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Power Systems

SUSTAINABLE & INNOVATIOVE POWERSUPPLY FOR DATA CENTER

Questions to be asked

How big will your Data Centre be?

- On day one?
- When complete?
- What footprint do you have to work with?

What is your priority?

- Reliability & Availability?
- Technology?
- Capex?
- Scalability?
- Opex?

Showcase 1: Energnist Esbjerg, 2000 kW Diesel UPS, battery free

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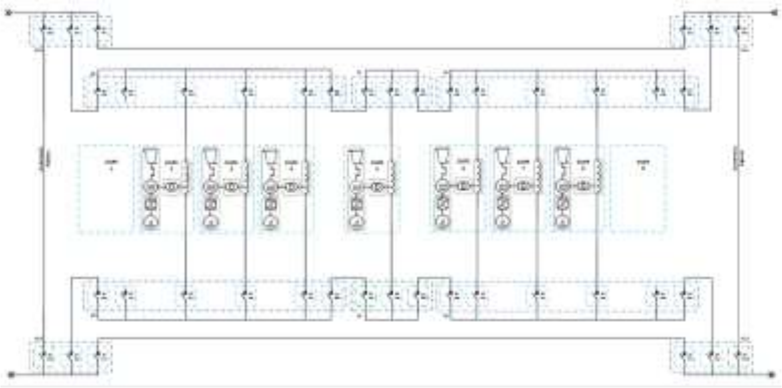
Key-points:

- Uninterruptible electrical power supply of 2000 kW
- Back-up of all sensitive and safety related functions
- Direct connetcion to 10 kV Medium Voltage level
- Short term energy source: flywheel
- Long term energy source: Diesel engine
- Highly efficient power supply for all sensitive loads
- Fully containerised DRUPS system
- Designed for a product lifetime of 25 years+
- Significant advantages in TCO to other UPS concepts
- Supply reliability more than 6 times above other UPS-concepts

Showcase 2: Nyt Odense University Hospital, 10 MW DRUPS, battery free

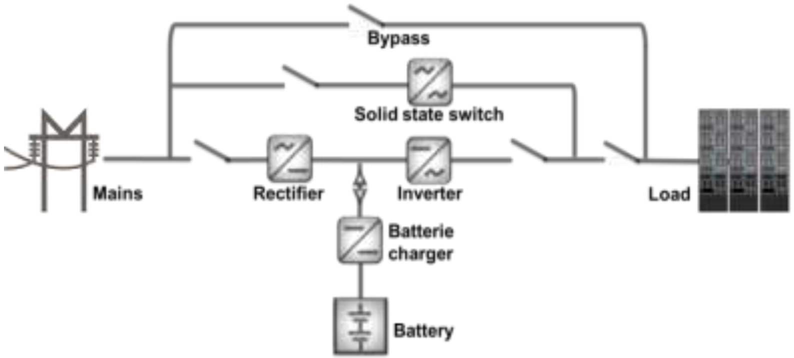


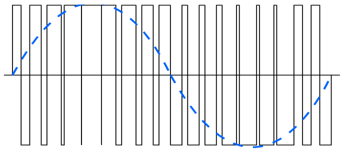
Key-points:

- Total power demand of 10 MW Diesel backed UPS for the complete hospital supply.
- 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 400 V inside the hospital buildings
- 2 groups with a common N+1 redundancy, as a swing unit, designed with 7 DRUPS, each rated to 1,8 kW single block power.
- All power supply equipment installed in a central building
- Design for a product lifetime of 25 years+
- Significant advantages in TCO to other UPS concepts
- Maximum reliability, by the responsibility to protect human life.

Fundamental UPS technologies

SUPS

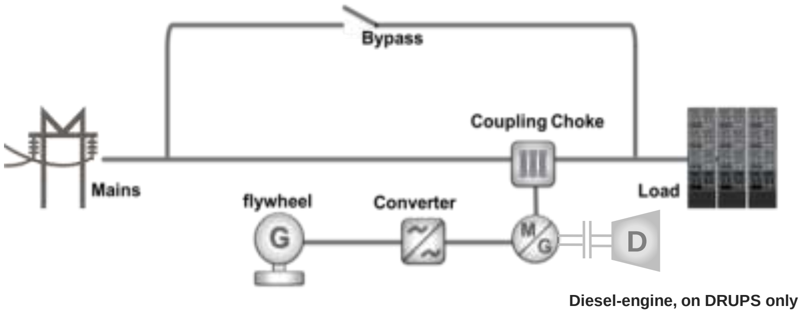


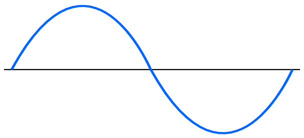


Artificial sine-wave by switching of IGBT's

- ❑ Limitation by power electronics
- ❑ Higher capacities by paralleling

UNIBLOCK [DRUPS]

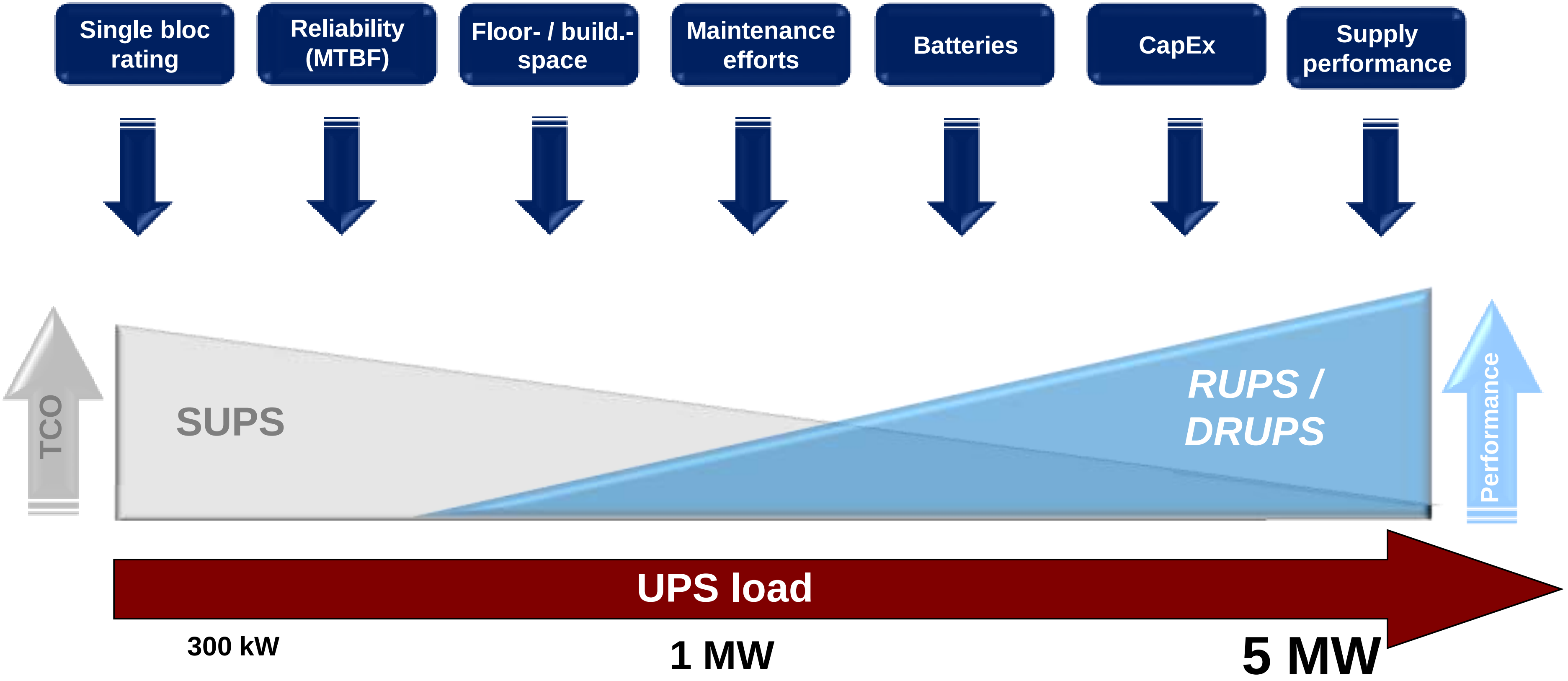




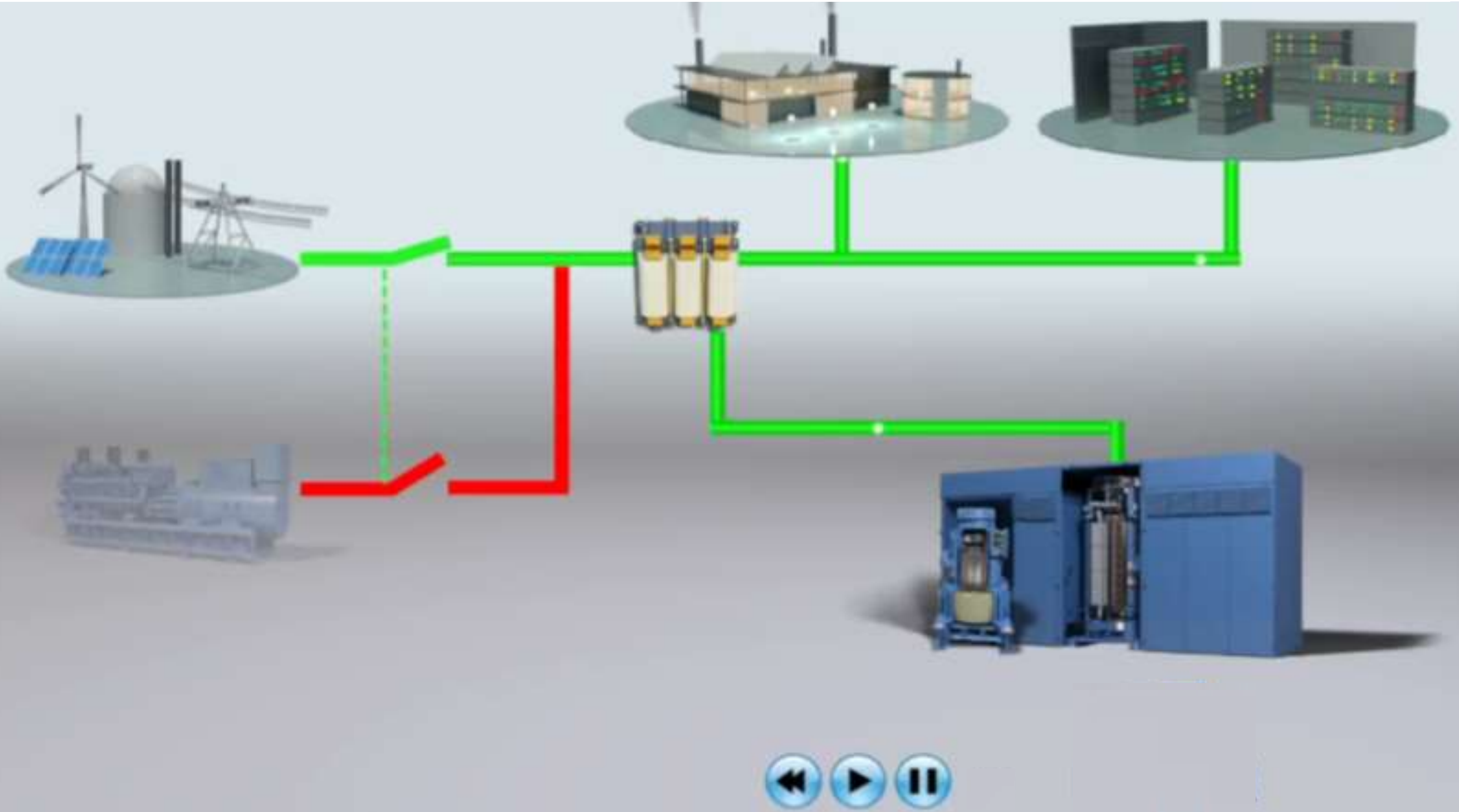
Natural sine-wave genrated by an electrical machine

- ❑ High single block ratings > 3MW
- ❑ Advantageous supply performance data

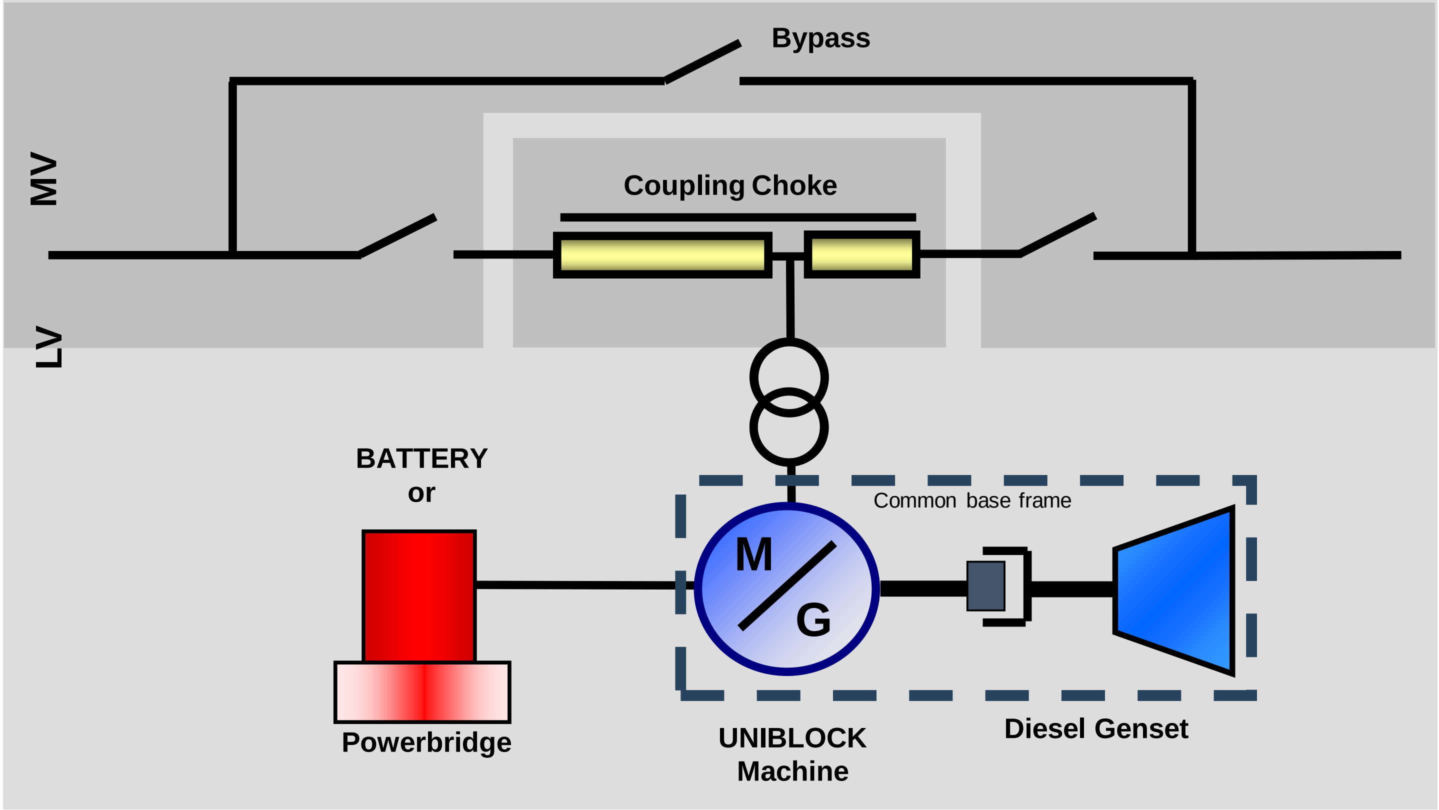
UPS selection criteria's



RUPS function

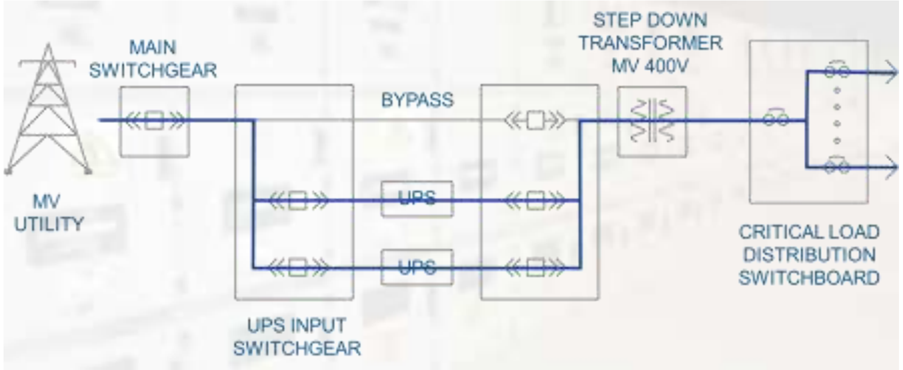


DRUPS architecture



Large Power ratings and benefits 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.

Further questions to be asked

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What level of power security do you need?

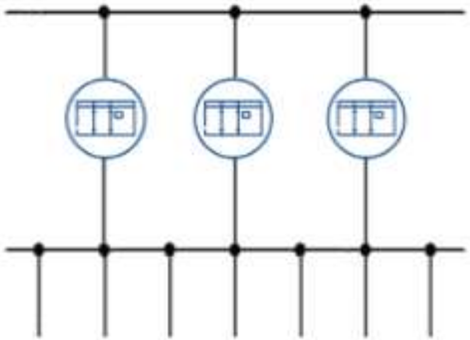
- N
- N+1
- N+2
- 2N+1
- UTI Tier III
- UTI Tier IV

Electrical Supply Schemes

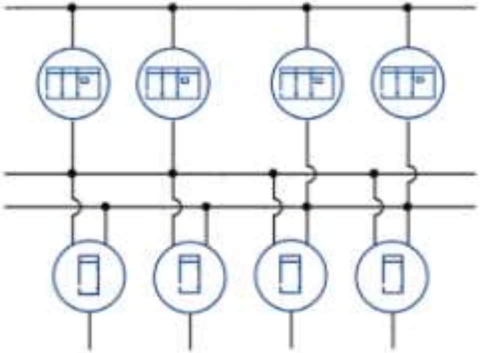
Power-critical facilities are tending to be larger and have an increasing number of sensitive loads, requiring more and more highly-reliable electrical power.

- Parallel UPS and System-redundant UPS configuration
- IP-Bus System UPS configuration
- Is there a benefit of HV over LV ?

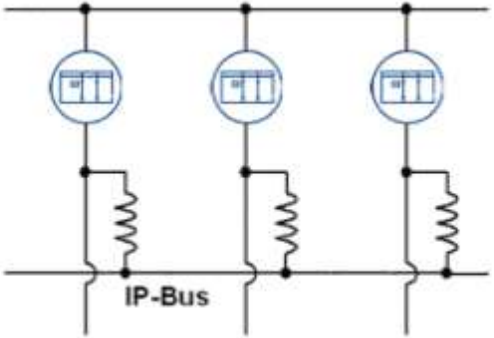
UTI Tier IV approved



Parallel UPS configuration



System-redundant UPS configuration with STS



Basic design of an IP system

Direct Comparison between Key Technology Factors

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Footprint

Reliability and Availability

Efficiency

Total Cost of Ownership

Floorspace – (= Sustainability)

Foot Print

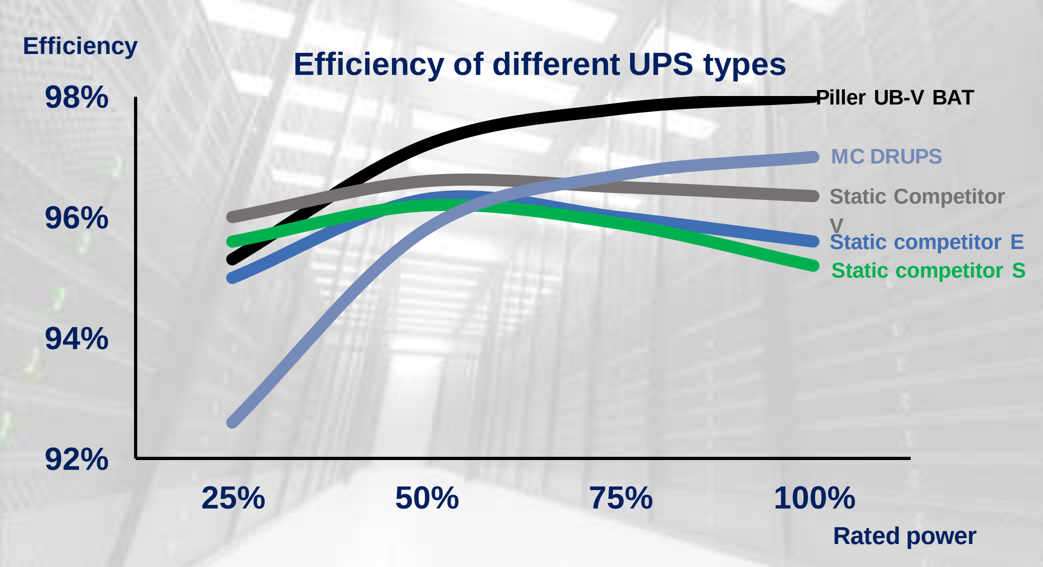
- Single unit (D)RUPS- design eliminates the need for multiple-paralleled power stages necessary in Static UPS
- Power per square metre up to 20% higher
- No paralleling switchgear
- Space saving can be used to fit in more power, or
- To increase the white space and generate additional revenue

Foot print comparison (UPS only) based upon 2MW
UB-V = 6,3m² Static = 8,1m²

Efficiencies – (= Sustainability)

Efficiency

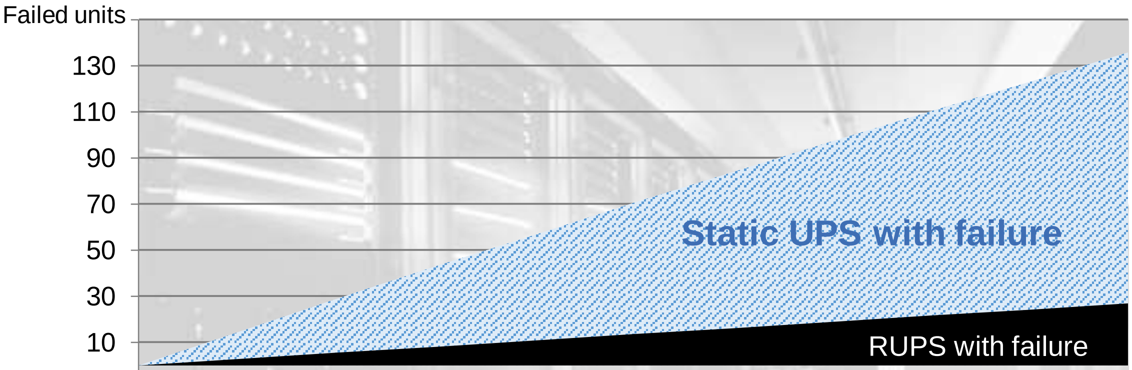
- Modern Static UPS have good online efficiencies
- UB-V efficiency is better across the majority of nearly all load level
- UB-V has no internal paralleling
- Higher Static UPS efficiency possible;
  - by switching between alternate modes (e.g. ECO), but this introduces risk and is not normally adopted, 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



Reliability

MTBF

- MTBF is not related to lifetime
- MTBF traditional Static UPS 587,450 h (n+1 modules)
- MTBF RUPS system 3,217,440 h



N(0) = 1000	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	Hours	**8,760**	**17,520**	**26,20**	**35,040**	**43,800**	**52,560**	**61,320**	**70,080**	**78,840**	**87,600**
Static UPS with failure		14.5	28	42.9	56.7	70.4	83.9	97.2	110.2	123.1	135.8
RUPS with failure		2.7	5.4	8.1	10.8	13.5	16.2	18.9	21.5	24.2	26.9

Failure rate = λ = 1/MTBF

Number of working units after time t:
$N(t) = N(0) \times e^{-(\lambda \times t)}$

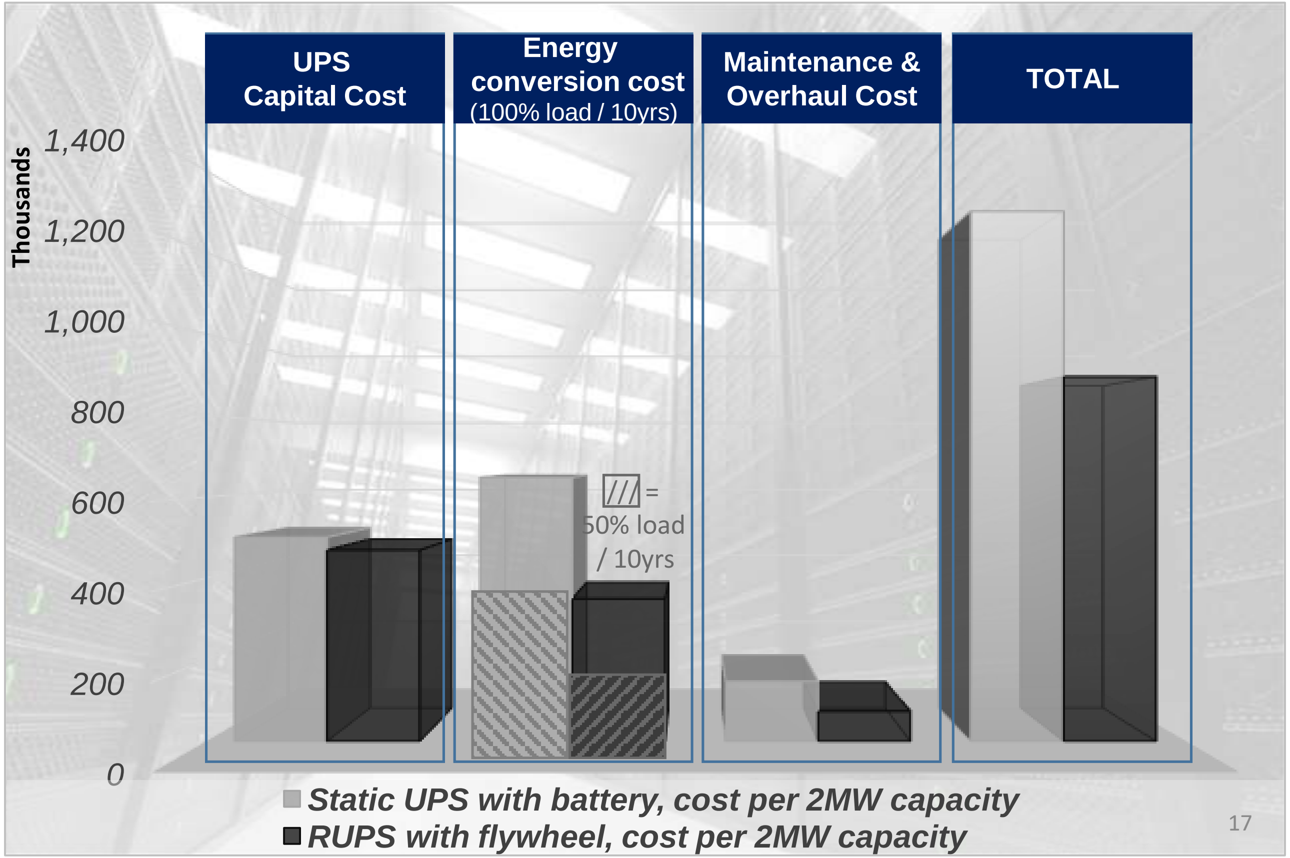
In a 10 years' time period the likelihood for a failure is ***5 times*** higher for a static UPS compared to the RUPS

TCO Comparison

2MW Static vs RUPS

Isolated Redundant

- ❑ Low maintenance
- ❑ Low TCO
- ❑ High efficiencies with Redundancy
- ❑ Concurrent Maintainability
- ❑ High Uptime / Availability



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 RUPS (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 €

RUPS Energy + Maintenance cost savings over Static UPS = 4.349.104 € in 10 y

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

Conclusion - Piller makes the difference

Sustainability

- Higher efficiency than Static leading to significant energy savings – Carbon emission reduction
- More compact UPS means smaller building required for same power
- Less e-waste
- (D)RUPS are 95% recyclable to 85% Static

Savings

- Higher efficiency – less electrical cost
- No Capacitor and Fan change required
- No UPS change on 25year mark
- Smaller building required

Simplicity

- Simplicity leads to higher reliability and significantly lower downtime.
- Significantly reduced component
- use of more robust components (Thyristor over IGBT)
- Elimination of failure prone components - No Capacitor and Fans

Supply Chain

- European manufactured


Q&A