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Keeping the Lights on Learning – Power back up for Facilities Managers in Education

Introduction

Picture the scene – a research project that has been underway for three years with molecular biology samples that need to be kept at a certain temperature. The power goes down and the results are invalid.

Or the critical impact on students and staff if the emergency lighting fails when there is an unexpected mains power failure.

Educational establishments, whether universities, colleges or schools need high-quality power protection to keep people and premises safe. But what are the main considerations to ensure that when the power goes down, there is back up in place to stop disasters happening?

In practice, there are a lot of considerations and challenges installing and maintaining systems in an ever-changing education environment, particularly larger ones such as universities.

In this white paper, we will be looking at some key areas to ensure that compliance is adhered to and some thoughts on how best to install, update and maintain systems to suit requirements – while running power solutions safely, effectively, and efficiently.

If you have questions after reading this white paper – or that are inspired by this white paper, please get in touch.

Alex Emms
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What sorts of power back up are needed?

With many of today's universities needing to be operational 24/7, the need for resilient backup power solutions has never been greater. For example, universities often have specialist departments that require continuous power supply to preserve biological research work that can require refrigeration or heating to a particular temperature – any fluctuations or gaps in monitoring data could result in lost research and ultimately years of work.

But what happens if a power failure occurs?

Even a short power failure can be extremely damaging – invalidating an ongoing study, compromising, or in some cases a total loss of files, damaging devices and subsequently causing unexpected costs for repair or replacement.

These problems can be avoided by using an uninterruptible power supply (UPS), which protects these critical devices from major power problems, including total power failure, fluctuations, spikes and dips.

If the power goes out, an organisation also has a duty of care to keep its people – staff, students and visitors – safe. This includes ensuring suitable emergency escape lighting and providing critical power protection to support the operation of life safety applications such as emergency lifts, smoke extraction systems and electronic-access doors.

When evaluating what power level and type of back up is required, it is important to evaluate not just the load but also the space available and environment equipment may be placed in. No one wants to be responsible for a noisy standby generator starting up next to a hall full of students taking final exams!

Scenario x 1
Maintaining power for study

Accelerated by the COVID pandemic, technology has become increasingly embedded into education. Leicester University, for example, uses a ‘One iPad per student’ programme. Students bring their iPads to every class session to take notes, capture online resources, collaborate in group work sessions and use multimedia learning materials. Other universities in the UK and worldwide are implementing similar ‘1:1’ policies. This demands faster internet and Wi-Fi. The associated wireless network infrastructures require UPS power protection so that education can continue through any mains power problems. The power must be clean as well as uninterrupted, to prevent damage from surges or sags caused by, for example, problems with an air conditioning system or high-power research equipment.

Similarly, many universities conduct complex laboratory experiments, either for teaching or research purposes. These may need to run unattended for extended periods; power interruptions can destroy samples, data or even the equipment itself.

Scenario x 2
Emergency lighting systems

With large populations, power problems can threaten public safety. As well as multiple educational and administrative systems, a power outage could take out campus lights, phones, computers, and even electrically controlled door locks. Such results can create panic or disorder incidents.

An educational campus is a diverse environment with many emergency lighting system demands. Safe evacuation provision is essential, especially as sports facilities, gymnasium equipment, science laboratories, industrial-level machine shops, commercial kitchens, licensed student union bars and similar facilities fall under the category of “defined locations” in emergency lighting legislation.

Considerations for choosing a UPS

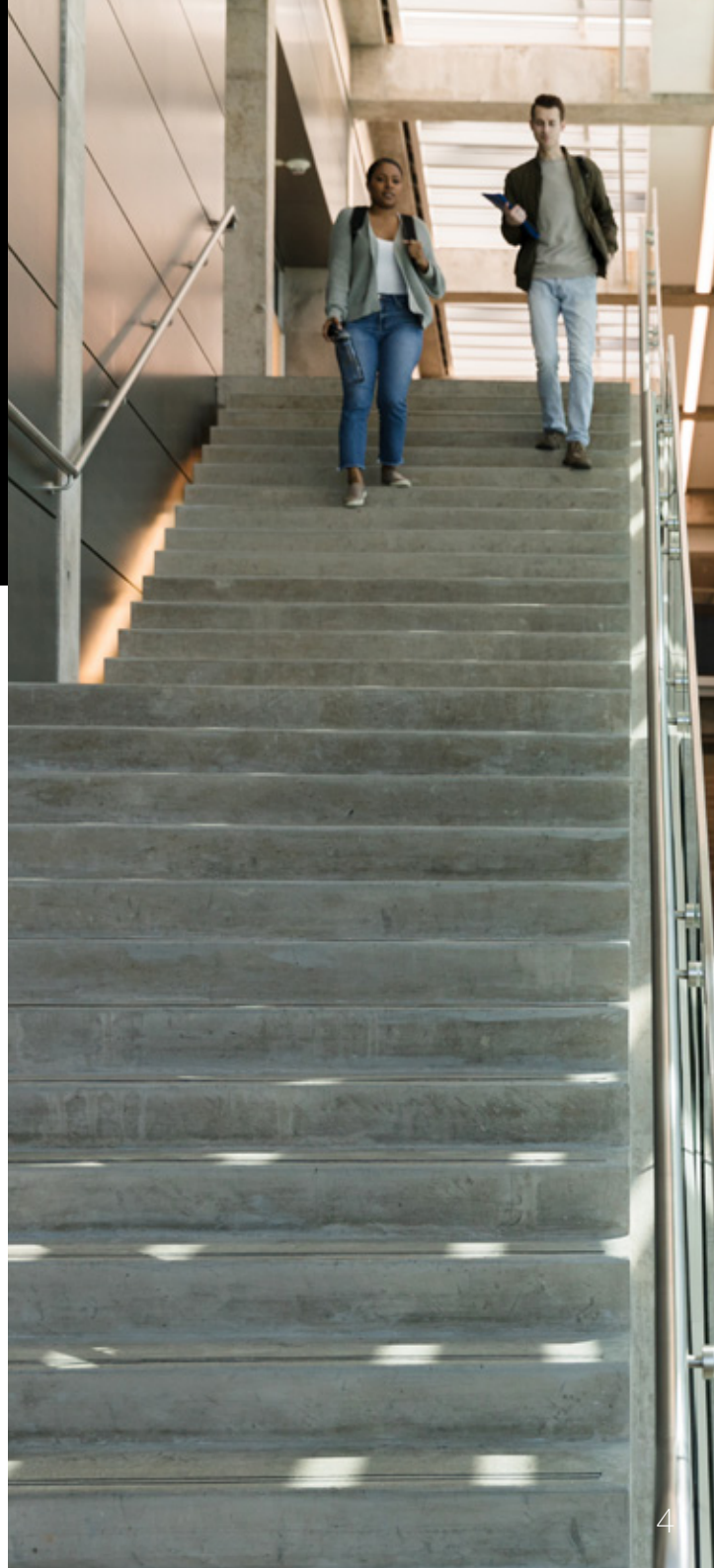
Universities and colleges typically require a range of UPS solutions, ranging from a small single-phase UPS to protect critical laboratory equipment or a building access control system, through regen-compatible emergency lift UPS systems and modular high availability UPS for critical servers, right up to a multi-MW three-phase UPS and generator installation to support a supercomputer and life safety systems.

UPS power solutions and stand by generators

A UPS system and back-up generator complement one another perfectly in an education environment. If there is a mains power failure, a true online UPS system continues to deliver the seamless uninterrupted power essential for much ICT equipment. However, the UPS battery autonomy, however large, is always vulnerable to prolonged blackouts and therefore a standby generator can help to support the load for a longer period of time. Conversely, a standby generator cannot start quickly enough to avoid a power interruption intolerable to ICT loads, but once running, can continue indefinitely with sufficient fuel, meaning that the UPS can take the load initially without any disruption to emergency power kicking in.

Maximum possible reliability and availability are essential to any UPS solution. Competitive purchase pricing must be complemented by energy efficient operation - both to control costs and to minimise the site's carbon footprint. A compact, energy-efficient UPS system that integrates easily with standby generators and is supported by reliable, low-hassle maintenance and monitoring are essential requirements to today's educational estate managers. Many university faculties in particular are housed in buildings that are hundreds of years old or otherwise have limited space for power protection equipment. Adding to that, operations on campus are always evolving, with loads increasing or decreasing in step. Therefore, flexibility and scalability in power protection systems is essential, allowing them to flex with evolving campus requirements.

Modern, modular UPS systems offer the attributes essential to resolving these issues. And once established, we recommend the system is reviewed annually to ensure critical power backup is maintained as site design changes are implemented – this could be a new IT relocation of equipment or a new building.



Back-up Generators and Lighting

Back-up generator requirements for education

Any chosen standby generator must accept an Automatic Mains Failure (AMF) detection signal alerting it to start up. It must also start quickly and reliably on demand and once running, supply an AC waveform stable in both amplitude and frequency. Additional requirements in educational settings will include noise emissions, on top of environmental emissions considerations. Noise abatement and exhaust gas treatment systems can add significantly to the footprint of a generator, so it is worth considering inherently lower noise models and those with better fundamental combustion control.

Choice of fuel can be another important element when looking at environmental impact – today, many modern generators can run on sustainable fuels. The front-runner of these is HVO, Hydro-treated Vegetable Oil. Unlike hydrogen, which is still mainly produced from fossil fuels, or traditional biodiesel, which has a short shelf life before the risks of clogging can affect standby use, HVO can be produced from a variety of sustainable sources and its stability is substantially longer than that of traditional diesel.

It is important to check however that a generator is certified by the manufacturer for use with HVO, as not all are.

Generator reliability comes from careful generator maintenance, adequate fuel supply for the engine and a healthy starting battery. Generators may also benefit from a heating jacket. Voltage amplitude is set by the alternator windings, and stability is controlled by an Automatic Voltage Regulator (AVR). Frequency stability, which is essential for uninterruptible power supply synchronisation, is best managed by electronic engine governors, which are superior to mechanical types.

Emergency Lighting

Educational environments are complex and require emergency lighting that operates reliably when called upon and provides sufficient illumination along all escape routes. This can make the difference between safe evacuation and panic, injury or possibly even death. Emergency lighting is an essential part of any building services installation.

Fully compliant equipment is required throughout an educational environment and regular risk assessments should be carried out so needs and solutions are kept up to date.

Emergency lighting, by definition, depends on a continuously charged battery backup power source. The lighting can detect a mains power failure and switch to battery backup automatically and immediately. Escape and safety lighting can be powered by central battery inverter units or decentralised local batteries, though the challenges of traceably testing and maintaining the latter frequently outweigh their lower initial installation costs.

As well as being well-designed, well-maintained and always fully charged, the battery power source must be highly reliable.

| *Sustainably* sustaining power

Maintaining critical power and watching your carbon footprint

Ever-increasing political and economic pressures to operate green, sustainable policies are compelling universities and other educational establishments to pursue all possible avenues for improving energy efficiency and reducing environmental footprint. Earlier, we highlighted the ability to dramatically reduce impact by selecting HVO instead of regular diesel for standby generators. We should recognise though that these generators will only run during irregular events. In contrast, power is continually flowing through UPS systems, supporting the IT and data processing facilities that are often some of the largest energy users on an estate. This means that devoting effort to improving the energy efficiency of UPS systems can contribute significantly to achieving not just financial benefits but also sustainability policy aims.

What does this mean for critical energy considerations?

For sustainable uninterruptible power supply (UPS) systems, there are three key considerations for energy innovations in technology and processes.

These are:

1. Reducing power loss - by choosing a high efficiency UPS
2. Size to actual load – by taking advantage of the correct load and smart running modes
3. Battery technologies – taking a wider view including management and recycling

For many years, the efficiency of a UPS has been gradually improving but it has been overshadowed by focus on mechanical cooling systems for IT and data processing facilities. Now by taking all three of these points into consideration, facilities managers and systems engineers in education can improve their energy efficiency – with immediate effect.

Making sense of modes

UPS Operating Modes

UPS systems can offer different types of protection. These concern the level of power conditioning (ie how much independence from variations in mains frequency or voltage variations is provided), when the system switches to battery power and when it does, how quickly that occurs.

As shown in the diagram below, the most basic form of protection is “VFD” mode, where equipment is unprotected from variations in voltage or frequency and there is a short break in power as the system switches to battery in the event of a mains failure.

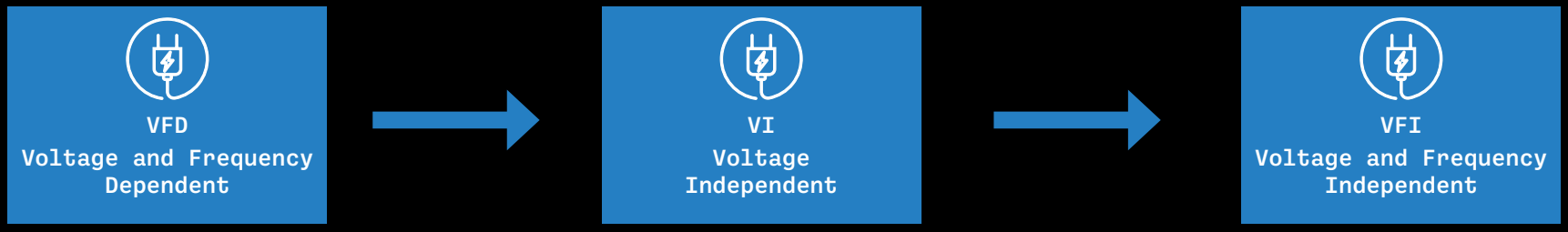
On the other end of the scale is “VFI” mode, where a UPS is continuously online and its technology is designed to avoid breaks in power that might affect critical loads.

UPS systems that are able to provide continuous VFI protection can often be set to operate in a lower protection mode to save power. Usually called “Eco mode”, this is equivalent to VFD operation. Better headline efficiency figures result, but protection is reduced and so in practice it is rarely used except where the mains supply is very stable and the load will not be affected by a break in power.

Fortunately however, advances in technology and the growth of modular UPS systems mean new “smart” modes of operation are available that genuinely reduce energy use without compromising protection. These intelligently manage the load across the UPS modules so that each is operating as close as possible to its most efficient loading point and those that are not needed are put into active standby, while still respecting required redundancy levels.

Known as Xtra VFI Mode, Kohler’s smart mode is a great option for those who require VFI level protection but have variable loads. By managing the load, Xtra VFI avoids the normal decline in efficiency when load falls below 25%, delivering 2-3% additional efficiency and, by intelligently rotating active modules, equalises ageing to extend service life.

Reducing environmental impact, optimising Power Usage Effectiveness (PUE) and delivering significant financial savings through reduced energy and cooling costs, Kohler Xtra VFI is available on several KUP UPS systems including the 50-300 kW PW 9250DPA, 100-3000 kW PW 9500 DPA and new 750-6000 kW MF Series.



The move to modular

How UPS format can affect UPS size

Traditionally, UPS design involved a large individual, or 'standalone' system, which had to cover all the capacity required. Therefore, the whole system was always powered, and frequently would not be operating in its most efficient load band. If redundancy was required, a complete additional system would be needed, further increasing the risk of sub-optimal loading.

Nowadays, UPS designs exist where a single cabinet or frame contains several UPS modules that work together to support the overall load. As discussed earlier, smart modes allow these modular systems to more efficiently protect variable loads. In addition modular design also brings easy scaleability and a highly cost effective way to deliver required redundancy.

Rather than having to install a UPS system sized to the maximum eventual load at the start, modular systems allow 'right-sizing' for whatever the load is at a particular time. Often a frame and cabling to support the eventual maximum load is installed initially, but not all module slots will be populated. As load grows further modules can be added, whilst if it contracts modules can be put into standby to retain efficiency.

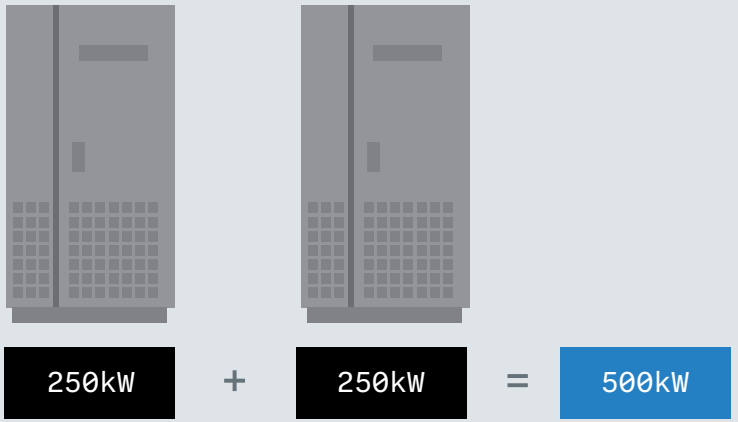
It is wise though to consider anticipated load steps and work to match these with module sizes. Each module will require routine maintenance for instance, so reducing their number reduces ownership costs, but making each too large limits the load steps available.

For instance, a 100kW ultimate load system would usually comprise 10 or 20kW modules whilst a 1.5MW ultimate load system would utilise 250kW modules. To support loads above 1MW, often several modular UPS frames will operate together as one system.

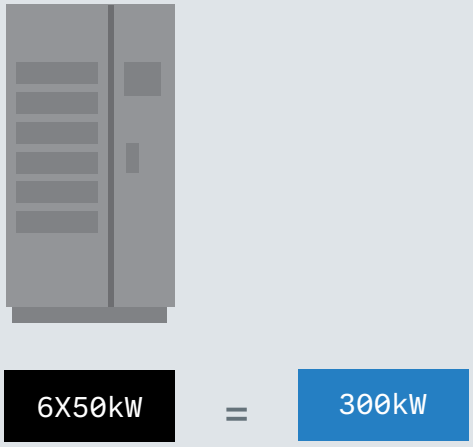
Particularly for N+1 redundancy, modular design can also dramatically reduce overall system size. As shown in the adjoining illustration, delivering N+1 redundancy with 250kW standalone systems requires purchase of 500 kW of UPS capacity. In contrast, only 300 kW of capacity must be bought (and powered and maintained) if using a modular system of 50 kW modules.

SIZING A 250kW (N+1) UPS SYSTEM

TRADITIONAL MONOLITHIC/STANDALONE



MODULAR DESIGN



Considerations for choosing a UPS

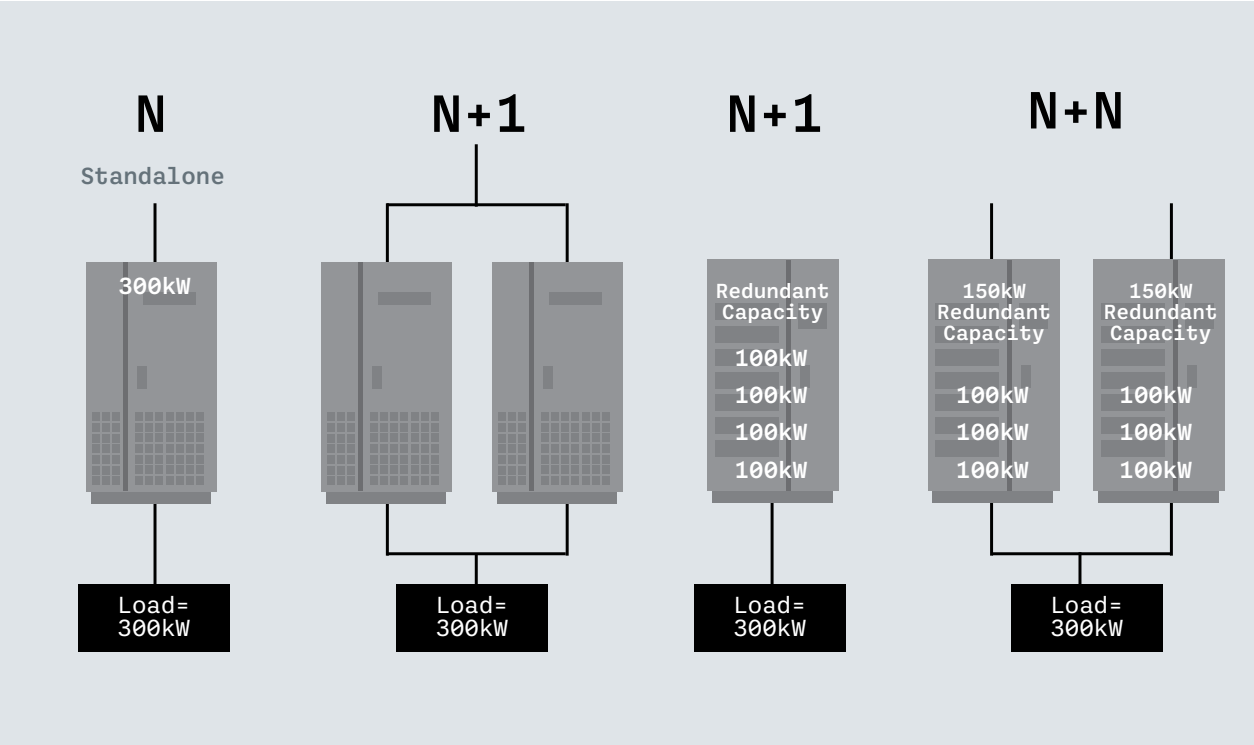
Managing the load

Today, we manage by the load by understanding what level of power would be needed and we size to cover redundancy. To a certain extent, this also enables us to future proof the system, building in future capacity for a change in circumstances.

For instance, if we knew we needed 300kW of power, today, we can make up that system with 6 modular UPS of 50kW, rather than 2 larger ones of 250kW to cover the critical power needed. The modular system offers a 40% reduction in UPS size and the power doesn't all need to be on all the time.

Building in redundancy to the UPS

Where centralised UPS are used, it is recommended to have redundancy to allow for the load to be protected during maintenance or equipment failure.



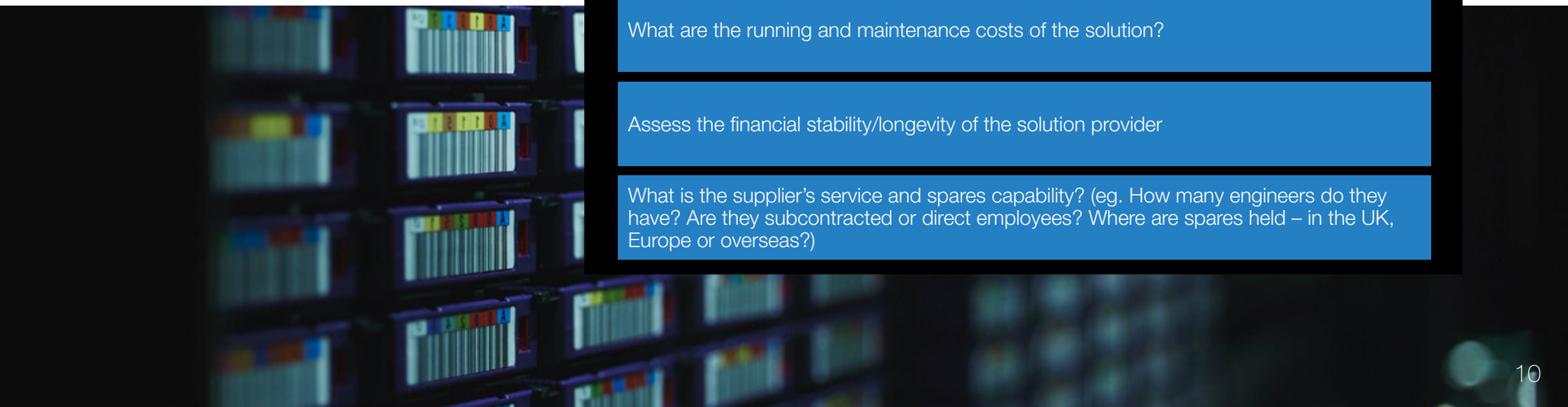
Questions to ask your supplier

Facility managers and system engineers in education need to be informed to ensure the choices they make are right for ensuring critical power back up – for today and with future ongoing demands.

This means collaborating with suppliers and consultants who understand current and future challenges and who can make this decision-making process much simpler. In-depth knowledge, extensive experience as well as a comprehensive choice of solutions that will fit the educational centre's specific needs should be considered. And this level of expertise must be continued throughout the life of the protected power installation, to meet the challenges of providing timely UPS maintenance and adapting to evolving site requirements.

If you are looking to update your UPS system, here are some considerations to ask your supplier.

- What is the basis of your supplier's claims? Are they proven-in-field? Factory tested? Or extrapolated from technical research?
- What is the availability and historical on-time delivery performance?
- Can your supplier offer a complete system – UPS, battery, emergency lighting, generators and training?
- What are the running and maintenance costs of the solution?
- Assess the financial stability/longevity of the solution provider
- What is the supplier's service and spares capability? (eg. How many engineers do they have? Are they subcontracted or direct employees? Where are spares held – in the UK, Europe or overseas?)



Conclusion

University campuses have large and complex power infrastructure requirements for critical power, emergency lighting and for their population of students, staff and visitors. They also often have sustainability policies that focus on energy and power being reduced.

As a complex set up, an educational facility requires ongoing risk assessments, and review of equipment – across all its power requirements. Due to the complexity of the different environments and changing needs, collaboration is key to ensure both business continuity and people safety. You need to work with a power protection company that is experienced and competent to deliver comprehensive commercial power solutions comprising UPS power supply, back-up generators and emergency lighting to meet guideline requirements.

Training

Continuing Professional Development

Kohler Uninterruptible Power offers free technical seminars for consultants and electrical engineers. These keep you up to date with the latest technology available, power protection specification and selection requirements. The content of the seminars has been independently certified as conforming to CPD guidelines by the Chartered Institute of Building Services Engineers (CIBSE).

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Backed by Kohler Co.'s 100+ years of power protection experience and innovation, Kohler Uninterruptible Power is well resourced and well positioned to provide the necessary depth of advice and support. It provides expertise, remote support facilities and an extensive network of field service engineers offering fast 24/7 availability.

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