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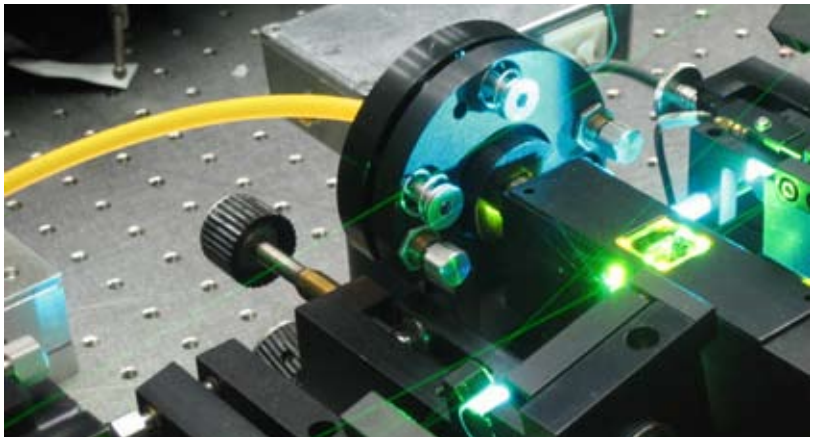
New power under the sun. (7)



Laser eyes. (10)

Renewables

Innovation

Laser measurement

Power upgrade

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Sustainable power solutions

Carlos Poñe
CEO, ABB South Africa.

Renewable energy sources are assuming an important role in the future of energy policy. Many governments have incentive plans to promote generation and integration of energy into the grid to increase their renewable energy power mix and minimise environmental impact.

ABB is involved in supplying to large-scale solar and wind projects in several countries, such as Algeria, Finland, Germany, Italy, Portugal, Spain and the United States. The projects include photovoltaic power plants, thermo-solar plants, solar mirror production plants, integrated solar and combined cycle power plants, and both land and offshore wind farms.

In South Africa there is a growing interest in both solar and wind power, although the public sector requirement is relatively small. The government has recommended, as part of the draft integrated resource plan, or IRP2010, that South Africa's energy mix in 2030 would comprise 48% coal, 16% renewable energy, 14% nuclear, 9% peaking open cycle gas turbine, 6% peaking pump storage, 5% mid-merit gas and 2% imported hydroelectricity.

South Africa's Minister of Energy Dipuo Peters recently spurred interest in solar by unveiling a plan to host the world's biggest solar power plant in Upington in the Northern Cape. This ambitious proposal entails an envisaged investment of R150-billion for the production of three times the power of the Koeberg nuclear plant (installed capacity of 1 800 MW) using sunlight.

A recent report from business research and consulting firm Frost & Sullivan finds that the off-grid solar power market in sub-Saharan Africa is expected to grow at a compound annual growth rate of more than 10% between 2009 and 2015. Several wind projects in North Africa presently in the development stage will be operational in 2010, increasing the installed wind power capacity in Africa.

Global interest in solar energy is understandable when we consider that it remains one of the largest untapped sources of renewable energy on earth. Every hour, the Earth absorbs more solar energy than the world's population consumes in a year. By converting solar energy into electrical energy, for each kWh hour generated, carbon dioxide (CO2) emissions that pollute the planet can be reduced by 600 grams.

ABB has been a leading player in the solar power industry since the early 1990s when we developed an automation platform for the world's first test facility for concentrating solar power technologies at the Plataforma Solar de Almeria (PSA) in Spain. Since then, ABB has been involved at a pioneering stage in just about every type of photovoltaic (PV) and concentrating solar power (CSP) technology developed, be it in Europe, North America, Australia, Africa or the Middle East.

With our 30 years of experience, in-depth know-how, global manufacturing footprint and thorough understanding of both wind turbine applications and power systems, ABB is the leading supplier to the wind power industry of electrical products and solutions. Demand for wind turbines continues to grow, driven by commitments to reduce CO2 emissions and to diversify into renewable energy sources. Using ABB products helps manufacturers demonstrate the quality and reliability expected in the turbine design. ABB's proven products for wind turbines are designed and built to operate for long lifecycles in the variety of harsh operating conditions common to turbines.

In this issue of *Technology Solutions* we feature ABB's involvement in the Desertec solar power super grid, the objective of which is to interconnect the power grids of Europe, the Middle East and North Africa and generate large amounts of electricity in the region's deserts. Electricity would be transported to consumers using ABB's high-voltage direct current (HVDC), a power transmission technology pioneered by ABB.

These articles offer an overview of some highlights of ABB's involvement in solar power. For further information on both solar and wind power, please visit the ABB website (www.abb.com). Should you want to discuss ABB's renewable energy solutions with ABB in South Africa, please e-mail ross.botha@za.abb.com or call Ross Botha, Sales Manager, ABB South Africa, on + 27102026061.

I would like to take this opportunity to thank all our customers for their valued business during 2010. On behalf of the management team and our employees at ABB South Africa, I wish you health, happiness and success in the New Year.

Carlos Poñe
CEO
ABB South Africa

South Africa throws the switch

Wide-ranging changes are coming in the way energy is generated, and the new energy target of 40 000MW by 2030 includes a big contribution by sun and wind.

Text Tom Nevin

South Africa will produce some 40 000MW in new power between now and 2030, giving the country the electrical energy resource of around 80 000MW that it will need for sustained economic growth.

There are no ifs and buts about this, says Minister of Energy Dipuo Peters. It simply has to be done if South Africa is to realise its true potential. The cost, with escalations and inflation, could well top a trillion rand.

As the plan stands now – outlined in the draft of the recently released Integrated Resource Plan of 2010 (IRP2010, or IRP2 as it is the second such programme) – some 7 000MW will be renewable, but that could change, and probably will, as the IRP is revisited every two years via the multi-year price determination (MYPD). This check and balance takes into account the industry's ever-shifting financial regime and allows for adjustment accordingly. It also implies that the 20-year IRP is not inflexible, allowing for innovation that might change the composition of the energy mix and costs. In that process it is a good bet that the megaWatts in renewable energy assumed today will revise upwards as new technology affects costs and efficacy in the next two decades.

The proposed composition is 48% coal, 16% renewable energy, 14% nuclear, 9% peaking open cycle gas turbine, 6% peaking pump storage, 5% mid-merit gas and 2% imported hydroelectricity. About 4 500MW has been set aside for wind generation and 600MW for solar.

The government's long-awaited roadmap, prescribing South Africa's great trek to sustainable energy, is not lacking in candour. "There is a serious risk of electricity shortfall over the next five or six years," warns IRP2 bluntly. "From 2011 to 2016 rolling blackouts are anticipated unless extraordinary steps are taken to accelerate the realisation of non-Eskom generation and energy efficient projects."

"There is a serious risk of electricity shortfall over the next five or six years."

For non-Eskom generation read independent power producers (IPPs) and translate energy efficiency into transmission and distribution and into how electricity consumers must mend their ways and make better use of their power.

In effect, IRP2 is a balancing act and addresses that most hazardous of all endeavours: trying to please all of the people all of the time. On one side of the scales are cost, carbon emission, water usage

Doug Kuni
Managing director of the South African Independent Power Producers' Association.

and security of supply and on the other are fossil fuels, nuclear and such renewable fuel resource as sun, wind and hydro.

The IRP2 is radical in its shift to cutting reliance on coal by more than half and to seriously moving towards renewable for future electricity production. Coal-fired generation falls from its current 90% to just 48% in IRP2's lifecycle. It could be even less.

In the view of Doug Kuni, managing director of the South African Independent Power Producers' Association, a 16% quota for renewables is generous for the next 20 years. "But we would have to test, in the South African context, how the renewables actually fit into the system," says Kuni, "and what support those renewables would need from, say, coal-fired stations. That's untested at the moment.

"Suppose you put in 2 000MW of wind. If the wind dies down, for whatever reason, for a day, when base load is required, that is not despatchable load. So there's still much testing ahead to see how renewables will complement the current system," he says.

"Discussion is wide-ranging on the wind versus solar allocations, for instance, and it's anticipated that the renewables quota could be amended. Cost is a factor, especially in the different types of solar applications. Concentrated solar is envisaged for the Upington project, globally photo-voltaics is coming down in production cost. Solar is attracting debate and could lead to revision in the final IRP document. It will be reviewed every 24 months, allowing windows for critical decisions to be made. We live in uncertain times, and that is a pragmatic approach."

Kuni says there's a lot of talk about the green economy and the kind of economy and employment opportunities it would create.

"I think we need to press forward carefully on this," he cautions. "It is very difficult, in a short space of time, to suddenly change the energy intensity trajectory of the country. Investments into energy intensive industries are matched to the power supply, and you can't suddenly change it. I think that for the next ten years, South Africa's problems are in base load and until that is stabilised we will have chronic power shortages."

Kuni believes South Africa must evaluate how it implements its carbon strategy and points to the carbon strategies of China and India, which suggest they will be building coal-burning power stations right into 2030. "So the question for us is how do we phase out coal in that horizon? Is it not a better strategy – seeing that coal is a certain, plentiful and well understood primary fuel – to take advantage of the opportunities coal presents and stabilise the base load over the next ten years, without affecting the environment?"

The IRP2, still in draft form and destined for promulgation in the next few months, is short on specifics of the role IPPs. "The snag is that the policy and regulatory environment has yet to be sorted out," says Kuni. "And if those matters are not attended to then IPPs will be ineffective in helping in a critical situation. The risk is too high for investors to invest their money. It's common knowledge that Eskom has limited access to funds, and even after the Medupi, Ingula and Kusile power stations are up and running, we'll still be short of power. So the question is who will do the building, if not the IPPs?"

The snag seems to be that the regulatory environment stands in the way of arriving at a power purchase agreement.

"If the regulatory and policy environment were conducive to private investment, I believe the investment would come," says Kuni.

The die is cast in the form of the IRP2, the guide for South Africa's energy supply fortunes for the next two decades, with a bigger emphasis than ever before on renewables.

Desert electricity farms

The Sahara, Kalahari and other deserts could be useful for farms after all. Not the food-growing kind, but solar farms, which energy experts say could one day supply all the electricity needed to keep the world turning.

Situated in the Sahara Desert, the European project Desertec could power much of Europe within five years, half the initial ten-year estimate. The project is funded with the help of the EU and some European companies, in the hope that Europe will meet its target of generating 20% of its energy from renewable sources by 2020.

A grand plan to build a 5 000MW solar mega-park on the edge of the Kalahari Desert has drawn keen interest from investors the world over. Touted as potentially the world's biggest solar project, the mooted installation at Upington in Northern Cape Province could also be the catalyst for reshuffling the energy mix proposed in the government's Integrated Resources Plan 2010 due for promulgation in a few months' time. In the plan, solar power is allocated just 600MW in targeted new energy of 40 000MW by 2026.

The cost of the facility is estimated at R150-billion and it appeared from the enthusiasm of the 400 investors and global solar players at a conference at the Upington site that most, if not all, the required funding could be raised in the private sector.

"It's unbelievable how some of the developers want to take development risks and put their money into the project even without any definition of the process," reported Ompi Aphane, acting Deputy Director General of the Department of Energy. "There's a lot of interest out there in the market about our urgent need for capacity and I think investors want to take advantage of that, particularly if it's clean energy,"

The region is said to have some of the best conditions in the world for solar power. Promoters say the project could generate 1 000MW by 2012 and 5 000MW by 2020.

New power under the sun

A vision for large-scale solar power from the world's deserts.

Text Andreas Moglestue

Without the sun, life would not be possible. Most of our energy – fossil fuel, biomass or wind – derives directly or indirectly from sunlight. Mankind has, until now, met most energy needs by harnessing these derivative sources – mostly in the form of fossil fuels.

Demand for energy continues to grow. And with the planet's population likely to reach ten billion by 2050, merely securing basic necessities like clean water will call for energy-intensive technologies. How can this thirst for energy be satisfied without environmental damage? How can long-term energy supply be assured in the face of limited reserves of fossil fuels?

Solar power plants in a desert area of only 90 000km^2 – 300km by 300km, a small fraction of the world's deserts – could meet today's global electricity needs. Furthermore, 90% of the world's population lives within 3 000km of a desert – a distance over which economic transmission is considered feasible with HVDC technology.

The Desertec Industrial Initiative is a working group in which ABB has joined forces with several partners for the advancement of such a project in the Europe, Middle East and North Africa (EUMENA) region. Desertec envisages solar generation on a large scale within 30 years.

Human activity is consuming 15 terawatts (15 000GW) of power. To put this into perspective, North Sea oil production contributes about 420GW[1)] and coal production in the US 760GW[2)]. World electricity generation is about 2 200GW[3)].

Fossil fuels, which currently cover 80 to 90% of demand, are finite in supply but will be the main source of energy for a long time to come.

Use of fossil fuels will even rise in the medium-term. But other sources play a role in reducing carbon dependency, and many are already growing rapidly in absolute terms and in market share.

However, energy from the sun provides 170 000TW of power to the Earth, 90 000TW of which reaches the Earth's surface. That is 6 000 times total human consumption, or the equivalent of mankind's energy use being delivered every 90 minutes. In the time it took the average reader to reach this point in this article, the Earth's surface will have received the equivalent of six months of North Sea oil production.[4)]

Photovoltaic panels are a common sight on roofs of buildings, or powering pocket calculators or parking meters, and increasingly also feeding electricity into the grid. A drawback of solar energy is that it is not constant, and the problem is not only at night; clouds adversely affect performance. In deserts the problem diminishes.

Rather than using photovoltaic panels, the proposed desert power plants will

The Extresol power plant

Extresol is a 100MW CSP installation currently being completed in Spain's Extremadura area. ABB is supplying the control equipment with which 1 248 parabolic troughs will follow the sun's movement to an accuracy of 0.03 degrees. ABB's contribution also includes instrumentation, the automation system, motors, drives, low-voltage equipment and substations.

The plant will store excess heat in liquid salt tanks permitting generation to continue when the sun has set. The first 50MW are scheduled to commence operation at the end of 2009, and the second 50MW six months later.

ABB's involvement with Desertec

In July 2009 ABB signed a memorandum of understanding with the Desertec Industrial Initiative. Why is ABB participating?

ABB was already working on the idea of a European grid integrating different kinds of renewable energies in the early 1990s. This included utilising the sun's energy in deserts to supply Europe with emission-free power. It is logical that ABB has been talking with the Desertec Foundation and supporting the project for many years. Our technology and know-how can contribute to its success.

Is this vision of supplying clean power from the desert to Europe technically feasible?

The technologies are available and have been tried and tested. More than 50 years ago ABB invented high-voltage direct current (HVDC) transmission, the key technology for long-distance transmission. HVDC has been continuously enhanced to enable the utilisation of renewable energies, the interconnection of power grids and increased efficiency.

In Desertec the distance is 3 000km. How much electrical energy will be lost in transmission?

Power can be transported over large distances with relatively low losses. At a voltage of 800kV we expect losses to be 3% per 1 000km. At 3 000km, this means less than 10% losses. Long distance connections, however, will likely be an exception. A much more realistic option will be to feed power from North Africa into the European grid via Southern Europe.

Does ABB have experience with such long transmission distances?

ABB is building a high-voltage direct current transmission system in China to transport 6 400MW of power over a distance of 2 000km. This is the capacity of six nuclear power plants. In addition, we won a contract this July for the world's longest power line. Here, HVDC will connect two new hydropower plants in the northwest of Brazil with the economic metropolis of São Paulo, bridging 2 500km.

Will it be economical to produce power for Europe in the Sahara?

We wouldn't be supporting the project if we weren't convinced that it can be economical in the medium- and long-term. With Desertec we are looking at a long time frame – decades rather than years. The first pilot projects will be implemented in a couple of years, and by 2050 the solar power plants in the Sahara will be expected to cover 15% of European requirements. Experts predict the power from solar plants to be competitive within the next 20 years. During this period, the power from conventional energy resources will become more expensive.

How can the energy generated in the desert be fed into the existing European grid considering that the grids are already used to full capacity?

The European grid infrastructure will have to be upgraded across international borders anyway – not least because of the planned offshore wind farms in Germany, Belgium and Spain. It can only be advantageous to consider the integration of the Desertec project from the very beginning.

What about investing more in solar energy storage? Is research in this area currently going on at ABB?

Solar radiation in deserts is more intense and more regular than in Europe. There are no long cloudy periods and hardly any seasonal variations. In addition, use of solar thermal energy allows short-term energy storage. This means heat generated in the day can be stored in molten salt storage systems so that the turbines can continue turning at night. But I expect further improvements in power storage.

Do you think solar energy from deserts will replace conventional nuclear, gas-fired and coal-fired power plants?

Desertec is a visionary project, which takes Europe closer to a carbon-neutral power supply. But it may be some time before power from the desert flows to Europe. Therefore, energy demand must be covered by a broad mix. We will still need conventional energy generation.

Peter Smits is the regional manager of ABB in Central Europe and the CEO of ABB AG, Germany.

Peter Smits co-initiated the Desertec Industrial Initiative on behalf of ABB.

Sceptics say that different interests of countries in Europe, North Africa and the Arabian world could represent an obstacle to this project...

This is a challenge and a reason why the initiative plans to spread the power plants across the entire North African and Middle Eastern region, and to transport power to Europe via several "energy bridges". I am confident political hurdles will be overcome when the project shows that it is economically profitable. African and Arabian countries will benefit as well.

In what way?

Solar energy could become a major export for these countries, generating added value from a resource that is available in abundance – sunlight. This will create new jobs, drive technological development and increase prosperity. These countries will use the Sahara power themselves, for example to desalinate seawater. Production of drinking water from seawater is very energy-intensive.

Financing remains unresolved. Will ABB contribute to costs?

It is ABB's aim to supply the technology for the Desertec project, and by doing so help to ensure its feasibility and reliability. These are important prerequisites for investors.

Peter Smits was interviewed by Melanie Nyfeler, Communications, ABB Switzerland.

use concentrating solar power (CSP). In such a plant, reflectors concentrate sunlight to heat water to steam, to feed turbines. CSP is not only more efficient and economic under desert conditions, but – in contrast to photovoltaic cells, which stop generating in the dark – heat can be stored for generation at night.

Also, turbine-based generation means additional steam can be supplied by combustion-based processes, permitting either a backup source of power or even a mixed-generation facility. Co-generation (involving heat generated as a by-product) is also an option.

A valuable development initiative

Regions in which CSP plants are built can benefit immensely. Besides immediate advantages such as jobs on the project, the areas reap benefits from the affordable and sustainable energy. For example, desalination plants can be built for drinking water and agriculture, revolutionising economic prospects in disadvantaged areas.

The technology

As ambitious as the technical aspects sound, the largest hurdles lie in creating political and economic frameworks. The technologies are the lesser challenge, being either available today or adaptable from such technologies.

The basic idea of solar concentration is not new. It dates back at least 22 centuries to when Archimedes proposed an array of movable mirrors to focus the sun's rays and set fire to enemy ships. Modern CSP plants use much the same principle: movable mirrors constantly adjust to the sun's position, permitting maximum energy capture. Reflected light is concentrated on a focal point where temperatures reach hundreds of degrees Celsius.

Power plants using variants of this principle have been in use in California since the 1980s, with installations added in various locations over the years. ABB has been involved in several of these, for example the Extresol project in Spain .

Once generated, electricity must be moved over large distances, which is where high-voltage direct current (HVDC) technology comes into play. Converter stations transform electricity to high voltages for transmission over long distances with very low losses. Losses on an HVDC line are about 3% per 1 000km. Power can also go via underwater cables, which will be useful for crossing the Mediterranean.

The Desertec Industrial Initiative

ABB has joined forces with several manufacturers, utilities and finance partners to realise plans in the EUMENA region. The Desertec Industrial Initiative strives to build on the recent creation of the Union for the Mediterranean – set up to improve and simplify co-operation between countries.

Besides providing public information, the Desertec Industrial Initiative will perform feasibility studies on the political, organisational, financial, technological and ecological aspects of the project. It aims to develop a plan to meet a target of 15% of Europe's electricity demand by 2050. Smaller reference projects will be identified and specified, permitting feasibility of the concept to be tested and demonstrated.

Desertec's plan features a network of electrical super highways interconnecting principal areas of generation and consumption across the region. Besides linking CSP plants, this super grid will also connect large onshore and offshore wind farms, hydroelectric plants and biomass and geothermal facilities.

Integrating installations into the existing grid presents challenges, including adapting operations of conventional power plants and making the grid better suited to renewable energy – areas where ABB can contribute expertise.

Pioneering role

The Desertec Industrial Initiative, established earlier this year, had less formal origins in the 1990s when it was brought into existence by the German section of the Club of Rome (an international think tank).

As long ago as 1992, ABB presented a vision of Europe's future power grid – drawn up by Gunnar Asplund, then development manager for ABB's HVDC technology – which bears remarkable similarities to the Desertec initiative.

Green power from a bright sun

Feasibility studies should be completed within three years. Pilot installations could make an early contribution, but a large-scale impact on the region's power supply is unlikely for several decades.

Although the initiative focuses primarily on EUMENA, the concept can be applied in other desert regions, such as in the Americas, Australia and Asia.

For more information on Desertec, please visit www.desertec.org.

Major HVDC projects

ABB recently completed a link between China's Three Gorges hydroelectric plant and the city of Shanghai, permitting 3GW to be transmitted over 1 060km. This followed on from two other major HVDC links built by ABB, connecting the same power plant to Changhzou and Guangdong. These links are rated at 500kV and 3 000MW.

ABB has recently won a contract to supply key technology for the Rio Madeira link, a 2 500km project connecting a hydroplant in Brazil's Amazon region to the city of Sao Paulo. The link will carry 3 150MW at 600kV.

ABB has also supplied many underwater HVDC links, most notably the recently completed NorNed link under the North Sea between the Netherlands and Norway. This 580km link (the world's longest underwater link) carries 700MW. The cables are also a key ABB technology.

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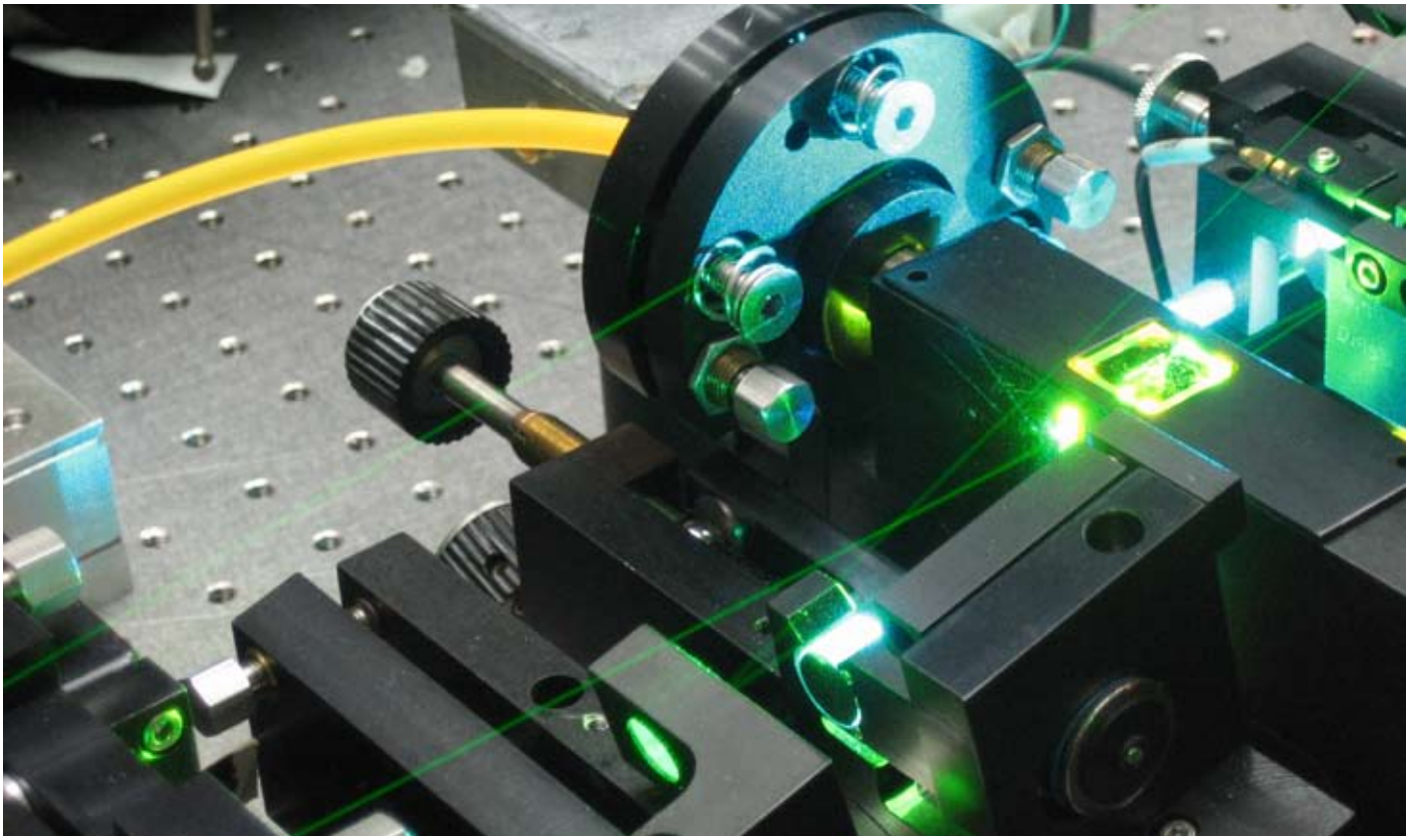
Footnotes

1 North Sea oil production is about six million barrels per day. The thermal equivalent of a barrel is about 6.1GJ of energy.
2 About 1 000 megatons of coal are mined in the US annually. The thermal equivalent of a kilogram of coal is 24MJ.
3 Nineteen trillion kWh.
4 Assuming the average reader reads 250 to 300 words a minute.

Laser eyes

A simple approach to technology brought great success for James Portman and his company – which is now in the ABB fold.



Not many people know that laser technology to measure solids inside vessels was pioneered in Johannesburg by a company called Laser Measurement (Pty) Ltd, recently acquired as part of ABB's international acquisition of instrumentation and measurement company K-TEK.

Laser Measurement was founded by engineer James Portman, a graduate of the University of the Witwatersrand in Johannesburg.

"I could see there was a market for being able to measure the level of liquids or solids contained in vessels," Portman told *Technology Solutions*. "From a business point of view, it was critical to maintain this focus and steer away from trying to use lasers in other applications."

By ensuring that Laser Measurement "stuck to the knitting" and by concentrating on supporting the technology and the skills required to drive it, Portman ensured that the company's market focus was never diluted.

"I knew lasers could be used to measure distance and that it was a simple principle, basically involving taking a flash of light, launching it in a specific direction, bouncing it off a surface and measuring how long it takes to come back. Each of these concepts is simple in itself but the devil is always in the detail, for example the speed of light," he said.

"We needed to create a timing system that worked at the speed of light, but of course the problem was that electrons don't travel at anywhere near that speed."

Portman was convinced that if a short flash of reasonable intensity lasting a few nano-seconds could be produced, a solution could be found. Essentially, a semiconductor laser had to be hit with 2kW of power within a nano-second.

"The solution was fascinating and the timing problem required original thought.

"We needed to create a timing system that worked at the speed of light, but of course the problem was that electrons don't travel at anywhere near that speed."

I believed it must have been done somewhere before so I went to Wits University and found a paper dating back to the 1950s, compiled by German physicist Dr Walter H Schottky, on manipulating transistors to deliver very high levels of energy in a very short time.

"Dr Schottky had discovered that it was possible to get a transistor to deliver very high energy in a very short time. It was amazing that nobody was using transistors in this way. Schottky's discovery had literally been forgotten!

"We took the concept, repeated the experiments and found that we could use the principle. It was relatively low cost, provided extremely high power and was very, very fast – ideal for our purposes. This was quite bizarre and to this day it still amazes me that there were very few engineers who knew about it or made use of it."

Portman said the technique has become common knowledge now and is used by other laser companies as it is perfect for measuring levels. However, after the concept was first tested, it was to be five years before the company fully overcame problems with speed-of-light timing.

"It was restricting the performance of the instruments and we noted that our big competitors were unable to create a simple, inexpensive solution. We too could not get the speed of the electronics right and were aiming for a resolution of 1cm, which would be faster than any electronics available at the time."

This is where the tale takes a fishy turn. Portman was fishing for trout in a dam near Belfast in Mpumalanga and was giving some thought to the speed problem. He came up with an idea that he claims is not original: instead of speeding up the electronics, rather slow down time and use conventional electronics.

Portman, trout rod still in hand, began to conceptualise a "black box time machine with a large knob at a normal time setting that could be turned to make the electrical circuits think that time is slowing down.

"I could actually visualise time slowing down and realised it was possible to stop time and reverse it. Usually this would be regarded as lunacy but I had been able to conceptualise our complex electronics and convert them to something that was ground-breaking in its simplicity."

Measuring material in a vessel can be distorted by further material coming into it and therefore the last event, the last light, is what needs to be captured for an accurate reading.

"The best way to find out when the last occurrence happened is to reverse time to the first thing that happened, so the answer was to run time backwards so that the last event happens before the laser is fired. We were able to develop a little chip that allows time to be slowed down, making the operation run backwards so that we could use a stopwatch to time it."

The core internal capabilities were so simplified that the technology is robust and highly reliable. The technology is now deployed in a unique solution via a small, compact, low-cost and high-performance product that is regarded as world beating.

"We have the technology completely under control. Customers don't care how it works; only that it works. Today it is a highly reliable, completely proven product and our attention has been turned to distribution and evolving markets for it. This is where ABB is now opening doors for us.

Laser products for precision measurement.

"The acquisition by ABB provides a huge stepping stone and we are bringing out next generation products in 2011. An ongoing process is the development of a full 3D volumetric measurement solution and there is focus on creating new markets and new demand, all the while continuing to give our customers superb precision and service."

Portman stresses that the company will continue to take a broader view and use its collective imagination to think out of the box, take different views and devise new and better ways of doing things. "We've learnt that if we don't try, we don't get anywhere."

Local manufacturing at Longmeadow, Johannesburg.

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Note to readers

ABB's recent acquisition of K-TEK, an American company based in Louisianna and specialising in level detection of liquids in vessels for the oil and petrochemical industry, resulted in Laser Measurement becoming part of ABB. It had been acquired by K-TEK in the late 1990s when K-TEK saw value in Laser Measurement's capability to accurately detect the level of solids in tanks, silos and other vessels with laser non-contact technology. Laser Measurement was conveniently located near the ABB headquarters in Longmeadow and the company, its 40 employees and its equipment and stock have already been relocated to the ABB complex.

Finding the right way to refurbish substations

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A well-planned and well-executed refurbishment of its 132 kV switchgear gives a substation a new lease on life.

The Grytten substation is a part of Statnett's regional grid in Norway and, as the sole feeding point, provides electrical power to the area around Åndalsnäs. The substation is in a dramatic setting, a stone's throw from the River Raumaälven and surrounded by high mountains. With popular tourist attractions such as Trollväggen, Trollstigen and the Raumabanan rail line, the area is one of Norway's most visited.

History

The substation was built in 1965 with two lines and one transformer. As was common at the time, it was built with a primary bus and a transfer bus. It was planned to subsequently expand the substation to include a double busbar system with transfer bus.

In 1972, one line and a feeder from Grytten hydro power plant, as well as one transformer, were added. At the same time, the switchgear was complemented by a second primary busbar to create a double busbar system with transfer bus.

The double busbar system was necessary to guarantee uninterrupted service during transformer and circuit breaker maintenance.

Maintenance and repairs

Disconnectors and older circuit breakers were maintained at three- to five-year intervals. Moreover, the disconnectors' main contacts were inspected using thermal imaging on a yearly basis to detect any overheating tendencies.

Three older circuit breakers have been replaced with modern SF6 circuit breakers. These were inspected after one year of service and a maintenance interval of 15 years was subsequently established.

Just one voltage transformer and a few surge arrestors on the transformers have otherwise been replaced.

A modern switchgear solution is created

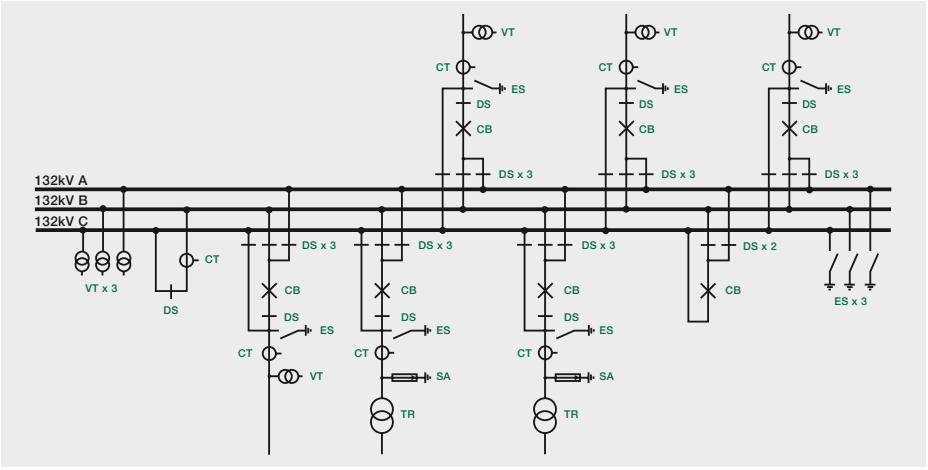
Reasons for refurbishment

In Statnett's maintenance plans, the useful service life for disconnectors had been set at 35 years and they were accordingly scheduled for replacement. It had also been decided to replace the substation's control equipment.

The question came up as to whether the replacement should be done device by device or whether a new, all-embracing solution should be considered. Statnett had studied the solution at Norsk Hydro's facility in Sundalsöra and therefore wanted to look at a solution with disconnecting circuit breakers.

Disconnecting circuit breakers

Disconnecting circuit breakers satisfy demands both for disconnectors and circuit breakers in one device. The primary component is an SF6-based cir-



Before refurbishment

01 Grytten substation prior to refurbishment – The old switchgear was traditionally designed with a double busbar system (A and B) and a transfer bus (C). The switchgear included in total six bays: four line bays and two transformer bays, as well as the C bus circuit breaker bay and a disconnector bay for interconnecting of the B and C buses. Because the Grytten substation is the only feeding point in the Åndalsnäs area, the demands on availability are very high.

cuit breaker that is also type-tested as a disconnector. Because the disconnector function cannot have a visible opening distance, there is an externally fitted, motor-operated grounding switch. Checking the position of this switch determines whether power has been turned off to the lower side of the circuit breaker.

Furthermore, a disconnecting circuit breaker is equipped with an interlocking and blocking system that prevents unintentional operation. IEC 62271-108 is the applicable standard for disconnecting circuit breakers.

Operational requirement

As the substation is the only feeding point for the area, at least one of the transformers had to be in service throughout the refurbishment project. This spoke for replacing device by device.

Technical description

The old switchgear was designed with three lines and one feed from the Grytten hydro power plant, as well as with two transformers. Moreover, there was a C bus circuit breaker and a disconnector between the B and C buses.

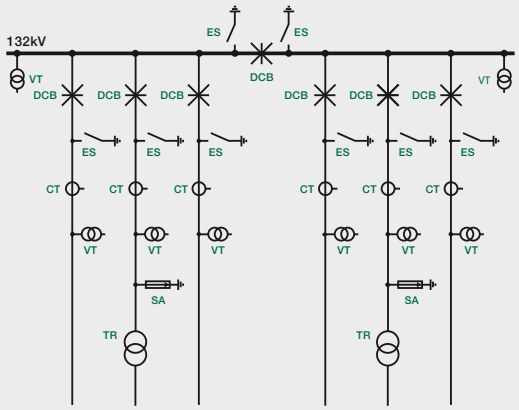
The new switchgear was to be planned to be within the same scope of connected objects.

The old solution with double busbar and transfer bus enabled maintenance to be carried out on any switchgear component, with one transformer still in service. This capability was also to be included in the refurbished substation.

Planning of new switchgear

The old switchgear had 81 single-pole disconnectors. This complicated operational switchovers. Furthermore, lengthy periods with reduced service capabilities were necessary as portions of the switchgear had to be taken out of service for maintenance of these disconnectors. A simpler solution was therefore requested by maintenance personnel.

This led to an alternative that did not include disconnectors being discussed in the early planning stages. It was determined that a proposal with disconnect-



Legend

CB	Circuit breaker
DCB	Disconnecting circuit breaker
VT	Voltage transformer
CT	Current transformer
SA	Surge arrester
TR	Power transformer
GS	Ground switch
DS	Disconnector

After refurbishment

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ing circuit breakers and a sectionalised single bus should be evaluated.

Proposals for single-line diagrams and layout drawings were prepared. Additionally, availability calculations were conducted for both a sectionalised single busbar system and for double busbar system with transfer bus. The calculations were intended to show the theoretical annual downtime caused by the high voltage switchgear. The supply from the medium voltage switchgear on the transformers' lower side was used as a reference point. Because downtime in both cases was close to zero, it was decided to move forward in planning with the alternative without disconnectors, but with a sectionalised single busbar.

But would it be possible to build an entirely new switchgear system while keeping the old one in service? It was discovered that the existing C bus, with just a few changes, could be used as a busbar in the new switchgear. It had the correct length and was located at the most appropriate location, and there was even space for the sectionalising breaker. Because a transfer bus is only used during circuit breaker maintenance, it could be disconnected from the rest of the switchgear without affecting operational capabilities.

The new switchgear could then be completely assembled, and reconnection of lines and transformers could be scheduled so that service did not need to be interrupted.

Refurbishment project

Turnkey contract

After a customary procurement procedure, ABB was selected as the general contractor.

The equipment was ordered and work at the site began in 2007. The C bus was disconnected and converted into a sectionalised single busbar system. A disconnecting circuit breaker was also used for section switching.

Once all the devices were installed, one line was connected to one of the sections. After this, one of the transformers could be moved over and the section could be powered up. The other devices were subsequently moved over and, lastly, the old switchgear was removed.

Freed space

The new switchgear occupies about 30% of the space of the old switchgear and the freed space can be used for other needs that may arise.

Maintenance requirements

In practice, the only devices that require maintenance are the disconnecting circuit breakers. A 15-year maintenance interval was proposed for full inspection. Every other year, visual inspections of the devices will be conducted, but without removing equipment from service.

Increased availability

One of the sections can always be in service during circuit breaker maintenance. During maintenance of the sectionalising breaker, power is first disconnected from one section, and this side of the sectionalising breaker is disconnected by removal of a special connection link. The section is then powered up and power to the second section is disconnected. The sectionalising disconnecting circuit breaker is then free for work. If work requires an interruption for a longer period, the breaker can also be disconnected from this section according to the same procedure. The sectionalising breaker is then entirely disconnected and both sections can be in service. Disconnection and connection of the sectionalising breaker is expected to take less than two hours.

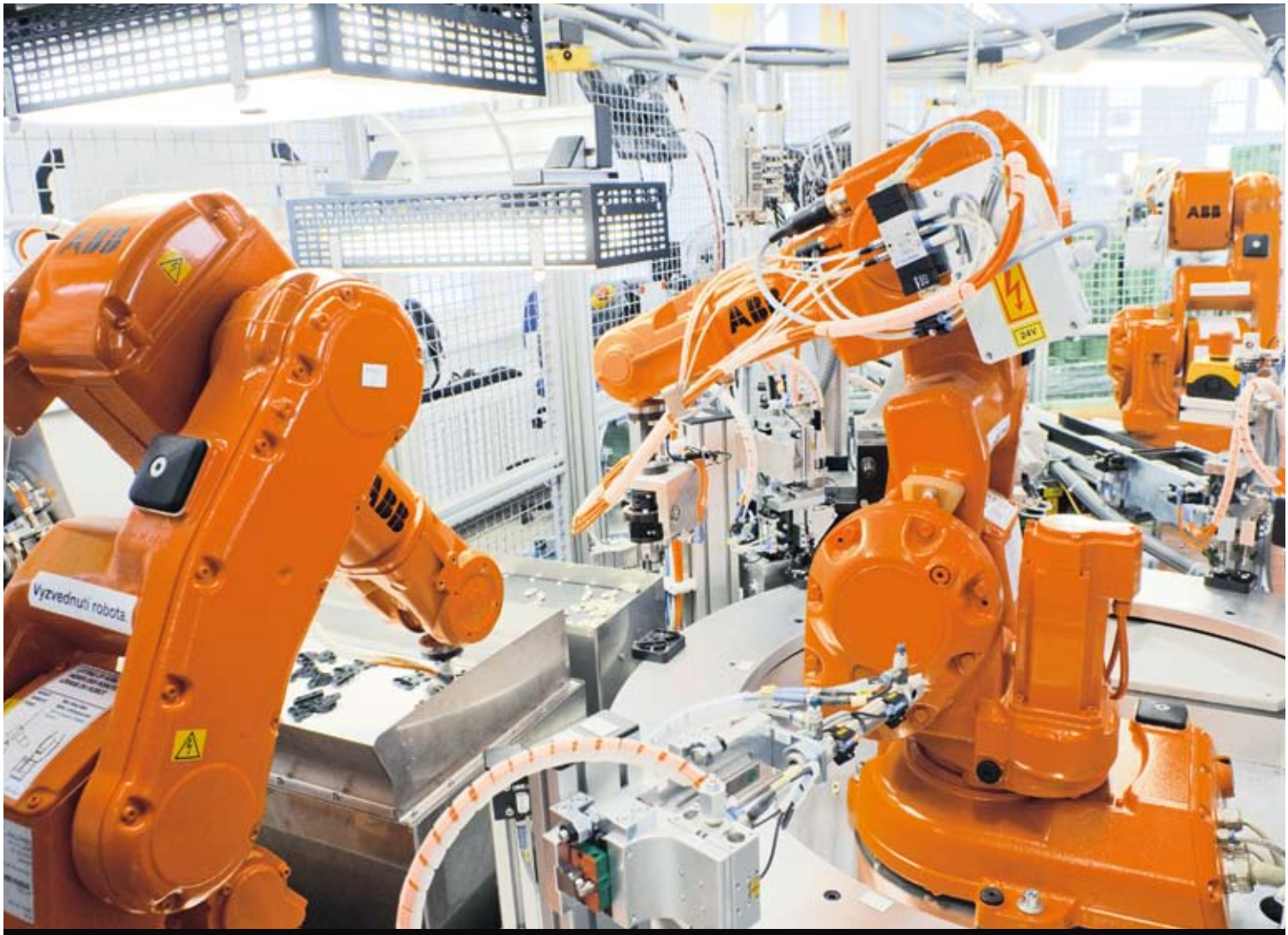
Experiences

Statnett's experiences from the project have been very good. Statnett has obtained a new switchgear based on modern technology with a minimum of maintenance requirements. The substation, which is situated at an important location in the grid, has high availability and is very operationally forthcoming.

The short installation time and the well-planned switchover of operations enabled the entire refurbishment project to be performed without interrupting the power supply to customers.

02 Simple installation with ABB's disconnecting circuit breakers. In conventional switchgear, there are normally four switching devices for each bay. If a solution, with a sectionalised single bus and disconnecting circuit breakers, like the one chosen by Statnett is employed, there is only one switching device per bay. Because all of the devices require installation, connection and secondary cabling, it is easy to see that the time gained is considerable.

03 To further reduce maintenance needs, Statnett chose Motor Drive™ as the operating mechanism for the disconnecting circuit breakers. The optimised design with just one moving part in the operating mechanism reduces mechanical stress to a minimum. Electronically controlled operation is accomplished without mechanical stopping, which means very quiet operation.



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