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GRIDLOCK

The Government’s target of ten percent of electricity to be generated from renewables by 2010 has very substantial implications for the patterns of generation and transmission and for developing grid requirements.

In March, Ofgem invited industry stakeholders to take part in a consultation forum regarding the changes to the grid codes for the expansion of wind generation. Following the forum, the transmission licensees for both the Scottish Grid Code and the England & Wales Grid Code have submitted aligned proposals and Ofgem is intending to issue its decision by mid-May.

Most of the UK’s electricity comes from a small number of very large generating units and we have a transmission system that is appropriate for that small number.

If the Government’s targets for renewables are to be met, there will also be a large number of much smaller generating units situated in different parts of the country. This means that in addition to the centralised power stations directly connected to the national grid system, there could be as many as 300 distributed generators linked to each substation within the network.

This is a massive change that will require significant investment and adoption of new innovative connection solutions if it is to be achieved in an environmentally sound and efficient way and ensure security of supply.

Technology innovation has a key part to play in the cost-effective accommodation of wind farms and embedded CHP units into existing utility networks. ABB is drawing on its experience of installing power networks all over the world – many involving small-scale generation – to develop and deploy innovative solutions based on tried and tested technologies.

As you will see in this edition of our newsletter, we are actively working to address many of the embedded generation issues currently facing network operators and developers. Technologies that will enable non-synchronous generators such as wind farms to comply with new technical connection requirements.
In May 2003, operating under the banner of ‘Lighting For Staffordshire’, ABB commenced a 25-year contract for the renewal of Staffordshire County Council’s road lighting and illuminated traffic sign equipment, as well as the ongoing maintenance of some 106,000 items of county-owned illuminated apparatus.

Under the terms of the contract ABB is renewing all items of apparatus which are in poor condition or which exceed their anticipated lifespan. The renewal programme is being planned in five-year phases and we expect to replace around 25,000 street lights in the first five years. In the first nine months of the contract we focused our attention on the Newcastle-under-Lyme area, where we replaced 1,180 lighting columns, 267 traffic signs and 105 bollards. We are now starting to pick up the pace by rolling out the replacement programme across Staffordshire to include Stafford, Tamworth, Rugeley and Burton-on-Trent.

**WHITE LIGHT**

In some areas of the project we are taking the opportunity to replace traditional sodium or mercury street lighting with new technology fluorescent lights. These have the advantage of providing a ‘white light’ which offers better colour rendering. This aids perception and should have a positive effect on reducing night-time injury accidents. Some studies indicate that this type of lighting can also help to reduce crime. To date well over 100 streets are already seeing the advantages of white light.

**MAINTENANCE**

Maintaining Staffordshire’s existing lighting stock is another key element in the PFI project. Every single item of apparatus is being inspected at least once a year to ensure its electrical safety, optical performance and structural condition are acceptable. Anything which does not meet our standards is being repaired or replaced. Lamps are also being renewed on a regular basis to maintain lighting standards.

We have been set a target of ensuring that a minimum of 98 percent of all lights are working correctly at any one time. To help achieve this, our patrollers are scheduled to visit each item at night once a month in the summer and twice a month in the winter. Any faults identified by our patrollers are recorded and repaired. I am pleased to report that currently we are beating our target by keeping over 99 percent of the stock in full working order.

**FAULTS AND EMERGENCIES**

In addition to our own monitoring, we receive around 200 fault reports a week from the public, either by telephone to a dedicated call centre or via the special website we have created (www.lightingforstaffordshire.net). We aim to repair most faults within five working days. We also receive around 40 emergency calls a week, where there is a risk to life or property. For these cases we provide a two-hour response – at any time of day or night - and out of the first 1200 emergency reports we were late just once, and then by just one hour.

Primarily, we see our role for Staffordshire County Council as an asset management service. So, as well as making sure that the county’s road lighting stays lit, we are working to ensure the longevity and reliability of the lighting stock to maximise the return on both ABB’s and the council’s investment in the maintenance and renewal programme.

The feedback we have received is that the council is pleased with progress to date. This is also opening up opportunities to undertake additional work, both for the council and for private developers, such as providing lighting schemes for new housing developments.

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**Staffordshire’s White Nights**

The innovative, multi-million pound PFI (Private Finance Initiative) renewal and maintenance project for Staffordshire County Council’s road lighting is now approaching its first anniversary. A progress report from Simon Clarke of ABB.
Work has begun on a £12 million contract to design and build a replacement 132kV interconnector substation at Port Ham, Gloucester, for Central Networks (the new name for Midlands Electricity). The use of gas insulated (GIS) switchgear will enable the replacement substation to be housed in a new purpose-built building that will occupy less than one quarter of the space occupied by the existing air insulated (AIS) substation. The project is being undertaken by a consortium consisting of ABB and Balfour Beatty.

Less Space, More Performance

The Port Ham interconnector substation is a grid supply point, which feeds electricity from the National Grid substation at Walham into Central Network’s distribution network. This network feeds most of Gloucestershire and Herefordshire and parts of south and east Worcestershire – the equivalent of over one million homes.

The existing Port Ham substation, built in the early 1950s, having been subject to above average load growth is now reaching the end of its useful life and is being replaced to ensure continued reliability of supply.

NON TRADITIONAL APPROACH

The traditional approach would be to construct a new outdoor substation alongside the existing substation using similar AIS (air insulated switchgear). This would have required the purchase of additional land. In addition, the outdoor solution presented engineering complexities in order to maintain supplies and meet safety clearances. Central Networks therefore decided on an alternative based on ABB’s state of the art compact ELK-04 gas insulated (GIS) switchgear housed in an indoor building. This has the advantage of requiring less than one quarter of the space. The site is also in a environmentally sensitive area, being positioned on the edge of a flood plain by the river Severn. The ABB and Balfour Beatty consortium’s approach to the project offered engineering solutions to meet the required planning requirements to address these environmental issues.

In addition to saving space, GIS also offers two further advantages to Central Networks. Circuit downtime will be reduced as the new circuits in GIS can be constructed with the existing units still in service. So the downtime is then reduced to the re-routing of the network connections. This is crucial due to the critical position of Port Ham in the supply network. In addition, the GIS can be constructed outside the existing live compound thereby considerably reducing health and safety risks to personnel working on site. The switchgear will be installed on the first floor of the building to ensure that it is 600mm above the predicted level of the once in 100 years flooding plain level.

The ABB and Balfour Beatty consortium is providing a complete design, construction and installation service for the new substation, which will feature 20 bays of switchgear and provide a 132kV interconnection for eight incoming and outgoing circuits. It is expected to become operational towards the end of 2006.

Four new substation projects

ABB (Northern Electric’s distribution business) has placed orders worth around £4.6 million with ABB for four 11kV distribution substation projects.

The largest order is for the design and build of a complete new 11kV substation at Norton, near Stockton-on-Tees. It will feature two ABB 132/11kV transformers and a 16 panel 11kV switchboard, which will supply power to the local distribution network. It will be constructed on the same site where ABB is currently carrying out a £9 million project for NEDL to construct a new 132kV indoor interconnector substation (see Space Saving Substation story on opposite page).

At Ravenscar, ABB is to install a new 132/11kV transformer and a 33kV switchboard, while at Wormald Green ABB is to install a new 132/11kV transformer. ABB will also carry out a general refurbishment of the Ormond Street substation with various switchgear and associated equipment.
A two year contract, worth several million pounds, to supply equipment to support the refurbishment of its network and growth of wind farms, has been won by ABB from Scottish and Southern Energy (SSE).

The contract includes the supply of 90MVA 132/133kV transformers which will be installed on sites in Scotland and southern England. The equipment represents an ABB standard solutions package, thus reducing the risk for the customer and saving on investment costs.

SSE’s business portfolio includes a high voltage transmission system (132kV and 275kV) in Scotland and southern England. It relies on a variety of conventional and alternative energy sources including hydroelectric, wind farms and thermal generation.

The transformers will be supplied by ABB’s state-of-the-art plant in Lodz, Poland.

The new £9 million 132kV indoor substation at Norton, near Stockton on Tees, which will interconnect the National Grid and NEDL’s distribution network at 132kV, with eight incoming and outgoing circuits, is on target to commence operation towards the end of 2004. Twenty bays of state of the art compact ELK-04 gas insulated (GIS) switchgear have already been successfully installed.

The use of ABB’s GIS switchgear, rather than conventional air insulated switchgear (AIS), is enabling the new substation to be housed indoors and condensed into around one quarter of the space.
Network Rail is upgrading the power supply across its Southern region to enable South West Trains, South Central and South Eastern Trains to bring around 2000 new, more comfortable, carriages into service by 2005. In this article Andy Mitchell, Network Rail’s Project Director, outlines the background to what is probably the world’s largest DC power project.

Southern Region Power Upgrade

The aim of the project is to support the introduction of the Electrostar and Desiro trains that are being phased in to replace the old Mk1 rolling stock, which the Railway Safety Act of 1999 requires to be taken out of service. The new trains offer much improved passenger comfort and security with features such as central door locking, CCTV and air conditioning. However, they place greater demands on the 750V traction power supply system, and when all 2000 of the new trains are in service they will draw around 23 percent more power than the existing network can provide – hence the need for the power upgrade.

To give an idea of the scale of the project, I am told that Southern Region is the UK’s largest private operator of an electrical distribution system, and the upgrade is the largest DC project of its type ever undertaken anywhere in the world. Including site and office based administration staff we have around 800 people currently working on the project. Since the start of the year activity has ramped up sharply, so we now have something like 50 active sites. In one single day in March 120 new carriages entered service simultaneously. And over the next two months we will bring 20 substations online. That level of activity may be routine for a global concern like ABB, but it is certainly remarkable for a single rail infrastructure organisation.

One of our main challenges has been in understanding exactly what we required the upgrade to achieve so that we could define the scope of the project. The starting point was to take the timetable model, add an electrical analysis package, factor in the traction characteristics of the new trains and then compare this with the existing system. An additional complication was that some of our systems are 40 years old, which means that their operating parameters are not as closely defined as modern equipment. We also needed to allow for system resilience to cope when equipment has to be taken out of operation, or when running a perturbed timetable.

Throughout the 18 month design process simplicity was our watchword. Technically, we have made a point of not breaking new ground where at all possible – for example we are not using regenerative braking, although our design does allow the flexibility for this to be introduced in the future. We have also placed an emphasis on modularity, so that equipment is manufactured in a controlled factory.

Project Facts

- £3 billion total investment in new trains and infrastructure
- 2,000 new carriages including Bombardier Class 375/376 Electrostars and Siemens Class 450 Desiros
- 3,196 miles of track
- 9,389 passenger and freight trains every day
- 77 feeder cables totalling more than 300km will be laid
- 2,500 cable joints to be fitted
- 97 substations to be upgraded
- 1,700 impedance bonds will be fitted
environment rather than being assembled on site. I am convinced that this elimination of complexity has helped reduce the risk in the project and will keep us on target both in time and cost.

When we appointed the project contractors it was important that they could demonstrate capability in the design and installation of large electrical projects as well as experience in the rail industry. The contracts have been let over four areas: Inner London, Kent, Sussex, Wessex. We are of course working on a very busy rail network and we have to keep the impact on normal running of trains to a minimum. So a great deal of effort has gone into making this a ‘non-rail’ project where possible, using road access rather than rail to deliver equipment. Much of the work is being carried out at night and weekends. We are also taking every available opportunity for access to sites – normally you need to give 18 months notice but in some cases we are able to piggyback on access that has been granted for other work.

The final measure of the success of this project will be when we see all 2000 new carriages in service, on time and running reliably. Passengers will benefit from a new modern train fleet. The train operating companies will continue to experience a resilient and robust electrical supply system, and Network Rail will gain an improved and more reliable infrastructure. Ideally the process will have been ‘invisible’ to the vast majority of train passengers.

ABB/Mowlem upgrading the Kent area

In 2003 Network Rail awarded an ABB/Mowlem consortium a seven year framework contract for the Kent area of this power upgrade project, as well as some additional sites in the Inner London area.

The scope of this activity includes:

- 25 substations and 13 feeders to date
- 26 off 3 or 4 MW transformers
- 26 off 70kVA auxiliary transformers
- 100 panels of switchgear
- Installation of around 25km of 33kV cable

For the project ABB is using its new ZX1.2 range of metal-clad gas-insulated medium voltage switchgear which has gained technical acceptance from ENA (the Energy Networks Association) and Network Rail for use at 33kV for ratings up to 31.5kA and 2000A.

The containerised substations are being housed in stainless steel enclosures which should last for 40 years. They are fitted out off site, this reduces the need for protection staff and keeps site costs down.
ABB was chosen as electrical services contractor for Castlepoint shopping park. It was able to bring its ‘new connections’ expertise to bear in bringing power to the new centre and its occupants on time and in spec.

The Retail Connection

Everything about Castlepoint is impressive. Covering an area of nearly 60,000 sq m (645,000 sq ft) it is the largest retail development in the south of England, occupying a 41-acre site and providing over 3,000 car parking spaces. It contains 40 retail stores including market leaders such as Sainsbury’s, ASDA, Marks & Spencer, WH Smith, B&Q, Virgin, Boots, GAP and Next. The original design allowed for the supply of 9MVA on either or both cables supplying the site, the actual present load is 7.9MVA.

The electrical services work was undertaken by ABB, who with its sub-contractors, succeeded in not just delivering a first-class service but in doing so on time. ABB began work in December 2001 and, except for minor client modification work, finished in December 2003.

ABB was chosen as the electrical services contractor on the basis of its vast knowledge, experience and ability to deliver innovative solutions. The developer, Castlepoint Limited Partnership, working with the main construction contractor Kier Build, was instrumental in making the selection.

The selection of an independent contractor as opposed to using the DNO (distribution network operator) to make the electrical connections was a critical strategic choice. The developer believed that this route would not only save it money but give it and its customers, the retailers, far greater freedom and flexibility.

Historically, only the host DNO would have been permitted to provide the electricity infrastructure required to service a development such as this. However deregulation of the market has given ICPs (independent connection providers) such as ABB, the opportunity to offer a real alternative. The regulator has actively encouraged ‘Competition in Connections’ and this is having a real impact on the planning and delivery of such projects.

Developers, large and small, can now take advantage of the reduced capital outlay, contract terms, and timely delivery that ABB has to offer. This option in no way limits the end user to its choice of electricity supplier, and thus ensures that continuing savings can be realised.

One of the challenges facing the electrical services contractor was that it had to make up a 5.5MVA shortfall in what was previously available on the site, supplying the smaller Hampshire Centre.

Another challenge was that the work had to be carried out while the existing Hampshire Centre was still functioning.

A TOTAL PACKAGE

The ABB solution included the installation of five new substations, the refurbishment of three existing substations and the installation of eleven high voltage ring main units. A total of 3.6km of 11kV cables, in two circuits, was laid connecting the ring of substations.

All substations are of an identical design, a factor that has reduced costs and simplified maintenance and support requirements. High and low voltage connections have been made to different stores according to their requirements and each unit operator has had the freedom to use different suppliers. Some have chosen EDF, others Scottish & Southern Energy (the local REC) and some are using GPU (Midlands) and other new operators.

The entire 11kV and LV network has been adopted by Scottish & Southern Electricity, having confirmed that the network has been completed to its demanding specification. The company undertook regular inspections throughout the entire programme.
Today most wind farms are directly connected to the AC grid. With increasing wind power coming on line and a trend towards large-scale installations in remote locations, it is becoming necessary to have an interface between the wind farm and the AC grid in order to maintain power quality and network stability.

HVDC Light® is a DC transmission system based on voltage source converter (VSC) technology. It is suitable for connecting large amounts of wind power to networks (even at weak points in a network) without having to improve the short-circuit power ratios and without the need for additional reactive compensation, as is this inherent in the converters.

HVDC Light uses underground (or submarine) cables and not overhead lines as the link between the two converter stations. In a number of cases the cable cost can be lower than for an equivalent overhead line route. This has significant environmental benefits and results in less public objections to construction and significantly shorter project completion times.

An overview of a transmission system for bringing offshore wind power to a network with HVDC Light is shown in figure 1.

The HVDC Light system can control active power transmission in an exact way, ensuring contracted power can be delivered as requested. The power transmission can be combined with a frequency converter that varies the power to override or support the network frequency.

Thanks to the ‘turn on/off’ capability of the power semiconductors, the converter offers excellent controllability and flexibility. During periods with reduced transmission capacity in the grid, the output from the wind farm can be optimised with all turbines still running.

A very significant feature of the HVDC Light converter is the control of reactive power, along with AC voltage control of the network connected to the converter station. Such rapid AC voltage control can also be used to improve the power quality by the control of flicker and transient disturbances.

In the case of a connection to a passive network such as a wind farm, the HVDC Light transmission system can provide control functions for active and reactive power, so that both voltage and frequency can be controlled from the converter station. This allows ‘black’ starting by controlling the voltage and frequency from zero to nominal.

HVDC Light also gives the possibility of providing reactive power to the windmills during start up and ‘fault-ride through’ conditions, greatly assisting with grid compliance and stability issues.

A further benefit of HVDC Light is that the DC cable has no charging current, and as a result there is effectively no technical limit to the transmission distance. Extruded polymer cables are used for power transmission, linking compact converter stations which have been specifically designed to sympathetically blend into the local environment.

Currently ratings up to 350MW are available for the HVDC Light stations, however continued improvements in semi-conductor technology will see power handling values increase in the near future.

More information about HVDC Light can be found on: http://www.abb.com/hvdc
The Aus$100 million Murraylink interconnection took just 39 months from concept to commissioning, a major achievement for such an ambitious project. The 176km cable itself was laid in less than ten months. The 200MW interconnector runs between Riverland in South Australia and Sunraysia in Victoria State and carries enough power to meet the needs of around 120,000 homes.

The ambitious project not only won the support of planners, consumers and other groups because of its minimal effect on the environment, it also won a prestigious award. TransEnergie Australia (a subsidiary of the utility Hydro Quebec) awarded the project construction contract to ABB which has employed its HVDC (High Voltage Direct Current) Light technology to transmit the power from one state to the other.

HVDC Light technology converts current from AC to DC and uses special extruded cable, laid in bipolar pairs, to transmit the power underground. Anti-parallel currents eliminate magnetic fields. Converter stations are built at either end of the HVDC cable, and can handle power flow in either direction – important in the deregulated energy market. The advantage of HVDC compared to conventional AC transmission lines is that it uses fewer cables, and can be laid underground. The components of the converter stations are compact and modular, allowing for relatively short lead and construction times on projects.

The Murraylink installation consists of two high voltage direct current (HVDC) cables laid 100mm apart in a trench dug within a 3-4m wide easement.

A key criteria for this type of project is to have a resistivity level in the material around the cables that allows correct heat dissipation during operation. As a result, 300 test holes were dug along the proposed route with each site classified as having adequate resistivity, requiring imported materials or requiring heavier cable. The route was also surveyed to identify vegetation that required clearing.

The contractor’s job was to lay two 85mm diameter cables 100mm apart in a 450mm wide, 1.4m deep trench, with screened bedding material to cover from 150mm below the cables to 200mm above them (after compaction). The bedding needed to be compacted to 95 percent MDD to meet resistivity requirements, and this was tested by a NATA certified authority.

The cables were supplied in lengths ranging from 700m to 1000m. To avoid cables being cut computer analysis was used to optimise cable use so that for all but two of the 200 road, pipe and cable crossings the cable terminated at the appropriate location. The single pass cable laying reached production rates of up to 3100m in a 10-hour day, and work was completed three weeks ahead of schedule, despite the difficult and demanding conditions.

ABB and its contractors followed strict environmental guidelines on the project, and as a result did not need to use any of the available budget for tree replanting.

The project set new benchmarks in installation and environmental performance, and is an achievement of world significance. Murraylink is benefiting consumers in both the states it serves by enabling electricity trading in Australia’s deregulated power market.

In addition to the Case EARTH Environment Award, Murraylink has also received an Environmental Planning and Conservation award from the Royal Australian Planning Institute.
Reducing the number of components that make up power grids helps make them more reliable and easier to maintain. ABB has designed more features into a central component of a power substation – the circuit breaker.

The new PASS (plug and switch system) M0 170kV hybrid switchgear integrates the functionality of a circuit breaker with one or more combined disconnector/earthing switches, bushings for connection to single or double busbar systems and a current transformer in one compact module, eliminating the need for separate pieces of equipment for each function.

Currently undergoing the approval process for both ENA and NGT, the PASS M0 fits into a standard truck container and does not require any packaging. No special arrangements are needed for shipping and transportation, and once on site just a simple 30° rotation of the outer poles is needed for the final layout.

The PASS concept is a hybrid of ABB's traditional air insulated (AIS) and SF6 metal-clad gas insulated (GIS) switchgear units and is designed as a self-contained switching module suitable for use in outdoor distribution substations up to 170kV.

Each module is compact, energy-efficient, easy to install and virtually maintenance-free.

In an innovative design, the line and busbar disconnectors, as well as the earthing switches, are integrated in the breaking chamber. This gives these components complete immunity from all environmental conditions, thereby ensuring lifelong reliability, and eliminating routine maintenance of high voltage parts. This overcomes a major weakness of AIS substations.

Standard functions include current measurement, current interruption, disconnecting and earthing, all of which can be customised and added to according to customer requirements.

Specifications:
- Rated voltage 72.5/123/145/170kV
- Rated frequency 50/60Hz
- Rated current 2500A
- Rated short time withstand current (1s) 40kA
- Rated peak withstand current 100kA
- Temperature range -30°C/+55°C

Protection the way you like it

ABB’s universal object terminals allow users the freedom to select terminals that meet a wide variety of protection, monitoring and control requirements of both present and future electrical power systems.

When it comes to protection, monitoring and control of overhead lines, cables, transformers, breakers and busbars whatever the voltage level, object terminal protection functions fulfill the most stringent requirements in speed, sensitivity, selectivity, security and dependability, - minimising disturbances.

Built-in multi-functionality reduces the need for space, engineering and installation time. Pre-configured application-specific solutions allow smooth connection and integration into a system or standalone unit and the advanced engineering, operation and analysis tool ensures efficient operation.

The 500 series of protection, monitoring and control terminals is designed to give you exactly what you need, the way you like it.

The recently released “2.5 version, has been submitted for ENA approval and offers a step up in performance with special attention paid to backward compatibility to versions “2.0 and “2.3.

For more information on individual ABB 500 Series and specific applications, email albert.a.shield@gb.abb.com, or visit web site at www.abb.com/substationautomation for application and system solutions.
ABB has developed and delivered a comprehensive range of substation automation solutions including protection, monitoring and control for transmission and distribution substations, power plants as well as industrial applications. These solutions range from single function units such as feeder terminals and feeder protection relays to fully integrated, comprehensive high-performance substation automation systems encompassing full automation and asset management functionality.

Are you in control?

A great deal of attention has been paid to making ABB substation automation systems user friendly, to cut down training time, to rationalise procedures and to reduce the possibility of human error, thereby providing real operational benefits straight to the bottom line.

In addition, high operational reliability, due to extensive automatic self-supervision, means that maintenance is considerably reduced.

The move from solid state equipment to programmable microprocessor techniques has made it possible to combine many functions into one physical unit. So the traditional discrete relay or protection function is now combined with many other functions within a single terminal unit. The ABB solution provides flexibility while retaining security and functionality.

SUBSTATION AUTOMATION CONCEPT

The integration of functions within one digital unit means that the terminals play a key role in the ABB substation automation concept, which can integrate all the primary and secondary equipment in a substation within an on-line, real-time monitoring and control system. The capability to upload recordings of disturbance waveforms from the protection and monitoring terminals enables a detailed analysis of system faults and the potential causes to be carried out to improve outage management. It is possible to incorporate an automatic power restoration system to shorten outage times.

The ABB substation automation system offers the flexibility to include building blocks from various product ranges and equipment generations, including non-ABB equipment and conventional static/electromechanical relays, which makes it suitable for partial retrofit as well as completely new installations.

This continuity for old and new products also ensures that the system is fully open for the incorporation of future developments such as new sensors or intelligent switchgear. The system is fully scalable from a single-user/local user on an industrial application up to a national network control centre covering thousands of customers.

For more information go to the dedicated website www.abb.com/substationautomation.