WHITEPAPER

Ensuring optimal total cost of ownership in critical applications

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Introduction

In critical power infrastructure, where reliability is the cornerstone of maintaining essential services operations, power protection and conditioning are crucial. Power disruptions or low-quality power can result in costly downtime, compromised data integrity, damaged equipment and even risks to human safety.

This criticality is particularly evident in healthcare, where patients require medical equipment demanding uninterrupted power. Additionally, in sectors such as food and beverage, water utilities, mining and Oil & Gas, low-quality or disrupted power can jeopardise operations and potentially harm individuals and communities.

However, the pursuit of resilient critical power systems presents a multifaceted challenge. Inefficient power systems can result in the waste of resources, leading to higher costs, customer dissatisfaction, reduced competitiveness and a greater environmental impact. In the contemporary business and industrial environment, rising energy prices are a significant concern. Moreover, an eco-friendly approach to power consumption is imperative for organisations seeking to align with sustainability goals and meet the growing expectations of environmentally conscious stakeholders. Balancing reliability, efficiency and environmental impact requires the implementation of strategies that can optimise use of resources without compromising performance.

At the heart of this challenge is Total Cost of Ownership (TCO), the calculation and assessment of all direct and indirect costs associated with acquiring, operating and maintaining an asset over its entire lifecycle. TCO takes into account not only the initial purchase price, but also ongoing expenses such as maintenance, losses due to downtime, monitoring and even environmental costs. This approach provides a more accurate and holistic view of the true cost of an investment, helping organisations make informed decisions based on the complete financial and environmental impact.

This whitepaper will explore the intricacies of achieving optimal TCO in critical power infrastructure, and examine the strategies that organisations can employ to meet operational needs while reducing costs and minimising environmental impact.

Understanding Total Cost of Ownership

In critical power infrastructure, TCO analysis involves an assessment of expenses linked to the entire lifecycle of power-related systems and equipment. This includes the initial cost of purchase and any additional equipment required, installation and ongoing maintenance, energy consumption, financial impacts stemming from downtime and loss of productivity, potential replacement or upgrade costs, environmental considerations, and the strategies in place for risk management.

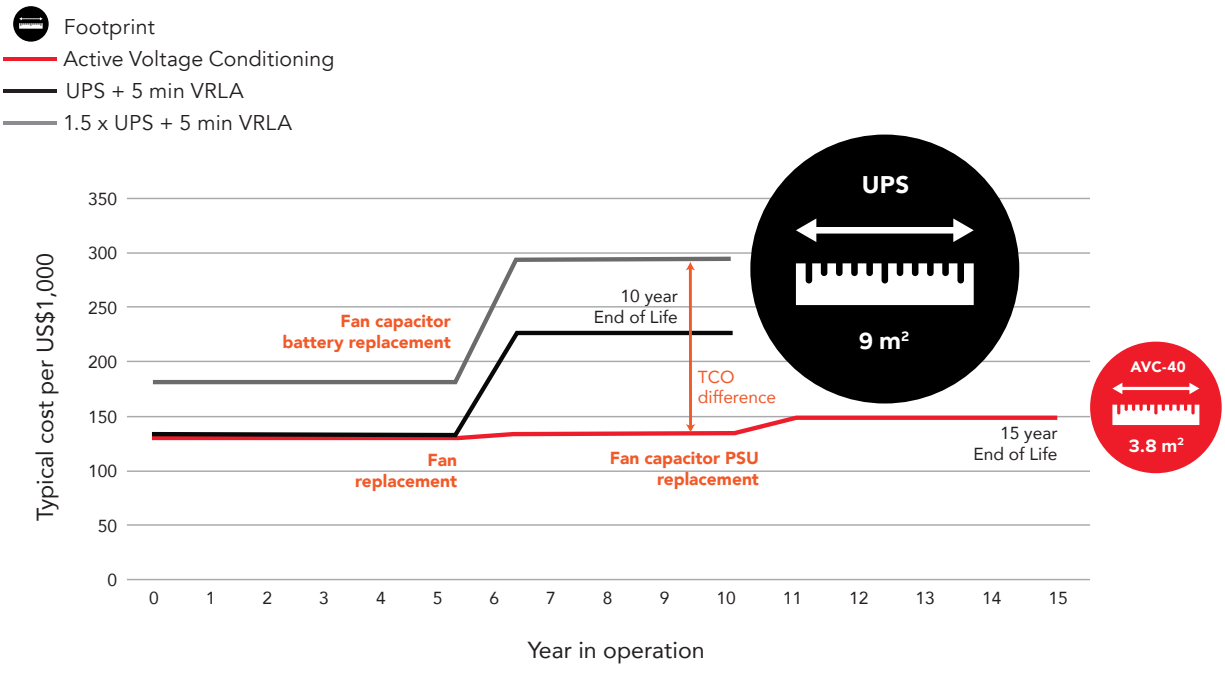
When assessing TCO, organisations must consider the unique operational requirements within their industry including power demands, regulations, environmental considerations and level of sensitivity to downtime.

Power protection and conditioning equipment can proactively maximise efficiencies, optimise energy consumption and prevent disruptions. By choosing industry-compatible solutions, organisations can ensure a longer equipment lifespan, fewer maintenance requirements and enhanced reliability.

As an industry leader in power protection and conditioning, ABB offers a wide range of solutions designed to cater to a diverse range of applications. From advanced uninterruptible power supply (UPS) systems that guarantee non-stop power, to power conditioning systems (PCS) that maintain stable voltage levels, ABB's offerings support organisations to improve reliability and achieve long-term value.

The following graph provides a visual representation of cost savings achievable through the utilisation of different power protection solutions.

Comparing lifetime costs of power protection technology



Bolstering resilience while reducing TCO and environmental impact

In an interconnected world that's dependent on technology and constant access to information, resilient critical power infrastructure forms the backbone of essential services and operations. Data centres are just one example of critical infrastructure that requires uninterrupted operation to ensure the integrity, availability and security of data and services.

The quantity of data generated globally continues to grow exponentially, requiring more physical memory locations and more electrical infrastructure capable of supplying continuous conditioned power. Whether it's telecommunications data centres, enterprise solutions, co-locations or cloud/business service providers, these data centres and operators demand systems that can run 24/7. Downtime and load-drops threaten the safety of data transactions, storage and recovery.

The role of data centres in telecommunications is a prime example of the importance of resilient power systems. Data centres provide the necessary infrastructure to connect people across vast distances and facilitate instant communication, data sharing and collaboration. Without dependable power, networks may face disruption, impeding the dissemination of information and hindering emergency services. By enhancing resiliency, operators can increase a power structure's failure-prevention capabilities and its ability to keep running despite faulty equipment or software.

Unlocking energy efficiency

The growth of data centres to meet the demands of modern life has led to a greater emphasis on energy efficiency. Achieving higher energy efficiency can reduce losses and greatly improve the operational costs associated with cooling systems. If a product is running nonstop for 15 or 20 years, any improvement in energy efficiency is going to result in significant savings.

Energy efficiency is also a critical component of environmental responsibility. Increased energy consumption contributes to higher carbon emissions and strains power grids. By integrating resilience with environmental responsibility, organisations can take a balanced approach whilst reducing Total Cost of Ownership. Every percentage point of energy saved represents significant cost savings and reduction in carbon emissions.

As a power solutions provider, ABB aims to drive sustainable development. Through its EcoSolutions product label, the company offers transparent, independent information on the environmental performance of its technologies across the entire life cycle. Products within this portfolio comply with a minimum set of key performance indicators defined in ABB's circularity framework, as well as having an environmental product declaration or independently verified product life cycle assessment. This supports organisations to prioritise solutions that emphasise energy efficiency, emissions reduction and sustainable practices. The following sections will take a closer look at offerings within ABB's EcoSolutions portfolio that align with these objectives.

Mitigating upstream disturbances for smooth operational flow

Critical facilities such as data centres and hospitals provide vital services that cannot afford interruptions. In hospitals, uninterrupted power is indispensable for the operation of life-saving medical equipment and procedures, as well as the integrity of electronic medical records systems.

The ability to manage and control power supply can support these facilities to maintain uninterrupted operations and ultimately improve resilience. A power protection and distribution approach at the medium-voltage (MV) level provides the perfect solution.

Medium-voltage UPS

ABB's HiPerGuard MV UPS – based on impedance (Z) isolated static converter (ZISC) architecture – is engineered to offer significant advantages in reducing Total Cost of Ownership while ensuring reliable multi-megawatt power protection.

The UPS's high-performance inverters – designed using ABB proprietary power electronics technology – combine with the ZISC architecture to ensure that the output voltage is regulated no matter what input supply disturbances are present.

In Australia, the HiPerGuard MV UPS is designed to be versatile, capable of operating across three medium voltages: 6.6 kV, 11 kV and 22 kV.

This unit provides continuously regulated, filtered power, reducing the risk of voltage spikes or sags, which can lead to equipment damage or downtime.

To maximise scalability, the HiPerGuard MV UPS system is built using UPS blocks, each with a rated power of 2.5MVA. Up to ten of these blocks can be paralleled in a so-called hard-parallel configuration to give 25MVA. The hard-parallel configuration allows fast deployment of additional units, increasing the overall system capacity without additional complexity. This scalability prevents the over-provisioning of power protection capacity, minimising upfront expenditures and reducing TCO.

The HiPerGuard MV UPS is designed to meet the typical requirements of a large data centre. It offers maximum availability that is driven by a robust MV design approach that delivers high power levels from single blocks, a lower switchgear count and a modular design that allows the loss of up to two converters without automatic transfer to bypass mode.

Other internal redundancies for fans and switched-mode power supplies further increase system availability. For large parallel configurations, if the system designer includes a redundant unit in the system, unit maintenance is possible while keeping the system online and the load fully protected, thus further increasing system availability. The HiPerGuard MV UPS's flexibility allows it to accommodate several common data centre architectures.

In accordance with IEC62040-3 class 1, the HiPerGuard MV UPS delivers a clean output voltage and can also supply high fault currents for downstream protection and fault clearing of up to five times nominal current.

This UPS has a class-leading efficiency of 98 per cent for the load spectrum from 50 per cent up to full rated load and better than 96 per cent for 25 to 50 per cent load. Low no-load losses and modular design ensure a near-flat efficiency curve, allowing maximum foreseen capacity to be installed on day one, whilst minimising energy wastage if the initial loading is low.

With the power protection at the MV level, facility build and operation costs are reduced as currents and electrical losses are lower at this higher voltage resulting in cables with decreased cross sectional area can be utilised.

An MV UPS can be placed on less expensive real estate – for example, in an electrical room or substation – distant from the loads. Furthermore, because MV requires less infrastructure, reliability is inherently improved.

Click to learn more about HiPerGuard MV UPS

A greener solution for the maritime industry

Critical power and power stability is vital across a diverse range of industries beyond data centres. The maritime industry faces unique challenges due to operations in various regions with different power grid frequencies. Additionally, shipping is a significant source of greenhouse gas and pollutants, accounting for approximately 2.6 per cent of total global greenhouse gas emissions[1].

Cleaner, more efficient power conversion solutions, such as ABB's SureWave Static Frequency Converter (SFC) technology, can support ships to connect to local power grids, reducing the need for diesel generators and less efficient rotary systems while docked. This leads to lower emissions and contributes to environmental sustainability.

Efficient power conversion

ABB's SureWave SFC features a modular design, offering reduced downtime and ensuring operations remain uninterrupted, ultimately contributing to lower maintenance costs and optimal Total Cost of Ownership.

This unit allows the connection of 60 Hz powered equipment to a 50 Hz supply network and 50 Hz powered equipment to a 60 Hz supply network. Additionally, the SureWave SFC is often utilised as an industrial grade power conditioner for stabilising the frequency and the voltage to allow the correct operation of sensitive equipment when the supply is not sufficiently regulated.

With a 15-year design life, the SureWave SFC offers the potential for substantial operational cost savings, supporting optimal TCO. Ship owners and operators can reduce CO_2 emissions by approximately 350 tonnes compared to traditional rotary systems, and realise operational cost savings of around $US1.4 million over the same period[2]. These savings, combined with the reduction in environmental impact, make SureWave SFC a compelling choice for enhancing both resilience and sustainability in maritime operations.

In addition to its environmental benefits, SureWave SFC provides enhanced flexibility and stability. Its modular design allows for higher power capacity, ranging from 250 kVA up to 2.25 MVA. The smart controller enables parallel connections with other voltage sources, supporting higher loads of 10 MVA and greater through multiple system parallel connections. This flexibility ensures seamless power conversion in diverse maritime settings, from small to medium port- and shipyard installations to vessels of varying sizes, from super yachts to supertankers.

Click to learn more about SureWave SFC

1. https://www.itf-oecd.org/sites/default/files/docs/reducing-shipping-greenhouse-gas-emissions.pdf
2. https://new.abb.com/news/detail/87376/from-super-yachts-to-super-tankers-surewave-offers-clean-power-in-port

Driving efficiency through decentralised technology

The proliferation of data, coupled with the rise of artificial intelligence, streaming, gaming and autonomous vehicles will continue to drive an increasing demand for data centres. These facilities must be able to expand efficiently to accommodate growing volumes of information and the requirements of new technologies. In order to build scalable and resilient power infrastructure that achieves optimal Total Cost of Ownership, it's essential to question existing ideas surrounding critical equipment specification.

In the past, redundancy was traditionally achieved by paralleling two UPS systems. Then there was a shift towards centralised modular systems, which offers flexibility, scalability and a degree of redundancy. However, there can still be single points of failure within these modular systems if critical components fail.

When it comes to UPS systems, decentralised parallel architecture (DPA) offers increased redundancy, scalability and the ability to distribute the load evenly. It enables maintenance to be performed without having to schedule outages, leading to reduced downtime and increased efficiency.

Decentralised parallel architecture

ABB's Decentralised Parallel Architecture (DPA™) is an innovative approach to uninterruptible power supply (UPS) design that enhances reliability and fault tolerance by modularising the UPS system. In DPA, the UPS system is divided into autonomous modules, each equipped with all the necessary hardware and software components for independent operation. Each UPS module has its own independent static bypass, rectifier, inverter, logic control, control panel, battery charger and batteries. With all the critical components duplicated and distributed between individual units, potential single points of failure are eliminated.

The MegaFlex DPA is a modular UPS designed specifically for critical high-density computing environments across private and public enterprise, as well as data centres for colocation, hosting cloud and telecommunications.

Its accompanying ABB support infrastructure – such as intelligent switchgear, smart sensors, cloud-based predictive maintenance and enterprise and site-specific monitoring – deliver the high level of system-wide resilience essential to the global data centre industry.

As a data centre's power requirements can fluctuate dramatically, a high level of adaptability is required to effectively manage different usage levels. Traditional UPS systems can fare poorly when the load is less than 25 per cent of full system capacity.

The MegaFlex DPA UPS Xtra VFI operating mode is a smart way to minimise losses and improve efficiency when running in the default double conversion mode. When Xtra VFI mode is enabled, it automatically adjusts the number of active modules according to the power load requirement. Modules that are not needed revert to standby, ready to reactivate if the load increases. The switching regime can be set by the user to increase reliability, extend service life and equalise ageing. To achieve this, the system rotates modules between active and standby mode at fixed intervals. Should there be a mains failure or other abnormal situation, all modules can revert to active mode within milliseconds.

The MegaFlex solution presents a comprehensive approach to optimising Total Cost of Ownership, coupled with a commitment to environmental sustainability. Key features include:

- Extended design life: with a design life of 15 years, the MegaFlex offers a durable and long-lasting power infrastructure solution
- Impressive efficiency: achieving efficiencies of up to 97.4 per cent at the system level, the MegaFlex minimises energy wastage and promotes cost-effective operation
- Reduced power losses: this solution boasts power losses that are 30 per cent lower than traditional alternatives, resulting in enhanced energy conservation
- CO_2 emissions reduction: over the lifetime of the product, the MegaFlex contributes to a substantial reduction of 641 tons of CO_2 emissions, showcasing its environmentally conscious design
- Maximised power density: the MegaFlex manages to combine industry-leading efficiency ratings with a minimal footprint without compromising performance

Click to learn more about MegaFlex DPA

Modular uninterruptible power supply

The DPA 250 S4 features high efficiency, modular architecture, offering best reliability for environmentally conscious organisations that also needs zero downtime and low cost of ownership. It is specially designed for critical, high-density computing environments such as small-to medium-sized data centres.

Setting the standard for the next decade of UPS progress, the DPA 250 S4 has advanced features such as its transformer-free IGBT converters offering three-level topology with interleaving controls to enable market-leading efficiency of 97.6 per cent for the UPS module. This high efficiency reduces operational costs and minimises environmental impact.

This modular UPS is based on decentralised parallel architecture (DPA™), where every UPS module is practically its own UPS, having all the essential functional units needed for independent operation. DPA increases system reliability and availability compared to other modular UPS solutions in the market, as there is inherent redundancy between the UPS modules on all functional levels.

The DPA 250 has a small footprint and the modular architecture means that the specification is flexible. If power needs grow or are larger than anticipated, another module or two can easily be added. Online access to status and environmental parameters and a clear HMI also ease commissioning as does the bottom and top cable entry, which means the footprint is not increased by having an extra cabinet for cable entry or having to leave space to get cables in.

Click to learn more about DPA 250 S4

Selecting the right technology for industry-specific equipment

Power supply events such as power outages, sags and surges represent one of the biggest threats to manufacturers and industrial facilities around the world. For instance, in the oil and gas sector, a momentary power interruption could halt critical process operations and safety processes, resulting in significant financial losses and delays.

Many UPS systems are designed for equipment-friendly environments. In these settings, heating, cooling, ventilation and humidity are permanently controlled.

However, a large number of industrial settings introduce a multitude of harsh conditions. Dust, moisture, vibration, excessive heat, corrosive air contamination, are just some of the challenges that a UPS would have to face in industrial process plants, factories, electrical substations, oil and gas installations and similar environments. For this reason, ABB created a modular UPS for use in these industrial applications: the PowerLine DPA UPS.

Modular UPS for industrial applications

ABB's PowerLine DPA is an industrial online double conversion UPS offering the advantages of ABB's unique modular UPS architecture for locations that are usually tough on electronic equipment.

Leveraging ABB's Decentralised Parallel Architecture (DPA™), this system ensures the highest availability, flexibility and ease of maintainability. Modules can be replaced without switching the whole system to bypass or powering off, so routine maintenance is simple.

Additionally, this UPS features a fail-safe electrical design with high overload and short circuit capability, along with optional system integrated galvanic isolation transformers.

Offering higher ratings of ingress protection and a robust mechanical design, the PowerLine is suitable for industrial plant environments that have a variability of temperatures, dust, moisture and corrosive contaminants. With a service life exceeding 20 years, it supports optimal total cost of ownership.

Click to learn more about PowerLine DPA

Addressing power quality to achieve optimal TCO

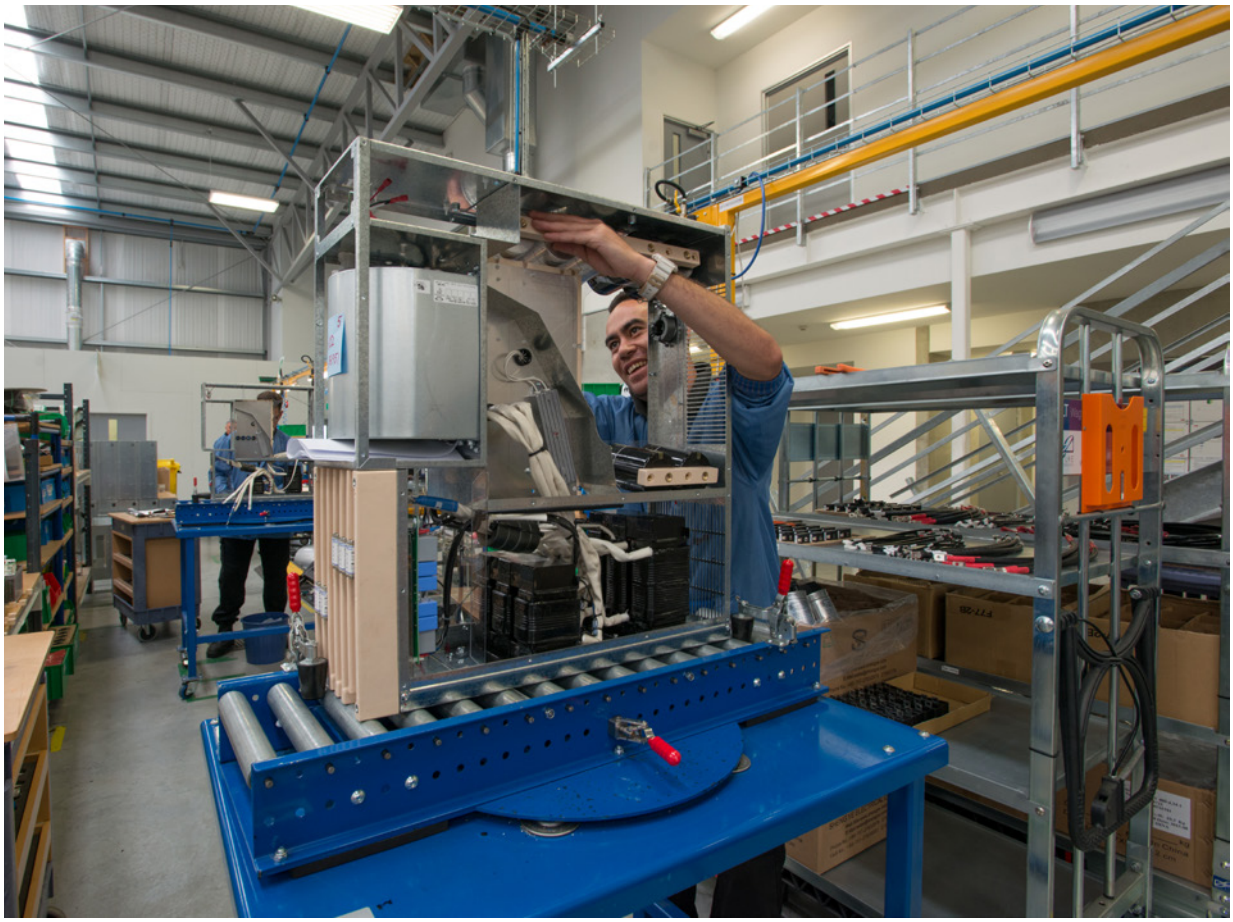
With the advent of automation in modern industrial settings, the sensitivity of processes to power quality events is growing. In the food and beverage (F&B) industry, for example, power interruptions can result in food waste and downtime which, combined, result in significant financial losses. Similarly, in the pharmaceutical industry, inconsistent power can compromise delicate manufacturing processes and jeopardise product quality.

Voltage sags or dips can also be an issue in industrial areas, where a number of industrial sites are located together, even in developed countries with modern power networks. In such scenarios, the high density of power consumers means if a particular user disturbs the utility voltage it will impact other users. Faults or weather events in other parts of the utility network can lead to voltage sags well below the nominal value for a period long enough to affect connected equipment.

The physical consequences of power interruptions are obvious when they occur, but what really matters is the financial cost of power interruptions. In industries such as food and beverage, manufacturers rely more than ever on technology based systems, machinery and high speed continuous processes. Disturbances on the power supply to this precision machinery can result in unscheduled interruptions that can be very costly in terms of lost material, production units, non-delivery, and hours spent clearing and cleaning to restart. Even a momentary interruption of a process that then requires addressing a possible contamination issue can be very expensive.

Automation plays a key role in high speed, high volume processing and packaging applications. Typically this machinery has very sensitive electronics and fast moving motors, and also relies on a very high level of synchronisation between operations upstream and downstream. Mishaps can cause unexpected downtime throughout the entire operation.

Hence, organisations need to invest in equipment so that the risk of uncertain power supply is eliminated, and at the same time, a steady supply of clean and high-quality power is ensured. In some scenarios, AVC systems offer the ideal solution.



The facility in Napier, New Zealand, where ABB's power conditioning products are manufactured

Maintaining clean and high-quality power

Manufactured locally in a purpose-built factory in Napier, New Zealand, ABB's power conditioning products are underscored by a commitment to quality and operational excellence.

Within this range is the PCS100 AVC-40 – an active voltage conditioner designed specifically to solve voltage disturbance problems. This high-performance power electronic system features an industrial design and impressive correction capabilities, making it suitable for the challenging conditions of industrial and large commercial applications.

The AVC40 is specifically engineered for deep sag correction, for example, If a facility was faced with a voltage sag to 60 per cent of nominal voltage the PCS100 AVC-40 would boost the voltage back to nominal voltage for up to 30 seconds. This high level of performance extends to single phase sags, which are the most common type, with voltage sags down to 40 per cent of the nominal voltage able to be fully corrected.

In case of deeper voltage sags, the PCS100 AVC-40 provides a partial correction, which can often prevent loads from tripping. In extreme scenarios where the input voltage reaches 0 per cent of its nominal value, it can still boost the voltage back to 57 per cent with a correction time of 600 milliseconds.

The PCS100 AVC-40 is engineered for dynamic and industrial loads, thus alleviating the need for oversizing, and operates without the need for an external source of stored energy. These factors, combined with an operating efficiency of up to 99 per cent, achieve the lowest possible total cost of ownership.

Click to learn more about PCS100 AVC-40

Case study: PCS100 AVC helps Fonterra minimise production downtime

Leading multinational dairy manufacturer Fonterra produces a number of products including fresh milk, ultra high temperature (UHT) milk and cultured dairy food at its facility in Takanini, Auckland.

The facility's production lines package more than 750,000 litres of fresh milk each day, with the capacity to produce around 6.4 bottles per second. This demands the best resources to guarantee the production of high quality milk that adds real value to Fonterra's customers.

Most problems are short term voltage sags caused by faults and events in the external electricity utilities network. When this happens there is no guarantee the milk is sterilised for consumer use, so disposal or re-processing of the milk is required.

Peter Williams, New Zealand's Fonterra's Brand Group Automation and Control Manager, said, "When a glitch occurs in our facility, we need to go through a sterilisation process which takes around four hours. An event like this across seven production lines, costs us 28 hours of downtime and around $50,000. This would typically happen to us two, three or four times a year."

ABB's PCS100 AVC is able to mitigate voltage disturbances in Fonterra's Auckland facility, minimising unwanted downtime and wasted milk product, while saving the company approximately $500,000 a year.

With a small design footprint, the PCS100 AVC was able to fit into a confined area of Fonterra's equipment room, making this an ideal solution for facilities that don't have large amounts of space for their power protection requirements.

Conclusion

The power challenges experienced at Fonterra's Auckland facility highlight the real-world impact of power disruptions within industries that rely heavily on continuous and reliable power.

By investing in power protection and conditioning solutions, organisations can achieve uninterrupted operations, ultimately safeguarding their bottom line by minimising costly downtime and productivity losses.

Total Cost of Ownership offers an invaluable framework for evaluating the true cost of power infrastructure over its lifespan. By considering factors beyond initial investment, organisations can make informed decisions that prioritise efficiency, resilience and long-term sustainability.

Don't let power disruptions compromise your bottom line. Click to find out more about how ABB's comprehensive range of power protection and conditioning solutions can help your organisation establish resilient critical power infrastructure.

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