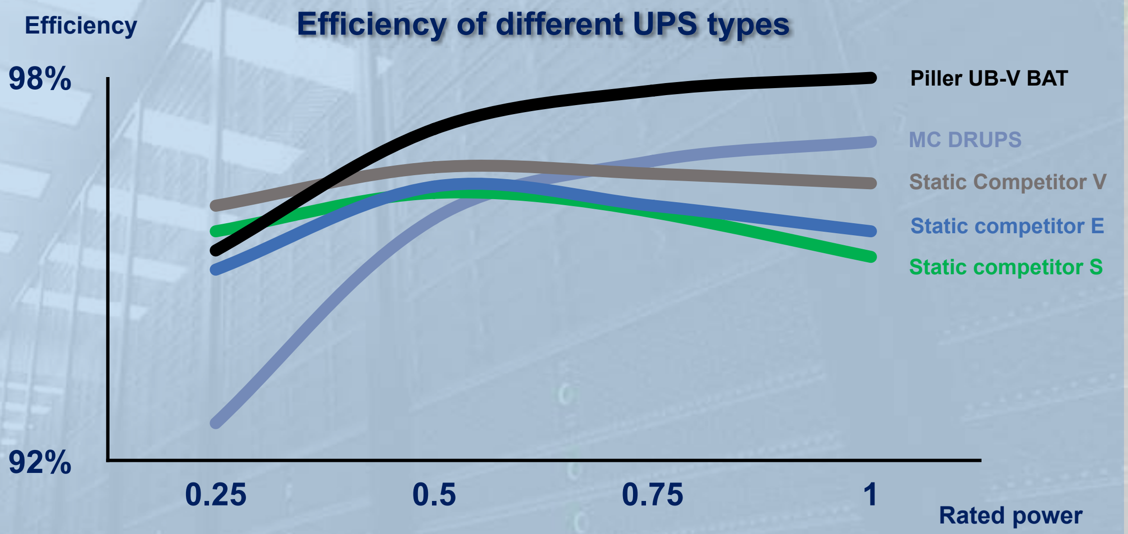


Efficiencies – (= Sustainability)

Efficiency

Modern Static UPS have good online efficiencies

- UB-V efficiency is better across the majority of loadings
- 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

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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

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- 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 @ $0.17 / kWh)	$14,117,987	$11,434,105
Maintenance (incl. Fan / Caps & Batteries)	$4,400,000	$2,600,000

UB-V Energy + Maintenance cost savings over Static UPS = $4,483,882

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

Conclusion

- Sustainability is key for the future!
- Electrical networks require client & UPS operators participation in demand response.
- Classifying UPS is not as simple as it once used to be - it needs to do more!
- HV UPS and distribution network within the DC works well with renewables upstream.
- Historic labels are insufficient in indicating the differences surrounding
  - performance,
  - maintenance,
  - reliability and flexibility, especially in the context of the modern Data Centre.

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Q&A