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Dear Reader,

The business of running data centres is ever more demanding. Operators are under pressure to meet growing levels of efficiency and flexibility without compromising availability to meet their customers’ demands for uninterrupted up-time and low costs.

As consumers of large amounts of power, data centres are calling for power systems and components that deliver ever-higher levels of performance and efficiency in a small footprint.

In support of this, ABB offers its extensive capability and engineering know-how in power distribution, grid connections, critical power and infrastructure management. It supports its customers not just with products but also entire systems to power data centres reliably and efficiently.

The rapid pace of technological development in the data centre world means that to remain competitive, operators must be quick to adopt new technologies. With ABB’s track record of innovation, we’re always moving, inventing, growing and answering the changing requirements of forward-thinking data centre owners and operators.

Today’s state-of-the-art technology from ABB improves the efficiency and performance of the systems that power data centres, helping operators to gain the competitive edge and maintain focus on computing power.

In this newsletter, we’ve gathered together examples of what ABB does in the realm of data centres and we hope that you find it informative. Please get in touch if you’d like any more information.
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Every data centre has its own set of needs and these can be broadly categorised into four areas where ABB has expert knowledge and experience.

**Power distribution**
This includes the products, systems and expertise required to distribute power reliably and safely. It also keeps operating costs down through improved electrical efficiencies.

ABB supplies not just individual products but also develops and implements whole systems, from power delivery and distribution to micro-grids and automated monitoring and control. This leads to data centres that more readily attain their operators’ performance goals and includes aspects such as simple maintenance, enhanced reliability, increased safety performance and reduced likelihood of human error.

ABB supplies productions and systems including:
- Alternating current (AC) power systems
- Direct current (DC) power systems
- A wide range of low and medium-voltage products
- Distribution substations

**Intelligent grid connections**
Many operators demand their own grid connection to meet growing demand for power as well as greater levels of redundancy. ABB's equipment, systems and expertise mean that it can reliably create new connections at up to 132 kV and its turnkey grid connection capabilities provide:
- Better management of energy demands
- Optimal utilisation of renewables and power assets
- Integration into smart grids and microgrids
- Substations

Data centres are becoming more strategic to the always-on global enterprises they support. Today’s leading operators view them as coordinated and optimised facilities that are built to be intelligent, highly efficient and increasingly flexible. That’s why data centre designers and developers turn to ABB as a partner for their most critical equipment and systems.
Critical power

Critical power systems ensure that data centre customers have continuous access to their data. Products such as uninterruptible power supplies are built to withstand the rigours of data centre operation and ensure many years of reliable, trouble-free service. ABB’s offering includes:

- Modular UPS
- Genset sub-supply and integration
- Energy storage systems

Data centre infrastructure management (DCIM)

Decathlon® for Data Centres provides industrial-grade tools to manage a flexible network of power, cooling and IT systems, so you can deliver data services faster, in the most reliable, efficient and sustainable way possible. It is the only DCIM solution that provides controls to automate both workflow and physical infrastructure processes, enabling you to continually optimise your data centres to the highest levels of performance.

Its benefits include:

- Real-time monitoring and visibility
- Contextualised decision support
- Higher system availability and performance
- Intuitive capacity planning and management
- Resource forecasting and energy planning
- Reliable facility and IT automation
- Rapid troubleshooting and root cause analysis
Commissioned in 2012, ABB created the power supply infrastructure for Facebook's data centre in Luleå, Sweden. The social media giant selected the location because of its stable supply of clean hydropower as well as reliable communications and electricity networks. In addition, the site offers a plentiful supply of cold air for cooling.

The Arctic climate is a boon for cooling

To supply power to the site, ABB built two high and two medium-voltage air insulated switchgear substations including high-voltage air-insulated switchgear (AIS), transformers, high-voltage cables, medium-voltage switchgear, substation automation equipment and control and protection systems.

DCB for a small footprint
The site’s high-voltage switching is supplied by ABB’s Disconnecting Circuit Breakers (DCBs), which has a significantly smaller footprint than conventional AIS. Conventionally, AIS comprises circuit breakers, disconnectors and current transformers as separate components. In a typical arrangement, disconnectors were located on both sides of each circuit breaker to isolate it in case of failure or to enable safe maintenance.

When ABB introduced the DCB in 2000 it extended the functionality of the circuit breaker, integrating the disconnecting function into the circuit breaker's breaking chamber and meeting the standards of both types of equipment.

In doing so, the concept reduced the footprint required for AIS and paved the way for simpler installation, lower maintenance, lower failure rates and improved levels of safety. Plus, because the primary contacts in a DCB are enclosed in SF₆ gas and protected from the environment, reliability is greater than standalone air-insulated disconnectors.

And while the Luleå installation also includes voltage and current transformers for measurement, the latest version of the DCB has integrated highly accurate measurement in the form of the latest state-of-the-art Fibre Optic Current Sensor (FOCS).

The FOCS sensor eliminates the need for voltage and current transformers, not only reducing the overall footprint of a substation design but also saving energy consumed by the transformers. FOCS is even compatible with IEC 61850 standard, in common with the substation automation system supplied for the Luleå data centre.

The substations connect to three server buildings with a total area of 84,000 square metres, equivalent to 11 full-sized soccer fields. The centre has a total power consumption of 120 MW, which exceeds the city of Luleå’s consumption on cold winter days.

A clean and green centre
All of the power demand is met by the local supply of clean and green hydropower and the Arctic climate helps to keep cooling costs to a minimum by eliminating air-conditioning equipment.

Building on the success of the centre in March 2014, Facebook announced plans for a second data centre adjacent to its existing site in Luleå and announced in a blog post that it has achieved a PUE (Power Usage Effectiveness) of around 1.05. This means that for every 1.05 watts of power feeding into the data centre, 1 watt is used to run the computing equipment.

Elsewhere in the industry, PUE levels of 2.0 are not uncommon, meaning that operators must consume 2 watts of energy for every 1 watt used by the servers.

And in April 2014, Greenpeace recognised Facebook’s commitment to clean operation and transparency in its report ‘Clicking Clean: How companies are creating the green internet’.

An illustration of a substation at Luleå

Success stories
Leading Asia Pacific data centre operator AWAN Data Centre selected ABB as its preferred supplier of electrical equipment for the second phase of its new data centre in Singapore.

Under the agreement, ABB will supply DC electrical distribution equipment as well as Decathlon, the DCIM (data centre infrastructure management) solution. AWAN will also seek to be a potential hosting site for ABB in Singapore.

AWAN’s objective is to deliver a data centre with Tier-4 infrastructure, certified by US-based Uptime Institute, as part of a purpose-built and very secure DC facility that is ideal for large corporate customers in the financial industry as well as retail colocation operators and cloud-based service providers.

Once complete, the new 52 MW facility will be a major new Tier-4 data centre for Asia and will meet the requirements of Singapore’s BCA-IDA Green Mark Scheme.
Success stories

Green’s Zurich-West leads the way for DC

The world’s data centres demand around 80 million MWh of electricity per year, which equates to 2 percent of total CO₂ emissions and demand is growing. An extra 5.75 million new servers are added to the ranks every year, causing demand to grow by 10 percent.
To balance the financial and environment costs of growing demand, operators are keen to improve the efficiency of their data centres. One major opportunity is in eliminating the energy lost when converting AC (alternating current) to DC (direct current) and back.

While the grid carries AC power to the door, electronic equipment works from DC, as do the batteries in UPS systems. By switching to a DC power system, data centre operators can convert from AC to DC only once, simplifying their power supply and removing the need for equipment, as well as saving the energy that is lost during conversion.

Because less equipment needs to be purchased, installed and maintained, investment costs are 15 percent lower and the footprint is 25 percent smaller than a comparable AC system. Fewer components lead to fewer outages, improved reliability and lower operating and maintenance costs in a sector where outages can cost upwards of $1 million per hour.

**World’s largest DC data centre**

The world’s largest DC-powered data centre opened its doors in May 2012 in Switzerland following a project between operator Green, and partners ABB and HP. The Green group is a major Swiss data centre operator employed by banks, insurance companies, system integrators and technology companies around the world.

Its stringent ecological values meant that it jumped at the opportunity for ABB to deliver the pilot project, which had the goal of operating the data centre with greater efficiency and consuming less energy than a conventionally powered centre.

ABB’s installation is a fully redundant one megawatt DC power distribution solution for a 1,100 m² expansion of the 3,300 m² Zurich-West data centre and meets the specifications of the International Electrotechnical Commission (IEC). The project won the prestigious Swiss Federal Office of Energy’s Watt d’Or prize for buildings and space in 2013.

Performance tests have shown that the data centre's power distribution system is 10 percent more efficient than comparable AC technology and investment costs were 15 percent lower.

Franz Grueter, CEO of Green said: “The implementation of 380 volt DC technology in our data centre is part of our long-term energy optimisation strategy, a big step that has set a new standard in the industry. When fully loaded, the system will result in energy savings of up to 20 percent in power consumption from grid to chip and in cooling.”

**DC power distribution**

The system was installed by ABB Switzerland in collaboration with Validus DC systems, a leading supplier of DC power systems and is powered by AC power from the local grid at 16 kV or an emergency power system. These feed into ABB’s ZS medium voltage GIS (gas-insulated switchgear). Power is then converted into 400 V DC by a rectifier unit made up of a medium-voltage switch, a highly efficient transformer and a rectifier unit based on high efficiency power electronics and semiconductors.

DC power is then distributed to servers throughout Green’s facility with no need for further transformation to power equipment or to connect with the site’s battery system, which is based on DC power and which stores energy to power the site for 10 minutes while the emergency power system is brought online.

**AC comparison**

From the point of the medium-voltage GIS, a comparable AC power supply would include medium-voltage transformers, AC switchgear, power conversion equipment for the UPS, AC power distribution units and AC power supply units for every item of equipment in the data centre.

Switching to DC will not only cut the costs of power engineering equipment but will also save costs in installation, operation and maintenance and will free up valuable space for servers. Plus, by removing the individual power supply units for every item of equipment, the operator will not only improve energy efficiency but will also reduce the need for cooling in the IT room (and the energy demands of the cooling equipment).

**Decathlon for Data Centres**

Green is also making use of Decathlon for Data Centres, ABB’s data centre infrastructure management (DCIM) solution, at Zurich West. The software delivers precise monitoring, control and automation of the building management and electrical power systems and is Green’s primary data centre automation solution. As part of the package, ABB has deployed its Decathlon Command Centre Extended Operator Workplace solution, which enables operators to oversee and manage the entire operation.

**Reliability and efficiency**

Tarak Mehta, head of ABB’s Low Voltage Products division said: “Across all our business areas, customers are asking for improved availability and energy efficiency, and DC power is an effective solution. Zurich West will serve as a global showcase to demonstrate that DC is a complementary technology in data centres as it enhances reliability while minimising footprint, installation and maintenance costs.”
Success stories

Power security in Docklands

ABB has successfully future-proofed the power supply for a major data centre in London’s Docklands by providing a dedicated primary 132 kV substation for leading provider of global data centres and managed ICT solutions Telehouse. During a turnkey project, ABB designed, supplied, installed and commissioned all the electrical plant required.
When it built the latest addition to its Docklands campus in 2010, Telehouse wanted to ensure the highest level of power security for any data centre in the UK and become the only data centre operator in the UK with separate connections to two individual 132 kV transmission grids, giving the ultimate in redundancy. In addition, it wanted to future-proof its supply to meet growing demand for its services while delivering reliability of 99.999 percent.

Around 500 major international organisations base their IT infrastructure at the Docklands campus and the site also supports connectivity for internet service providers, carriers, operators and internet exchanges.

Growing demand

While maximum demand from the existing campus was in the region of 16 megavoltamperes (MVA), growing demand and an extension of the campus meant that Telehouse wanted to create a substation that could meet a maximum demand of 40 MVA.

The most cost-effective route to powering the site was replacing the existing metered feed from UK Power Networks’ 11 kV distribution network with a direct connection to the 132 kV transmission grid. Telehouse brought together a consortium to deliver its new primary substation led by Arcadis and selected ABB to design, supply, install and commission the electrical network.

Contestable connection

ABB is one of a select group of companies accredited under the National Electricity Registration Scheme (NERS) that is operated by the Lloyd’s Register Group on behalf of the UK’s Distribution Network Operators (DNOs). This means that ABB is able to deliver contestable connections. As a result, it was able to liaise closely with UK Power Networks during the project so that the DNO was able to focus only on providing the 132 kV supply points.

One important element of the project was that the substation had to be energised in May 2012 in time to support Telehouse’s operations during that summer’s Olympic and Paralympic Games.

Substation equipment

ABB supplied its state-of-the-art ELK-04-735 GIS, which has a compact size that minimised the footprint of the substation as well as 33/50 MVA 132/11 kV grid transformers. Before being installed, the GIS had to undergo UK Power Networks’ rigorous approval procedure.

On the secondary distribution side, ABB installed its UniGear 2500 A, 11 kV switchgear and all of the ancillary equipment, including 350 kVA transformers, earthing resistors, substation earthing, batteries and battery chargers, SCADA interface and 415 V switchgear.

To create the new connection, ABB tapped into two separate 132 kV circuits operated by UK Power Networks and fed new cabling into the substation via underground cabling. This dual redundancy means that if the normal live feed is interrupted, the supply will switch seamlessly to the other feed. It also required doubling up of key equipment, including the GIS and grid transformers. Plus, by tapping straight into the 132 kV grid, Telehouse can avoid paying DUoS (distribution use of system) charges to the distribution network operator.

The site’s central London location and close proximity to Docklands meant that ABB was careful to keep noise and disruption to a minimum, particularly when working in the Telehouse campus and on the high voltage cable routes. Its location in the busy Docklands business area meant that the project demanded careful planning and execution, especially in the scheduling of deliveries and civil works.

Low Total Cost of Ownership for Munich Re

Munich Re selected the UPS for its low running costs

When the world’s largest reinsurer Munich Re wanted to modernise and extend its computing centre, it chose ABB’s PowerWave 33 uninterruptible power supply (UPS). Having done their sums carefully, Munich Re selected the PowerWave 33 because it delivers the performance at the most attractive total cost of ownership over a lifetime of 15 years.

Munich Re’s computer centre had been equipped with a 8 x 120 kVA single-block UPS that no longer fulfilled requirements. ABB replaced this with a 2 x 3 x 300 kVA PowerWave 33 system. Plus, the existing single power bus was replaced by a dual-feed system for additional power security.

The work was carried out in two phases. A new power bus was installed in parallel with the existing bus and then the existing bus was replaced by the second of the new dual feeds and the PowerWave 33 was installed to replace the existing infrastructure. The architecture will make it possible to extend the facility easily with four units to each power bus in the future. Daniel Haller said:

“Alongside the technical excellence of the product, deciding factors were the exceptional energy efficiency, low maintenance cost and the operational savings these will deliver over the next 15 years.”
Eliminating the power connection bottleneck

ABB is a leading Independent Connection Provider (ICP) with the proven capability to deliver new connection projects including the turnkey management of multi-million pound contestable connections for large data centre projects.

Working with DNOs to achieve a fast connection

Procuring and securing utility connections can be a major concern for data centre developers in delivering their projects in terms of cost, risk and on-time delivery.

Many UK DNOs (Distribution Network Operators) are heavily over-subscribed with new connection applications. In some cases they are simply unable to provide a new connection offer and/or the associated works within the desired timescale which can lead to significant project delays and sometimes even prevent otherwise viable projects going ahead.

ABB offers a very successful approach to new connections that can help reduce this bottleneck. This allows the DNO to focus on the ‘non-contestable’ element of a project – in essence they verify that there is a point of connection available and sufficient electrical capacity in the networks to enable the new connection. ABB will then deliver a project focused single interface to design and construct the actual connection substation to the DNO’s own standards.

Once the works are complete the substation can be handed over to/adopted by the host DNO who will take on the overall management of the substation and earn the associated revenue from this newly adopted asset. Because of this, the DNOs regard ABB as working in partnership with them and they have come to welcome our services in this area.

PASS M0 switchgear
Years of experience
Ofgem, the UK’s regulator of gas and electricity markets, first brought competition to the new connections market in 1997. Since then, ABB has completed many new connection projects for private developers and end users from 11 kV up to 132 kV, something that is beyond the scope of most ICPs.

Commitment, expertise and customer focus
The specific benefits of working with ABB will vary from project to project. In the majority of cases we offer significant cost and time savings, but the real advantages often lie in our commitment, technical expertise and customer focus. Indeed, many customers are delighted to find that, when we are invited to tender for a new connections project, we often find more innovative options or approaches to a particular new connection requirement which can reduce time, money and programme risk – all of this is detailed in a comprehensive ABB tender document.

Innovation
ABB is always pushing the boundaries of what is achievable in substation projects. Most recently, we have introduced the state-of-the-art PASS M0 hybrid high-voltage switchgear that creates an extremely compact installation footprint. We are also exploring UK opportunities for our underground substation concept that enables up to 98 percent of an installation to be tucked away below ground, with only cooling ducts and access routes visible above ground. The approach means that ABB can integrate a transformer substation into any urban environment while meeting and future-proofing customer needs.

Flexibility
Making a new connection is a critical part of most projects. On major developments, the one thing a client needs is flexibility. If the project needs to go ‘off-plan’ for any reason, it is vital that the electricity contractor can adapt to meet the changing project requirements. In our role as an ICP, ABB understands the evolving needs and priorities of different projects. We also recognise the need to work with all the equipment suppliers whose products are approved by the local network operator.

We also understand the need for financial flexibility and can arrange contracts with commercial terms that reflect the competitive nature of the market, including staged milestone payments as the project progresses.

NERS Accredited
ABB is one of a select group of companies to be accredited under the National Electricity Registration Scheme operated by the Lloyd’s Register Group on behalf of the UK DNOs. This scheme provides technical assessment of service providers who elect to be assessed for accreditation for contestable works associated with the installation of electrical connections.

ABB has a broad NERS registration that covers design, project management, cable laying, cable jointing, overhead lines, substation installation and associated civil engineering works.

Why connect with ABB?
Comprehensive scope from low voltage through 11 kV, 33 kV, 66 kV up to 132 kV
– Just one interface for the entire connection project
– Flexible, responsive service for fast-track ‘power-on’
– Commercial flexibility with milestone payments
– UK-wide coverage
– NERS accredited

ABB’s innovative underground substations can make the most of space
Freedom Group orders UK’s first PASS M0H

Freedom Group, the provider of engineering services to the utility sector and wider markets, has ordered the UK’s first installation of ABB’s innovative PASS M0H switchgear.
The switchgear is due to be installed in a new data centre campus, now under construction in the UK, that is set to become the country’s greenest data centre. The initial 130,000 square foot building at the site is the first of three phases and will consume 10 MW power.

Working on behalf of the data centre operator, Freedom Group’s Colchester office has specified a dedicated grid connection with a 2N level of security that will connect to two separate incoming 132 kV transmission feeds.

Freedom turned to ABB to supply the switchgear that will control the incoming high-voltage power as well as medium voltage switchgear for distribution inside the centre. ABB is supplying its innovative PASS M0H high voltage switchgear module and its UniGear ZS1 medium voltage switchgear.

The PASS M0H is the latest addition to ABB’s well-established PASS (Plug and Switch System) high-voltage switchgear family and enables the fast-track construction of compact ‘H’ configuration substations.

**Flexibility and security**

PASS M0H encloses all the functions of a complete switchgear bay in a single-phase gas-insulated housing designed for connection to the high-voltage network in an H configuration. These include circuit breaker, combined disconnector and earthing switches, current transformers and fast acting earth switch.

The module will be connected to two separate incoming 132 kV feeds from the local UK Power Networks grid and will feed two 132/11 kV power transformers. On one side, it uses silicone rubber outer insulated bushings and on the other side plug in type cable connections.

As hybrid switchgear, the PASS M0H module integrates elements of air-insulated switchgear (AIS) as well as gas-insulated switchgear (GIS). On one side of the H, traditional air-insulated connections control equipment and on the other side, bay functions are enclosed in a single-phase gas-insulated housing. A changeover switch in the cross bar of the H will deliver total flexibility and security of supply by seamlessly switching between the two incoming or outgoing circuits when required.

**Compact footprint**

Because it encloses the functions of a complete switchgear bay with an H configuration in a single sub-assembly, the PASS M0H has a significantly smaller footprint than alternative solutions.

For a data centre operator this means that more of its footprint can be dedicated to income-generating server space without losing any performance or resilience of the grid connection. It also minimises the resources required for civil engineering and enabling works.

**Fast-track construction**

Another benefit of using a PASS M0H module is that it is delivered to site completely factory assembled and tested, meaning that it can be installed quickly.

In addition, a key advantage of PASS M0H is that the modules are fully factory assembled and tested, reducing on-site logistics and associated costs and reduced maintenance as all live contacts are in SF6 gas. By eliminating on-site assembly, testing and commissioning work, Freedom Group will not only cut out the work but also its associated costs and risks. And because the module is a self-contained single unit, it minimises vehicle movements, leading to simpler construction logistics and a lower environmental impact.

**Meeting high standards**

While the switchgear will be owned and operated by the data centre operator it meets UK Power Networks’ stringent specifications for grid-connected high-voltage switchgear and has full Energy Networks Association (ENA) approval.

UK Power Networks has given its approval to switchgear from the PASS M0 family and is adopting a number of PASS M0 modules that are being installed as the grid connections for solar photovoltaic farms that feed into the 132 kV transmission network in the East of England.

**Pre-engineered reliability**

Richard Watkins, ABB’s Regional Sales Manager for southern UK said: “Not only does the PASS M0H offer exceptional reliability and flexibility by enabling the data centre operator to reconfigure the power supply as needed, it delivers this capability in a compact pre-engineered, factory tested module for fast-track delivery and commissioning.”

**Medium voltage switchgear**

ABB is also supplying its UniGear ZS1 medium voltage switchgear rated at 11 kV to Freedom Group for the new data centre. The panels will control the power distribution circuits inside the new facility.

The switchgear is tried and tested in data centre environments and each panel consists of a single unit that can be equipped with circuit-breaker, contactors or switch-disconnector, as well as all accessories for the switchgear’s conventional units. A cubicle in the upper part of each panel houses auxiliary instrumentation. All service operations are carried out from the front, removing the need for rear access for installation or maintenance – a factor that keeps the footprint of the installation to a minimum.

Left: The innovative PASS M0H
Ready to meet or exceed new legislation

David Hughes, Head of ABB’s Power Products division in UK and Ireland explains the repercussions of the EU’s ecodesign legislation and how ABB’s amorphous core dry-type transformers are already exceeding the energy efficiency demands of planned future legislation.
In June 2014, new ecodesign transformer regulations were passed by the European Commission (EC) that introduced new efficiency standards for small, medium and large power transformers used in electrical transmission distribution networks and industrial applications.

The legislation comes into force in July 2015 and so gives the industry only one year to adapt so now is the time to gain an understanding of the legislation and how to react to it. One important aspect to note is that the legislation does not apply to all transformer products – for example, single phase transformers are not affected.

It is part of the EC’s ecodesign legislation, which covers more than 40 types of product that use, generate, transfer or measure energy. The list includes household appliances, refrigeration equipment, computers and industrial products.

The Commission estimates that the combined effect of all of the ecodesign minimum efficiency regulations will contribute around a third of its energy efficiency target, called the 20-20-20 target. This aims for a 20 percent reduction in greenhouse gas emissions, raising renewable energy consumption to 20 percent and improving energy efficiency by 20 percent.

Because large quantities of power pass through transformers, they account for 30 – 40 percent of the losses in transmission and distribution systems. With this in mind, even a small increase in transformer efficiency can have a significant impact on energy losses and CO₂ emissions.

Intended to prevent high loss transformers from being installed in the EU, the legislation is phased. The first phase, known as Tier 1 introduces a set of efficiency requirements from July 2015 but it’s only the start. By 2021, a Tier 2 standard will demand transformer designs that are around 10 percent more energy efficient than Tier 1.

By eliminating the worst performing transformer models, the EC expects to see energy savings in the range of 16 terawatt hours (TWh) per year from 2020. That’s equal to around half the annual electricity consumption of Denmark and is equivalent to avoiding CO₂ emissions of 3.7 million tonnes.

Making even marginal improvements in transformer efficiencies can yield substantial energy savings in a working life of 30 years or more. And when multiplying these efficiencies by the number of transformers in Europe, the potential energy savings are considerable. And the potential savings are growing too. The number of transformers in the EU is growing from an estimated 3.6 million in 2011 to nearly 4.7 million units by 2025.

By selecting transformer models with high efficiency, data centre managers can not only select transformers that already meet the requirements of Tier 1 and Tier 2 but also deliver energy savings that reduce operating costs.

ABB can help its customers make a head start in meeting the new regulations. It already has the advanced technology in hand that enables the production of highly efficient transformers that exceed the rigorous demands of the Tier 2 standard that will be introduced in 2021.

**EcoDry transformers**

One example is ABB’s ultra-efficient EcoDry distribution transformer. The dry-type transformer has a low-loss amorphous core that has been well proven in liquid-filled transformers. It is available in ratings from 100 to 3,150 kVA with operating voltages of up to 36 kV.

Being dry-type transformers, EcoDry transformers offer all the practical advantages of their type, such as: no fire risk; no risk of escape of pollutants or fire-hazardous substances; long lifetime; high mechanical strength; ability to cope with load changes, overloads, short-circuits and over-voltages; and reduced installation footprint.

The range includes three models, each of which is designed to meet the differing needs of applications where losses are either predominantly ‘no-load’ losses, ‘load’ losses or a combination of the two.

‘Load’ losses are most relevant to data centre operators as they have the greatest impact on transformers that are operating at or near full capacity constantly. They occur in a transformer’s conductors and increase quadratically with the load on the transformer and are a result of ohmic loss and eddy currents.

Of the three types of transformer in ABB’s EcoDry family, the EcoDry99plus is designed for full-load efficiency and can operate at more than 99 percent efficiency. This means that in a typical data centre application, an EcoDry99plus transformer rated at 1,000 kVA with 10,000 V primary voltage would reduce annual power losses by more than 30,000 kWh and cut CO₂ emissions by around 18 tonnes per year. This not only enhances the environmental performance but also enables operators to cut running costs.
Medium voltage

Smart grid-ready UniGear Digital

The latest iteration of ABB’s popular UniGear switchgear integrates protection, control, measurement and digital communication to help substation operators prepare for the coming smart grid era.
Designed to enable a safe, flexible, eco-efficient and smart electrical network, UniGear Digital takes the well-established switchgear concept to the next level with an advanced design and components.

The difference to previous UniGear models is that state-of-the-art digital current and voltage sensors are integrated into each panel, along with multifunctional Relion IEDs (Intelligent Electronic Devices), which are compatible with the IEC 61850 digital communications protocol.

The combination is designed to perform a central role in medium voltage smart grids and models from the Relion 615 range form the backbone of the UniGear Digital communication concept.

**Saving time and resources**

Because switching, sensing and communication functions are packaged together in a single panel, the new generation switchgear has less complex purchasing, engineering, installation and commissioning. Its delivery lead-time is 30 percent quicker than conventional UniGear ZS1 models.

Another benefit is the reduced footprint, with no separate metering panel required. This reduces the need for the size of substation buildings and means that UniGear Digital uses less material and cuts out the on-site handling of heavy instrument transformers.

Plus, the substations based on the digital version uses less energy than conventional UniGear ZS1 because the in-built digital sensors eliminate energy loss that takes place in instrument transformers. In a substation with 14 feeders, UniGear Digital has the potential to save 250 MWh over 30 years in operation, which is equivalent to 150 tons of CO₂.

By integrating more functionality into the panels, UniGear digital has simplified its approach to medium voltage switchgear. Using the in-built IED, connecting to a customer’s SCADA system is simple and the user-friendly human machine interface (HMI) is designed for straightforward operation, either on-site or remotely.

**Operational performance**

From an operational perspective, UniGear Digital represents higher than ever levels of substation availability and safety. The Relion relays enable remote connection via an Ethernet interface, meaning that remote monitoring or reconfiguration are possible without the need for a site visit.

It meets the highest requirements of peer-to-peer GOOSE (Generic Object Oriented Substation Event) communication that is faster than traditional hard-wired systems and which also enables constant supervision. This means quick and reliable tripping following an event.

The switchgear is also enabled for high performance applications such as high-speed busbar transfer and fast load shedding, meaning that UniGear Digital is ushering in a level of performance that is better than ever before.

**Future proofing**

As demand grows, the digital panels can be plugged in to upgrade and extend substations using the interoperability of the IEC 61850 standard, which ensures that devices are compatible irrespective of manufacturer. This means that UniGear Digital is built for flexibility, scalability, modification and expansion without the need for complex additional wiring.

**Availability**

While the UniGear range includes switchgear for single level, double level and double busbar solutions, UniGear Digital is currently available exclusively as an option for UniGear ZS1 up to 17.5 kV, which is popular in utilities, industrial and infrastructure applications. And being based on UniGear ZS1, the switchgear is withdrawable for straightforward maintenance and low total cost of ownership.

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**Slimline switchgear**

Another form of ABB’s switchgear that is proving popular with space-constrained data centres is the UniGear 500R.

Designed for 11 kV power distribution, the air-insulated switchgear has been developed especially for customers who have a limited footprint. Also because it can operate under free cooling conditions with no need for air conditioning, it supports energy efficient operation.

At only 500 mm wide, UniGear 500R represents a significant space saving compared with standard switchgear panels, which are typically 650 mm or more. In a typical data centre application, banks of 10 or more panels might be installed and so the space savings quickly mount up.

It can be fitted with IEC 61850 compliant Relion IEDs for smart grid communication.

Inside the panel, mechanical interlocks between the circuit breaker, three-position line disconnector and cable testing device ensure maximum safety. All components can be accessed from the front of the panel, eliminating the need to access the rear. A fixed version of ABB’s well-proven Vmax vacuum circuit breaker provides the breaking mechanism and it can be replaced in less than 90 minutes should a problem arise.
Minimising risk from arc flash

Although arc flash incidents in power distribution systems are rare, they are extremely hazardous when they do occur. In a data centre, they could be caused by human error, poor maintenance or legacy equipment. Awareness of the dangers of arc flash has increased dramatically in recent years following the introduction of new guidelines and standards by international trade and safety bodies such as the Institute of Electrical and Electronic Engineers (IEEE) and the US Occupational Safety and Health Administration (OHSA).
During an arc flash incident, the sudden release of energy causes an intense flash of light and a temperature rise as high as 20,000°C, which itself causes thermal expansion of air that leads to an explosive blast.

Not only does this pose significant risk to operators but it can also damage essential substation equipment and cause expensive service outages and down-time.

The key to minimising the risks posed by arc flash is fast detection and clearing of faults. Arcing that lasts 40 ms (milliseconds) or less typically causes no personal injury or switchgear damage, whereas if left for 500 ms or more, an arc has the potential to result in serious personal injury and major damage to switchgear.

Two of ABB’s products are designed to detect and clear faults quickly and reliably. The REA arc flash relays detect faults rapidly and UFES (Ultra Fast Earthing Switch) enables fast switching to earth. Both can be retrofitted into existing installations, improving safety standards and enabling operators to reduce the need for personal protective equipment.

**REA arc flash protection relays**
The intense light emitted by an arc is the key to the ultra-fast detection and tripping time of ABB’s REA 10 arc flash relays. A long unclad fibre optic light sensor will pick up the light from an arc flash and transmit it to the relay at the speed of light.

In normal operation, both bright light and overcurrent need to be in evidence simultaneously to trip the circuit and the system can be installed into new substations or retrofitted into existing sites.

At up to 60 metres in length, the sensor can cover the same protection zone at a much lower cost than is possible with individual lens sensors, while overcoming any shadowing issues. Because the sensor can be configured in a loop, it can provide regular self-checking of the sensor’s integrity and generate an alarm if a problem is detected.

**Ultra Fast Earthing Switch**
The Ultra Fast Earthing Switch (UFES) protects switchgear against arc flash incidents by initiating a 3-phase short-circuit to earth in the event of a fault. An extremely short switching time of less than 1.5 ms and rapid and reliable fault detection ensures that an arc fault will be extinguished almost immediately after it arises.

Rapid operation is achieved by channeling the uncontrolled release of energy of the arc through a solid metal three-phase earth connection. It’s the low impedance of this earth connection that encourages the arc current to flow through the UFES unit, triggering the switch to open and stop the current.

UFES is available as a withdrawable assembly to insert into a panel or as a box mounted on top or on the end cover of a panel. Once fitted, UFES will spring into operation when the flash of an arc forming triggers one of several optical sensors. Arc detection takes only around 2.5 ms and together with three-phase current detection will lead UFES’s primary switching elements to channel the current to earth and break the circuit, quenching the arc before it forms.

**IS-Limiter**
Medium-voltage circuit breakers are typically too slow to provide protection against exceptionally high peak short-circuit currents. By installing ABB’s IS-limiter, operators can detect and limit a short-circuit current at the first rise. This ensures that the maximum instantaneous current remains well below the peak short-circuit current level. The device is ideal as a link between an ‘unprotected’ and a ‘protected’ switchboard as it can significantly reduce voltage drops for a more reliable power supply.

One advantage is particularly helpful to data centre operators. When operated, the voltage in the parts of the system that are not affected by a short-circuit only drops for a fraction of a millisecond. This means that even sensitive computers remain protected from drops in the system voltage.

The IS-limiter consists of three independent phases, each made up of an extremely fast switch that can carry a high current but has a low switching capacity and a high rupturing capacity fuse arranged in parallel.

An electronic device inside the IS-limiter monitors the current and at the very first rise of a short-circuit current, it decides whether tripping is necessary. When triggered, a small charge opens the switch on the main conductor within 0.5 ms. The current then continues to flow through the parallel fuse, where it is limited and then finally interrupted as the voltage passes through zero.
Future-proofing substation automation

Until recently, there was no overall standard for the serial communications in substation automation. This meant that the many thousands of substation automation systems installed worldwide were based on proprietary standards and that each system was either limited to using components from a single supplier or that complex and costly protocol conversions had to be supplied.
The introduction of the IEC 61850 standard in 2004 is changing this. Major industrial power users such as data centre operators want to safeguard their investment in substation automation equipment. The standard meets a growing demand for flexible, future-proof systems that are able to cope with changing requirements, philosophies and technologies.

The IEC 61850 ‘Communication Networks and Systems in Substations’ standard is the first and only global standard that considers all the communication needs within substations.

It effectively defines standard data models and sets, communication mechanisms and the system configuration language. Its goals are interoperability of system components and software tools, free allocation of functions and choice of system architectures, reuse of configuration data, and understanding of the system functionality.

IEC 61850 native products

Developments in communication technology typically move faster than developments in substation automation, protection and control equipment and because of this, the standard is future-oriented by taking ease of adaptation and evolving technology into account.

ABB was instrumental in development and implementation of the standard through a number of initiatives and continuous engagement with the standard. Before it was launched, ABB had already committed to a ‘native implementation’ philosophy so that IEC 61850 would be fully implemented in new products.

In a typical IEC 61850 native design, the functionality of an intelligent electronic device (IED) must consider the entire process, including specification and evaluation, system and device engineering, system commissioning and operations and maintenance.

A 61850 native IED should provide a number of features and functionality. These include a full set of protection and control data provided to substation automation systems to ensure interoperability. In addition, fast communication and application performance is essential for generic object oriented substation event (GOOSE) peer-to-peer communication. Adherence to data modeling and substation configuration language (SCL) information is also vital, as is ease of adaptation.

ABB’s approach has been based on consistent implementation, modular solutions and guaranteed system openness for future hardware and functional extensions. Integrating third-party devices and systems means that its approach is compatible with multi-vendor systems.

Plus, ABB can verify substation automation schemes before installation, testing and commissioning at its customers’ sites. It has a System Verification Centre (SVC) in Baden, Switzerland that is the world’s first vendor test centre with official qualification by UCA International, an independent user organisation for IEC 61850. This is complemented by a System Verification Facility in Stone, Staffordshire, where a near-identical site de-risks substation automation projects for UK customers.

Potential of IEC 61850 for data centres

Data centre operators can plug into the full potential of the IEC 61850 standard for communication, power monitoring and interoperability of substation automation equipment with ABB’s Relion family of IEDs.

The Relion product family was one of the first to undergo the IEC 61850 transformation. The products required a completely new platform architecture that integrates communication services and data representation into the core protection and control applications. This development was carried out in parallel with the development of the standard itself to ensure that the product family was designed to support the standard from the outset.

Relion includes the widest range of products for the protection, control, measurement and supervision of power systems. The family of products is split into a number of series that group together devices in terms of their application and complexity.

Of these, relays from the 605, 610, 611, 615, 620 and 630 series have applications in power distribution for industrial and these include protection and control of motors, busbars, transformers, back-up, power management, transformers and more.

Relion 615 series

The 615 series has a number of devices that are well suited to applications in data centres. The series offers a compact and powerful solution for utility distribution and industrial applications. It includes standard configurations to meet the needs of protecting industrial power systems and utility substations.

Features of 615 series IEDs

- Standard configurations for several applications.
- High performance GOOSE messaging.
- Compact design that minimises footprint in new and retrofit installations.
- Plug-in cases for speedy installation, maintenance and testing. The cases can be installed and wired before the plug-in units are delivered to site.
- Straightforward commissioning once the application-specific protection parameters are set.
- A human-machine interface or remote control system that enables customisation of interlocking schemes.
- Advanced earth fault/ground fault protection, including transient protection to detect faults in any cable and overhead network.
- Three-channel arc-fault protection to enhance safety for personnel and equipment and to minimise down-time.
Decathlon takes the hurdles out of DCIM

ABB has launched the latest version of Decathlon® for Data Centres. The software provides the industrial-grade tools for flexible management of power, cooling and IT. It helps operators deliver data services faster and in the most reliable, efficient and sustainable way possible.
The data centre infrastructure management (DCIM) software builds on the capabilities of traditional management systems (BMS) and building automation systems (BAS) to provide visibility, decision support and control across worldwide operations through a single interface.

It is the only DCIM system that tightly integrates with third party solutions and it lets operators ‘see’ system performance and environmental factors with real-time monitoring and analytics. Reporting is context sensitive, meaning that relevant information such as historical trends, forecasts, workflow processes, intelligent alarms and incident reporting is provided quickly for rapid response and resolution.

Plus, Decathlon’s centralised controls enable efficiencies through automation, helping to reduce human error.

Key benefits
While DCIM solutions vary widely, ABB groups the benefits of Decathlon into five categories:

- **System availability and performance** – Decathlon enables precise monitoring of IT and facility systems so that operators can view status, energy consumption and environmental data from anywhere.
- **Capacity planning and management** is possible by monitoring and planning based on IT assets’ current and future states.

Optimising energy consumption in Manhattan

One major operator selected Decathlon for its New York data centre in April 2014. Telx, the rapidly growing colocation, interconnection and cloud enablement service provider has ordered the system for its new NYC3 data centre in lower Manhattan. Telx currently serves 1,200 customers via a network of 20 data centres across the USA with total power consumption over 115 MW.

Telx will incorporate Decathlon into a 3 MW data centre as part of a renovation of a 10th floor space at 32 Avenue of the Americas. It will use Decathlon to optimise the energy consumption and cooling in the new data centre by managing some 14,000 calculated points.

According to Telx’s leadership team, one of its major reasons for selecting Decathlon was its open platform designed and built with industrial controls rather than with the office building management approach that is typically used by other DCIM products.

Plus, the system will give Telx a single view of its entire data centre operation and Telx will be able to continuously update and expand its infrastructure with functional components from any vendor.

Rich Ungar, Head of Data Centre Automation for ABB in North America said: “In evaluating infrastructure management systems for its Manhattan site, Telx project leaders found three advantages in ABB Decathlon. Its industrial control perspective offers exception reliability and operational control. Its enterprise support has a software package that can unify their new systems with their existing data centres. Plus the commitment of ABB to provide the software and services in a timely cost-effective way was also an advantage.”

Download Decathlon for a free trial

Data centre operators can download a preview version of Decathlon to evaluate the software first-hand. The trial software is available in two options: a preview for power distribution and a preview for power meters.

Installation is quick and easy on a Microsoft Windows operating system with IP connection to devices. Using a web browser, the user can configure the service and monitor equipment. An auto-discovery setting will identify connected devices, minimising set-up time.

Search on ABB’s website for ‘ABB Decathlon Preview’ to find and download either version of the software for a 21-day trial period.
Reconfigure without powering down

In a fast-paced data centre environment, operators have the challenge of minimising their investment in infrastructure while ensuring the flexibility to adapt to future hardware changes. ABB’s low voltage MNS PDU (power distribution unit) gives the flexibility to reconfigure, expand and modify without disrupting live operations.
High value computer installations need to operate on a 24-hour 365-day basis to ensure availability of data and processing for national and multi-national corporations. Data corruption or loss following an unscheduled power interruption of just a few minutes can take weeks to retrieve.

With this in mind ultimate reliability in a data centre’s power distribution system is vital. Down-time is extremely rare and so the industry requires products where traditional maintenance has been ‘designed out’ and which allow asset migration during live operations.

Expanding, updating and maintaining networks calls for system managers to add or remove hardware without disrupting the operation so the power distribution system should allow parts of the system to be removed while adjacent circuits remain live.

**Flexibility**

ABB’s MNS PDUs (power distribution units) are high-level distribution boards designed specifically for computer rooms and data floor environments. The modular switchgear is built for flexibility and SPN, SPSN, 3-pole and 4-pole modules can be mixed and matched on the same PDU without the need to power down the installation or replace or modify the existing PDU.

At the heart of the cabinet is the ‘multi-functional wall’, a patented precision-moulded composite barrier that is both the carrier for the distribution busbars and the segregation between them and the main busbars. This touch-proof compartmening keeps technicians safe from hazardous voltages and maximises uptime.

**Reliability**

The switchgear is part of the MNS family of switchboards, PDUs and motor control centres that are designed for a life of more than 25 years. Based on ABB’s tried and tested technology, today there are more than 1.8 million MNS cubicles in operation in all types of industrial environment.

One aspect of the design that enhances reliability is that the precision engineered power stabs are independently certified for more than 1,000 operations, which is more than five times the industry standard. Plus, cable forces are decoupled from the power stabs, reducing cable stress and breakage. Individual venting of compartments leads to better cooling and eliminates thermal interference and hot spots to further increase reliability.

Real-time condition monitoring allows operators to monitor the health of their assets and address problems before they occur, reducing downtime by as much as 50 percent. In addition, redundant communications interfaces ensure 100 percent process control back up.

**Modularity**

Because the MNS is modular, it allows operators to adapt through the life of the data centre and expand to meet growing demand. Additional client cabinets can be added with minimal downtime and satellite client cabinets can be added without interruption to supply.

The MNS platform provides the flexibility to mix and match feeders, motor starters, variable speed drives, soft starters, and reactive power compensation, all in a single line-up.

The mechanical structure and the main bus bar system are designed to be maintenance-free and front accessible. By eliminating the need to access the equipment from the rear, MNS can be installed virtually anywhere in a facility.

**Ease of maintenance**

The MNS product family is designed for lower maintenance requirements. All operators require a certain amount of planned downtime for essential maintenance activities and to keep everything in working order. ABB has built reliability and ease of maintenance into MNS with aspects such as withdrawable units, which keep maintenance downtime to minutes instead of hours. This enables facilities to get back on line 20 to 30 times faster than common fixed installed starter modules. Plus, standardised parts leads to simple and straightforward maintenance, enabling customers to reduce their spare parts inventory.

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**Features of the MNS PDU**

- The MNS is suitable for switchboard, motor control centre and PDU applications at up to 8,000A continuous or 120 kA fault current. It is AC and DC rated, arc fault tested to IEC 61641 and seismic tested.
- It allows designers, installers and operators to:
  - Adapt through the life of the data centre, not the process
  - Expand and modify without powering down
  - Populate as required
- Asset manage through modular design
- EPO (emergency power off) test without powering down
- Provide backwards and future compatibility
- Reduce downtime by using an approved maintenance-free busbar system
- Apply non-intrusive maintenance
- Carry out simple installation
Emax 2: from circuit breaker to power manager

Rob McCaskie, ABB’s Product Manager for Power Circuit Breakers in the UK, explains how the new Emax 2 concept enables a low voltage air circuit breaker to become a power management device fit for the smart grid age.

The Emax 2 circuit breaker is ideally suited to applications such as data centres where protection and control of large amounts of energy are used in a low-voltage environment. Replacing an existing circuit breaker with the new Emax 2 is technically simple and energy savings will typically pay for the new equipment within one year.

By integrating compatibility with the IEC 61850 standard, the breaker has extended ABB’s IEC 61850 offer across high, medium and low voltage circuit breakers. ABB introduced its Emax 2 low voltage circuit breaker to meet calls for greater performance in a more compact design, combined with enhanced control functionality. The time had come for a major evolutionary step in low voltage technology so we effectively started from blank sheet of paper to create the brand new Emax 2 design.

The most obvious difference is the low size and weights compared with previous models. An Emax 2 unit rated for an uninterrupted current of 1250 A weighs 32 kg, compared with 60 kg for the original Emax. Another obvious advantage is the user-friendly touchscreen interface.

But to see the real difference we need to explore the Emax 2’s full capabilities that enable it to cover power management, among many other things.

Control
Central to the operation of the Emax 2 is a protection trip relay with an integrated power controller that measures and evaluates energy consumption, then manages the loads to maintain or reduce the demand for power.

To manage this, the Emax 2 switches off the power to non-essential equipment, returning it as soon as acceptable power levels are reached. A built-in controller and software uses complex algorithms to take low priority loads offline when demand rises.

The Emax 2 also integrates new generation Rogowski sensors to measure current, voltage, power and energy to high precision. The in-built sensors eliminate additional external instrumentation, freeing up space and funds. Plus, by eliminating instrument transformers, the Emax 2 consumes less power, saving on running costs.

The conventional method for switchboard control is to equip circuit breakers with complex communication systems and
programme the supervision software. However, by integrating a system called Ekip Link, the Emax 2 can be controlled either locally through a user-friendly colour touchscreen or remotely via the web. It’s a plug and play system that saves on the need for specific programming, meaning that it provides an economic way for a small plant to increase its monitoring capabilities or for a large plant to simplify local supervision and maintenance.

Connectivity
Multiple cartridge communication modules can be fitted to the circuit breaker at any time. These integrate the module into automation and energy management systems through the seven most popular global communications protocols, including IEC 61850, future-proofing the breaker for extensions or alterations.

The units have been designed for flexibility of installation. The rear terminals can be rotated from horizontal to vertical on-site and have been designed to fit the most common bus configurations. Installation is designed for simplicity of connection and installation and each terminal has been created to the standard width of bus bar for its current, meaning that less bus bar stock is required.

Further flexibility comes from the ability to modify the neutral position from left to right. And the largest model, the E6.2 is available with neutral conductor sizes of 50 or 100 percent to allow for the correct sizing of bus bar and an opportunity to reduce construction costs.

Performance
Four frame sizes are available and each is sized to be only as wide as its current rating requires. This means that panel designers can optimise their use of space and materials.

A fan module contained inside each unit continuously monitors the internal temperature of the fixed switchgear part and activates cooling fans if required. This enables the increased current-carrying capacity.

Ease of use and safety
The large colour touchscreen display provides clear and simple navigation in ten languages for quick access to information and adjustment capability. Because they can be read and used directly, there is no need for an expensive human machine interface.

Plus, they can be accessed and programmed via a smartphone, tablet or computer using the Ekip Connect application. Breaker settings can be implemented with ABB’s DOC software and the Ekip Connect interface. This avoids possible errors when retyping the settings into the breaker or software programme.

In terms of safety, an accessory mounting area is kept separate from the operating mechanism and it’s possible to lock the breaker during maintenance to avoid unwanted operation. Dedicated guide rails ensure correct, locked and clearly identifiable positioning on the withdrawable part. The rails extend outside the fixed part for easy insertion of the mobile part and shutters on the fixed part can be locked from the front.

Learn more about the Emax 2 at abb.com/emax2.
The DPA way

Why decentralised parallel architecture (DPA) increases UPS availability and lowers cost of ownership.
An uninterruptible power supply (UPS) ensures a continuous source of clean power. But the UPS itself can become a focus of reliability. Because in many cases, the result of a UPS failure could be catastrophic for a data centre – causing chaos for credit card companies, banks or online traders. That’s why their most critical loads are protected by the very best UPS design - decentralised parallel architecture (DPA). DPA not only provides the best availability, but also the best serviceability, scalability and flexibility. Taken together, these features all deliver a low total cost of ownership (TCO).

Availability
Availability measures how much time per year a system is up and available and is one of the most important reliability parameters for IT equipment.

Since power problems are the largest single cause of computer downtime, increasing power availability is the most effective way to increase overall system availability.

Power availability has two components: mean time between failures (MTBF) and mean time to repair (MTTR). Therefore, two most important issues in increasing power availability are increasing the MTBF and decreasing the MTTR of the power protection system.

DPA architecture
UPS systems with a centralised parallel architecture (CPA) have some degree of hierarchical, centralised control or hardware (e.g. static bypass). They are vulnerable as one fault can bring down the entire UPS. With DPA, the UPS is modularised and each module has all the hardware and software needed for autonomous operation - rectifier, inverter, battery converter, static bypass switch, back-feed protection, control logic, display, and mimic diagram for monitoring and control. A module’s output is not affected by failures elsewhere in the UPS. If redundancy is provided for, i.e. there are more modules than needed to supply the critical load, then one or more modules can be lost without jeopardising the load.

In other words, a multimodule system is fault tolerant and there are no single points of failure. Availability is maximised.

DPA – load transfer and load sharing
The CPU in each UPS module continuously monitors the status of its inverter, bypass and loading and shares this information with the other CPUs. In the event of a fault, the CPU of each module reports the availability of the module’s inverter and bypass to the module system logic. Based on this information, the modules then decide together if the critical load should remain on the inverter or be transferred to the bypass.

For load sharing the situation is different. One module is the master and all the others are slaves. The master’s control circuit continuously monitors the current in each module and, if it is deviating from specification, a message is sent to the relevant modules to regulate their current. Should a master module fail, the next module takes over as master.

These DPA decision making and load sharing features are at the core of its ability to maximise system availability.

Modularity and redundancy
A major advantage of DPA's modularity is the ease with which redundancy can be accommodated.

If N UPS modules are needed to cover the power needs of a particular critical load, then, often, one extra module is used so that even if one module subsequently fails there are still enough healthy modules left to power the load. This is called N+1 redundancy. Of course, an entire second set of N modules could be held in reserve – this is even more reliable and is called 2N redundancy. To further improve reliability one module extra could be added to each set, giving 2N+1 redundancy, and so on, though 2N+1 is usually quite sufficient to cover most premium reliability and availability requirements.

Scalability
As UPS power requirements change – if a data centre is expanded for example – the modular nature of DPA makes it really easy to add modules and increase the power capabilities. So, there is no need to over-specify the initial configuration to cater for future expansion, modules are added as required. The operator then only has to add power and cool what they need. Power consumption is a major concern for most operators and the energy savings offered by the modular approach over the service life of the UPS are substantial.

Hot-swapping and serviceability
Modules can be hot-swapped, i.e. removed or inserted, without risk to the critical load and without the need to power down or transfer to raw mains supply. This unique aspect of modularity directly addresses continuous uptime requirements, significantly reduces MTTR, reduces inventory levels of specialist spare parts and simplifies system upgrades. This approach pays off too when it comes to serviceability and availability. Online swapping of modules means there is no need to switch off during replacements, so there is no downtime and service personnel do not need special skills.

This online-swap technology, as well as having a significant impact on cost, can also help achieve six nines (99.9999 percent) availability - highly desirable for installations in pursuit of zero downtime.

Energy and space costs
The modularity and scalability described have a major positive impact on achieving a low cost of ownership. Costs are also minimised by DPA designs that have best-in-class energy efficiency. ABB’s concept-power DPA 500, for example, operates with an efficiency of up to 96 percent (in-class energy efficiency). ABB’s concept-power DPA 500, for example, operates with an efficiency of up to 96 percent. Furthermore, cooling costs can be substantial and, because less power is consumed, high-efficiency modular UPSs require less cooling effort, creating further savings.

Modularity lends itself well to keeping the UPS footprint small, too, which is ideal where real estate is limited and expensive.
ABB has launched the PCS100 Medium Voltage UPS (PCS100 MV UPS), designed for mega data centres and large critical industries.
The new PCS100 MV UPS offers medium voltage capability – 6.6 kilovolts (kV) and 6 Mega Volt Amperes (MVA) – for the mega-size data centres, which are increasingly being developed to satisfy the current global expansion in cloud computing and co-location services.

ABB already holds a strong market position in industrial power protection for data centres with a substantial installed base of the low voltage PCS100 UPS-I industrial UPS product. For many years these highly efficient and reliable products have protected some of the world’s most critical data centres from voltage sags and outages. The trend towards free air cooling and centralised protection makes medium voltage UPS protection an industrial solution which makes medium voltage UPS protection with an industrial rating product a very attractive solution.

The PCS100 MV UPS is also applicable for retrofits, allowing for custom designs that suit applications in data centres that need additional protection or where traditional rotary UPS solutions require replacement.

Because the energy storage is kept at low voltage levels, a wide range of energy storage options are available from traditional lead-acid batteries to super capacitors and lithium-ion batteries.

One of the challenges facing design engineers is the limited fault current capacity of many traditional static UPS designs. The rugged fault and overload capability of ABB’s medium voltage UPS allows for better electrical protection and discrimination, which in itself has a major impact of overall system reliability and availability.

Total cost of ownership is a major consideration when selecting power protection equipment. The PCS100 MV UPS is designed to minimise life cycle costs with very low losses and a wide operating temperature range which reduced cooling costs. While many commercial UPS designs have capacitors and other core components selected with a design life of five or fewer years, ABB has targeted a design life of more than 10 years. In terms of overall lifetime cost, the reduced maintenance saving is huge. The very small footprint and ability to locate the product remotely from the protected loads also result in reduced ownership cost.

Watch a video on ABB’s YouTube channel on the UPS called ‘ABB’s PCS100 Medium Voltage UPS’

Voltage and current conditioning

While the UPS is often the technology of choice for a data centre, it can come at a relatively high operational cost particularly as a result of the need for battery maintenance and replacement. In a typical power system, some 90 to 95 percent of voltage events that cause problems are voltage sags which can be corrected with a voltage conditioner.

ABB’s PCS100 AVC range of active voltage conditioners correct voltage sags and surges within a few milliseconds while maintaining exceptional efficiency. For applications where outage ride through is not required they can offer an ideal solution. This can include bypass (or reserve) supply conditioners for UPS, conditioning of balance of data centre loads to prevent nuisance trips through to conditioning the alternative feed on a dual reticulated server protection application where running two independent UPSs is not justified.

Voltage disturbances are not the only power quality problem present in data centres. Power electronic loads on both the balance of data centre equipment and servers can create harmonic and power factor problems. Most servers utilise wave shaping rectifiers on their switch mode power supplies but these will often draw leading reactive current (capacitive) under light loading conditions. As most of these supplies are redundantly configured they do run very lightly loaded.

Harmonics and power factor problems cause increased apparent power (kVA) loading on the electrical supply often resulting in higher electricity charges from the utility. Most data centres also run standby diesel generators and they can require considerable de-rating for poor power factor, harmonics and supply imbalance.

Leading power factor is a particular problem for generators and even quite low levels of leading reactive current can cause the alternator to enter an unsafe operating area and potentially lose control of voltage.

The PCS100 RPC Reactive Power Conditioner is an active solution to power factor and low order harmonic problems. Its fast operation and flexible control mean even the most difficult power factor problems including leading power factor are resolved. In addition to power factor and harmonics the RPC can also correct the component of supply imbalance, negative sequence current that is most problematic for diesel generators.
Cool running

Heat generation is a cause for major concern in data centres. Indeed, up to 45 percent of their total energy usage can go to just cooling the server racks. Servers are becoming ever more compact and, as a result, power densities are increasing. At the same time, the heat flux from commercial microprocessors has increased from around 1 W/cm² to 100 W/cm² over the past decade and is expected to rise further. So there is a massive increase in the demands placed on cooling systems.
Data centre cooling requires the transfer of heat generated by the IT equipment to the environment in a two-step process. The heat is first transported by a medium (air or liquid) out of the server racks and then it is rejected to the environment, both these steps consume electrical energy. The target of cooling efficiency measures is to reduce the energy required to remove the heat and recover and reuse as much of it as possible. This can be achieved through innovations in the design of the cooling system itself as well as by inventive operating strategies – e.g. Smart sensing and monitoring and integrated system management.

**Novel cooling designs**

There are various cooling technologies at different stages of commercial maturity and some of these show promising results:

- Aisle containment is practised commercially and can improve system efficiency by up to 30 percent.
- On-chip cooling is at a preliminary research phase and has been reported to achieve cooling of up to 15°C for heat fluxes as high as 1,300 W/cm².
- Liquid cooling is expected to reduce cooling energy consumption by as much as 50 percent compared with conventional air-cooled systems and is being commercialised now.
- Membrane air drying and evaporative cooling is reported to reduce energy requirements by up to 86.2 percent compared with conventional mechanical vapour compression systems.
- The waste heat from a data centre can be augmented by solar thermal energy to drive an absorption chiller, further improving power usage effectiveness.

Liquid cooling, absorption cooling and evaporation-based cooling are already applied in other industries. However, data centres pose unique challenges in terms of the variable heat generation associated with highly dynamic load behaviour and the requirements for high reliability. ABB’s expertise in ensuring the high reliability of critical power system components, combined with extensive experience in integrated process management, can help address the integration challenges of novel cooling technologies.

**Monitoring and sensing**

The first step in managing and controlling cooling is to monitor the thermal behaviour of the data centre. Hot spots are a major concern and they can be detected using infrared sensing or wireless sensors. Soft sensors that combine data already available with detailed computational fluid dynamics models, or empirical models, are another important tool.

ABB has demonstrated the use of concepts such as infrared sensing, wireless communication, soft sensing and fingerprinting across different application areas in the power and automation domain. This knowhow is being extended, with suitable adaptations, toward data centre performance monitoring.

**Cooling control**

A data centre cooling unit has a chiller, cooling tower, pumps and thermal storage. It often also has an economiser, which provides a form of ‘free cooling’. Economisers complement the existing cooling by drawing in colder outside air and using it to reduce chiller energy consumption. The external air passes through one or more sets of filters to catch particulates that might harm the hardware. It is also conditioned to an appropriate relative humidity.

Optimising such a cooling system in an integrated way involves minimising the net cost of power while ensuring that cooling requirements for a given IT load are met. This often results in a complex demand-response problem that involves inputs of weather forecasts, energy prices and load-versus-efficiency curves for all the equipment involved. An integrated cooling approach involving only economiser integration, along with model predictive control strategies for temperature control, has been shown to reduce cooling management costs by up to 30 percent. This situation can be further improved by the use of additional storage and demand-response management to exploit energy price variation.

**A modular approach**

Modular cooling units allow data centres to expand their capacities incrementally. However, they present a challenge to integrated cooling control as there is an interaction between them and related common facilities such as the chiller, evaporator and economiser. This poses additional constraints on the integrated cooling control challenge.

ABB’s cpmPlus Energy Manager has the ability to handle such integrated demand response management problems to help customers realise additional benefits.

**Integrated management of power, IT and cooling**

In almost all existing data centres IT load management is not coupled with the cooling management or the power supply. That means the IT load management software makes an independent decision to start new IT jobs, or when to migrate running jobs, without any consideration for the cooling or power required. This ‘selfish’ behaviour can reduce the power used by the IT equipment, but at the expense of a higher cooling energy consumption.

To avoid these problems, coordination of all three subsystems is required. Furthermore, it is also necessary to have a dynamic and predictive IT load management tool so that the data centre location and corresponding time-varying energy provisioning can be taken into account. This kind of advanced load management, which could be integrated with ABB’s Decathlon data centre infrastructure management (DCIM) system, can deliver energy savings of 20 to 40 percent.
Variable-speed drives keep costs in check

Carl Turbit, Team Leader for HVAC Drives for ABB in the UK, explains how the relatively straightforward action of retrofittting variable-speed drives to the motors in HVAC systems can help data centre operators reduce the energy costs from such systems by up to 70 percent.
Conventionally, fluid or air flow rates in cooling systems are controlled by ‘throttling’ the flow with valves, vanes or dampers while the pump or fan works at a fixed speed using a fixed speed motor. But the power required to run a pump or fan changes with the cube of its speed. In practical terms, this means that a centrifugal pump or fan running at 80 percent speed consumes only half as much energy as a unit running at full speed. Even a small reduction of just 7 percent speed, 3.5 Hz can deliver a 20 percent energy saving.

By introducing variable-speed drives (VSD), data centre operators can take advantage of this phenomenon and reduce running costs with a payback period as short as six months. Plus, because the VSD has the capability of optimising the current on start up this puts mechanical assets under less strain. The cost of maintenance can be reduced and equipment can last longer, typically 25 percent.

Another benefit is that reducing the running speed of motors may avoid the production of harmful harmonic waveforms on supply lines and cut ambient noise.

The drives are also eligible for the government’s Enhanced Capital Allowances, as well as helping qualifying organisations reduce their energy use and emissions as required by the CRC Energy Efficiency Scheme.

Operationally versatile
With a range of pre-loaded macros, ABB drives can be readily set up to run any of the cooling and air conditioning applications in a data centre – supply fans, return fans, liquid cooler fans, condenser water pumps, chiller compressors or chilled water pumps.

Selecting a macro sets up the drive for the expected duty. An ABB drive can increase the system’s efficiency by adjusting the motor speed to the correct operation point, reducing running costs by 20 to 70 percent. The drive incorporates a kilowatt hour calculator to enable easy monitoring of energy consumption, as well as calculating the energy saved compared to a direct-on-line system in terms of carbon and money. The drives also incorporate energy optimisers to minimise energy usage continuously throughout the drive’s life.

ABB’s ACS880 and ACH550 drives are popular with data centre operators and one major operator was able to cut £140,000 from its air conditioning bill, as well as save 1,300 tonnes of CO₂ production per annum after installing ABB drives.

Supporting maintenance
ABB drives feature a real-time clock with calendar function, enabling users to schedule activities for different times of the day or week. The timer function enables the drive to be used as a small building management system (BMS), as the I/Os can be used to control other devices. Any faults within the system are recorded by the real-time clock with a time and day stamp.

Using the real-time clock, users can set limits for running hours or motor rotation, so that the drive gives an alarm when the limits are reached, enabling preventive maintenance at regular intervals.

Starting, stopping and braking can be programmed to reduce stress on mechanical equipment such as pumps and fans. This increases equipment life and reduces maintenance requirements for pumps, motors and pipework.

Minimising harmonic pollution
Under the Electricity Association’s recommendation G5/4, the users of drives are responsible for keeping harmonic pollution within certain limits. ABB drives offer swinging DC chokes that suppress harmonics caused by the inverter, reducing total harmonic distortion by up to 25 percent at partial loads. ABB drives can also be offered with low harmonic rectifiers, or with active closed loop harmonic suppression to bring harmonic levels within the G5/4 limits.

Lowering motor noise
A noise optimisation feature increases the switching frequency of the drive when the motor load is reduced, lowering motor noise. Noise is further reduced through the higher switching frequency of the sensorless vector control platform, a motor control method used to maximise torque production in the motor. The on-board cooling fan runs only when necessary, reducing noise levels further.

Specify VSDs with confidence
VSDs have changed dramatically in recent years, becoming more efficient with fewer losses. They offer greater energy efficiency, which leads to reduced energy bills, faster installation and commissioning times and lower noise levels. Plus the effects of harmonics can be avoided with technology such as winging chokes that help to reduce harmonic levels by 25 percent.

Many drives have features such as the ability to pre-programme drives, a drive control panel, multilingual alphanumeric displays or the facility to copy the drive’s parameters for backup or downloading to another device. And there’s more to specifying VSDs than just the product. As much emphasis should be given to the levels of service and support that a manufacturer or supplier offers.

To help building services consultants specify VSDs with confidence, ABB has published a checklist so that the VSD has the right features as well as service and support levels for their building. The checklist is included in ABB’s publication ‘A guide to selecting variable-speed drives for use in buildings – Checklist for building services consultants’.

It is available on ABB’s website or from ABB’s BrochureLine on 0800 783 7491 or energy@gb.abb.com.
Lifetime service for data centre power assets

It’s vital to maintain data centre power assets to ensure optimum performance, to prolong the life of equipment and avoid costly equipment failures. ABB offers a comprehensive service that enables our data centre customers to continue to enjoy safe, reliable, efficient and profitable performance from their power assets, large or small.

Understanding unique service needs, ABB’s approach to service is based on customer collaboration. Together with our knowledge base and skill sets, this enables us to provide service solutions tailored to meet individual customer requirements.

Our customer support can commence at any stage of product ownership, from pre-purchase engineering to attending factory acceptance testing, end of life expectancy and all stages in between. We can assist with training of customer personnel, through to planning preventative maintenance and execution of all works.

Service Level Agreements (SLA)
By implementing an SLA, our customers benefit from guaranteed 24/7 technical support; a scheduled agreed preventative maintenance plan and guaranteed agreed rates for any unplanned maintenance. By contacting our 24 hour hotline, our customers have instant access to our technical support and skilled maintenance teams who can effect round the clock emergency repairs to their network.

ABB’s Service Strategy
At the centre of our service strategy is an understanding of the customers’ assets. In-depth knowledge of the actual status of equipment is based on the recorded history of assets, review of their design and advanced diagnostic techniques. This enables us to identify potential faults before they happen and put in place condition-based maintenance schedules or take corrective action.

ABB has a network of certified regional service hubs around the world, from which we can provide a fast response. Personnel with the right qualifications and certifications operate under rules and regulations to ensure reliable and safe operation.

Wherever possible, we carry out all work on-site at the customer’s facility but when more extensive work is needed, full factory repair and refurbishment of major plant such as transformers can be arranged in one of our specialist facilities.

Our customer tailored maintenance plans, which include inspection, maintenance and repair, enable our specialist engineers to ensure that critical high-value network assets are maintained in optimum condition, to guarantee maximum reliability and safety.

Power networks
ABB specialises in the service of all aspects of electrical power distribution equipment and networks including transformers, cables and control systems, from 400 kV down to 400 V for utility, industrial and public sector customers.

Cable fault location
ABB’s service engineers are equipped with a suite of test equipment that enables them to perform immediate on site diagnostics on the key network elements of switchgear, transformers and cables. If the fault is identified in a cable – as is often the case – and the network is interconnected,
they can sectionalise the problem circuit to restore power to as much of the network as possible, bringing in additional generation if necessary. The next task is to locate the position of the underground cable fault with maximum accuracy, since this makes it easier to find and repair so that the full network can be restored quickly.

Our fault location regime is very accurate in locating underground cable faults in both modern XLPE type cables and older PILCSWA (paper insulated lead covered steel wire armoured) designs. It is usually carried out on cable networks up to 11 kV, however the techniques can be applied on cables up to 33 kV.

Remote condition monitoring
Remote on-line monitoring is the best tool data centre operators can use to increase performance, reduce failure risks and cut maintenance costs on their power network assets. Compared to traditional diagnostic methods, which are performed onsite with the equipment de-energised, monitoring gives the asset owner access to real-time condition information, even from remote locations. When changes in conditions are detected, the operator is notified immediately.

Through remote access, ABB helps asset owners to evaluate the status of their equipment without dispatching an engineer to the site, saving both valuable time and resources. Since monitoring detects condition changes in real-time – versus periodically with traditional diagnostic methods – the asset owner has time to plan and act before a fault can result in data centre downtime.

Lifecycle management
As infrastructure ages, it’s important to be ready to address obsolescence, maintenance, reliability and safety issues. In support of this, ABB is the first major switchgear supplier in the UK to offer an Energy Network Association assessed retrofit of out-dated and ageing switchgear at medium voltage. This can enhance the life of time-served switchgear by 20+ years at a cost that is typically around 30 percent less than completely replacing the switchboard.
We take a systematic approach to cyber security through our operations on a global level. For instance, we have established the Power Systems Security Council to keep track of global needs and requirements concerning cyber security. The mandate of the council is to ensure that products and solutions used in power systems meet the expectations of our customers.

Besides continuously adapting security requirements to keep up with changing demands, the Security Council drives proactive R&D efforts to address emerging trends and ensures fast and efficient security improvements. We also recognise the importance of cyber security standards and we are an active member in several industry initiatives, including IEEE and IEC. This involvement ensures that the specific needs of our customers are considered in the creation of new standards and that ABB remains abreast of new developments. It also enables us to incorporate new standards into our products and systems, helping our customers to comply with new regulation as it comes into force.

To ensure reliability and availability of electrical power, ABB has developed the SDM600 as a data manager for the whole system. It checks the credentials of cyberspace visitors on behalf of network equipment, it logs IED (Intelligent Electronic Device) disturbances to produce comprehensive reports, and it tracks software versions to ensure everything is kept up to date, all with a unified interface for comprehensive management.

We have also established a strategic partnership with the well-known cyber security company Industrial Defender to provide in-depth monitoring, enhanced management and protection for utility operations networks that can complement the SDM600 Data Manager platform.

Ultimately, cyber security is about much more than having a firewall and anti-virus protection. It’s really a state of mind.

ABB has identified cyber security as a key requirement for data centre power projects and we are committed to providing products, systems and services that clearly address this issue.

ABB has a strategic partnership with Industrial Defender