Focus on power grids

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ABB’s Power Grids division is the world’s leading supplier of power and automation products, systems and service solutions across the power value chain of generation, transmission and distribution serving utility, industry, transportation and infrastructure customers directly and through channel partners. The division is focused on addressing key areas such as the integration of renewable energies, growing network complexity, grid automation and microgrids. The division also offers a full range of consulting, service and asset management solutions based on a lifecycle approach.

Dear reader,

When National Grid published its Future Energy Scenarios report in July, it generated a great deal of interest in how the grid will respond to an increasingly uncertain world. Industry insiders grapple every day with the challenges of maintaining a reliable and sustainable power supply – but it’s rare that these catch the eye of the wider public, so the report is worth celebrating. On page 28, our Technology Strategy Manager Peter Jones explores one of the themes of the report.

Elsewhere in FFWD, we’ve highlighted some recent project wins and new technology applications in the UK. One particularly interesting project comes from the rail sector, where we have won a contract to supply a Static Frequency Converter to upgrade the power supply for the East Coast Mainline – see page 14 for details.

And we were extremely pleased when the Minister for the Northern Powerhouse opened the Energy Centre at Chester University, where ABB supplied protection and control equipment that will support the university’s research into the future of microgrids (see page 8).

Service and optimisation of existing assets are also always at the forefront of our minds here at ABB and our recent repair of a failed transformer for CEMEX in Rugby on page 30 is an example of how our high voltage transformer service team goes the extra mile.

So whether your focus is utility T&D, renewable energy, industrial power or rail traction power, in ABB our work touches on all sectors.

We hope that you enjoy reading FFWD magazine. As mentioned in the news section on page 7, we need to refresh our mailing list in line with incoming data protection law, so please re-register and also take a moment to give us your feedback via our readers’ survey at: abb.co.uk/ffwd

Best wishes,

Karen Strong, Marketing Communications Manager for ABB Power Grids
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Major order for Hinkley Point C

ABB has won an order of around $130 million (£99 million) to build the power transmission infrastructure for EDF Energy’s new Hinkley Point C power plant in Somerset. This will be the UK’s first new nuclear power plant to be built for a generation and will provide seven per cent of the country’s electricity from 2025.

“This is a great opportunity to showcase ABB’s global expertise in executing large, complex and time-demanding projects,” says Claudio Facchin, President of ABB’s Power Grids division. “It reinforces ABB’s focus on leveraging its vast portfolio, technology strengths and project management capabilities to deliver differentiated customer value and enable a stronger, smarter and greener grid.”

ABB’s UK Power Grids businesses will be responsible for the design, supply and installation of the power transmission infrastructure, including substations for two separate units that will feed 3200 megawatts (MW) of power produced by Hinkley Point C to the National Grid. The plant will be capable of supplying around 6 million UK homes with electricity.

The project will create 25,000 job opportunities and 1,000 apprenticeships during construction and is already one of Europe’s largest construction sites. Some 2,000 people are working at the Somerset site every day.

Stuart Crooks, Hinkley Point C Managing Director, said: “We have signed over £9 billion of contracts and this major contract marks another significant step forward for the project.

“Hinkley Point C is bringing together companies and expertise from the UK, France and the world.

“Construction is fully underway and we remain firmly focused on what we need to deliver in the year ahead and beyond.”

As part of the contract, ABB will supply six 700 Megavolt ampere (MVA) generator transformers, six auxiliary transformers, 400 kilovolt (kV) gas insulated switchgear, control and MicroScada systems as well as the transmission feeds to transfer power from the plant.

Network reinforcement at Shurton

As well as delivering the Hinkley Point C grid connection for EDF Energy, ABB has also won a contract from National Grid to reinforce its high voltage infrastructure to accept electricity produced by the new power station.

Under this contract ABB will design, manufacture and install a brand new 400 kV substation at Shurton.

New double circuit connections will connect to National Grid’s existing substations at Taunton and Melksham. The new Shurton substation will feature gas-insulated switchgear (GIS) and gas-insulated busbars (GIB) and will be housed in a compact building as space on site is restricted. ABB will also deliver advanced digital control, protection and telecommunications systems.

Sue Adam, National Grid’s Head of Major Infrastructure Development, said: “This is a significant project for National Grid. Connecting this new low carbon source of energy into our network will help meet the country’s increasing demand for sustainable energy. We are delighted to award the contract to build the new substation to ABB, which will be a vital link between the new Hinkley Point C power station and the electricity network.”
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### Improving the UK’s industrial productivity

A reception at the House of Commons in June was the ideal opportunity for ABB to highlight to MPs, policymakers and business leaders the urgent need to tackle the UK’s productivity record with investment in digital skills and technologies.

ABB’s UK Managing Director Ian Funnell used the event to raise the debate on industrial digitalisation, quoting the World Economic Forum’s research that 65 percent of children entering primary school today will eventually work in new types of job that don’t yet exist.

The event was hosted by Claire Perry, Minister of State for Climate Change and Industry and Bill Cash, MP for Stone, Staffordshire. Claire Perry said: “the Government wants to work with companies like ABB to help make us a more attractive place to invest and to ensure our industry is competitive on the global stage.”

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### Doubling the voltage of wind turbine transformers

A new generation of powerful offshore wind turbines will operate at a world record voltage of 66 kV, twice the existing 33 kV level. The WindSTAR transformer can fit into the tower of a wind turbine and by boosting the voltage the new transformer will increase the efficiency of the wind generation systems and help to reduce losses.

ABB has already delivered five new WindSTAR transformers to MHI Vestas Offshore Wind for the world’s first 66 kV offshore wind farm. Located off the coast of Northumberland, the 41.5 megawatt (MW), five-turbine Blyth Offshore Demonstrator will deliver enough clean power for 34,000 homes.

Markus Heimbach, Managing Director of ABB’s Transformers business said, “The development facilitates the integration of offshore wind energy, bringing clean power to people and reinforcing our position as a partner of choice for enabling a stronger, smarter and greener grid.”

Eleven more transformers will be installed in large-scale offshore wind turbines at the European Offshore Wind Deployment Centre, a 92.4 MW offshore wind test and demonstration facility located 2.4 km off the coast of Aberdeen Bay.
FACTS technology smooths the way for East Anglia ONE

ABB has won an order from ScottishPower Renewables to supply two SVC Light® Static Compensators (STATCOMs) for the East Anglia ONE wind farm. Located approximately 43 kilometres off the Suffolk Coast, the wind farm is expected to provide 714 megawatts (MW) of renewable wind energy from 102 wind turbines to meet the needs of over 500,000 homes.

The STATCOMs will smooth out the voltage fluctuations that are an inherent feature of intermittent wind energy. They will increase power transfer capability, improve power quality and enhance grid stability, enabling more energy efficient and reliable power supplies for millions of consumers.

STATCOM is part of ABB’s family of FACTS (Flexible Alternating Current Transmission Systems) technologies that help reduce losses, enhance the capacity and flexibility of power transmission systems and contribute to more efficient and reliable grids. Acting as the brain of the STATCOM is the ABB Ability™ MACH system which monitors, controls and protects the sophisticated technology in the station.

Two advanced ABB TrafoStar™ Autotransformers will be incorporated in the STATCOM system. These compact and low weight transformers are ideal for this type of application as they combine the functionality of two transformers in one, while boosting energy efficiency by significantly reducing the total losses.

The sound of silence

Workers at two of ABB’s construction sites have reduced overnight noise and reduced impact on neighbours, according to Health, Safety & Environment Manager Paul Lightfoot.

Site teams traditionally rely on diesel generators to power lighting and other loads. However, ABB has implemented hybrid units that integrate a diesel generator with battery energy storage. The systems deliver silent and emission-free power to site cabins out of hours, meaning that the noise level overnight is reduced.

Telemetry data showed that the hybrid generators halved the runtime of the diesel gensets, saving 1,200 litres of fuel and more than 3 tonnes of CO₂ emissions per week.

Paul Lightfoot said: “Being a good corporate citizen is central to ABB’s success. Positive perception by neighbours and other stakeholders around our sites flows reflects well on us as our customers recognise that we deliver projects smoothly and efficiently without ruffling feathers.”

Planting the seeds of sustainability

A week of activities following World Environment Day on 5th June 2017 emphasised the importance of sustainable practice. The week highlighted how ABB’s business and construction activities can impact the environment and our neighbours and stakeholders. Events included demonstrations on wildlife and emergency response. A photography competition will form the basis of a 2018 calendar.

Jon Downs, General Manager of ABB’s Substations business, said: “ABB employees came up with practical and achievable actions that can improve our sustainable performance. For example, by switching off electric signage, we’ll cut our energy consumption.”
ABB is acquiring the mission-critical communication business of the KEYMILE Group to strengthen its communication networks portfolio. KEYMILE is a leading manufacturer of mission-critical and broadband telecommunication solutions, with installations across 100 countries. It is based in Hanover, Germany and will form part of ABB’s Grid Automation business within the Power Grids division.

Mission-critical systems such as electrical grids require communication networks with unparalleled performance and robustness based on special technology, protocols and software. This means that reliable information is key to quick and accurate decision making in today’s increasingly automated world. KEYMILE’s communication portfolio makes it a leader in the field of mission-critical communications as it is geared to meet the demands of network operators for reliability, availability and cyber security.

“ABB is a global leader in communication networks for utility customers. The acquisition of KEYMILE’s mission-critical communication business will strengthen this position and extend our market reach in the industrial, transportation and infrastructure sectors,” said Claudio Facchin, president of ABB’s Power Grids division. “This move supports our growth plans and digitalisation push as part of our ABB Ability offering, as we strengthen our position as the partner of choice in enabling a stronger, smarter and greener grid.”

ABB’s Power Service team has won a Presidents Award from the Royal Society for the Prevention of Accidents for 10 consecutive years of outstanding performance in health and safety at work.

A new group of apprentices is joining ABB in September 2017. Nine new recruits have passed ABB’s assessment and are starting the four-year scheme, which is accredited by the IET. The new joiners will have options to take a career as a service or test engineer, or in commercially-focused roles in health, safety and environment, project planning, project management, tendering or supply chain management.

Jon Downs said: “Having started out as an apprentice myself, I’m particularly pleased to welcome our new recruits and look forward to watching them develop.”

New privacy regulations are coming into force in May 2018 that will change the way all organisations in the EU communicate – so all readers of this publication should sign up online if they want to continue to receive it.

The EU General Data Protection Regulation (GDPR) legislation is designed to give individuals control over their own personal data. The new law states that individuals must give “clear and affirmative consent” to the processing of their data.

Karen Strong, ABB’s Marketing Communications Manager said: “We need to start afresh with our marketing communications mailing lists – so if you want to continue to receive FFWD and be invited to our events, then please take action by subscribing to FFWD again and opting into our marketing communications.”

To continue receiving FFWD from ABB Power Grids from May 2018, subscribe at www.abb.co.uk/ffwd
University of Chester to demo UK’s first intelligent campus microgrid control system

ABB has deployed the UK’s first intelligent campus microgrid control system at the University of Chester’s Thornton Science Park in Cheshire, a major research and innovation hub. The microgrid forms a key element of the university’s Energy Centre, which will promote and accelerate the development of the latest energy technologies – including using smart technology to optimise the integration of conventional and renewable generation.

ABB’s state-of-the-art microgrid is the first of its kind at a UK university campus, and will play a key role in the Energy Centre’s mission to provide a flexible environment where new energy technologies can be developed, tested and demonstrated, bringing industry and academia together to drive innovation. These technologies will include new types of photovoltaic (PV) solar cells, innovative energy storage solutions, developments in low power motor drives, new algorithms for load balancing on microgrids, and non-electrical energy systems such as heat networks and thermal storage.

The Thornton site has 90,000 square meters of industrial laboratories, workshops and office space for new and existing companies. It is an emerging centre of excellence for the energy, engineering and advanced manufacturing industries.

Integrating multiple energy sources
ABB will provide some of its leading-edge technologies for the Energy Centre, including the overall control system that will act as the ‘brain’ of the microgrid. This will enable the integration and optimum deployment of multiple energy sources and storage units connected to the same local power network. The individual elements within the microgrid include a combined heat and power (CHP) unit, diesel generation, solar PV plant, a new energy storage facility and a load bank.

The Energy Centre will offer its clients access to an advanced and multi-vector microgrid for product development, evaluation and demonstration of technologies including customer trials. It will provide a cost-effective testing capability to enable evaluation and demonstration of novel energy equipment in real-world scenarios.

Platform for learning
As a fully managed facility, with technical and commercial support on hand from Energy Centre staff, it will provide access to academic R&D expertise from the University of Chester’s Science and Engineering Faculty co-located onsite. Located within an ‘Enterprise Zone’ it also offers a clear pathway of growth from the science park to the adjacent Protos development.
“The Thornton Science Park microgrid is a pioneering initiative and we are pleased to contribute with our domain expertise, experience and know-how,” said Massimo Danieli, Managing Director of ABB’s Grid Automation business unit, a part of the company’s Power Grids division. “This project is a good example of how ABB partners with academia to demonstrate and promote the adoption of leading-edge technologies that make us a partner of choice for enabling a stronger, smarter and greener grid.”

Professor Joe Howe, Executive Director and Professor of the Thornton Energy Research Institute at the University of Chester said, “The Energy Centre has been created to demonstrate and promote the development of the latest technologies and forms part of a wider energy focus for Thornton Science Park. The ABB microgrid control and storage solution is a particularly exciting development that provides a platform for learning and is a great example of industry and academia working together to address real-world issues.”

Maximising renewable energy
ABB’s microgrid solution will demonstrate how DER (distributed energy resource) technologies can work together to minimise fuel costs and emissions within a grid. It will also maximise the penetration of renewable energy in a grid. The microgrid controller will manage the Energy Centre’s connection to the campus network, and then the connection to the local grid. This will highlight the microgrid’s ability to connect or disconnect seamlessly from the main grid and operate in ‘islanded’ mode, ensuring continuity of supply in case of an outage.

“Microgrids will produce savings through their ability to take advantage of the changing cost dynamics of newer technology, including energy storage systems, the falling costs of solar and wind energy systems, and reduced exposure to increasingly volatile fossil fuel prices,” commented Peter Jones, technology strategy manager at ABB’s power grids division.

Microgrids typically integrate multiple sources – such as solar, wind power, biomass, small hydro, geothermal, waste-to-energy and CHP systems – and are increasingly being equipped with energy-storage systems, especially as lithium-ion batteries become more cost-competitive.

“Even in advanced economies such as the UK, microgrids can be used to increase the reliability and quality of power supply in both grid-connected and islanded operation,” added Jones. “They can also enhance predictability of supply, and help to reduce the carbon footprint and overall environmental impact. We are seeing a substantial level of interest. The technology is not new – it’s just there are new applications for it. Now is the time for the UK to embrace microgrids.”
Grant McKay, ABB’s Regional Marketing and Sales Manager for HVDC and FACTS technology explains how Flexible Alternating Current Transmission Systems (FACTS) technologies helps transmission system operators make the most of their infrastructure.

In the 1950s, ABB delivered the first ever 400 kV series capacitor for the Swedish State Power Board to enable long-distance 400 kV transmission. Since then, we have remained at the forefront of technological development and have delivered more than 800 projects worldwide.

As the power grid evolves, FACTS technologies can help operators of utilities, renewable generation, railways and other industries. They can increase capacity in line with higher peak demand, integrate renewables by supporting fulfilment of the requirements of the Grid Code and control voltage fluctuations and harmonics for major industrial or rail traction loads.

Two branches of technology make up the FACTS family today: series compensation and dynamic shunt compensation. What these have in common is that they have the ability to radically increase the capacity of transmission networks – by up to 50 percent, as well as ensure voltage stability, grid reliability and power quality of long-distance high-voltage AC transmission.

A major benefit is the relatively small footprint of FACTS installations, a feature that gives operators the ability to extend capacity without the need for a major investment programme.

**Fixed series compensation**

Fixed series compensation has long been the preferred solution for optimising performance in very large bulk transmission corridors. Installing a capacitive reactance in series in a long (typically more than 200 km) transmission line reduces both the angular deviation and the voltage drop, which increases the loadability and stability of the line. Since the current through the transmission line directly ‘drives’ the MVar output from the capacitor, the compensation concept is ‘self-regulating’, and this straightforward principle ensures that series compensation is an extremely cost effective solution.

Series compensation provides increased transient (angular) stability of a power corridor and increased voltage stability of the grid. It also improves the voltage profile along the power corridor and optimises power sharing between parallel circuits.

**Thyristor controlled series compensation**

Series Compensation with Thyristor Control (TCSC) enables rapid dynamic modulation of the inserted reactance. At interconnection points between transmission grids, this modulation will provide strong damping torque on inter-area electromechanical oscillations. As a consequence, a TCSC rated at around 100 MVAr makes it possible to interconnect grids having generating capacity in the many thousands of megawatts. Often the TCSC is combined with fixed series compensation to increase transient stability in the most cost effective way.

The TCSC concept also enables inherent immunity against sub-synchronous resonance (SSR), and thus allows for extended use of series capacitors in specific transmission grids with large scale thermal generation. The immunity to SSR is a result of the ABB patented SVR control strategy.

**Static Var Compensators**

Static Var Compensators (SVCs) are shunt connected devices that can quickly and reliably control line voltages. An SVC will typically regulate and control the voltage to the required set point under normal steady state and contingency conditions and thereby provide dynamic, fast response reactive power following system contingencies (e.g. network short circuits, line and generator disconnections). In addition, an SVC can also increase transfer capability, reduce losses, mitigate active power oscillations and prevent over voltages at loss of load.

An SVC consists of a number of fixed or switched capacitive or reactive branches, at least one of which includes thyristor switching. Each SVC is customized to fit the needs of the specific system application.
Static Compensators
Like an SVC but faster, a STATCOM can continuously provide variable reactive power in response to voltage variations, supporting the stability of the grid. ABB STATCOM technologies are based on Voltage Source Converter (VSC) technology which generates and absorbs reactive power by electronically processing voltage and current waveforms, rendering it unnecessary to include physical capacitor and reactor branches for generating/absorbing reactive power. It is capable of yielding a high reactive power input to the grid more or less unimpeded by possible suppressed grid voltages, and with a high dynamic response.

This is particularly useful, for instance, to support weak grids and to improve the performance of large wind farms under varying grid conditions, as well as of grids loaded by a large percentage of air conditioners in hot and humid climates. With high effective ratings and unrivalled speed of response, ABB STATCOM technologies are applied in many varied applications such as high speed rail systems and heavy industrial plants where they are applied for voltage balancing of asymmetrical loads, mitigating voltage flicker created by electric arc furnaces, and active harmonic filtering.

In the UK, ABB has recently received orders from ScottishPower Renewables for STATCOM systems to smooth out voltage fluctuations and support the grid connections for the East Anglia ONE offshore and Kilgallioch onshore windfarms.

Static Frequency Converters (SFCs)
These devices use the same technology as shunt-connected STATCOMS and are often used to interconnect electrical supplies with differing voltage and frequency, such as railway networks, shore-to-ship connections in ports or industrial interconnections. One new example is highlighted on page 14.

Service
And while the hardware is important, it is also essential to support its lifetime performance. Adopting a service agreement will ensure up-time, availability and reliability of FACTS infrastructure and will help to control total cost of ownership. Individual tailored programmes can be proposed, choosing from a wide range of services such as rapid response, training, scheduled maintenance, consulting and evergreen services.
Enabling Ireland’s Integrated Single Electricity Market

Ireland’s wholesale electricity market is undergoing significant transformation to align with the energy requirements of the European Network Codes and the Target Model. The new market design to reflect these regulatory changes, known as the Integrated Single Electricity Market (I-SEM), will be adopted in May 2018.
Jan Ydens, director of energy portfolio management, explains how ABB Enterprise Software has become the solution of choice to support I-SEM compliance and drive the significant commercial opportunities that this new energy market brings.

ABB has a long-standing commitment to the Irish wholesale power markets, supporting the existing SEM since 2007, when we first implemented our market bidding and settlement solutions for several market participants, market operators and the transmission system operator (TSO).

This meant that when the new market arrangements were introduced, ABB was already in a great position to identify the new opportunities this would bring for market participants, and support them by delivering a solution to take advantage of these.

To accommodate the transition to the new market model, the Irish regulator recognised the need for a complete market redesign, and the I-SEM was born. The I-SEM will take the Irish wholesale market from a managed pool market to a fully commercial continuous trading power market, leading to great new opportunities for market participants.

In parallel, ABB evaluated how we would help our customers make this transition. We interviewed existing customers, partners and other market players to identify the key characteristics of a successful I-SEM solution.

One of the most important findings related to risk. Participants were looking for a proven solution that was already successfully operating in markets similar to the I-SEM. Customers were also looking for a solution that could operate in the cloud, and one in which market updates (which occur frequently in wholesale electricity markets) would be taken care of by the vendor without additional cost.

ABB’s team concluded that all these elements were already covered by ABB’s proven nMarket solution, which we have been deploying for the past 15 years in North American markets (which are very similar in design to the I-SEM), and is in use with more than 40 customers.

Crucially, ABB had just transformed nMarket into a full Software-as-a-Service (SaaS) solution delivered using Microsoft Azure Cloud. While validating our approach, most consultants suggested to us that utilities were not yet ready to adopt cloud-based wholesale market solutions. However, we found that our customers not only welcomed the SaaS approach, but were actively requesting it.

ABB’s nMarket solution approach is being embraced in Ireland: several market participants have already signed multi-year deal, and there has been interest from new energy and renewables companies. The fact that ABB’s solution was already tried and tested, was cloud-delivered and included updates were major factors in this success. Another important component was ABB’s customer engagement program which offers contracted customers a way to contribute to the design, and interact closely with the team developing the solution as well as other contracted peer companies.

Some of ABB’s largest customers in Ireland are also participants in the UK electricity market, and have asked us to look into extending the solution into Great Britain. Currently GB market participants tend to use a patchwork of modules interconnected with bespoke integration to run their wholesale electricity bidding and settlement. This is costly in terms of license fees and maintenance, as well as software changes when market rules change. We also see huge advantages for utilities, who are all trying to simplify their solution and vendor landscape and move to the cloud to keep costs down.

ABB has a network of delivery partners with whom we have long-standing relationships, including companies such as Accenture, Wipro and Baringa. These have received training on nMarket, and their consultants are actively engaged and implementing nMarket and the wider I-SEM landscape for customers in Ireland. ABB also has a strong global technology partnership with Microsoft, especially around Azure. This has proved valuable in terms of both development of a best-of-breed cloud solution, as well as ability to go to market together.

Based on the success of our SaaS wholesale power market solution for the Irish market, ABB has accelerated the availability of multiple solutions on the cloud, which has further strengthened our partnership with Microsoft. A great example of this is ABB Ability™ which is based on the Microsoft Azure stack, and is set to offer the largest industrial IoT cloud on the planet, helping move our customers towards the ‘Fourth Industrial Revolution’.
The SFC will convert the three-phase grid supply to a single-phase traction supply.
RAIL

SFC technology to boost the East Coast Mainline power supply

Jay Mehta, ABB Rail Sector Manager, explains how ABB power electronics will triple the traction power capacity for a key section of the East Coast Mainline (ECML) – at 40 percent of the cost of a new grid connection.

The UK’s main rail link between London and Edinburgh is the East Coast Mainline (ECML). Network Rail, which owns and operates the UK’s rail infrastructure, is currently preparing for the introduction of the new 125 mph Hitachi InterCity Express Trains, which are expected to start passenger services in 2018. The new trains are bi-mode, allowing them to run on both diesel and electric power. However, one section, near Doncaster, needs additional traction power for both the main track and Hitachi’s new state-of-the-art depot that will serve the new rolling stock.

Network Rail requires a 25 kilovolt (kV) traction feed with a capacity of 50 megavolt ampere (MVA). However, only a maximum of 15 MVA is available currently. It appeared that the only solution was a new connection to the local 132 kV grid. This is not only costly, but it can take a considerable amount of time to complete the application process with the DNO (distribution network operator) as well as obtain the necessary planning and environmental consents. Network Rail therefore called in ABB’s rail team to investigate alternative options.

We were able to propose a considerably more cost-effective, fast-track approach based on the innovative application of our Static Frequency Converter (SFC) technology that has already proved its capability in a similar project at the Wulkuraka rail depot in Brisbane, Australia.

Generally, ABB deploys SFCs, based on our PCS6000 (Power Converter System), to connect equipment at different frequencies. A typical example is when a cruise ship with an on-board network operating at 60 Hertz (Hz) needs to plug into a port where the on-shore power network runs at 50 Hz.

However, for the Doncaster ECML project, the SFC will not be converting the network frequency. Instead, it will take a 33 kV / 50 Hz (Hertz) supply from the existing Northern Powergrid three-phase local distribution network and convert it to a single-phase traction power supply at 25 kV / 50 Hz. This approach will result in a total cost saving of around 60 percent compared with building a new high voltage grid connection.

Not only will the SFC deliver the 50 MVA required, it also offers a range of additional operational benefits including: full load balancing; reduced train harmonics; improved reliability of the overhead line equipment (OLE); the opportunity to remove problematic phase separations in overhead lines. SFCs allow doubly fed catenary sections, which enable improved corridor performance due to more stable voltage conditions and reduced conducting losses. Furthermore, the SFC technology supports the reuse of regenerative train energy by increasing the corridor lengths.

ABB is delivering, installing and commissioning a complete SFC solution for Network Rail including the PCS 6000, transformers, switchgear and cabling.

This project is a perfect example of how smart solutions can result in reduced connection costs for railway projects. It also shows that innovation isn’t always about brand new technology. In this case we are using tried and tested SFC technology in an innovative way that could be applied in many similar projects as the UK rolls out electrification across its rail network.
Welsh Water demonstrating eco-credentials with SafeRing AirPlus

The UK’s first unit of eco-efficient SafeRing AirPlus switchgear is now in operation. The secondary distribution ring main unit (RMU) controls power for essential process equipment and was supplied to Welsh Water through contractor EPS Construction.

When it ordered the switchgear in 2016, Welsh Water proactively requested the eco-efficient switchgear rather than conventional GIS.

Ian Yates, Electrical Safety Manager at Welsh Water said: “Welsh Water has a responsibility to the sustainable future of the environment and the communities we serve. Our philosophy is to be proactive in seeking out new ways to enhance our environmental performance and customer service. When the high-voltage switchgear at our Gowerton Waste Water Treatment Works came to the end of its life, we wanted a more environmentally friendly alternative and settled on ABB SafeRing AirPlus.”

The utility invests in innovation projects to improve services and the environment at the same time as reducing costs for its customers. Examples include renewable energy generation, publishing alerts about storm water overflows from combined wastewater and storm drainage systems and managing the impact of non-native invasive species.

ABB introduced the switchgear as an environmentally sustainable alternative to gas insulated switchgear that is insulated with sulphur hexafluoride (SF₆) gas. By choosing SafeRing AirPlus instead of a conventional RMU, customers can avoid using 3 kg of SF₆, equivalent to more than 70 tons of CO₂ emissions should the gas ever be released into the atmosphere.

Welsh Water’s RMU was one of the first AirPlus units to enter operation, demonstrating the utility’s approach is leading the field. Since then, public services operator SÜC Coburg has ordered Germany’s first SafeRing AirPlus in the town of Coburg in Bavaria. The operator ordered the switchgear to support its drive towards climate-friendly technology at the same time as adopting highly automated units to increase the reliability of the power grid.

SafeRing was the first product launched in the AirPlus product range. The RMU is available in IEC ratings up to 24 kV with 16 kA short-circuit and 630 A nominal current.
Introducing the ZX2 AirPlus

Since AirPlus was introduced in 2016, ABB has extended the range of eco-efficient switchgear to include ZX2 AirPlus medium-voltage primary distribution switchgear. It has the same footprint, safety and reliability as the well-established ZX2.

Customers have the option to choose their preferred technology for ZX2 switchgear. For example, they can order conventional ZX2 filled with SF₆, AirPlus or a third alternative ‘Ready-for-AirPlus’, which gives the option to switch to the eco-efficient alternative in the future.

ZX2 AirPlus is available in an IEC rating up to 36 kV, with 31.5 kA short-circuit and 2,000 A nominal current. It features individual gas compartments for the circuit breaker and busbars, for either single or double busbar applications.

In June 2017, German utility Netze BW adopted ZX2 AirPlus switchgear at its Trochtelfingen facility, where eight of the site’s 31 switchgear panels are insulated with the new fluoroketone gas mixture.

Netze BW’s Managing Director of Technology, Dr Martin Konermann, said: “We place great value on an environmentally sound supply of electricity, gas and water and bring in as much renewable energy into the network as possible in order to support Germany’s commitment to make the country largely greenhouse gas (GHG) emissions-neutral by 2050. We are also attempting to apply technological innovations to classical electrical equipment.

“We are happy to have this operational phase with ABB, where we can prove reliability of this alternative fluoroketone gas. If we see positive results, and early indications are good, we will be able to convert all medium-voltage switchgear from SF₆ to this alternative gas, so that we can ultimately deliver SF₆-free power distribution for the entire network.”

An eco-efficient alternative to SF₆

ABB launched AirPlus switchgear in April 2016 following a successful pilot project at the Oerlikon substation in Zurich, operated by Swiss utility ewz.

The switchgear uses a fluoroketone gas called C₅-PFK to deliver the insulating performance, reliability and compact size of equivalent SF₆ switchgear but with a global warming potential (GWP) of less than one, which is almost 100 percent lower than SF₆.

SF₆ is an important insulation and arc-extinguishing medium for high and medium-voltage switchgear. However, in the unlikely event that it escapes from switchgear, SF₆ has a high potential for global warming. In addition, because it is chemically unreactive, if it escapes it could remain in the atmosphere for many years. For this reason, operators use special techniques to handle and contain the gas.

Along with other leading manufacturers of switchgear, ABB published a study in 2003 that found that SF₆ emissions contribute less than 0.005 percent to the global warming potential of Germany.

However, ABB recognised that customers are always keen to reduce risk and adopt more sustainable alternatives. It therefore developed the new fluoroketone-based gas mixture in collaboration with 3M, the science-based technology company.
POWER QUALITY

APCQ capacitor bank puts an end to poor power factor

Stephen Joyce, Power Quality Business Manager at ABB’s Power Grids business in the UK, outlines the advantages of the new APCQ range of capacitor banks.

A poor power factor should attract the attention of anyone interested in the profitability and smooth running of an industrial or commercial site, from facility management to the boardroom. Because a site with a low power factor is effectively burning money. And high energy bills – with the added risk of financial penalties from your utility supplier – are only part of the problem. Power factor also impacts both the reliability of the network and its capacity to add new loads when the business expands.

Power Factor (or PF) refers to the relationship between the active and reactive power on the network. It measures how effectively it uses the electricity purchased from a supplier and in an ideal world it would be one (unity).

A useful analogy is a frothy latte. The capacity of the glass is the total apparent power as measured in kilovolt amps (kVA). The coffee body is the active power, measured in kilowatts (kW) that can be used to do work, while the froth on the top is reactive power measured in kVAR (kilovolt amps reactive) – some froth is useful but too much is a waste.

Latte glass = Capacity = kVA
Coffee = Useful energy = kW
Froth = Waste capacity

A frothy latte = Poor power factor correction
A perfect body = Good power factor correction
Most loads on an electrical distribution system are categorised as one of three types – resistive, inductive and capacitive. The most common in modern networks are inductive loads such as transformers, fluorescent lighting and AC (alternating current) induction motors. They need reactive power – the kVAR – to maintain the magnetising current they need to function.

What difference does a poor power factor make?
Between 0.9 and 1.0 is usually considered as a good power factor, meaning that metered power and used power are almost equal.

However, when ABB’s service engineers survey customer sites it is very common to find a much lower PF – sometimes down to 0.8 or below. To demonstrate why this is a concern, when PF drops from 1.0 to 0.9 then it could be using 10 percent more current. But the relationship is not linear. A power factor of 0.7 could require approximately 43 percent more current - and a power factor of 0.5 requires approximately 200 percent (twice as much) current to handle the same load.

When the PF is low, the utility supplying the site must provide all the power needed - both productive and reactive. For the utility that means larger generators, transformers, conductors and other system devices that push up their own capital expenditure and operating costs. These costs have to be passed on to industrial users. And, in some cases, they are made explicit in the form of power factor penalties.

It’s not just about reduced energy bills
Clearly, improving a site’s power factor can contribute directly to the bottom line in terms of energy bills. But there are other compelling reasons to take action. First, reducing the load on the network will help improve the operating life of equipment, boosting reliability and reducing the need for maintenance and replacement.

However, the most significant reason is that optimising PF can help defer, or possibly even avoid completely, major capital investment to increase a site’s load capacity to facilitate the installation of new equipment.

How do you solve a low PF?
A low PF is solved by adding power factor correction (PFC) capacitors to the site distribution system. These capacitors work as reactive current generators that supply reactive power (kVAR) to the system.

By generating their own reactive power, industrial users free the utility from having to supply it. Therefore, the total apparent power (kVA) supplied by the utility will be less, which is immediately reflected in proportionately smaller bills. Capacitors also reduce the total current drawn from the distribution system and subsequently increase system capacity.

New APCQ range of capacitor banks
ABB’s portfolio of PFC solutions has just expanded with the new APCQ range of low voltage automatic capacitor banks for customer networks including residential/commercial buildings, and in diverse industries like mining, steel, chemical, pulp and paper, cement, plastics, printing, automotive, food and beverage and light-to-medium manufacturing. The range offers three type of capacitor banks:

- **APCQ-L**, a wall-mounted and compact cubicle,
- **APCQ-M**, a free floor standing cabinet for networks slightly polluted by harmonics,
- **APCQ-R**, a free floor standing cabinet, with detuned reactors for networks polluted by harmonics.

The APCQ series is easy to install, operate and service and offers exceptional reliability and safety. Installation of the APCQ is fast because of its easy access to all electrical connections. The modular design allows easy maintenance and has space provision to increase the power rating if required in the future.

The new APCQ range of capacitor banks use proven and innovative ABB technology which includes ABB’s new QCap low voltage capacitor. The reliability and the safety of this range is further ensured by other ABB components produced in line with strict specifications: ABB reactors with a specific design for electrical robustness in networks with harmonics and the ABB UA range of contactors optimised for capacitor switching.

The APCQ-R range is capable of handling voltage distortion pollution levels of eight percent, in line with voltage distortion levels on the low voltage (LV) bus that can appear in industrial networks. The APCQ range has an intuitive interface when used with ABB RVC or RVT power factor controllers.
Enabling Transformer intelligence for smart operations

Sagnik Murthy, Sales & Marketing Manager UK & Ireland, for ABB’s Transformer Components and Insulation product group explains how ABB enable condition-based maintenance through transformer intelligence sensor-based monitoring solutions, giving transformer operators the ability to carry out reliable asset monitoring while supporting the digital transformation of electricity networks.
It is testament to strong design, robust construction and good practice in operations and maintenance that a large proportion of the world’s transformer population has been in operation for more than 50 years. However, an aging fleet of transformers represents a challenge to grid operators that are under pressure to make the most of their maintenance budgets.

A new generation of sensor and diagnostics technology is opening up potential for digital and analogue monitoring of transformer health including critical components such as bushings and on-load tap-changers. ABB’s Transformer Intelligence devices are designed to give operators insight into the performance of individual transformers and entire fleets.

ABB’s Transformer Intelligence is based on two monitoring solutions: CoreSense® and CoreTec®. CoreSense® is a dissolved gas analysis (DGA) sensor, which continuously monitors hydrogen and moisture levels in transformer oil to act as an early warning system. CoreTec® is a complete transformer monitoring system, which includes bushing and tap-changer monitoring as well as cooling control. It integrates data from sensors and displays a large number of operational parameters through a web interface. Combining CoreTec with CoreSense and other sensors is designed to give operators of transformers a complete asset health monitoring solution and the confidence to schedule maintenance. ABB Comem eDevices are sensors with digital and analog output providing continuous monitoring of key transformer parameters, such as oil and winding temperature, air humidity, internal pressure, gas and moisture levels.

The result is more informed and better decision-making over maintenance, refurbishment and replacement. Knowledge of asset condition allows operators to prioritise maintenance, as well as predict and avoid asset failures.

For example, advanced cooling control of a transformer is possible by sensing the transformer oil temperature. ABB Comem eOTI, a liquid temperature indicator, provides a digital signal to CoreTec® about the rising oil temperature inside the transformer due to increasing electrical demand. In response, CoreTec® turns on the fans in the cooler banks fitted to the transformer radiators to cool the oil. These cooler banks are controlled in groups, so as load increases, more cooler groups are switched on. ABB’s Transformer Intelligence® solution can be applied to power transformers from any manufacturer. It enables customers to implement reliable asset performance management, optimist their operations and maintenance budgets and enhance workforce productivity and safety.

ABB’s Transformer Intelligence® is also compatible with ABB Ability™, a solution platform built from common technology components at the device, edge, control and cloud level. It combines software-enabled and connected devices to enable customers to centralise their data, securely share and integrate industry data, apply big data and predictive analytics, and generate insights that can help them drive performance and productivity improvements through increased uptime, speed and yield.
ABB and DONG Energy to implement world-first frequency response solution at Burbo Bank Offshore Wind Farm

Danish integrated energy company DONG Energy is to implement a world-first frequency response solution using ABB Battery Energy Storage System (BESS) at its Burbo Bank Offshore Wind Farm, off the west coast of the UK. The combined wind power and battery solution will help keep the grid frequency stable at 50Hz and maintain the operability of the grid.

If frequency deviates from this, it can affect everything connected to the grid, from home appliances to power stations. The ability to inject or reduce bursts of active power enables the grid to rapidly respond to any change in frequency.

Renewable power sources, such as wind, are important for the future generation mix. However, they are intermittent by nature and do not offer the spinning reserve of the kind provided by traditional, steam turbine-based power generation – which has historically provided a high degree of frequency stability across the UK power grid.

When it comes to frequency stabilisation during periods of over- or under-production at wind farms, grid operators need solutions that can provide the short-term reserve needed to respond to frequency changes within fractions of a second over periods of several minutes. This reserve needs to be 100 per cent reliable and available at all times.

As Richard Smith, Head of Network Capability (electricity) for National Grid said, “As the UK’s energy mix changes, we know that ensuring a safe and stable supply of energy in future will require more flexible services. I’m looking forward to seeing how the DONG Energy solution of storage connected to the offshore wind farm

ABB will supply and install a 2MW BESS for the 90 MW Burbo Bank Offshore Wind Farm, which has been fully operational since 2007 and is capable of supplying electricity to power up to 80,000 UK homes. The addition of the BESS, scheduled to be installed by the end of 2017, represents the first time an offshore wind farm has been integrated with battery storage to deliver frequency response to the grid.

Frequency response is used by National Grid to help manage grid stability by keeping what is a continuously changing variable close to 50 Hz.
will provide services to help us respond to day-to-day operational challenges and maintain the frequency of 50 Hz on our electricity system.”

Ole Kjems Sørensen, senior vice president, partnerships, mergers & acquisitions and asset Management at DONG Energy, said, “The need for flexibility is expected to grow, and as a low-carbon leader, we’re keen to be part of the solution to make the energy system smarter. We already offer leading flexibility products to our business customers, and now we’re focusing on enhancing what we offer on the generation side to help National Grid manage grid stability.

“We’re excited to use battery technology to demonstrate this wind power and battery hybrid capability,” Sørensen added. “With eight existing offshore wind farms in the UK and another four under construction, we expect to leverage further technology improvements and innovations and ensure that DONG Energy supports the stability of grid systems as generation capacity becomes cleaner and more sustainable.”

ABB has significant expertise and experience in integrating BESS solutions at the grid scale. Large-scale batteries of the right specifications are available from several suppliers. But to meet the performance and reliability needs of grid operators – especially in enhanced frequency response – batteries need to be successfully integrated with the right power control systems, power converters, switchgear, transformers and management system. ABB has experience of delivering BESS solutions for grid stabilisation around the world, whether in standard containerised form or fully customised to the application.

Enhancing frequency response is the most pressing application, but ABB has also delivered BESS solutions for time-shifting of wind power, capacity firming, load levelling, peak shaving, power quality control and uninterruptible power supply.

ABB has more than a decade of experience in the deployment of BESS solutions and comprehensive knowhow in the substations domain around the world. Such experience gives operators unmatched competence across all aspects of energy storage with integrated grid connection and management, as well as the turnkey supply of solutions across a range of applications.

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**ABB innovative storage solution to deliver clean wind energy for up to 80,000 UK homes**

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PASS offers the best of both worlds for substation projects

Historically, the choice of high-voltage equipment for substation projects has been between air-insulated switchgear (AIS) and gas-insulated switchgear (GIS). With the space available usually being the key deciding factor since GIS, although more expensive, allows a more compact substation footprint. In simple terms, AIS was the preferred choice in rural areas while GIS was usually specified for urban installations. However, this picture started to change dramatically some 20 years ago when ABB introduced PASS.

PASS combines the best of the AIS and GIS worlds into hybrid technology switchgear. GIS is used for the main interrupting components of the circuit breaker and the disconnector/earthing switch to guarantee high reliability and compactness. At the same time, AIS is used to connect to the grid, so that PASS is positioned between AIS and GIS technology.

The PASS concept provides a reliable, low-maintenance solution to substation construction. Its modular and flexible design makes it a recommended solution in a number of cases:

- Where space is a constraint, as it allows a 50 to 70 percent space saving when compared with a standard AIS substation.
- On skid-mounted or mobile applications because the compactness of the module itself allows the whole bay to be transported more easily.
- For extension and retrofitting, as it is compatible with any type of GIS, AIS or hybrid substation.
- In harsh climatic conditions, or in heavily polluted sites like industrial or mining installations as all live parts are SF₆-insulated and protected in a grounded aluminium tank.
- Fast-track projects where a quick connection to the grid is required, such as in emergency recovery situations or in remote or dangerous areas. PASS is transported fully assembled and tested so no high-voltage test is required on-site and installation and commissioning is rapid.
- For railways, because single-phase or double-phase modules at various frequencies can be used.

PASS M0S 420 kV

ABB has focused on expanding the PASS portfolio to suit more applications and markets and the installed base is now well over 8,000 units worldwide. A significant recent development was the launch of the PASS M0S 420 kilovolt (kV) module that means that the PASS family now covers voltages from 72.5 to 420 kV with breaking currents from 31.5 to 63 kiloamp (kA).

In addition to standard modules, a special solution called PASS M0H offers a complete high-voltage switchyard with an ‘H’ configuration as a single transportable unit.

The 420 kV PASS hybrid module is a technical breakthrough as, despite its larger size, it retains all of the PASS family benefits – such as the integrated functionality of a circuit breaker, disconnector and earthing switch, as well as current and voltage transformers, so that each PASS module is equivalent to a complete switchgear bay.

The preassembled and factory-tested PASS M0S 420 kV can be easily transported and quickly installed, without the need to assemble any active parts at the installation site. It is currently the only 420 kV switchgear module that arrives on site completely assembled, so installation and commissioning is rapid.

Jon Downs, General Manager of ABB’s Substations business, outlines the advantages of Plug and Switch System (PASS) high-voltage hybrid switchgear.
The PASS M0S 420 kV has further advantages:

- Maintenance is easy. For example, since all active parts of the equipment are gas-insulated, there is no need to regularly clean the switchgear contacts. Encapsulation also reduces overall servicing time and cost, and enhances reliability and availability. Often, operations can be carried out without the need for an outage.
- It is highly customisable according to customer needs, yet, due to the modular design, it still has a short delivery time.
- The steel structure is compact so less civil engineering is needed.
- It can be mounted and transported on a trailer or skid as a complete mobile solution from the factory.
- Energisation time is shorter – less than one week for a 420 kV bay.

Rotating bushings

One of the biggest design challenges was the transportability of a fully assembled 420 kV module, given its large dimensions. The solution developed by ABB is the rotating bushing concept. For transportation, the insulators (3.6 metres long and weighing 350 kg) are rotated in the factory from the in-service position to the transport position, and back again at the installation site. This is made possible by an innovative and very safe bushing rotation design. The rotation takes less than 30 seconds per bushing.

Since its launch, PASS 420 kV has attracted the interest of many utilities worldwide who recognise the advantages of being able to quickly connect to the grid with a solution that is delivered fully assembled and tested.
DIGITAL GRIDS

Exploring opportunities with Imperial College to further expertise in digital grids

Ulrich Speisshofer, Chief Executive Officer of the ABB Group, recently visited Imperial College in London to sign a memorandum of understanding with Professor Nick Jennings, Vice Provost of Research, to explore opportunities for the creation of a unique digital power network demonstrator unit.

The demonstrator will comprise examples of ABB’s digitally enabled substation switchgear together with automation systems and energy storage. The aim is to mimic as closely as possible the operation of real-life power networks from transmission, through distribution to ‘behind the meter’ equipment such as domestic energy storage and electric vehicle (EV) charging stations.

Researchers could use the demonstrator to model the behaviour of future networks. It would also allow them to identify potential issues and solve them offline in safe and controlled conditions.

Ulrich Speisshofer said: “The demonstrator will build on our long partnership with Imperial College and will pave the way for greater excellence in power systems research and teaching. The transition to future energy systems, incorporating the ABB Ability digital offering will require a new generation of engineers with enhanced digital skills to build and operate the power grids of the future.”

“The ABB demonstrator would prove invaluable in helping our students explore the full potential of the latest transmission and distribution technology to help networks evolve to meet the growing operational and stability challenges presented by renewable energy, distributed generation resources and electric vehicles. It will also help to address the current skills gap for engineers who are ready to design, build and operate the UK’s Future Energy Networks”, said Professor Tim Green, Director of the Energy Futures Lab at Imperial.
Subsea cable connection takes shape for Caithness Moray HVDC project

This summer saw a key milestone in ABB’s major project to create the Caithness-Moray high-voltage direct current (HVDC) power transmission link on behalf of Scottish and Southern Electricity Networks (SSEN). That was the arrival in Scotland of the specialist cable-laying ship, the NKT Victoria. The vessel is now hard at work laying the subsea power cable to connect the grid either side of the Moray Firth, a distance of around 113 kilometres.

The Caithness Moray link, which is due for commissioning in 2018, will have a capacity of 1200 megawatts (MW) – that’s enough electricity to meet the needs of two million people. The project is at the heart of the biggest renewal of the north of Scotland’s electricity network in a generation.

ABB’s role is to design, engineer and supply two land-based HVDC Light converter stations, one at Blackhillock in Moray and another situated at Spittal in Caithness. ABB’s scope of supply also includes the submarine and underground cables that will connect the two stations. That’s where the cable ship comes in. It is installing the cable in two campaigns – the first from Noss Head to the midpoint of the cable route and the second from Portgordon to the end of the previously laid cable.

On land, ABB has also delivered the supergrid transformers for the two conventional substations at Spittal and Blackhillock that connect the grid to each end of the HVDC link.
Total eclipse of the grid

Peter Jones, ABB Technology Strategy Manager, explains why the 2026 eclipse will test the flexibility of the UK’s power distribution networks.

In the summer, National Grid published its latest Future Energy Scenarios document. It provides an intriguing overview of the UK’s current energy revolution. Four possible scenarios are outlined that might obtain according to predicted levels of prosperity and green ambition: ‘Two Degrees’, ‘Slow Progression’, ‘Steady State’ and ‘Consumer Power’. In all cases there is a predicted shift towards decentralised and renewable generation. The only difference is the pace and extent of this change.

Inevitably, there will be a profound change in the roles played by transmission and distribution networks. And the main reason is that the bulk of solar energy and other decentralised resources will be connected at the distribution level.

Historically, there has been a particular focus on building transmission networks that are needed to work hard in winter and less so in summer. But under some of National Grid’s future scenarios it looks like transmission demand is set to steadily fall in winter. And according to other scenarios, in summer it could virtually disappear at certain times of the day.

The trend for loads to move from transmission to distribution networks has already started. In fact, on one day in March this year, for the very first time the electricity demand on the transmission network was lower during the afternoon than it was overnight. The reason was the high level of solar generation.

**The 2026 eclipse will be a major challenge**

With the emphasis moving away from transmission networks, it is at the distribution level that greater flexibility is required to deal with complex, intermittent power flows.

It will be particularly interesting to see how distribution networks cope with the UK’s next solar eclipse on 12 August 2026. Under one of National Grid’s scenarios, the UK could by then have up to 26 GW of solar power, over twice the 12 GW we have today. That means that when the shadow falls at just past seven o’clock in the evening there could be a solar generation deficit of around 3.5 GW for 30 minutes.
Flexible solutions are ready to cope
The good news is that a whole raft of new technologies is coming through to help provide distribution grids with the new levels of flexibility they will require, especially demand response mechanisms. Storage will also play an important role, with up to 10.7 GW installed by 2050 under one scenario, including a substantial number of battery energy storage systems (BESS).

Energy storage could play a critical role in helping the UK’s power networks maintain a stable grid frequency. This is because renewable energy does not typically offer the spinning mass and inertia provided by traditional generation plant. The strategic deployment of energy storage can help bridge this growing inertia gap by delivering vital grid frequency support, absorbing power when the frequency is too high and injecting power when the frequency is too low. Other valuable energy storage services include load levelling, peak power shaving and power smoothing.

Another important factor is that network operators are facing ever greater challenges in finding the very significant funding essential for the construction of new infrastructure. This is prompting a greater interest in finding innovative approaches that can make existing networks work harder and smarter. One example of a technology that has great potential in this area is the Flexible Power Link, which is a back-to-back (AC-DC-AC) converter. It controls and transfers power between two previously incompatible distribution grids and allows the operator to balance generation and demand more effectively.

There is also considerable interest in Line Voltage Regulator (LVR) technology. Traditional distribution networks are designed on the basis of a voltage drop along the line from substation to the consumer. However, the introduction of distributed generation – such as solar plant – means that grids can experience voltage rises. If supply exceeds demand, there is potential for the voltage to exceed the statutory limits. In this case, the operator must curtail generation to maintain stability or even invest in a new connection. Instead, the LVR can effectively ‘recalibrate’ the voltage to maintain it in the allowed range.

Time to rethink our approaches to power networks
The need to accommodate renewables could be the springboard for a complete rethink of winter and summer network operations. It is even possible that we will see networks operating on a solid, interconnected basis in winter and changing to a more regional operation in summer – perhaps even made up of a large number of smaller scale microgrids.

There are some particular areas in which network design standards can help make a successful transition. More distributed energy resource in the form of renewables and other sources, like combined heat and power (CHP), embedded in the distribution network can by themselves improve network security and resilience if planned and co-ordinated to operate together. By carefully modelling the operation of these embedded resources within existing and new distribution networks large network cost savings could be realised and quantified.

It’s about more than electricity alone
The key to the future is joined-up thinking about the whole energy challenge. This means broadening the focus to cover not just electricity but also the role that gas and heat will play in handling peak demand to cope with intermittency well into the future. There are already signs that as DNOs (Distribution Network Operators) transition to DSOs (Distribution System Operators) they are looking to develop and publicise regional energy strategies. This will provide an overarching vision for the energy future of communities and industrial customers within a region and allow much closer customer involvement in planning for a clean and cost-effective energy future.
Building confidence for CEMEX

When leader in building materials CEMEX experienced a fault on one of the transformers at its cement plant in Rugby it called in ABB’s transformer service team. Johnny Sanchez, Engineering Manager for ABB’s Transformer Remanufacturing and Engineering Solutions (TRES) team, explains how ABB returned the unit to service.

CEMEX’s £200 million plant at Rugby is one of the most modern cement plants in the world. It has the largest cement kiln in the UK and can produce up to 1.8 million tonnes of cement each year, enough to build more than 72,000 houses. While CEMEX uses thermal power to heat the kiln, the rest of the site relies on electrical power supplied via two ABB power transformers that were manufactured in 1998.

When one transformer experienced a fault in October 2016, site operators switched over fully to the remaining transformer to power all of the site’s equipment, including milling, clinker and cement equipment as well as the security gatehouse, packing plant and dispatch office.

The site management was keen to gain access to ABB’s specialist knowledge and expertise, as ABB was the original equipment manufacturer (OEM), and so they called in the TRES team.

De-tanking and condition assessment
After an initial inspection, ABB’s first action was to move the transformer to a site where we store transformers before they are delivered to our customers’ sites. It was then washed with high-pressure hose to remove any dirt and dust.

The next step was detailed electrical testing and visual condition assessment to identify the source of the fault on the transformer, as well as the unit’s overall condition. Electrical testing included frequency response analysis, as well as measurement of dielectric frequency response, insulation power factor, excitation current and the voltage ratio for every tap changer position.

ABB’s engineers also carries out polymerisation measurement to evaluate the condition of the solid insulation. This is an important measure of the transformer’s overall condition and give an indication of the remaining life of the insulation around the windings.

Detailed visual inspection then required a de-tanking of the transformer, which is the process of removing the core and winding from the tank that contains them. This was the first such operation to be carried out by ABB in the UK, rather than at a specialist facility in Norway or Turkey.

Our thorough inspection gave CEMEX confidence that the transformer could be returned to service within a few months, rather than ordering a replacement and waiting for the long lead-time required for a brand new bespoke transformer.

The inspection established that the source of the failure was a fault in the tap changer and in January 2017, CEMEX gave approval for ABB to repair the transformer.

Refurbishment in Drammen
The transformer was then shipped to ABB’s specialist transformer facility in Drammen, Norway for refurbishment and factory acceptance testing.

In Drammen, the transformer was fitted with a new tap-changer as well as a replacement pressure relief valve as the original was clogged. Specialist technicians vapour dried the transformer to ensure low water content in the insulation materials – this is essential to ensure a long and reliable life.

CEMEX also ordered CORESENSE™ hydrogen and moisture sensor. These will enable the operator to detect incipient faults in the transformer and monitor moisture levels.

Following successful factory acceptance testing, the transformer was reinstalled at CEMEX Rugby at the end of March 2017 and filled with new transformer oil before being returned to service.
Peter Finney, Electrical Engineer for CEMEX UK said:

“ABB’s Transformer Remanufacturing and Engineering Solutions team carried out a fast-track inspection and repair of the faulty transformer from CEMEX Rugby plant. Their fast-track repair has enabled us to return the transformer to service and operate our plant with full confidence.”
Preparing for the digital era: National Grid’s VSATT platform

ABB and other partners from industry and academia have joined forces with National Grid to demonstrate a Virtual Site Acceptance, Testing & Training (VSATT) platform. The main objective of the project is to develop a standardised testing platform to prove multi-vendor standard bay solutions.
The VSATT includes virtual substation modelling and simulation, implemented using a Real Time Digital Simulator (RTDS). This can generate real-time analogue signals, such as current and voltage, as well as digital signals, such as circuit breaker control signals, for all kinds of load or fault scenarios.

Four feeder circuits from the 400 kV Cilfynydd Substation in south Wales were selected as the basis of the VSATT model, which was created at the University of Manchester. Intensive integration tests have been carried out at the university’s Power System Protection and Control Lab over recent months, and interoperability tests between IEDs, Merging Units and tools were at the heart of these.

ABB has played an important role in the development of the VSATT platform, and proposed an IEC 61850-based digital substation architecture for one of the feeder circuits (from Rassau), with standardised bus interfaces for both station and process buses (as shown in Figure 1).

The architecture is intended to offer the flexibility to enable equipment maintenance and replacement with minimal outage. It is also intended to be scalable, with the ability to interact with any future digital bays that are IEC 61850-compliant. The ABB architecture is based on Parallel Redundancy Protocol (PRP) on the station bus and provides segregated process buses, which means it closely follows conventional protection design philosophy in terms of main protection segregation.

After all four bays were integrated, a wide range of tests were carried out to demonstrate interoperability at various levels within the VSATT architecture, including:

- Sampled Values (SVs) between third-party Merging Units and ABB IEDs;
- SVs between ABB Merging Units and third-party IEDs
- Generic Object-Oriented Substation Events (GOOSE) on Station Bus, using cross-bay tripping generated from Circuit Breaker Fail protection
- GOOSE-based trips to Digital Merging Units (DMUs)
- Plant control, measurement and monitoring with third-party Substation Control Systems (SCSs)
- ABB’s IED Configuration Tool (ICT), System Configuration Tool (SCT) and their third-party counterparts.

Apart from proving interoperability at multiple levels, ABB has installed a conventional IED for line differential protection. Proving a mixture of old and new technologies is vital to replicate the real-world environment during the transition from conventional to non-conventional solutions.

The VSATT platform has provided an excellent insight into how various parts of the IEC 61850 standard have been implemented by each vendor. Several important areas for attention were identified during the implementation of this multivendor scheme. In addition, a demonstration session provided more than 40 industry experts from around the world with the opportunity to witness the levels of maturity and stability achieved by digital substation technologies.

Having proved interoperability at various levels, the VSATT platform will help National Grid to define how to deploy digital substation technologies in its infrastructure. The VSATT will also act as a training platform for National Grid’s own personnel, helping to nurture the next generation of power system protection and control engineers.
A totally different way of looking at health and safety

One of the hot topics among HSE professionals at the moment is that of ‘safety culture’. The idea is that if everyone in a company thinks about safety the same way, follows procedures and encourages colleagues to do the same, they can significantly reduce the risk of accidents. ABB’s Don’t Look the Other Way campaign was explicitly aimed at nurturing this kind of self-reinforcing cultural change, and now a programme has been developed in the Power Grids substation business at Stone that aims to complement it.
The programme is called CORE, which stands for Careful, Observant, Responsible, Engaged, which as the name suggests is central the way we all operate, with a fundamental focus on choice, and both the conscious and subconscious processes we all go through when making decisions in the course of the working day.

Paul Lightfoot is HSE manager at Power Grids Grid substations was one of the management team responsible for formulating the programme. He says the idea is to influence people’s choices in such a way that safety becomes a collective norm in a similar manner to other social norms – so, for example, somebody not wearing their personal protective equipment (PPE) or the incorrect PPE for the task would be as unlikely as doing a workout at the gym in a formal suit, shirt and tie.

He says: “ABB’s value pair – Safety and Integrity; is focussed on doing the right thing and taking responsibility. CORE underpins these values and is intended to help people at all levels of the organisation understand how to make better choices to keep themselves and others safe, inspiring everyone to make those better choices and influence others to do the same.

We engaged a specialist training organisation called Setters to initiate the cultural change who use a number of techniques to improve the safety culture in an organisation. One fundamental idea is that everyone should be using a ‘common currency’ when talking and thinking about safety. In other words, a set of common ideas and terms are used to create a shared understanding.

As an example of the kind of concept involved, Paul gives the notion of an ‘alpha state’, which occurs when someone switches to autopilot while carrying out a task. Other techniques revolve around the way the mind works and the main components with their associated strengths and weakness. It illustrates where forced and natural behaviours are driven from and the structure of people’s perception of reality. These are helped on their way with many enlightening exercises and structured role playing.

The training began in May with a two-day course on visionary leadership held in Stone. The programme is being rolled out to include ABB managers and as well as key contractors on our Canterbury and Richborough sites. So far, about 150 people have attended with other sessions scheduled throughout 2017. Understandably, Paul does not want to give out too many spoilers about the contents – apart from promising that no PowerPoint presentations will be involved but the feedback so far has been enthusiastic.

“Some people have told us it’s the best safety course they’ve ever been on, and that it’s a totally different way of looking at things”. When we asked people at the end of the two-day course how they feel about doing another, they have been very positive.”
In June 2017, ABB announced that it has successfully commissioned the DolWin2 offshore wind transmission link and handed it over to TenneT, the Dutch-German transmission system operator.

The HVDC link connects three offshore wind farms in the North Sea to the mainland grid: Gode I, Gode II and Nordsee One. Power from the wind farms is collected at a converter platform called DolWin beta before being transmitted along a 45 km subsea cable and 90 km underground cable to the Dörpen West substation in Germany.

ABB’s project scope included the design, supply, installation and commissioning of the compact offshore and onshore converter stations as well as the subsea and underground cable systems. The scope includes the platform for DolWin beta, which is the world’s most powerful offshore converter station.

The link has a capacity of 916 MW, which is enough to power around 1,000,000 households with clean wind energy. It is based on ABB’s HVDC Light technology, which uses Voltage Source Converter (VSC) technology.

The project supports Germany’s ‘Energiewende’ roadmap, which by 2020, aims to generate more than 6.5 gigawatts (GW) of offshore wind power and 15 GW by 2030.

“We are very pleased to have successfully commissioned and handed over the DolWin2 project and would like to thank TenneT for their continuing trust and cooperation,” said Claudio Facchin, President of ABB’s Power Grids division.

“HVDC is the technology of choice for reliably and efficiently transmitting large amounts of power over long distances with minimal losses. It is ideal for integrating remote renewable energy into the power grid and plays a key role in making ABB partner of choice for enabling a stronger, smarter and greener grid, in line with our Next Level strategy.”

Third offshore wind connection
DolWin2 is the third offshore wind connection project that ABB has completed for TenneT – in Germany’s North Sea.

ABB also delivered the grid connection for BorWin1, which includes 80 wind turbines rated at 5 MW each and is located about 130 km off the German coast in the North Sea. It also delivered the DolWin1, which connects the Borkum West II and Borkum Riffgrund wind farms.

HVDC Light technology
There are numerous environmental benefits to the HVDC Light system, including electrical losses of less than 1 percent per converter station, neural electromagnetic fields and compact converter stations.

Its relatively compact footprint means that HVDC Light technology is ideal for connecting remote wind farms to mainland networks without distance limitations or constraints on the grid.

Having pioneered HVDC Classic in the 1950s, ABB introduced HVDC Light technology in the 1990s on a 3MW link between Hällsjön and Grangesberg in central Sweden, ABB has now delivered 19 of the 25 VSC-based HVDC projects commissioned around the world and has extended the technology to up to 3,000 MW and +/- 640 kV.

Today, HVDC Light has the capability to transmit enough electricity to power several million households and enable power transmission over 2,000 km.
916 MW

enough electricity to meet the needs of

~1 Million

households with clean energy

World’s most powerful offshore wind connection integrates 916 MW of power

DolWin2 link transmits wind power from offshore wind farms in the North Sea efficiently with ABB’s HVDC Light™ technology.
ABB has won an order from TAURON Dystrybucja SA, one of Poland’s leading power utilities, to upgrade its 110 kV substation in Oborniki Śląskie, a town in south-western Poland. Once completed, this will be the first digital substation in Poland.

As part of the project, optical fiber cables will be used in most of the communication links, providing digital communication with higher data transfer capacity as well as transmission safety and security. It will also optimise costs and reduce environmental impact. The substation will also be equipped with fiber-optic current sensors designed to monitor electricity flow. They will replace time-served instruments and enhance security and accuracy.

“We are pleased to pioneer the concept of digital substations in Poland with this upgrade and equip it with our ABB Ability™ based technologies. The upgrade will enhance controllability and reliability while helping to optimise costs for our customer”, said Patrick Fragman, head of ABB’s Grid Integration business.

“This project reinforces our focus on service and upgrades and supports our vision of being a partner of choice for enabling a stronger, smarter and greener grid.”

Earlier this year, ABB completed a similar upgrade project of a key substation in New York City, where digital technologies have been applied to the system supplying power to hundreds of thousands of customers in Manhattan.

TAURON Dystrybucja supplies energy to over five million consumers in southern Poland and is investing in the development of network automation, grid diagnostics and reduction of transmission and distribution losses. The digitalisation of the substation will set a new standard for the Polish energy sector.
DPSP 2018: the IET’s conference on developments in power system protection

ABB is a headline sponsor for the IET’s DPSP (Developments in Power System Protection) conference at Belfast’s Europa Hotel on 12 – 15 March 2018.

DPSP is a must-attend event for ABB as it is the only UK forum that focuses on power system protection and control systems. The biannual conference is on track for a successful 14th event. It is attended by academics, consultants and engineers responsible for the application, ownership, management, design and development of protection and control schemes in more than 30 countries.

Dr Murari Saha from ABB in Norway will chair a conference session on new protection algorithms and software solutions.

Danny Lyonette, ABB’s Marketing & Sales Manager for Grid Automation said: "We will be at DPSP to highlight our automation solutions for transmission and distribution networks. Experts from across our Power Grids and Electrification Products divisions will share insight on a wide range of topics including the latest high and medium voltage technologies, business practices, applications and techniques in control and protection of distribution grids.

DPSP 2018 follows on from the 2016 conference in Edinburgh, which attracted more than 275 delegates featured more than 140 peer-reviewed papers on key industry themes such as utility and vendor experiences, algorithms and software, transmission protection, smart grids, low voltage and distribution networks, and testing procedures.
Let’s write the future.
Enabling a stronger, smarter and greener power grid.

The future of the grid depends on innovative technology for efficient, reliable power. Trust ABB’s technology to secure it.

ABB is helping to build the digital grids of the future with innovative technologies that reduce investment, risk and environmental impact. Our utility and industrial customers are now able to maximize the flexibility, controllability and availability of their power networks through key ABB innovations such as: digital substations that replace copper connections with fibre optics; flexible power links that balance voltages and power flows between distribution systems; microgrids that integrate distributed energy sources and loads. All this technology is brought together by ABB Ability™, our unified digital capability that extends from device, to edge, to cloud. abb.com