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A White Paper from the European Data Centre Association Technical Committee

DRUPS versus Static UPS Report

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EUROPEAN DATA CENTRE ASSOCIATION

Table of Contents

Executive Summary

This report examines the relative merits of Diesel Rotary UPS (DRUPS) versus the more traditional Static UPS combined with standby generators. The efficiency of static UPS systems has improved greatly over recent years and now is on a par with the efficiency of a DRUPS system, so one of the main drivers for adopting a DRUPS solution has been removed. DRUPS systems still tend to be more space efficient than Statics, however the capital costs remain higher. Lifetime costs over a 10yr period are approximately equal, depending in large part on off-peak efficiencies of both systems. Over a longer period DRUPS would still have the advantage, mainly because of the costs on replacement batteries for Static systems.

In terms of performance in protecting the critical loads from Utility power failure, the double-conversion static UPS has the advantage in that incoming power failure detection is a passive system based on DC voltage levels whereas in a DRUPS it is an active, software-controlled system that has the potential to work imperfectly.

Power quality on change of operating mode (utility power to generator power) is superior in a static system to that of a DRUPS system, mainly because static systems are electronic and DRUPS systems are basically electro-mechanical. Power quality in normal operating mode are similar for both systems in that the DRUPS act as a harmonic filter and power factor corrector, a static UPS also has these functions when running in double-conversion mode.

The conclusion of the report is that the traditional static UPS/ standby generator system is preferable to a DRUPS system in performance and costs unless there are site specific conditions such as lack of plantroom space, or if a very long-term view of costs is taken that might suggest a DRUPS system has the advantage.

Introduction

This report will explore the differences between Diesel Rotary Uninterruptable Power Supplies (DRUPS) and Static Uninterruptible Power Supplies (UPS) used with standby generators, with reference to the very large electrical loads found in modern hyperscale datacentres. Descriptions of the various types of DRUPS and UPS will be given to show the differences in configuration of the DRUPS or UPS in relation to the critical loads and how this relates to the performance of the system in its primary function of protecting the critical loads from Utility power failure. Efficiency and power quality will be discussed.

Data will be presented on the relative footprints of the different systems, and on the capital costs of these systems. Total cost of ownership for the different systems will be discussed and a typical TCO calculation presented along with caveats about such studies.

The crucial difference in mains failure detection between line-interactive DRUPS and double-conversion statics will be examined in depth, and the resulting efficacy in protecting the critical loads from Utility power failure will be discussed.

Static UPS versus Diesel Rotary UPS

First some definitions-

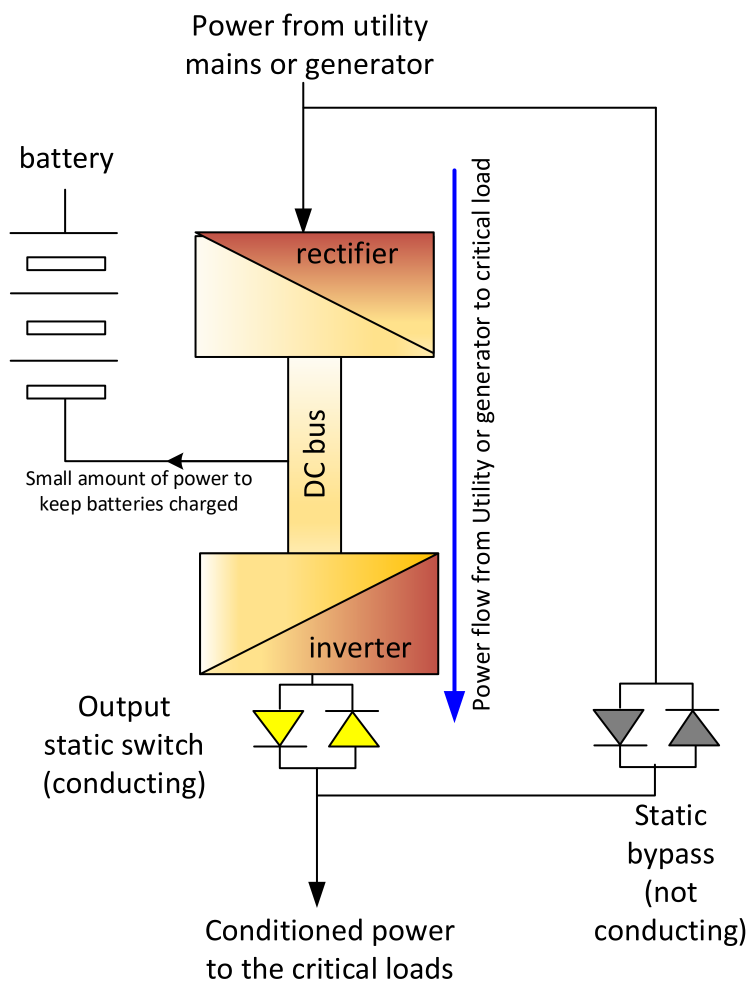
AC -alternating current	Electrical power supplied by a sine-wave voltage waveform, at 50hz in Europe, 60hz in the USA.
DC – direct current	Electrical power supplied by a steady voltage, for example from a battery
UPS – Uninterruptible Power Supply	a power supply system to protect the critical loads from mains failure
DRUPS- Diesel Rotary Uninterruptible Power Supply	An electro-mechanical UPS usually with inertial energy storage
Hybrid Rotary UPS	A UPS system that employs both electro-mechanical components as well as an electronic inverter
Static UPS	an electronic UPS usually with battery energy storage
Double-conversion topology IEC62040-3 Annex B2	UPS system where the whole power flow to the critical load passes through the UPS
Line Interactive topology IEC62040-3 Annex B3	UPS system that is configured in parallel with the power path to the critical load, often connected by series inductor to the load
Standby topology IEC62040-3 Annex B4	UPS system similar to double conversion topology but running normally through the static bypass ("UPS switch")

The most common type of UPS in the datacentre industry is a *static, double conversion UPS* which is referring to the fact that the AC mains is rectified to DC, and then converted back to AC using an inverter. Static UPS sizes can range from a few kilowatts to megawatts per system, often achieved by paralleling units together. In static UPS systems the energy used to ride through a utility power failure is normally stored in batteries which can be lead-acid, nickel metal hydride or Lithium-ion. It is also possible to store kinetic energy in flywheels as in hybrid systems. The autonomy time (time the UPS can support the load with no Utility/generator power) can be from a few minutes to for example 30 minutes depending on the quantity of batteries.

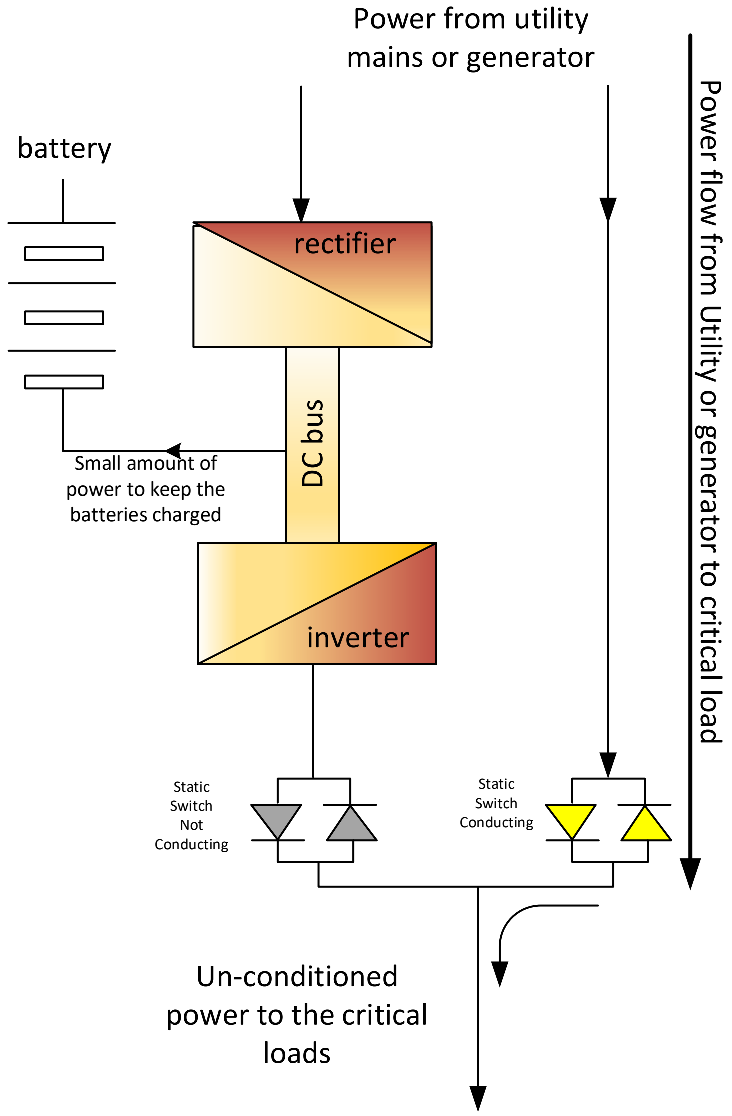
DRUPS tend to be in larger units, ranging from for example 250kW to 1.6MW per unit, and again units can be paralleled together to create large power systems. The energy required to ride through a Utility power failure is usually stored as kinetic energy in flywheels, which in single shaft DRUPS takes the form of the kinetic energy storage device. This kinetic energy storage device rotates at 1800rpm and slows down to 1500rpm as energy is extracted to keep the alternator spinning while the diesel engine starts up. The autonomy time is measured in seconds, usually 30s -45s.

Hybrid rotary UPS are somewhere in the middle in size, ranging from 150kW to 800kW per unit. If they are battery-backed hybrids the autonomy time are similar to statics.

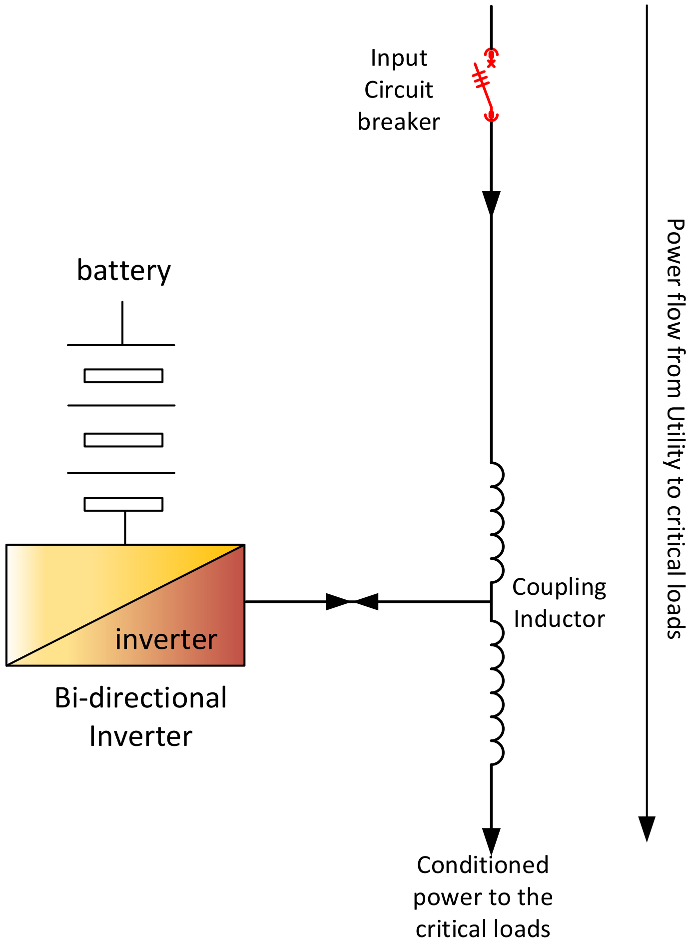
UPS topologies



Double Conversion UPS



Static UPS in standby topology



Line-interactive UPS

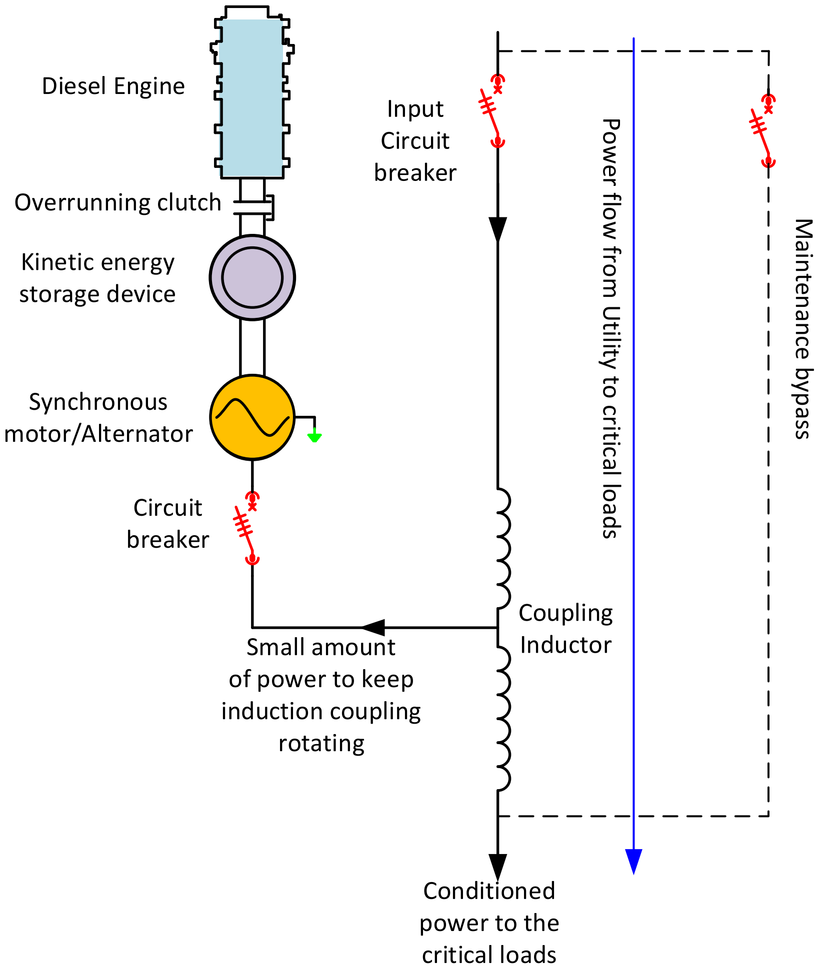
In the double-conversion UPS the power path to the critical loads is through the rectifier, DC bus and inverter. When the mains/generator supply fails the voltage of the DC bus falls to a point where current is drawn from the batteries, while the output from the inverter is unaffected.

In the standby topology UPS the power path to the critical loads is through the static bypass, a small amount of power is drawn from the utility to keep the batteries charged. When the mains/generator supply fails, this has to be sensed by the static switch control circuit and the static switch turned off to prevent backfeeds. The inverter static switch is then turned on, so there is a definite break in supply to the critical loads. This should be under 10mS so is invisible to these loads. As illustrated above, a standby topology UPS is simply a double conversion on-line UPS running through its static bypass. It should be noted that the power to the critical loads in unconditioned, which mean any voltage transients on the Utility supply appear at the critical loads.

In the line-interactive UPS in the normal mode of operation, the load is supplied with conditioned power via a parallel connection of the a.c. input and the UPS inverter. The inverter or the power interface is operating to provide output voltage conditioning and/or battery charging. The output frequency is dependent upon the a.c. input frequency. When the a.c. input supply voltage or frequency is out of UPS preset tolerances, the inverter and battery maintain continuity of load power by using battery power and the input circuit breaker disconnects the a.c. input supply to prevent backfeed from the inverter.

DRUPS are normally connected in line-interactive configuration in parallel with the Utility supply, as is shown below.

There are two basic types of DRUPS, the single-shaft type used by Eurodiesel, Hitec and Hitzinger and a compound type used by Piller. They all use kinetic energy storage in what is termed the "induction coupling" (Hitec), "kinetic energy accumulator" (Eurodiesel) and "powerbridge" (Piller).



Line-interactive single shaft DRUPS system

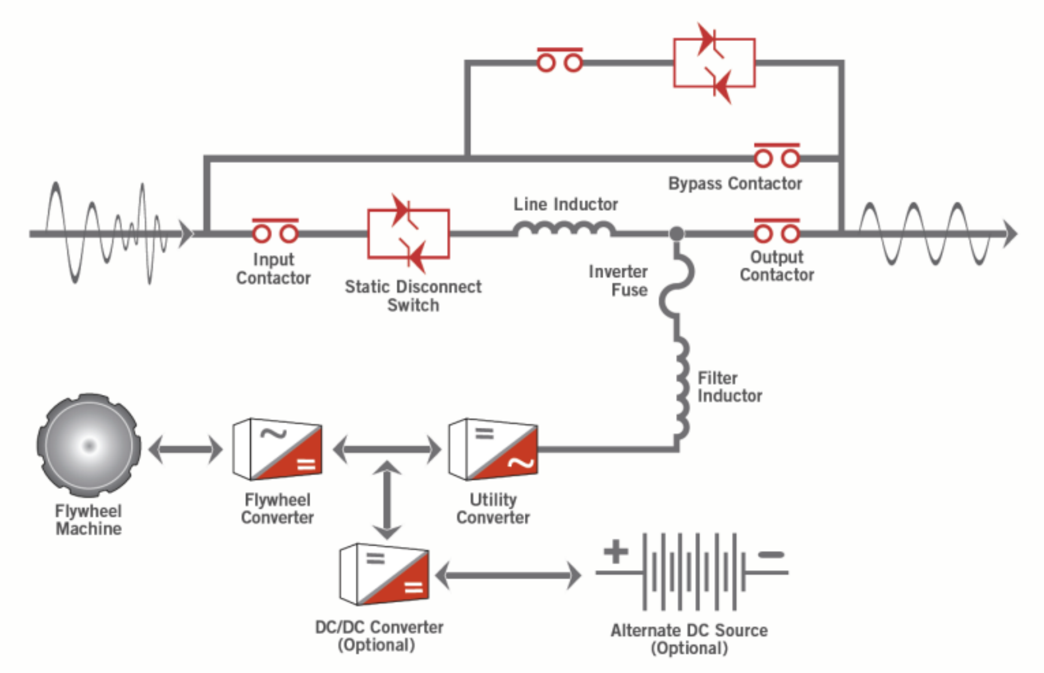
This is a part single line diagram of a typical DRUPS system. The coupling inductors function is to smooth out voltage fluctuations as the DRUPS machine goes from one operating mode to another, they also reduce the fault current levels which otherwise would be very high in paralleled systems. The input circuit breaker has to open when the Utility supply fails to prevent the DRUPS backfeeding onto the Utility system.

In Utility mode the power path is through the coupling inductors directly to the load, with a small amount of power flowing to keep the kinetic energy storage device rotating at typically 1800rpm. In this operating mode the alternator acts as a power factor corrector and harmonic current filter to the load currents, so that the Utility supply is protected from adverse effects of non-linear load currents (current "harmonics").

Upon mains failure the input circuit breaker must open immediately to prevent backfeeding onto the dead bus. The alternator now supplies the load with power, itself being driven by the energy stored in the kinetic energy storage device which slows from typically 1800rpm to 1500rpm as the diesel engine starts. The rotational speed of the alternator is controlled at 1500rpm by power electronic control of the strength of the magnetic field between the inner and outer rotors of the kinetic energy storage device. The engine is called to start upon detection of mains failure and within a few seconds the rotational speed of the engine has caught up with the kinetic energy storage device and the overrunning clutch engages. The diesel engine now drives the alternator, and the kinetic energy storage device accelerates back up to 1800rpm.

When the Utility supply returns the diesel engine/alternator synchronises with it and the input circuit breaker recloses. Power flow through this circuit breaker is controlled by the engine backing off, the engine then shuts down and the system returns to normal operating mode.

There are various types of hybrid rotary UPS systems, they generally work in line-interactive mode whether the energy storage is kinetic from flywheels or chemical from batteries.



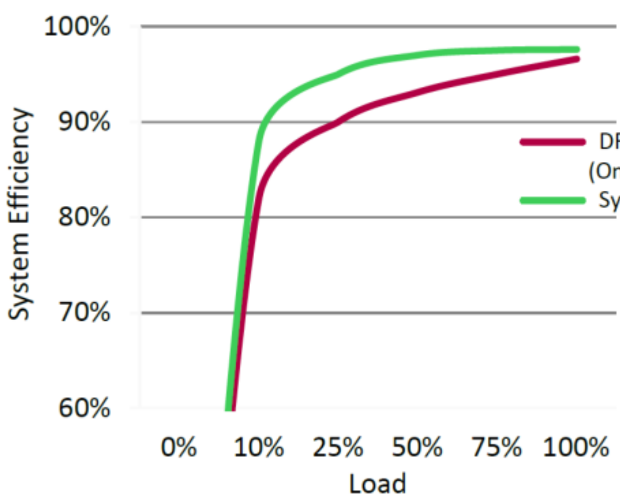
Hybrid rotary UPS system

The above is a extract from a Activepower CleanSource publication for a rotary UPS system (not actually a DRUPS as the standby generator is remote from the UPS). It is the same line-interactive configuration as a single shaft DRUPS, but it employs power electronics in the utility converter to generate the AC waveform. Like in the normal static UPS there is a static bypass to load/unload the UPS. The document neglects to mention that a standby generator and changeover is also required with this system.

Efficiency - DRUPS versus Statics

Until recently, the big advantage of DRUPS over Statics has been efficiency. DRUPS manufacturers claim efficiencies in the high 90%s, the only energy wastage is that required to keep the alternator and kinetic energy storage devices rotating. Eurodiesel claim 96% efficiency for example. There is some heat lost in the windings and some windage losses. They often ignore the losses in the coupling inductors, but these can be of a few percent of themselves as they carry the full load current.

The efficiency of a DRUPS under part load can be controlled by reducing the kinetic energy storage device speed and hence the energy storage, so that the designed ride-through time is the same at part load as it is at full load. This is of course a trade-off here between the ride-through time (measured in a few tens of seconds) and the overall efficiency.



Part Load Efficiency

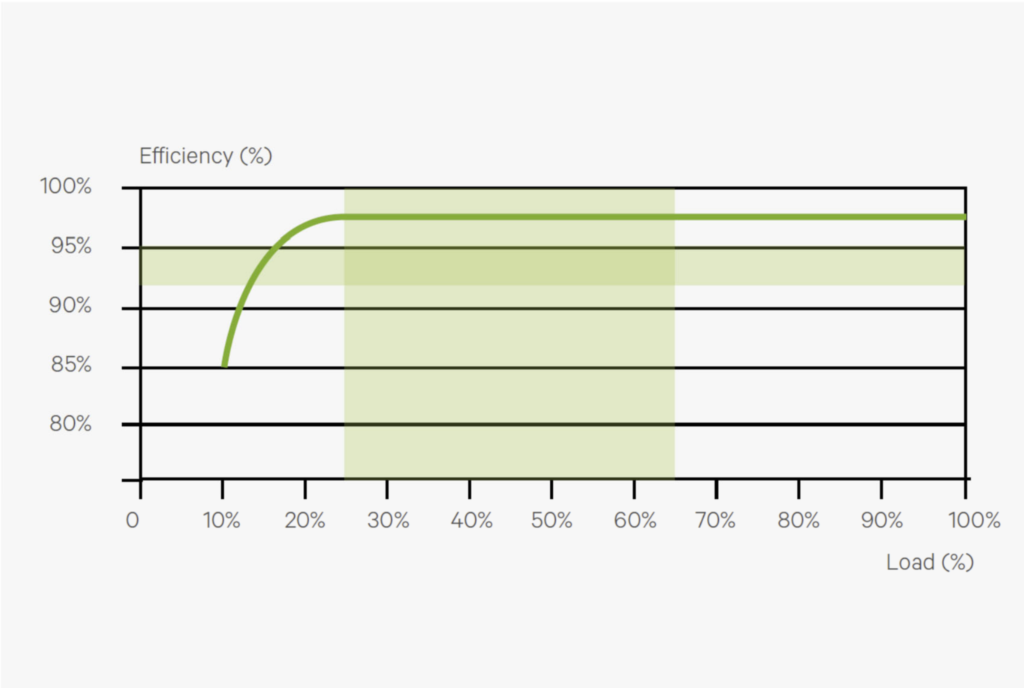
	DRUPS 2000kVA	Symmetra MW 1600kVA
0%	0.0%	0.0%
10%	82.0%	88.0%
25%	90.0%	95.0%
50%	93.1%	97.0%
75%	95.0%	97.5%
100%	96.6%	97.6%

Efficiency of a DRUPS compared to a particular type of static UPS*

*refer to the TCO section below for further discussion

There have been major improvements in efficiency of static UPS systems in recent years, at least partly driven by EU directives. Modern UPS's are described as high-frequency transformer-less designs using IGBT switching elements. Older static UPS's from the 1980's were based on thyristor switching elements, so-called 6-step switching. The inverters drove double wound output transformers and the systems suffered from poor neutral-point stability and low efficiency particularly at low loads. As UPS systems are often in 2N redundancy the maximum load is only ever 50% on one system and very often much less than that. At these loads the efficiency was a poor 75% or so.

Modern high frequency UPS system are much more efficient.



Liebert EXL AC/AC efficiency with Intelligent Paralleling feature

This is the claimed efficiency for a Liebert EXL UPS system. It is comparable to a DRUPS system, although is should be noted that the efficiency calculation excludes the standby battery recharging/ trickle charging loads (as is allowed by IEC62040-3).

Utility Failure Detection – DRUPS versus Statics

The fundamental function of any UPS system is to detect when the Utility supply fails and then to supply AC power to the critical loads. How UPS's do this depends on their configuration, whether on- line, standby topology or line-interactive. As we have said, DRUPS are normally in line-interactive configuration and it is in Utility failure detection that DRUPS are inferior to statics.

With on-line statics, as mentioned above, Utility failure detection is automatic and passive – the voltage of the DC bus just decays to a point where it is lower than the battery voltage so that power flow reverses. There is no need for active voltage detection and no switching action.

With standby statics, line-interactive statics or DRUPS, there has to be active voltage detection and switching. For a static UPS running in standby configuration, voltage waveform failure must result in turning off the static bypass thyristor drive circuit, which can be almost immediate. The same is true for the CleanSource system shown above as it also uses a static bypass.

In contrast, a DRUPS must detect the failure on the Utility supply and send an open command signal to the input circuit breaker, while at the same time ramping up the magnetic coupling on the kinetic energy storage device. This detection and switching action takes a significant time to perform, and this shows up as a voltage transient on the output waveform. For this reason, DRUPS systems do not normally claim compliance with IEC62040-3 for voltage waveform stability on changeover to diesel power.

The MTBF (Mean Time Between Failure) data for DRUPS is impressive but refers to internal failures of the DRUPS machine itself (as does the MTBF figures for statics). It does not reference the number of times the DRUPS machine correctly senses a Utility failure and supports the critical load without a break. In the real world a Utility failure is not normally a clean break like someone switching off a switch. Failures on the HV Utility supply are caused by things like diggers hitting an underground cable in cities, or trees falling across power lines in remote areas or maybe a transformer catching fire somewhere. The resulting voltage waveform is a chaotic pattern of voltage dips, recovery, overvoltage followed by a final disconnection. It is detecting this chaotic waveform that the DRUPS are poor at. Just relying on reverse power flow through the input circuit breaker is too slow, the change in speed of the alternator would be outside of the limit. Various quicker Utility failure detection methods are used but these can give rise to false trip signals and unnecessary generator starts. There has never been a satisfactory solution to this problem, nor has it ever been possible to simulate every Utility failure profile to be confident that the DRUPS system will operate correctly in all cases. In Europe the Utility supply is very stable and the DRUPS are hardly ever called upon to work for real, and therefore the manufacturers can claim all sorts of great performance figures. Elsewhere in the world that is definitely not the case, even in the US the Utility supplies are less stable and so the DRUPS performance figures look poor by comparison with statics.

Exactly the same criticism can be levelled against any line-interactive UPS system, or a static UPS running in "Eco-mode" ie through the static bypass in standby topology.

In contrast, an on-line double conversion UPS just sees a falling DC bus voltage so the whole issue of Utility failure detection is surmounted. This is the big advantage that on-line double-conversion static UPS system have over all other systems and is the reason that it is considered that maximum critical load protection is afforded by this configuration.

Power Quality – DRUPS versus Statics

In Europe the power quality standard for static UPS systems is IEC62040-3. In the USA it is the CBEMA/ITEC curve.

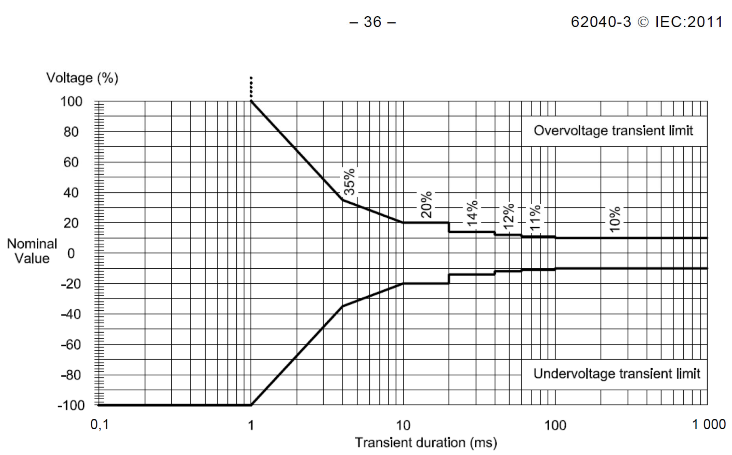


Figure 3 – Curve 2 – Dynamic output performance classification 2

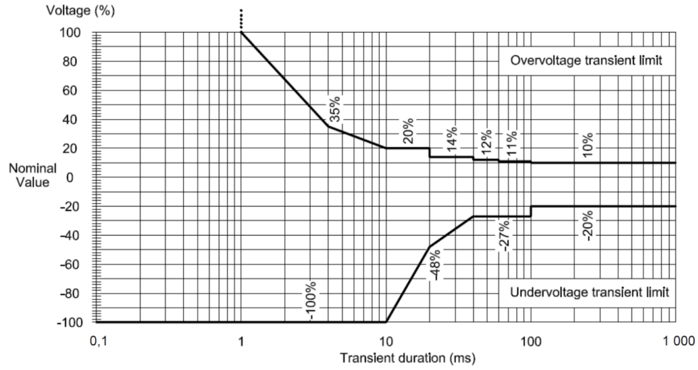


Figure 4 – Curve 3 – Dynamic output performance classification 3

In the IEC 62040-3 standard there are 3 curves, for most datacentre purposes the classification 2 curve is used. Classification 2 has an allowable break of 1mS, Classification 3 has an allowable break of 10mS.

As discussed above it is debatable whether any line-interactive single shaft DRUPS system can meet the IEC62040-3 standard for voltage waveform stability, DRUPS manufacturers do not claim compliance. The AC waveform frequency is also less stable, particularly when the overrunning clutch on the engine hits the kinetic energy storage device giving a jolt that can interfere with any static transfer switches in the system.

It is frequently claimed by static UPS manufacturers that DRUPS have higher maintenance costs. There is an element of truth in this, but a true comparison would be DRUPS versus statics plus standby generators plus changeover. Looked at this way the differences are less apparent, however historically single-shaft DRUPS did have ongoing problems with the kinetic energy storage device bearings. The basic problem turned out to be erosion of the bearing surfaces due to voltage harmonics. The solution was insulated bearing blocks as in normal alternators and better rotor shaft earthing. Although these problems have been solved for years it has negatively affected the perception of DRUPS reliability for some people in the industry.

Because the DRUPS tend to come in bigger units than statics, it is a common problem that the UPS system loses its redundancy while one DRUPS machine is in maintenance mode. Some large DRUPS systems have been designed with N+2 redundancy, so N+1 redundancy is still available with one set off line for maintenance.

The common complaint about statics are maintenance costs of the batteries, and it is true that a nominal 10yr VRLA (valve regulated lead-acid) battery installation can have some cells failing after 3- 5yrs. Wet cells are more reliable but cost more and have greater environmental impact. Modern batteries such as Lithium-ion are beginning to make an impact as their costs come down, and they offer much higher cycle lifetimes. However, real - world experience is limited for this technology in this application.

Plantroom Footprint – DRUPS versus Statics

This is one area where DRUPS have the advantage.

Figure 25: Diesel rotary UPS – area and height requirements

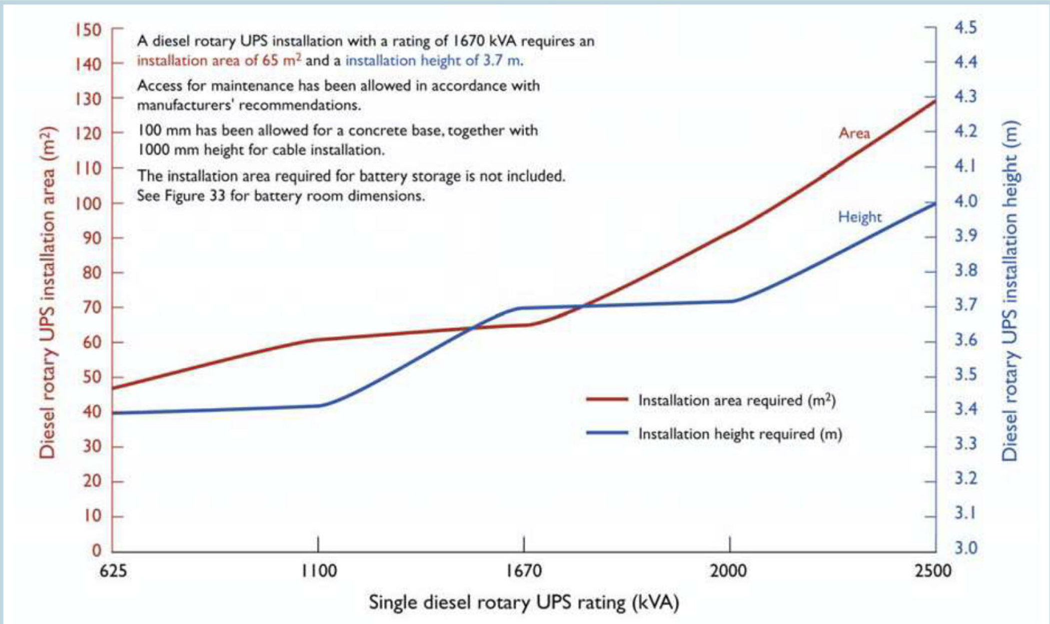


Figure 29: Static UPS – area and height requirements

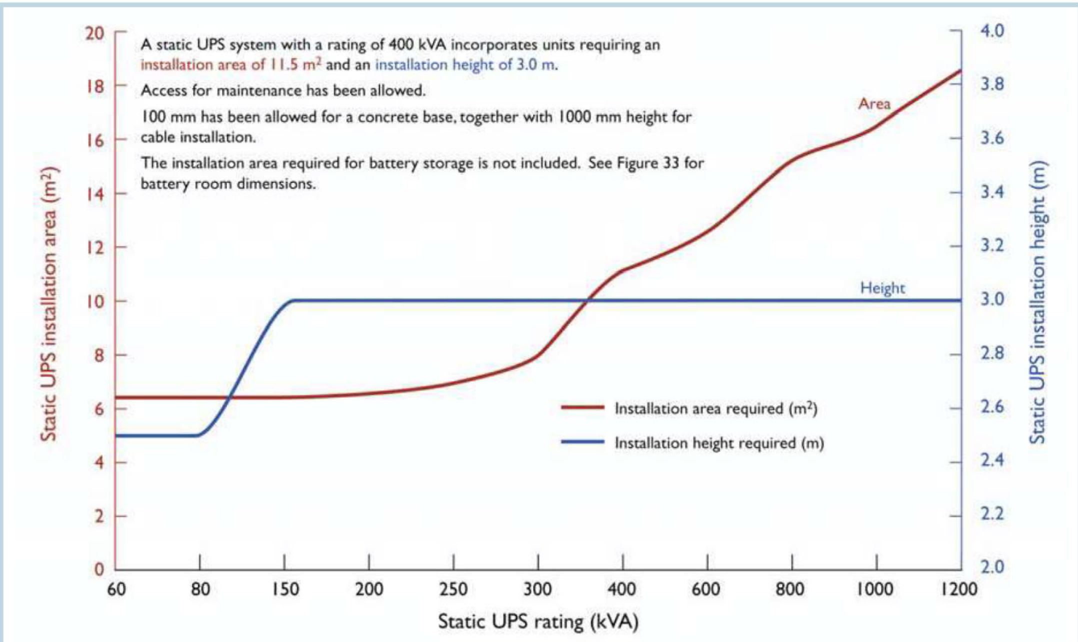


Figure 23: Diesel generators – area and height requirements

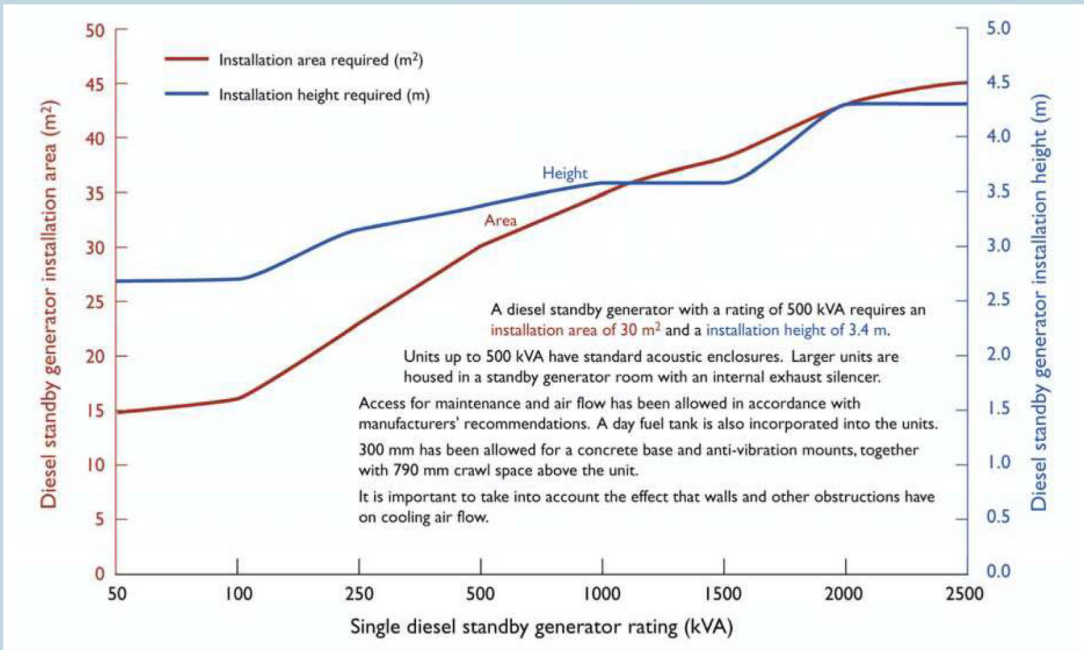
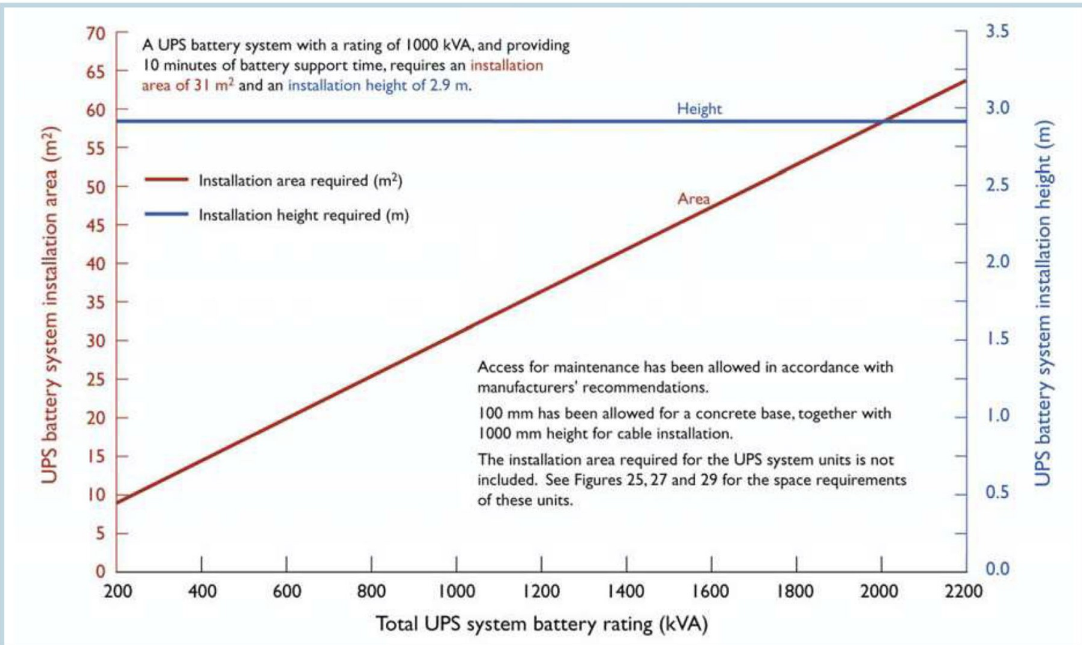


Figure 33: UPS battery rooms – area and height requirements



The above graphs are from the BSRIA "Rules of Thumb" handbook.

Technology	Size	Footprint	Total area
DRUPS	2000kVA	95m^2	95m^2
Static UPS	2 x 1000kVA	32m^2	
Batteries	2000kVA	60m^2	137m^2
Standby generator*	2000kVA	45m^2	

*external in canopies

Comparison of plantroom space requirements

These figures come from the Bsria "Rules of Thumb" handbook. They do not include electrical switchrooms. They show the plantroom footprint of DRUPS to be 69% of that of the combination of Static UPS, batteries and standby generator.

Reliability – DRUPS versus Statics

This is a contentious subject and there is no way to provide a definitive answer. Reliability modelling using the methods in IEEE Std.3006.7-2013 can provide numerical answers but the failure data particularly for DRUPS is hard to come by. The results from modelling both types of UPS system show that the system reliability is mostly dependent on internal plant redundancy, not on the inherent reliability of the components themselves. In other words, careful design can make a reliable system out of unreliable components with sufficient redundancy, and complete independence of the redundant power paths.

Reliability can be defined in many different ways, for example Mean Time Between Failures or Probability of Failure (Unreliability) at a particular point in time. From the perspective of the User it could be defined as the probability that the UPS system will successfully support the load for a given period of time, which encompasses the risks of Utility failure detection mentioned previously.

Internal failures of any UPS system can be mitigated by plant redundancy such as N+1, 2N etc. This is easier to do with statics as the module sizes are smaller, but it is perfectly possible to do it with DRUPS also. Static UPS battery cell failures can be mitigated by battery string redundancy and effective battery monitoring to identify standby failures.

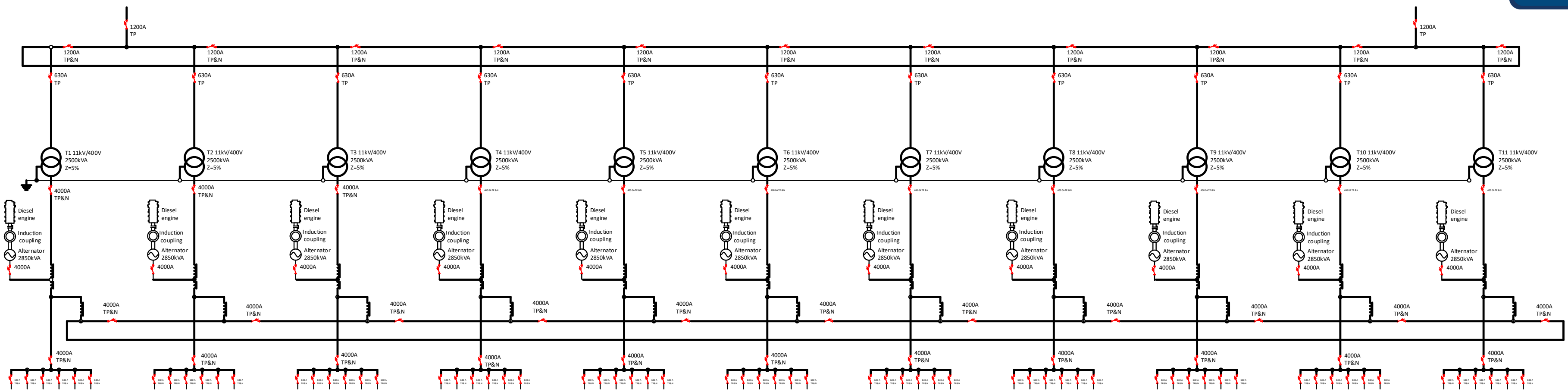
Modern lithium-ion cells used with static UPS are also gradually making an impact as their prices come down, and these offer longer lifetimes than VRLA. Real world experience of lithium-ion is limited especially as they need to be of a slightly different type than the ones commonly used in electric cars and grid-level storage.

Scalability – DRUPS versus Statics

This is where DRUPS are commonly supposed to lead statics – the DRUPS machines come in module sizes up to 2MW and can have 11kV alternators or can drive step-up transformers to provide UPS power at multi-megawatt levels by paralleling DRUPS together. There is no limit to how large these systems can get, other than engineering restrictions on fault current levels.

In contrast, static UPS units are confined to operation at 400V and the maximum power of any system is limited by the maximum size circuit breaker of 6300A, about 4MW. For this reason, modern large datacentres are tending to use distributed redundancy from UPS/generator modular blocks rather than a traditional 2N paralleled system. There is no technical limit to the size of a distributed redundant datacentre power system using this approach.

The part single line diagrams below illustrate the scalability of both DRUPS and static UPS systems.



Example of large scale DRUPS system

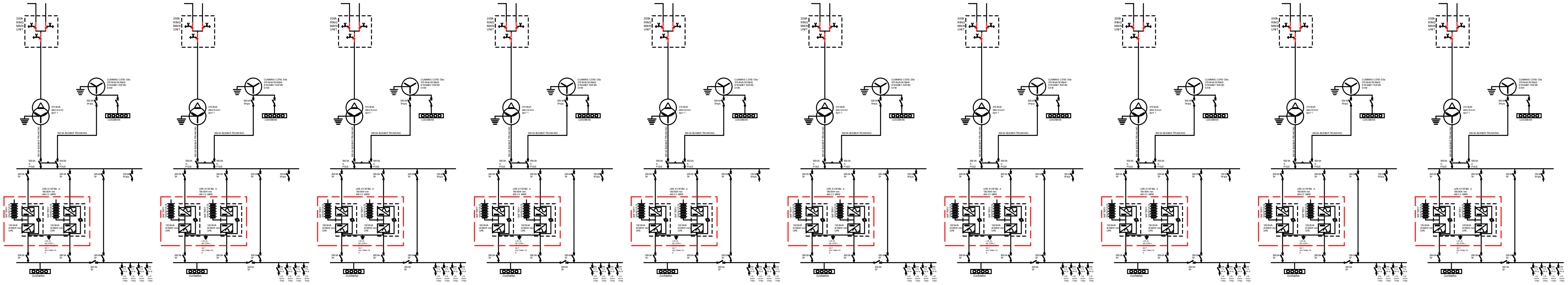
The above is a part single line diagram of an example large-scale DRUPS power system. This is at 400V, and is known as an IPBus (Independent Parallel Bus), originally developed by Piller but now offered by others. Fault currents are limited by the IP Inductors. There are 11 x 2850kVA DRUPS machines with 2000kVA rated kinetic energy storage devices, in N+1 redundancy the system could deliver 20MW of UPS power. The 2N MV utility supply is through an open ring arrangement so that either supply can be switched through to the transformers.

The major advantage of this scheme is that it provides a concurrently maintainable N+1 UPS system for very high power levels, making it more cost efficient than traditional 2N designs. However, a major disadvantage is that because of the paralleled bus a bolted short-circuit on one distribution switchboard can cause a momentary voltage waveform collapse on all switchboards until the circuit breaker clears the fault as the high fault currents flowing through the paralleled inductors causes a significant voltage drop across these inductors. Very careful engineering is required to limit these voltage transients to acceptable levels.

ABB have recently adapted this idea into their “ring-bus” architecture using static UPS, they overcome the issues of voltage waveform collapse by using their high-speed circuit breaker technology. This same technology could be used on a DRUPS IPbus system to the same effect.

Another approach would be to configure the DRUPS in to a “distributed redundant” configuration so that the machines do not run in parallel. This ensures that a bolted short circuit on one system does not affect any of the remaining systems. There would be a greater number of machines in for example a 3 out of 4 distributed redundant system, offering untilisation rates up to 75%.

DRUPS versus Static UPS Report



Example large-scale static UPS system. There are 20 x 1200kVA static UPS systems, 10 x 3MVA transformer, 10 x 3MW generators. It can deliver 20MW of IT power in distributed redundancy.

Capital Costs – DRUPS versus Statics

These are the capital costs according to Spon's, just for the main plant to give an idea of capital costs. The prices are for supply and install in the UK.

Technology	Size	Unit costs	Total
DRUPS*	2000kVA	£931,602	£931,602
Static UPS**	4 x 500kVA with 10 min batteries	£391,352	£786,149
Standby generator***	2000kVA inc. residential silencer and canopy	£356,366	
Automatic transfer switch****	3000A 4-pole	£38,431	

*Integral diesel rotary; 400V three phase input and output: no-break supply: including ventilation and acoustic attenuation, oil day tank and interconnecting pipework

**Three phase input and output: 10yr battery life in cubicle

***Packaged generator set in acoustic housing, residential silencer. Standby rated.

****Steel enclosure; solenoid operating; programmable controller; inc. commissioning and testing

These are very approximate prices but show the same differences as more detailed comparisons done in the past. Statics plus generators is generally cheaper than DRUPS, all else being equal.

Total Cost of Ownership

There have been numerous studies of TCO done over the years. Unsurprisingly, those done by DRUPS manufacturers tend to favour their products, those done by Statics manufacturers favour their products used with standby generators.

The following analysis is based on a study by Schneider comparing a "top DRUPS in market" to their product, a Symmetra MW UPS. This type of static UPS is not strictly a double-conversion but uses their own "delta-conversion" technology which is a few percentage points more efficient. The system they are analyzing is all 2N redundant, so the maximum utilisation of plant is 50%.

UPS Type	UPS load	UPS capacity	UPS loading	Part load UPS efficiency	Total UPS system loss
DRUPS-IT	3000kW	4x2000kVA (1600kW each)	47%	93%	226kW
DRUPS-cooling	1160kW	2x1670kVA (1340kW each)	43%	91%	115kW
Overall UPS system energy loss for DRUPS					341kW
Static UPS-IT	3000kW	4 x 1600kVA (1600kWeach)	47%	97%	93kW
Static UPS-cooling	353kW	2x400kVA (400kW each)	44%	96%	15kW
Overall UPS system energy loss for static UPS					108kW

Capital costs

Static UPS- including	DRUPS -including
2250kVA prime rated containerized generator	2000kVA containerized diesel rotary UPS
1600kVA prime rated containerized generator	1675kVA containerized diesel rotary UPS
Main switchboards with automatic transfer switch	Main switchboards
Main distribution boards	Main distribution boards
1600kW Symmetra MW static UPS with 5mins of battery runtime	Power distribution unit (PDU)
400kW Symmetra PX static UPS with 6mins battery	
N+1 CRAC for UPS and battery rooms	
Thermal buffer tanks 2 x 28.6m^2	
Power distribution Unit (PDU) with isolation transformer (2% losses taken into account)	

Notes on TCO calculation

Maintenance and cyclical replacement cost included for main equipment- generator, static UPS and DRUPS.

Maintenance costs includes a 5% CAGR.

For static UPS, battery replacement is every 5yrs, so there are 2 replacements calculated in the 10yr TCO analysis.

For DRUPS, 1 engine overhaul included in the 10yrs TCO.

Potential rental gains as a result of space savings is excluded.

Decommissioning and depreciation costs were not considered.

Total cost of ownership for 10yrs

UPS type	Capital expense	Maint. & cyclical replacement	Electricity cost	TCO for 10yrs
DRUPS	$8,374,978	$3,320,600	$70,306,263	$82,001,841
Static UPS	$6,047,104	$2,484,262	$67,578,380	$76,109,746

This analysis purports to show a 7% saving for Statics over a 10yr period.

This analysis cannot be taken at face value as not all of the data has been presented for validating, however it does show that the two technologies are very close in total cost of ownership. Any small change in efficiency assumption could change the conclusion, as could extending the period to 20years. This would likely favour the DRUPS as there would be another 2 sets of battery replacements and possibly UPS replacement while presumably there is no replacement for the DRUPS.

Changing the configuration from traditional 2N to a distributed redundant 3 from 4 system would also effect the figures as the higher plant utilisation pushes the systems into more efficient operating points.

Conclusions DRUPS versus Statics

It is hard for any potential Client to find independent data to be able to objectively compare the relative advantages of DRUPS versus Static UPS systems, manufacturers constantly put out advertising that is at best biased and at worse downright misleading. Manufacturers of both types routinely issue figures that flatter their own systems, but there is no doubt that the efficiency of modern high-frequency transformer-less static UPS units can compare with that of DRUPS.

It is still the case that DRUPS systems are more compact, square metres of plant space per kVA, than the equivalent static UPS plus standby generator system. If the datacentre is in a location where real estate is expensive such as the centre of a city, this consideration may still tip the balance in favour of DRUPS.

DRUPS versus Static UPS Report

In terms of cost per kVA, ignoring real estate costs, statics plus standby generators are cheaper than DRUPS. There is still an issue of lifetime costs, over a 20yr period the whole of the batteries of a static system would have to be changed perhaps 4 times, maybe tipping the balance in favour of DRUPS. Set against that is the increased cost of DRUPS maintenance, and it is quite possible over the same 20yr period the kinetic energy storage device bearing would have to be changed, cancelling out some of the possible advantage.

Power quality offered by statics is better than that of DRUPS (single shaft), however rotary UPS's of all types supply more fault current than statics which makes circuit protection design easier for the designers. For either system, careful design can result in systems that perform satisfactorily.

The crucial difference between the two systems is performance, not defined as plant reliability which depends on internal plant redundancy, but system effectiveness in protecting the critical loads from Utility power failure. The double-conversion on-line static UPS wins hands down over the line-interactive DRUPS in this crucial respect. This advantage is inherent in the configuration of the UPS with respect to the critical load rather than in the technology being used. For example, there are hybrid rotary UPS systems (Piller UBR) that can operate in on-line double conversion mode and these offer equivalent critical load protection as static UPS's, however their off-peak efficiency is poor, and their capital costs are high.

There are no limits to the scalability of either system. DRUPS systems are simpler to design for sure but there is no fundamental reason why statics cannot be scaled up to any size. There are limits on paralleling static UPS units, not on the units themselves but on the LV switchgear they are connected to. It is perfectly possible to step-up the output from a static UPS system to 11kV if the distribution to the datahalls is lengthy, and then use 11kV/0.4kV transformers in the PDU's instead of 0.4kv/0.4kV isolation transformers.

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