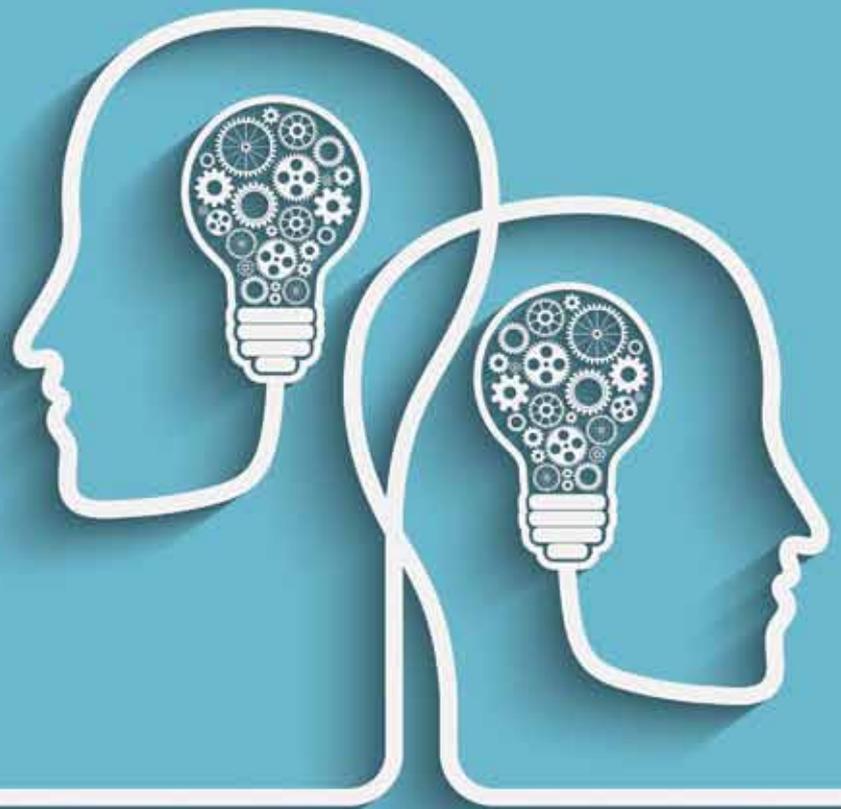


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TECHNOLOGY



THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | MARCH 2017

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GENERAL
REGULARS



SAIEE



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Now that the Festive Season is a distant memory and we seem to be back in the swing of things, it's my pleasure to bring to you this issue of **wattnow**, featuring Technology.

On page 22 you will find our first feature article, showcasing the mind-blowing technologies currently being developed by DARPA (The Defence Advanced Research Projects Agency) based in the US.

Mike Cary discusses Windpower in South Africa on page 28, comparing South African winds with the rest of the world, asking the question, "How many wind farms does it take to generate the same electrical output than Medupi?"

I bring to you a very interesting report, compiled by the Lloyd's Register in the UK, on the Nuclear Perspective. Read this on page 36.

The erstwhile Dudley Basson did it again, and wrote another informative historical article about Quantum Computers. Read this on page 46.

The 2017 SAIEE Smart Grid conference will be taking place on 19 - 21 September. Registration is now open and we have an awesome line up of speakers. Visit our website, www.saiee-smartgrid.co.za to register and qualify for a very nice early bird discount. Seats are limited, so book now to avoid disappointment!

The **wattnow** is slowly but surely moving towards being online. I've had numerous replies giving your preferences, and I thank you. If you haven't done so, please send an email to wattnow@saiee.org.za and include in the **subject line YOUR SAIEE MEMBERSHIP NUMBER & wattnow online/print – your preference**. Members, who opt for their printed copy, will still receive their copy in the post. If I do not receive an email from you by 31 March 2017 you will automatically receive the online copy.

Enjoy the read.



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TC MADIKANE 2016 SAIEE PRESIDENT

This is my last message as the President of this glorious movement for Electrical Practitioners.

On 30 March 2017, I will hand over the leadership of SAIEE to Jacob Machinjike, who is the current Eskom General Manager: Upkeep of National Power Grid Transmission Assets. I encourage our members, their guests and members of other constituent societies to join us for the Annual General Meeting (AGM) at SA Museum of Military History, Johannesburg.

The SAIEE continues to support the initiative of the Bergville Community Builders, which is led by our member, Nhlanhla Maphalala. We thank Zola Ntshangase, Vice Chairman and Chris Ramble, Past Chairman of SAIEE KZN Centre for attending the careers day on 11 February 2017, which featured more than eighteen different organisations. The improvement in the matric results from the area is noticeable. Okhahlamba High School achieved 100% pass rate, with 90% of learners receiving a bachelor pass. We congratulate Wandile Sithebe, who passed with flying colours, obtaining seven distinctions. We hope that many of the students will take electrical engineering as a career choice.

On 7 February 2017, I attended the special meeting of the KZN Human Research Development (HRD) Council where I serve as a Council Member representing the SAIEE. The Council is chaired by the Premier of KZN. Attendees included KZN HRD Council Members, KZN MECs, Principals from Institutes of High Learning, Student Representatives, Department of Higher Education and Training (DHET), National Students Financial Aide Scheme (NSFAS), as well as various other stakeholders. The main aim of the meeting was to ensure that there is no unrest at the Institutes of Higher Education in the forthcoming year. Students shared their challenges regarding the funding model.

The Institute's growth strategy is to ensure that we work closely with other Voluntary Associations which serve Electrical Practitioners. On 17 February 2017, I attended the AGM of the South African Council of Automation and Controls (SACAC) at the Forum Homini, the Cradle of Humankind, Letamo Game Estate, Mogale City. Members of SACAC include Universities and Measurement & Control Companies. SACAC will host Control Conference Africa (CCA2017) on

the 7-8 December 2017, in Johannesburg. I encourage our members who are in the control and automation space to diarise this and attend accordingly.

Continuing Professional Development (CPD) opportunities is one of the key activities which the SAIEE offers to its members as well as other electrical engineering practitioners. The Executive Committee (EXCO) took a decision to host the 2nd smart grid conference on the 19-21 of September 2017, at the Eskom Academy of Learning, Midrand. We thank Eskom in advance for their continuing support and collaboration with SAIEE. I encourage our members to diarise these key dates, the details of which will be shared on our websites and social media in due course.

SAIEE continues to work closely with the Engineering Council of South Africa (ECSA). Some of our members serve on various ECSA committees and they will be part of the professional teams that will undertake Accreditations of Universities, scheduled for the first quarter of the year. In April, there will be President's Forum and SAIEE will also be represented. We will keep our members abreast.

Finally, in March I will visit Buffalo City, East London as my last trip as the President to help revive SAIEE's Interest Group in Eastern Cape. We have many members from Water Sisulu University (WSU), Eskom, Consulting firms and other industries in that part of the world. We will advertise the date and venue on our website and social media once it is finalised.

TC Madikane

Pr. Eng | FSAIEE | FSAAE

IGNORANCE CAN BE COSTLY!

There is a good deal of confusion and misunderstanding about technical and performance aspects of electrical products and services, and their regulation. The SAFEhouse Association has produced a series of guides to help specifiers, suppliers and users determine the standards and regulatory requirements applicable to electrical products and services covered by legislation.

Guides contain helpful information on:

- Regulatory references & requirements
- Technology
- Indications of risk in using substandard products and services

Download FREE copies of SAFEhouse guides from
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SAFEhouse members have signed a code of conduct: Your assurance of commitment to offer only safe electrical products.

SAFEhouse membership is suppliers' assurance to customers of responsible behaviour and of customers' safety as a priority. SAFEhouse members regulate themselves. SAFEhouse is primarily a communications association that informs customers of safety requirements and occurrences of non-compliance with such requirements.



The SAFEhouse Association is a non-profit, industry organisation committed to the fight against sub-standard, unsafe electrical products.

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WATTSUP

UJ global leader in Intelligent Systems awarded national funding

Researcher Prof Qing-Guo Wang, from the University of Johannesburg (UJ), was awarded an A-rating by the SA National Research Foundation (NRF) for his global leading research in Control and Automation for Engineering and Financial applications on 27 February 2017.

Prof Tshilidzi Marwala, UJ Deputy Vice-Chancellor: Research and Internationalisation said: *“Prof Wang’s research is on modelling, optimisation and control. As we move into the fourth industrial revolution where much of the work that is done by people will be done by machines, Prof Wang’s work becomes even more important. His research to date touches many sectors such as manufacturing, finance and construction. At UJ’s Faculty of Engineering and the Built Environment, his projects range across mechanical to electrical and electronic engineering.”*

Prof Wang is an internationally renowned Electrical Engineering researcher in the areas of PID control, auto-tuning of control systems, and multivariable decoupling control. He is very well known for his work in system identification, relay feedback systems, time delay systems and multivariable control.

The NRF awards funding for research that can benefit all South Africans. Prof Wang joined the Institute of Intelligent Systems (IIS) within the UJ Faculty of Engineering and the Built Environment (FEBE) in 2016, and working with IIS Director Prof Bheki Twala.

Prof Wang is planning several research projects funded by the NRF, at the UJ IIS. These include industrial projects for power systems, building automation, chemical and electrical systems, new batteries/super capacitors, medical engineering and flying drones mimicking the flying action of birds; as well as theoretical projects on system identification and systems control.

Early in his career, Prof Wang gained extensive industrial experience in paper mills in China. *“During my Master’s and PhD studies, I worked for three years at a paper mill in the People’s Republic of China. There, my supervisor, a classmate and I developed the first-ever paper machine computer control system in China. The paper industry started using it in 1985. After that I helped to implement the system in many mills for another five years until 1990, at which time I moved to Germany. The spin-off company from this technology*



Prof Qing-Guo Wang
University of Johannesburg (UJ)

has dominated the China market since then,” says Prof Wang.

Prof Wang has collaborated with major engineering control giants such as Siemens for dynamic load dispatch; Yokogawa for multivariable decoupling control; Fisher-Rosemount/Emerson for PID controller auto-tuning; Honeywell for multivariable control; Aspen Technology for model predictive control; DuPont for real time optimal control; and Supercon Technology for robust process identification.

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END TO END POWER
TECHNOLOGY AND KNOWLEDGE



POWER-GEN & DistribuTECH Africa mission is to identify top challenges in African power

POWER-GEN & DistribuTECH Africa advisory board members and top executives have launched a series of African roadshows to consult power sector policymakers and industry leaders on the most pressing issues in African power provision today.

The missions to countries across sub-Saharan Africa are designed to support the development of a conference programme that adds meaningful value to pan-Africa's burgeoning power sector, and which brings together key players from across the continent to the event.

Nigel Blackaby, Director of Conferences at event organisers PennWell International Power Group, says some of the industry's finest minds from across the continent have contributed to the programme for POWER-GEN & DistribuTECH Africa. *"Building on our in-depth advisory board meetings, we recently staged the first of a number of missions to the sub-Saharan stakeholders who play an active role in POWER-GEN & DistribuTECH Africa. It was reassuring to note that many of the issues raised by the utilities and power experts we met had already been identified as essential topics by the advisory board and were scheduled for inclusion in the 2017 conference in Johannesburg."*

Dr. Willie de Beer, chairman of the POWER-GEN & DistribuTECH Africa board, explains that POWER-GEN & DistribuTECH Africa strives to develop a

conference programme that goes beyond talk, to help address real challenges in the sector. *"To complement the Advisory Board Meeting and the development of the draft programme for the July 2017 POWER-GEN & DistribuTECH Africa conference and exhibition, a visit to other countries within Africa was regarded as very important. The objective of the visit was to learn first-hand from other utilities, policymakers, regulators and service providers regarding their views, opportunities and challenges from an electricity supply industry perspective. Furthermore the 2017 draft programme was shared to gather inputs and to evaluate how best to adjust the programme to ensure that it address the requirements of Africa."*

De Beer added: *"Without exception all of the site visits were very positive and all indications are that the 2017 POWER-GEN & DistribuTECH Africa conference will address key industry challenges and opportunities. It is important to note that further visits to other Africa countries will take place during 2017."*

Among the issues African stakeholders touched on were renewables, the privatisation of state assets and challenges around financing for infrastructure expansion.

Blackaby reports: *"In Namibia, our meetings uncovered interest in baseload renewable capacity and concentrating solar power technologies. Other key issues mentioned*

were safety procedures and regulations for high voltage work, and the financing of electricity infrastructure expansion. In Botswana, we found refurbishment of ageing assets, funding for privatisation and the development of an IPP programme to exploit solar resources to be key areas of interest. Zimbabwe too, had concerns about managing risk and securing finance, and an interest in asset rehabilitation and CFB technology. Like a number of Southern African countries, Zimbabwe is keen to explore new market models and this is an aspect the conference will address."

Among the topics to be covered in POWER-GEN & DistribuTECH Africa 2017's Africa-focused agenda are finance and investment, the digital technology revolution in power plant technology, decentralised energy solutions, models for industry sustainability, asset performance management, opportunities in renewable technologies, solar energy, bioenergies, trends in utility management, lessons for Africa from world nuclear power programmes and a panel debate advancing visions for Africa's energy future.

As the leading Africa-focused power sector conference and exhibition, POWER-GEN & DistribuTECH Africa also hosts a 70-strong sub-Saharan African delegation, whose members engage in B2B meetings with the event's delegates and exhibitors, and exchange knowledge and best practice in Africa.

WATTSUP

Mini grid solutions for Africa in the spotlight at Energy Revolution Africa 2017



An estimated 600 million people in Africa live without access to electricity, the majority of which are in remote communities; requiring major capital expenditure and time to get connected to the grid. The role of the private sector is more and more important in reaching the goal of giving people access to basic energy services. This is why Energy Revolution Africa 2017 has identified mini grids and new technologies as integral topics in their programme for the co-located event at African Utility Week at the CTICC from 16 to 18 May.

Energy Revolution Africa 2017 will bring insights from private and public sector experts involved in mini grid projects across Africa as part of the three-day strategic programme focused on renewable energy and community scale projects.

Andrew Tonto Barfour, project coordinator for Ghana's Ministry of Power, Benon Bena, head of off-grid renewable energy at the Rural Electrification Agency of Uganda and Faruk Yusuf Yabo, Deputy Director of the Nigerian Federal Ministry of Power, Works and Housing are among the speakers who will discuss mini and micro grid projects that are currently underway and that are anticipated for the future. This will include discussions about the development of mini grids through public and private partnerships, including communities, and how government policy is accelerating this development.

On Wednesday, 17 May, the focus will be on how businesses, governments,

communities and households can benefit from an investment in energy efficiency. A case study of South Africa's National Business Initiative around tax incentives for energy efficiency will be presented by:

- Karel Steyn, Senior Consultant on Energy Performance Verification at Eskom
- Barry Bredenkamp, General Manager, Energy Efficiency and Corporate Communications at the South African National Energy Development Institute (SANEDI).

Other speakers and topics on the programme for 17 May include:

- Werner van Antwerpen of Growthpoint Properties and Justin Smith of Woolworths Holdings will present examples from shopping centres, mines, farms and green buildings of how energy efficiency and sustainability practices are tailored for various types of companies
- Victoria Cuming, Head of Policy for Europe, the Middle East and Africa at Bloomberg New Energy Finance in the UK will be one of the speakers discussing the future direction for embedded power generation and how it can reduce a country's dependency on a single source of energy.
- Alastair Dick, Operations Lead for Carbon War Room's Sunshine for Mines in South Africa will present a case study on embedded power generation for the mining sector.

New renewable energy markets in Africa are already showing greater appeal to international and local investors and as

such, Frank Rizzo (Partner and Technology sector leader for Africa at KPMG) and Evan Rice (Business Development Manager, Energy Products at Tesla, South Africa) will discuss exciting technology developments for the African power industry and renewable solutions to profitably reduce reliance on diesel. The technology session will conclude with discussions about storage solutions to help utilities and grid operators manage the integration of renewables and meet their specific demand requirements.

"We are very excited about the global and African energy experts, ranging from solution providers and renewable energy producers, to financiers and policy makers who will be meeting at this event," said Evan Schiff, event director of African Utility Week and Energy Revolution Africa.

"It will no doubt be of immense value to new energy purchasers and large power users, from commercial property developers and the agricultural sector to mines and metros as well as anyone interested in the exciting opportunities in the renewable technology sector." Schiff said.

Visit www.african-utility-week.com/era for more information about Energy Revolution Africa or email auw@spintelligent.com to sign up for the newsletter with industry updates.

Energy Revolution
Africa



NORDLAND LIGHTING TURNS 50

Nordland Lighting is celebrating its 50th anniversary this year and it is surely a milestone for any company.

What began as a small company in 1967 has grown to be a leader in the manufacturing and supply of hazardous, Industrial and commercial luminaires. Nordland Lighting has countless achievements and accomplishments, especially being the first Lighting company in South Africa to be awarded an ISO 9001 : 2015 Certificate early in 2017.

Johann Lamprecht, Sales Manager for Nordland Lighting says; "Without the support of our excellent team our success in the industry would never have been so big. Every one of you plays a very important role in the development of our company. It is for your enthusiasm, support

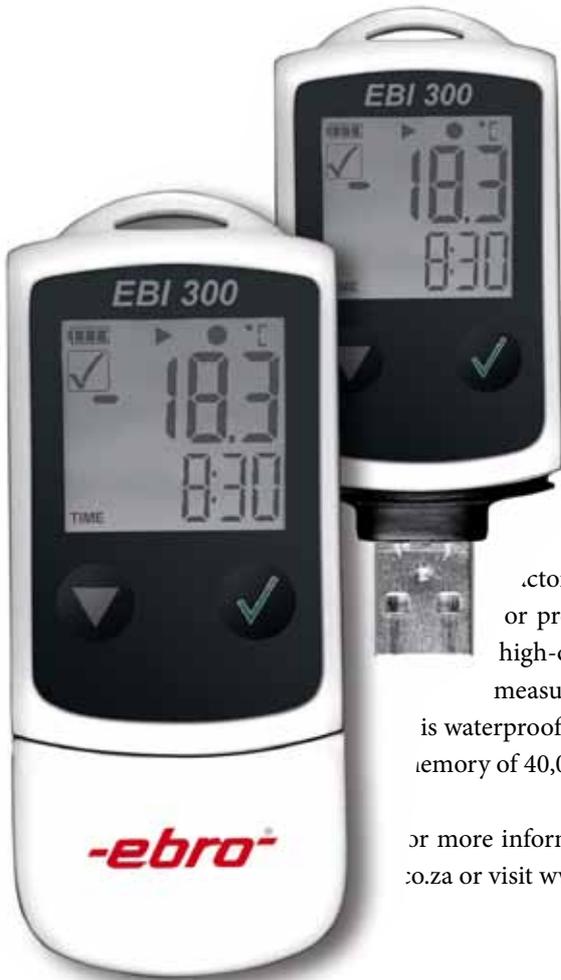
and dedication that have brought us to this height. We are also grateful to our clients and customers who have supported us to provide them immaculate services and products. Their demands, challenges and feedbacks have pushed us to go ahead and improve vigorously. Our success story remains incomplete without the support of our clients and customers. They spread the word faster and in a better way than any of our promotional means could."

Nordland Lighting are planning to keep their business and relationship growing with all their current as well as future clients and customers and will continue to provide the industry with nothing less than the best.

Happy anniversary Nordland Lighting and here is to another 50 years !!!



**NORDLAND
LIGHTING**



USB Temperature Data Logger for Cold Chain Monitoring (Transportation and Storage)

ebro Electronic GmbH, represented locally by Instrotech, has on offer the EBI 300, a data logger for temperature monitoring in transportation or during storage. After using the logger the user can access the recorded data anywhere with the EBI 300's automatic PDF report generation capability and any commonly available PDF reader software. This logger was designed to minimize training requirements, user errors and IT costs for loggers that require proprietary software to read the data. The data integrity is also ensured since no data manipulation is possible.

The EBI 300 is specifically designed for the transporting or storage of food since a factory calibration certificate is included. Suitable applications would also be in catering or process monitoring, where flexible control measurements are crucial. This compact, high-quality logger can be used for ambient temperature as well as for core temperature measurement with an external probe. The user can easily change the battery, and the EBI is waterproof (IP65) with a measurement range of -30 °C to +60 °C, an accuracy of ± 0.5 °C, and memory of 40,000 measurements.

For more information on the ebro EBI 300, contact Instrotech on 010 595 1831, sales@instrotech.co.za or visit www.instrotech.co.za

WATTSUP

Legal concerns in mine roll-out of Proximity Detection Systems

Moving machinery is the second highest cause of fatalities in South African mines after falls of ground, making the implementation of effective proximity detection systems (PDS) a crucial step, but there are still perceived grey areas in mine safety regulations.

According to Anton Lourens, Managing Director of leading PDS supplier Booyco Electronics, the Department of Mineral Resources has laid the groundwork for the wider application of PDS through the February 2015 amendment to Chapter 8 of the Mines Health and Safety Act (MHSA). It is now required that PDS be installed on all mobile equipment on mines. "Mines are required to assess significant risk in terms of moving machinery and people; and based on that assessment an action plan needs to be in place to mitigate that risk," Lourens says. "But there is still some uncertainty about exactly what mines must do, as the legislation has

changed in the last decade from being very prescriptive to now being more reliant on the 'reasonable man' test. The law does not say exactly what activity must be carried out; rather, it says that the mine must mitigate the risk."

He says there was also confusion on the issue of intervention. The Act deals with four industry categories: underground electric machines; underground diesel equipment; surface diesel machines and mining plant like refineries and smelters.

"The revised MHSA allows for intervention systems on diesel machines underground and on surface, but is currently excluded from the promulgation so that's where the confusion comes in," Lourens says. "Underground electrical machines must have intervention systems while underground diesel machines don't have to; it does appear that the



Anton Lourens
Managing Director
DS supplier, Booyco Electronics.

requirement will be enforced, but not right now."

Lourens says PDS technology is still being developed to fully cater for all the requirements of the revised law; hence the staged implementation of the various requirements. A global initiative by large mining companies – the Earth Moving Equipment Safety Round Table – was facilitating collaboration between stakeholders to help advance the technology.

Elquip Solutions and Hoffman offer a catalogue of tooling excellence unmatched for its range and quality

While all of South Africa's tool importers have catalogues of their products, none of these online or print publications contain nearly as wide a range of tools and ancillary products which are contained in the Hoffman Group catalogue, explains Elquip Solutions Managing Director Mike Cronin. "Experience has taught us that manufacturers prefer to source all their tool requirements from one highly reputable supplier who is able to offer ready availability," says Cronin.

One of Elquip Solutions key overseas principals is the Hoffman Group, a major international company which supplies 500 brands of tools, ancillaries and other

manufacturing-related products. Based in Nuremberg, Germany, Hoffman features Europe's largest tooling logistics centre. "By approaching the world's best tool manufacturers to manufacture specifically for them, Hoffmann accesses vast experience and expertise for the benefit of its customers," explains Cronin. "We are proud to be able to pass this on to our South African customers," he adds. Every year, the Hoffman Group issues a catalogue of the tools it is able to offer.

"As an indication of the sheer extent of their tool range, the most recent catalogue comprised some 1,655 pages. In these catalogues, manufacturers will find every conceivable tool

or ancillary to maximise the productivity of their businesses. Therefore, no matter what field of manufacture you are in, you will find the right tool at the right price in the latest Hoffman catalogue," continues Cronin.

With this colossal range, the catalogue only has sufficient space to list 65,000 of the 500,000 listed tools that Hoffman supplies. The catalogue is also able to offer a choice between premium, standard and economy brands of tooling.

In the prevailing tough economic conditions, flexibility in tool choice is a strong advantage. Hoffman's Garant brand

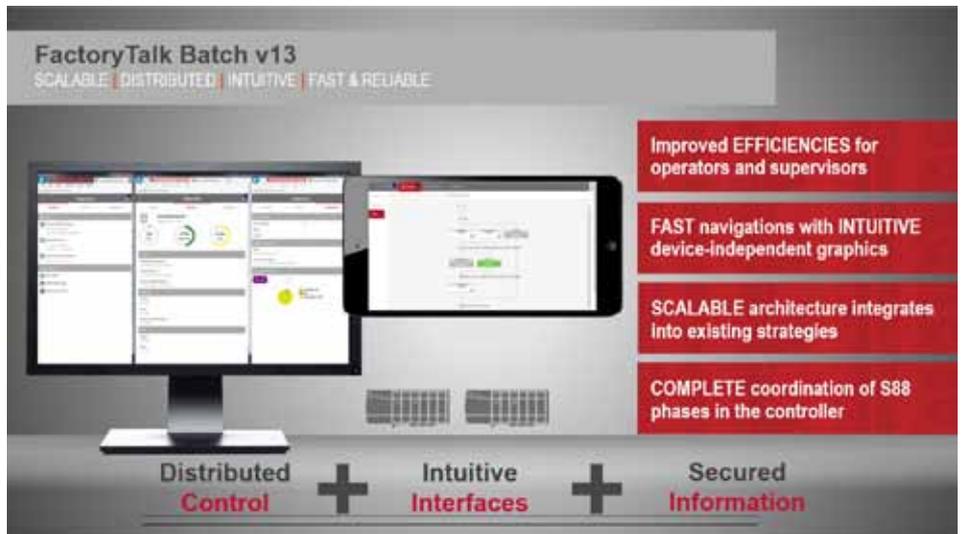
FactoryTalk Batch Software Introduces Modern Approaches for Batch Applications

Industrial producers with batch applications can now create more flexible, reliable and productive operations with the latest release of FactoryTalk Batch software from Rockwell Automation. The modern software enhances scalability and responsive control of distributed, skid-level phases with the integrity of plant-level coordination, while delivering an improved, reliable user experience with built-in mobility.

“Rather than trying to force-fit applications into rigid batch control systems, producers can now customise a modern batch system to their application’s needs,” said Christo Buys, Business Manager for Control Systems, Rockwell Automation sub-Saharan Africa. “These enhancements give batch producers greater flexibility when designing, operating and expanding batch systems. They also enable producers to use mobile devices for a more intuitive experience and improved workflows.”

markets excellent products of optimum quality which are guaranteed to exceed expectations and offer the certainty of an optimal cost/benefit ratio. However, when pure functionality is a requirement, Hoffman - through the medium of its catalogue - is able to offer more affordable alternatives.

Among the pages of the catalogue are many award-winning tools. For example, Hoffman’s electronic torque wrench manufactured by Garant was the winner of the coveted Red Dot Design Award this year, an international product design and communication design prize awarded by the Design Zentrum Nordrhein



Modern batch software from Rockwell Automation now improves batch responsiveness, scalability and productivity, and supports mobile devices

Integration with the SequenceManager solution from Rockwell Automation enables batch sequencing to occur at either the controller or server level. This allows machine builders to develop and deliver fully tested skids that end users can integrate into their batch process with minimal validation and commissioning effort. It also minimises the rework required when manufacturers with small, controller-based batch systems expand to larger, server-based batch systems.

New mobile support can help create intuitive workflows, reduce procedural steps and increase collaboration. With mobile devices, workers no longer need to be bound to control rooms and fixed terminals. Instead, they can access real-time information, interact with processes and secure approvals from anywhere in a plant. A modern web interface also helps reduce the number of clicks required to access information.

Westfalen in Essen, Germany. A testament to the scale of this achievement is that competitors from 57 countries took part in the competition with a total of some 5,200 products and innovations.

“What is absolutely vital for Elquip Solutions is that we not only supply the best products and solutions, but also ensure our clients have the expertise to use our tools and equipment to maximum effect,” says Elquip Solutions’ Internal Sales Engineer Daniel Cox.

To this end, the catalogue contains specifications for the optimal use of particular tools. In order to bring the latest tooling expertise to Elquip’s South

African customer base, he recently attended intensive training at Hoffman’s headquarters in Germany.

“Elquip Solutions is much more than simply a supplier of tools,” Cronin elaborates.

“Through the tools and equipment we have to offer, we are able to add real value to our customers’ operations through a strategy of innovation, product excellence and unmatched support. We encourage all South African industrial manufacturers are encouraged to contact Elquip Solutions to get a complimentary copy of this extremely valuable tool reference and resource,” he concludes.

WATTSUP

Omron mobile robots ramp up efficiency in African warehouse, distribution sector



With supply-chain management and logistics increasingly under the spotlight in Africa due to remote locations and time-consuming transportation, warehouses are turning increasingly to industrial mobile robot solutions to improve their efficiency and turnaround times.

This has resulted in Omron introducing its first industrial mobile robot product line, the LD platform, on 20 January 2017. “The fact that this latest technology is now available to the broader African market bears testament as to how highly we regard the opportunities presented by the continent to accelerate its uptake of innovation,” Omron Field Application Engineer Evert Janse van Vuuren comments. Omron mobile robots provide a new level of efficiency and cost-savings when it comes to moving goods around large facilities. This unique family of mobile robots is developed for rapid and reliable materials transport on a 24/7 basis.

Ideal for conveying goods throughout warehouses, distribution centres, and manufacturing facilities, the LD mobile robot platform has a payload capacity of up to 130 kg, depending on the model. Compared to traditional Automated Guided Vehicles (AGVs), Omron mobile robots can self-navigate entirely based on the natural features of the facility.

No costly and time-consuming infrastructure modifications are necessary, which means no need for floor magnets, tapes or laser beacons, all typically associated with classic AGV deployment.

“The simpler the technology is to get up-and-running, the sooner the end user can start to reap the benefits. This is of particular importance in Africa, where skill levels in terms of automation and robotics are scarce,” Janse van Vuuren highlights.

Flexible factory layouts are now also possible, taking into account space and size constraints in industrial areas. “This is now possible as delivery points can be modified for the mobile robots. Omron mobile robots also complement traditional automation, such as conveyors, and provide traceable movement of goods,” Janse van Vuuren adds.

This means that the latest Omron



*Evert Janse van Vuuren
Omron Field Application Engineer*

technology can integrate seamlessly with the older systems that are quite prevalent in Africa, where technological development lags mature markets like Europe and the US by a significant margin.

Equipped with patented Acuity technology, Omron mobile robots have a robust self-navigation system, even where there’s constant movement of people, pallets, carts and forklifts, and shelves being emptied and restocked.

On-board intelligence allows them to not only avoid obstacles, but also to choose the best path in order to complete a task. This ‘smart’ movement also makes them safe to operate alongside people.

A typical fleet can comprise up to 100 vehicles, which can now be managed centrally by fleet-manager software, who can interact with the factory or warehouse management software such as MES (Manufacturing Execution Systems) or WMS (Warehouse Management Systems).

ENGINEERING HUMOUR BY I POPPA HOWARD

A Truck Driver driving a high truck got stuck under a low bridge. First Traffic Cop on the scene: “So you got stuck hey”?! Truck Driver: “No, I was delivering this Bridge and I ran out of petrol!!”

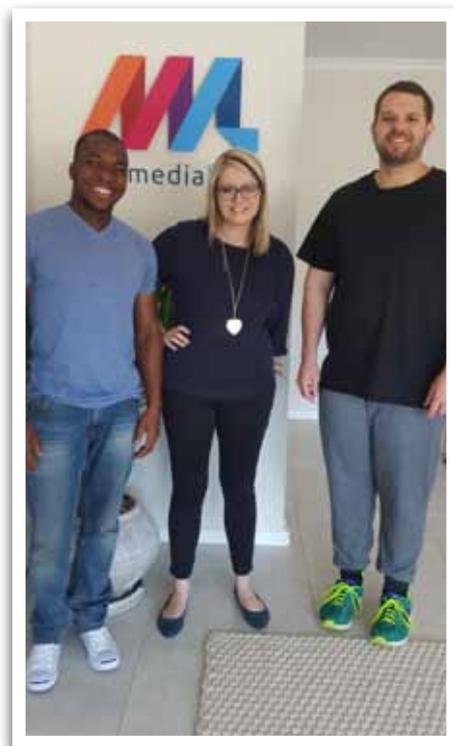
Port Elizabeth office provides remote working opportunities

Software development company, New Media Labs, recently announced the launch of its office in Port Elizabeth (PE) in the Eastern Cape, which opened in January this year. The opening of the office forms part of the company's strategy to attract the best skilled developers across the country by providing a remote working solution.

This is according to New Media Labs' General Manager, Dave Eagle, who says the company had already hired a few developers from PE who had great skills and were culturally a good fit for New Media Labs. "While some were open to relocate to Cape Town to work in our head office, we also came across a number of individuals, who would make great additions to our team, but who were not prepared to relocate. This is when we started thinking about an opportunity to hire some of these individuals to work remotely and bolster our already strong development team."

According to Eagle, integrating the PE team into the Cape Town office has not been a challenge. "The team integrated with our Cape Town team much quicker than what we had hoped for. We now have a team of four members working in our PE office who are constantly in contact with our Cape Town teams to deliver quality work for our clients. The developers we have found are fantastic," he adds. The primary intention behind establishing this new office was not to expand the company's footprint geographically, but rather use the office as a way to get to talent based in PE to work for the company," Eagle says.

Eagle states that the new office is also working on further expanding its skills pool. "We want to make sure we have the right balance and structures in place in terms of experience. We are still looking for individuals with significant experience who can fulfil the role of a technical lead and mentor to some of our younger developers," Eagle concludes.



Kweku Qansah, Simone Beets and Jean Joubert.

Optical Data Transmission made Efficient and Simple

The Leuze DDLS 500 optical data transmission photoelectric sensor is so much more than an optical sensor. This innovative sensing device offers many more features that make it both efficient and simple to use. And through continuous monitoring of the receiving level, the user can be alerted to an impending failure in good time.

Available from leading sensor solutions supplier, Countapulse Controls, the Leuze DDLS 500 enables the transparent, contact- and wear free transmission of data over distances of up to 120 metres in 100 Mbit/s real-time. This is achieved by using an invisible infrared laser which communicates bi-directionally between devices.

The sensor is ideal for all applications where data needs to be transmitted without cables, and more importantly without interference. It is favoured for applications where mechanical systems are pushed to their technical limitations.

To permit fast visual control, the Leuze DDLS 500 has an LED display that is clearly visible from a distance of

200 metres. All relevant information is precisely depicted on the control panel.

The device's patented single hand adjustment process and integrated mounting plate with alignment screws enables easy mounting by just one person. This makes it easy to install, and the aid of an integrated laser alignment and level facilitates rapid alignment, even over longer paths.

The modular design of the Leuze DDLS 500 allows the base model to be easily expanded with additional available functionality, and this allows it to be configured specifically for individual application requirements.

In addition, the sensor is web server integrated which facilitates remote diagnostics, and it can be detected as a PROFINET participant. The device supports all commonly used Ethernet protocols.



WATTSUP

Time to stop digging trenches manually

With the advent of trenching machines nearly seventy years ago, Ditch Witch the inventors, revolutionized the industry and put paid to manual trenching throughout most of the world.

Yet in South Africa the chain gang still prevails with manual labour used to painstakingly dig our trenches and foundations, almost as if it were some kind of job creation strategy. Unfortunately, the truth is that manual trenching is not a form of job creation at all; and if anything, it cripples the base of construction and infrastructure delivery to the extent that it prevents workers from obtaining more meaningful and sustainable employment.

Take a look at the affordable housing market where a backlog of nearly half a million houses dogs the industry on a monthly basis. So, what do well-meaning contractors who are trying to fill the gap do? They throw more men at it in the hope that 10 men can dig a foundation in a day and help them start catching up the backlog. But, this is futile: a small ride-on Ditch Witch RT45 trencher can dig up to 25 or even 30 foundations a day. Redeploy the ten labourers per house and with a bit of training they could be increasing housing outputs 20-fold or more.

SPEED AND PRECISION

Keith Smith, area sales manager of ELB Equipment, local distributors of Ditch Witch, says speed is just one reason to use a trencher, but there are many, even more compelling, reasons to add a Ditch Witch to the construction fleet. *“It also digs trenches and foundations to exact dimensions. This is*



important in terms of quality of trenches or foundation to avoid failures where they are too shallow or too thin as is often the case building sites.

“In terms of concrete usage alone, the savings in concrete will more than cover the cost of the machine when offset against money savings from accurate estimation and usage of concrete. If a chain gang were to dig a foundation just 100mm deeper or wider than the specification then the entire calculation would be out and the foundation may need 20-30% more concrete” says Keith.

INFRASTRUCTURAL MIND SHIFT

Phillip Mc Callum, ELB Equipment product manager agrees, adding that in the course of modernising the building site, the Ditch Witch RT-45 has far wider applications where it can equally revolutionise the way work is currently being carried out on applications such as laying of water, electric, fibre optics and gas utilities. These can also be done more quickly and accurately with a Ditch Witch.

“At this moment, there is massive call for trenches to be dug to lay fibre optics and with the addition of a Ditch Witch, contractors can lay more meters per day with a single machine, with less mess than an entire crew of 30 hardworking men can do in a day’s work” says Phillip.

He concludes that Ditch Witch has a long and proven track record in Southern Africa where it has been distributed and supported by ELB Equipment for more than 25 years. *“It is good to know the product has a reliable track record locally and enjoys some of the best aftermarket care and support from our in-house team of experts at ELB Equipment. But finding out which solution would best help your next project move faster, more accurate, profitable and smoother it would always be best to speak to a specialist about your requirement first.”*

ELB Equipment, Keith Smith, Tel: (011) 306 0700, Email: keiths@elbquip.co.za, Web: www.elbequipment.com

Standby power systems: Reliability boosted by ground-breaking local technology

In a bid to significantly improve the reliability and efficiency of standby power systems in corporate environments, Powermode, a leading Johannesburg-based power provisioning company, has launched a locally designed and manufactured GSM cellular-based monitoring system.

Dubbed the Powermode Monitoring Portal (PMP), the Internet-linked system is geared to monitor a company's standby power environment, reporting on a range of critical parameters associated with uninterruptible power supply systems (UPSs) solar PV systems and generators.

Powermode MD Jack Ward notes that the PMP is a 'first' for the SA standby power market, being based on the now universally-accepted principal of the Internet of Things (IoT).

"The IoT is defined as a system in which the Internet is linked to the physical world through any number of sensors which have the ability - and the power - to radically change the way people manage their lives and businesses, generally through resource optimisation," he notes.

Focusing on the PMP, Ward says empirical data is continuously streamed in real-time to Powermode's 24x7 Operations Centre in Johannesburg where technicians will react to an alarm signalling a disparity in standby power quality from accepted benchmarks by immediately notifying the company

concerned. If authorised, a service crew will be dispatched to any location country-wide.

Powermode boasts a nation-wide support infrastructure, complemented by telephonic response for technical queries and priority on-site response for emergency call-outs. Services are provided by trained and skilled technicians.

"With the frequency of power outages and the critical nature of South Africa's power grid, it is important that standby power plants, particularly in large enterprises, are safeguarded from threats that could disable them when they are needed most. In such instances critical computer systems may be forcibly shut down and cash tills will become inoperable," stresses Ward

He says many millions of rand are lost annually in South Africa through standby power systems failing to initialise on demand or as required. *"By electronically monitoring their status on a 24x7 basis using Powermode's ground-breaking technology this problem will be resolved."*

He says one of the most significant advantages of the PMP is no new infrastructure has to be built or designed for its failure-proofing benefits to be realised. Deployment is non-intrusive and does not affect the operation of the standby power device in any way. Users should therefore be able to see an immediate return on their investment.



Jack Ward
Managing Director
Powermode

Ward highlights the operational reports from a successful, six-month pilot project involving the roll-out of the PMP at a large South African chain of 118 retail stores.

They reveal that 44 stores were subjected to 195 potentially costly power outages during this period. More than 280 trading hours and 250 non-trading hours were affected. He says the results underline the importance and value of having deep insights into an organisation's power infrastructure.

Ward adds that the PMP is both cross-platform and vendor agnostic, meaning it can be retro-fitted to any backup power system irrespective of brand or type.

Ericsson and Tigo partner with GSMA to connect rural Tanzania

Ericsson and leading Tanzanian mobile network operator Tigo have partnered to launch the first of a series of rural pilot tower sites to provide mobile broadband coverage in parts of the Lindi Mtwara region, a rural province where there was previously no connection.

This deployment is the offshoot of a pilot infrastructure-sharing partnership brokered by the GSMA with Tigo, the government of Tanzania, and two other major mobile network operators to connect the over 13 million underserved individuals living in rural parts of the country.

Sharing infrastructure and engaging the government on reduced taxes in these regions allows operators to reduce the cost of deploying mobile broadband networks in places where it was previously not viable to do so.

Online banking fraud – consumers have a say and a responsibility

Incidents of online banking fraud continue to rise in South Africa as more consumers become comfortable with transacting on the internet. While cyber fraudsters are known to target companies – or financial institutions – in order to steal larger amounts, individuals are frequently targeted for quick and easy wins.

“Certainly, as we have seen in the past few years, banks can become the targets of cyber hacker syndicates. However, a lot of the online banking fraud we see is the result of malware or spyware that has been installed on a user’s computer or device unbeknown to the individual. Due to poor security measures on consumers’ devices, hackers are able to access their banking details and steal their money. Social engineering however is another growing problem. People are tricked into giving away their personal or banking details via phishing emails or over the phone. Fraudsters then use these details to gain access to their bank accounts online.

“Financial institutions are obliged provide secure mechanisms for their customers to conduct their banking safely online. But, there is some onus on consumers to protect their personal information and interests. Therefore, it is important for everyone transacting online to understand their rights and responsibilities,” says Charl Ueckermann, CEO at AVeS Cyber Security. According to him, most financial institutions offer stringent online security on their websites as well as a commitment that protects their customers while using their online banking features. These guarantees are created to protect consumers if they suffer a loss from unauthorised transactions made using the financial institution’s online banking

service. Consumers are advised to find out what security measures their bank has in place to protect them when banking online, what their bank’s online banking service commitments are as well as their policy on unauthorised transactions.

“Consumers have the right to ask what mechanisms their bank has in place to protect their personal information as well as their money when they transact online. Bear in mind that cyber criminals make it their business to stay a step ahead of their targets. So choose a bank that takes its online security very seriously. People should also take the time to read their bank’s online banking or electronic access agreement to check that they are meeting all the bank’s requirements for when banking online. Some banks may require users to install a specific security tool or add on the computer or device they use to transact online” he says.

On the flip side of this, it is the consumer’s responsibility to always keep their banking information, user IDs, passwords and PIN numbers confidential.

“If you give your online banking details to anyone, it comes with the risk of losing whatever protection your bank offers against unauthorised transactions. This could result in you being responsible for any unauthorised transactions on your account, and you won’t be refunded for your loss,” warns Ueckermann.

Consumers can help make their online banking safer by:

- Keeping PINs, passwords and personal verification questions secret;
- Always logging off the banking website properly, and closing the internet

browser completely after each and every online banking session;

- Installing tools and security add-ons provided by the financial institution to make online banking features more secure;
- Making sure that the IT security software on computers and devices used for internet banking are up to date;
- Avoiding the use of free WiFi hotspots to access the internet for online banking;
- Not opening attachments in unsolicited mails. This could activate the installation of malware onto your computer.
- Using encrypted sites where possible; check for the little padlock symbol in the address bar. Banks’ official online banking sites are encrypted.
- Never entering personal information onto a website from an external link or pop up. First open a new browser window and type the URL directly into the address bar to ensure the site is legitimate.
- Making sure financial providers can deliver information about the latest security trends and security mechanisms in place to protect consumers from being exposed to hackers.

“It is also important to regularly check your bank account for unusual or unexplained transactions. Report anything suspicious to your bank straight away. To keep tabs on the money flowing in and out of your account, register for sms notifications so that you receive alerts when there is a transaction on your account. Credible financial institutions will make these and other interventions available to their customers in order to enhance the level of protection,” concludes Ueckermann.

save the date.



19 – 21 Sept

Service Delivery for a **Smarter** Africa

Eskom Conference Centre

Registration opens on 9 March 2017

Only 300 seats are available.

The 2017 Conference draws on the success of the inaugural Conference that was held in February 2016, but has expanded to include a much wider eco-system including topics such as Smart Cities, the Internet of Things (IoT) and the Fourth Industrial Revolution. The program will also draw on plenary speakers from a number of the BRICS countries, in addition to speakers from Europe and the US.

www.saiee-smartgrid.co.za



DEHN protects

Two words, a big promise. The motto of DEHN has been both an obligation and an incentive for the past four generations of the family-owned company. These words represent an undertaking that the organisation keeps through its expertise and dedication – for the benefit of its customers, partners and employees.

DEHNgroup at a glance:

- Fourth-generation family-owned company since 1910;
- Approximately 1,700 employees worldwide;
- More than 120 employees within R&D/Construction Department and Quality Management;
- Approximately 150 apprentices;
- More than 4,000 devices and components; and
- Sales activities in more than 70 countries, with 20 subsidiaries and own offices worldwide.

DEHN's top priority is the reliable protection of persons, buildings, electrical and electronic devices, as well as systems, against the effects of lightning and surges.

The company has been at the forefront of developments within the fields of surge protection, lightning protection and safety equipment for decades, offering a broad range of systems, products and services.

DEHN's research and development activities allow it to develop innovations and continuously improve the quality and ease of installation of its products. Feedback from standardisation committees, as well as cooperation with external research institutions and universities, is also considered for the new and further development of the company's products.

More than 300 national and international patents, inventions and awards underline the success of DEHN's activities and quality of its products and solutions.

In line with its corporate philosophy, DEHN's products are based on high and uniform quality standards. Product types are adapted to normative framework conditions and the technical prerequisites of the relevant field of application.

LOOKING LOCALLY

DEHN Africa was established as a local subsidiary of DEHN + SÖHNE in May 2013, and has grown from strength to strength over the past four years. The Johannesburg-based company now boasts a network of DEHNpartners across Africa, from South Africa, Madagascar, Botswana, Namibia and the Democratic Republic of the Congo, to Zimbabwe, Mauritius, Rwanda, Uganda and Kenya.

DEHN Africa's mandate is to ensure that it employs the best talent available within the local market and, as such, the organisation now has a local team of 14 highly skilled staff members.

SKILLING UP THE INDUSTRY THROUGH DEHNACADEMY

In response to the information gap identified within the local market, DEHN Africa established DEHNAcademy in late 2015, a well-structured training and educational service, facilitated by experienced professionals in the field of lightning and surge protection and safety equipment.

Through DEHNAcademy, the company helps to educate fellow engineers and clients through the sharing of its wealth of knowledge.

The academy offers weekly training sessions and quarterly seminars, aimed at upskilling and informing engineers, end-users, consultants, electricians, and architects across Africa on lighting and surge protection.

DEHNacademy in Africa offers CPD (Continuing Professional Development) point seminars, training and workshops for specific markets.

SEMINARS

The organisation offers customer specific seminars, as well as a SAIEE (South African Institute of Electrical Engineers) approved, two-point CPD accredited seminar titled “A comprehensive approach to lightning protection” for engineers and consultants looking to continuously develop their profession.

Delegates will gain insight into:

- The characteristics of lightning, how it is formed and types of flashes that exist.
- How to assess the risks associated to a structure/building/plant and to apply mitigation methods to protect personnel, the structure and its equipment as per SANS 62305:2012 Part 2.

- Designing of a compliant and effective lightning protection system (LPS) according to latest interpretations of SANS 62305:2012 Part 3.
- Selecting compliant lightning and surge protection devices through understanding the full requirements of these devices according to SANS 62305:2012 Part 4.
- The certification of an LPS using the installation safety report as shown in SANS 10313 Edition 3.2.

TRAINING

The DEHNacademy training comprises multiple topics, including the IEC/SANS 62305 standard, DEHN’s Red/Line and Yellow/Line surge protection, lightning protection, earthing, safety equipment as well as DEHNconcept and DEHNsupport Toolbox software training.

WORKSHOPS

The workshops offered by DEHN Africa are industry and application specific. These include telecommunication sites, photovoltaic (PV) systems, wind power, petrol stations, LED lighting, mining industry, hazardous locations as well as earthing and bonding.

THE NEW AND IMPROVED DEHN AFRICA

2016 saw DEHN Africa relocate to larger, more central premises, based in Midrand, Johannesburg. The new office features a fully-fledged skills centre, accommodating up to 30 people per seminar, integral to the organisation’s knowledge transfer pledge.

For more information on DEHNacademy and to access the training schedule, please visit www.dehn-africa.com/en-za/dehnacademy.

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Technology:

The way of the future...

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George Jetson can eat his heart out. A new flying-car concept can do more than just take to the skies. In fact, the futuristic vehicle takes more cues from “Transformers” than “The Jetsons” in imagining how humans might get around in the future. In this article we take a look at various Technological inventions currently in the pipeline.



MEET THE POP.UP.

This “multimodal transportation concept” is a passenger capsule that can transform into different modes of transit, by attaching to wheels for driving, connecting to propellers for flying or joining a train-like transit system such as the high-speed transit concept known as the Hyperloop.

The futuristic capsule was envisioned by

aerospace company Airbus, and design and engineering firm Italdesign. The companies say the Pop.Up could unite aerospace and automotive technologies for a new kind of urban mobility.

Airbus and Italdesign revealed their transforming-car concept on 7 March 2017 at the Geneva International Motor Show, and described it as entering the “third

dimension” of transportation systems.

“Today, automobiles are part of a much wider ecosystem: If you want to design the urban vehicle of the future, the traditional car cannot alone be the solution for megacities; you also have to think about sustainable and intelligent infrastructure, apps, integration, power systems, urban planning, social aspects, and so on,”

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Italdesign CEO Jörg Astalosch said in a statement. *“In the next years, ground transportation will move to the next level — and from being shared, connected and autonomous, it will also go multimodal and moving into the third dimension.”*

There are three layers to the Pop.Up concept system, according to Airbus. The passenger capsule is one layer, with its ability to be coupled with electrically propelled ground and air transport (such as a car base or a drone top). The capsule can also be linked to a public transit system (such as trains or a Hyperloop).

The Pop.Up is designed to run on an artificial-intelligence platform, the second layer, that can choose the best route — by ground or air — to the passenger’s destination. The capsule will then autonomously travel the selected route, according to Airbus.

A video of the Pop.Up in action shows the system’s user interface, or the third layer, which offers passengers an interactive virtual environment. For instance, in one clip, a display in the capsule offers information regarding a museum the passenger is flying over.

The companies did not announce a time frame for developing the project, but they did note that traffic congestion is

expected to become increasingly worse. The companies say Pop.Up offers a solution to growing transportation challenges for urban commuters.

THE WAY OF THE FUTURE

The U.S. Defense Advanced Research Projects Agency (DARPA), has a reputation for working on some of the most cutting-edge, futuristic projects - many that could easily be mistaken for science fiction. The agency, which falls under the watch of the U.S. Department of Defense, is responsible for developing new technologies for the military.

From humanoid robots to flying armored cars, here are 10 of the coolest DARPA projects.



WILDCAT AND BIGDOG

As their names suggest, WildCat and BigDog are four-legged, headless robots designed to walk, run and carry heavy loads through potentially dangerous terrain, much like deployed troops. DARPA awarded contracts to Boston Dynamics to develop WildCat and BigDog for use by the military.

BigDog, created in 2005, is 3 feet (0.91 metres) long, and stands 2.5 feet (0.76 m) tall. The robot, which is roughly the size of a small donkey, is capable of hauling 400 pounds (181 kg) of cargo, and can

navigate difficult terrain and inclines up to 35 degrees.

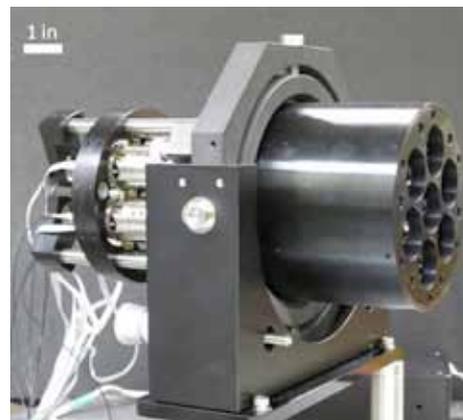
WildCat, however, is quicker and more agile. The robot can gallop up to 16 mph (25 km/h) on flat surfaces, and is part of a DARPA mission to develop robots that can assist human soldiers on a variety of ground missions.



AVATAR PROJECT

Sometimes life imitates art, as is the case with DARPA’s project to develop interfaces that enable soldiers to control and partner with semi-autonomous bipedal machines that, “act as the soldier’s surrogate.” Sound familiar? Hollywood director James Cameron explored the idea in his 2009 blockbuster hit “Avatar.”

In its 2013 budget, DARPA allocated \$7 million to its “Avatar Project,” which could enable soldiers to control surrogate robots in dangerous combat situations.





EXCALIBUR

To reduce the amount of “collateral damage” in war, particularly during battles fought in urban settings, DARPA is developing laser weapons that are small and efficient enough to be used in combat. These experimental laser weapons will be 10 times lighter than existing high-power laser systems currently in use, DARPA officials have said.

The lasers, developed for airplanes, may also be used for laser communications, target designation and airborne self-protection, agency officials added.



FALCON PROJECT

DARPA’s Falcon Project was announced in 2003 as a joint program with the U.S. Air Force. The project aimed to develop a reusable, unmanned, rapid-strike hypersonic vehicle.

A prototype Hypersonic Technology Vehicle 2 (HTV-2) first flew in April 2010 and again in August 2011. The ultra-fast, arrow-shaped drone flew at blistering hypersonic speeds of Mach 20 (about 20 times the speed of sound), more than 22 times faster than commercial jetliners. During the flight, surface temperatures on the vehicle reached 3,500 degrees Fahrenheit (1,930 degrees Celsius), which is hotter than a blast furnace capable of melting steel.

During both test flights, operators lost contact with the HTV-2 prototypes. In July 2013, DARPA confirmed it would not conduct a third flight of the HTV-2, but research on the project will continue until summer 2019 to gain better understanding of hypersonic flight.



TRANSFORMER

Imagine a militarized modern version of Chitty Chitty Bang Bang. This is the thrust of DARPA’s Transformer project, which aims to develop a flying armored car. The four-person vehicle will be able to drive normally but also take to the skies to avoid road obstructions or other threats on the ground.

The vehicle is being designed to take off and land from the vertical position, and will be able to fly up to 250 nautical miles on a single tank of fuel. Eventually, these flying tanks may be used for strikes, raids, counterinsurgency operations, reconnaissance, medical evacuation and supply missions.

ATLAS

DARPA’s Atlas project was revealed to the public on 11 July 2013. The bipedal humanoid robot stands 6-foot tall (1.8 m), and is designed to assist with a range of emergency services, including search and rescue operations. The U.S. Department of



Defense is not interested in using the Atlas robot in combat situations, officials have said.

Atlas was developed by Boston Dynamics and was based on some of the company’s earlier robot creations.



NAVIGATION CHIP

Advances in GPS technology have revolutionized tracking and navigation, but what about areas where GPS is unavailable,

Technology

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or the signals are interrupted? To help soldiers find their way around areas of GPS blackout, DARPA researchers are developing a tiny navigation chip that is smaller than a 10c piece.

The so-called timing & inertial measurement unit (TIMU) chip incorporates three gyroscopes, three accelerometers and a highly accurate master clock into a single miniaturized system. This can provide precise information for navigation, including orientation, acceleration and time.

DARPA officials have said the navigation chips will not replace GPS, but rather are designed to work when GPS is unavailable or doesn't work.



X-37

The Boeing-built X-37 reusable space plane started as a NASA project in 1999, but was eventually transferred to DARPA in 2004. The US Air Force took control of the project two years later.

The unmanned X-37 Orbital Test Vehicle, which resembles a miniaturized version of the space shuttle, rides into orbit atop a rocket and returns to Earth and lands as a space plane. The X-37 launched on its first orbital mission in April 2010.

Previously, DARPA reported it was

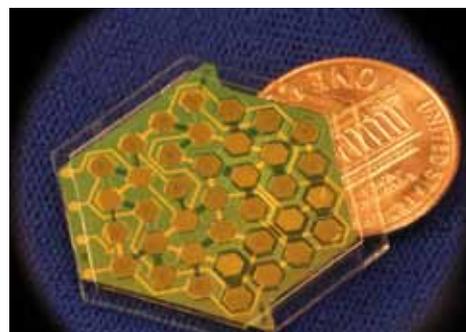
developing the X-37 to rendezvous and refuel older satellites or perform minor repairs in space using a robotic arm. Speculation mounted, however, that the X-37 was being used by DARPA and the Air Force as a vehicle for space-based weapons. In 2010, a high-ranking Air Force official involved with the project dismissed the rumors, and stressed that the X-37's main purpose is to test space technology.



BRAIN-MACHINE INTERFACES

Imagine if your brain could communicate with an external device, such as a thought-controlled mechanical arm or a device to restore sight. DARPA researchers are investigating potential communication pathways between the human brain and machines to build, assist, augment or repair human cognitive or sensory-motor functions.

Research on these so-called brain-machine interfaces began in the 1970s, and work by DARPA researchers is focused on neuroprosthetics that aim to restore damaged sight, hearing and movement. One of DARPA's brain-machine interface projects is Proto2, a thought-controlled prosthetic arm. Proto2 consists of a dexterous hand and fingers that can perform 25 joint motions.



MICROSCALE PUMPS

DARPA-funded researchers created the world's smallest vacuum pump system that can be used for any electronics or sensors that require a vacuum. In 2008, DARPA's Chip-Scale Vacuum Micro Pumps (CSVMP) program set out to develop the smallest, most power-efficient pumps ever created.

The vacuum pumps could be used to build tiny chemical sensors, such as ultra-sensitive gas analyzers to detect chemical or biological attacks, or to design new sensors or instruments for micro-drones. The penny-size vacuum pumps were created by researchers at the University of Michigan, MIT and Honeywell International. **Wn**



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COMPILED BY | MIKE CARY | PR ENG | SAIEE PAST PRESIDENT

GERMANY SETS RECORD FOR WIND-TURBINE INSTALLATIONS

Berlin - German construction of wind turbines reached a record high in 2014, with 4 750 megawatts - equivalent to the capacity of three nuclear reactors - brought on stream, a trade association said Thursday.

Germany now has 24 867 turbines in operation on land, part of a globally unprecedented plan to retire all nuclear

power generation and limit fossil fuel use in a drive to obtain as much renewable energy as possible.

Currently, Germany obtains 8% of its overall electricity used from wind. Last year, German Investors constructed 1 766 new turbines, the Wind Energy Federation said in Berlin. The federation said an upsurge in construction after changes to planning rules, as well as a rush to claim expiring subsidies, had enabled the industry to beat



Wind Power in South Africa

the record of 3 240MW of new capacity, which was set in 2002.

The data does not include energy from turbines in shallow offshore seas, which has been dogged by start-up problems.

GERMANY IS TO PHASE OUT NUCLEAR POWER IN 2022.

The government's planning target for new wind turbines last year was just 2 500MW. There have been concerns that wind energy

may be expanding too fast, since the existing network of power lines and power storage technology may be unable to cope with power spikes on particularly windy days.

German public opposition to nuclear power and enthusiasm for renewable energy dates back to the 1980s. Public opinion swung decisively against nuclear power after the 2011 partial meltdown of nuclear reactors at Fukushima, Japan.

In 2008, I attended the bi-annual CIGRE conference in Paris. On the Sunday afternoon, preceding the start of the formal programme, a series of 5 presentations of system failures which occurred in 2008 (of which Eskom was one). The Energy Commissioner from the European Commission presented the German case. One Sunday afternoon, when 27% of Germany's power was being generated by wind turbines, Germany suddenly became becalmed. As the European

Wind Power in SA

continues from page 29

transmission systems are interconnected, the generation in neighbouring countries saw this as a demand that needed to be served. Power rushed in from the rest of the interconnected grid, and the protection saw this as a fault, tripping out breakers, leading to a black-out in the whole of Europe.

The “fickle” nature of wind requires that there should be reserve margin available within a short space of time. Nuclear can take up to 12 hours to bring onto the grid, and likewise coal 3 hours (unless there is spinning reserve) (these figures can vary across different machine types and operating regimes). They are therefore suitable for the reserve. Gas generators, hydro, and pumped storage have a more suitable run up time, and can be used for this purpose.

Because of the way the electric grid works, constantly matching supply with demand to avoid dips and surges of power, the variable production of wind turbines is treated as part of the demand side of the equation. A base level of power is provided from large plants, and other plants are kept burning to be able to provide the maximum likely power (peak load) needed as it varies through the day. As demand drops, those plants are diverted from power generation, and as demand rises they are brought back on to resume generating the needed power. These plants burn fuel whether or not they are producing electricity.

With all the talk of going green, the question had been thrown out many times if there will ever be a time that we can use nothing but renewable energy to power our world. A small island in Denmark is trying answer that question with a resounding yes as they power up every single day via nothing but

wind power. The Danish island is the ideal setting as the wind literally never stops blowing. The North Sea offers the perfect opportunity to capitalize on the winds that come off of the sea and for them to use wind power as their primary source of power. As a matter of fact, the wind power that they are using is their ONLY source of power.

DEFINING THE WIND TURBINE

To further understand the nature of wind power, we should look at the land requirements, the speed, force and availability of the wind, and the size of the turbine.

LAND REQUIREMENTS FOR WIND TURBINES

A spacing of about 6 - 15 times the rotor diameter is the spacing one finds in wind farms. The spacing takes into account the geography of the site including altitude, as well as the interactions between the turbines – turbulence, shielding and electrical connections. One of the largest turbines is the Vestas V164, which has a rated capacity of 8.0 MW. It has an overall height of 220 m (currently the tallest in the world), and a diameter of 164 m. Companies are now working on the development of a 10 MW turbine. Currently the turbine with the largest swept area is the Samsung S7.0-171, with a diameter of 171 m, giving a total sweep of 23 020 m².

The widespread GE 1.5-megawatt model, for example, consists of 35 metre blades atop a 65-metre tower for a total height of 100 metres. The blades sweep an area just under an acre. The 1.8-megawatt Vestas V90 from Denmark is also common. Its 45-metre blades (sweeping more than 1.5 acres) are on a 80 metre tower, totalling 125 metres. Also gaining use in the U.S. is the 2-megawatt

Gamesa G87 from Spain, which sports 43.5 metre blades (just under 1.5 acres) on a 78-metre tower, totalling 122 metres.

Many existing models and new ones now coming out reach well over 120 metres high, with higher towers and extra-long blades designed to turn the generator in less-than-ideal sites.

The base of the steel tower is anchored in a platform of more than a thousand tons of concrete and steel rebar, 10 to 15 metres across and anywhere from 1.5 to 10 metres deep. Pylons may be driven down farther to help anchor the platform.

The gearbox - which transforms the slow turning of the blades to a faster rotor speed - and the generator are massive pieces of machinery housed in a bus-sized container, called the nacelle, at the top of the tower. The blades are attached to the rotor hub at one end of the nacelle. Some nacelles include a helicopter landing pad.

On the GE 1.5-megawatt model, the nacelle alone weighs more than 56 tons, the blade assembly weighs more than 36 tons, and the tower itself weighs about 71 tons, for a total weight of 164 tons. The corresponding weights for the Vestas V90 are 75, 40, and 152, total 267 tons, and for the Gamesa G87 72, 42, and 220, total 334 tons.

Besides the noise and vibrations such huge moving machines unavoidably generate, they must be topped with flashing lights day and night to increase their visibility.

In addition, new roads have to be built, or existing ones need to be extensively “upgraded.” It requires more than an old dirt logging track to get a 45-m blade, a

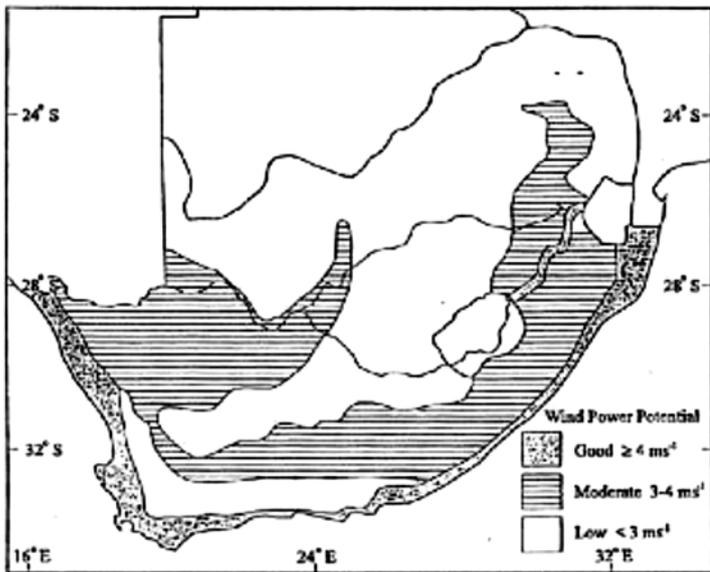


Figure 1: Diab's wind atlas

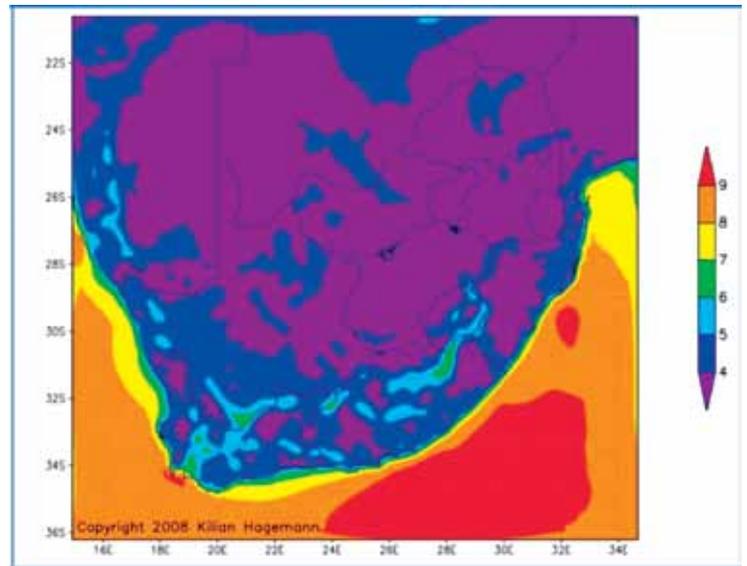


Figure 2: Hagemann's wind atlas

70-ton nacelle, or the huge crane needed to put it all together up a mountain. The road needs to be wide, straight, and very strong.

Several acres around each turbine have to be cleared as well. For best performance, the GE 1.5-megawatt turbine needs 82 unobstructed acres around it and the Vestas V90 needs 111. On a ridgeline, the sloping away of the land and the hope that the wind is always perpendicular to the line of the ridge mean that about 5 acres are actually cleared around each turbine.

Access to the area around the turbines must be strictly limited because of physical danger.

A facility may also require a new substation or two, as well as new transmission lines.

The combination of all this - road building, extensive clearing, and the installed facility itself - not only significantly degrades and fragments wildlife habitat, but also has a serious effect on erosion and water

flow, not to mention the aesthetics of a mountainside or open land. And, of course, the visual intrusion affects the landscape for miles around.

THE SOUTH AFRICAN WIND POTENTIAL

Several studies have been carried out to assess the wind energy potential of South Africa, and the estimates range from a very low 500 MW, to an extremely high estimate of 56,000 MW. In sharp contrast to the currently installed capacity, is the very large figure of 8000 MW of wind capacity, for which grid connection requests have been received by ESKOM. South Africa's wind resources are influenced by the large-scale weather patterns that have distinct characteristics between summer and winter.

DIAB'S WIND ATLAS

The first estimates of wind power potential for South Africa were done by Diab (1995), who concluded that:

- Wind power potential is generally good

along the entire coast with localised areas, such as the coastal promontories, where potential is very good, i.e. mean annual speeds are above 6 m/s and power exceeds 200 W/m²;

- Moderate wind power potential areas include the Eastern Highveld Plateau, Bushmanland, the Drakensberg foothills in the Eastern Cape and KwaZulu-Natal; and
- Areas with low wind power potential include the folded mountain belt (vast region of very complex and diverse terrain), the Western and Southern Highveld Plateau, the Bushveld basin, the Lowveld, the Northern Plateau, the Limpopo basin, Kalahari basin, the Cape Middleveld and the KwaZulu-Natal interior.

KILIAN HAGEMANN'S WIND ATLAS

A mesoscale wind map of South Africa was produced by Hagemann (2008) as part of his PhD research at the University of Cape Town. His thesis explores the utility of what is known as the MM5 regional climate model

Wind Power in SA

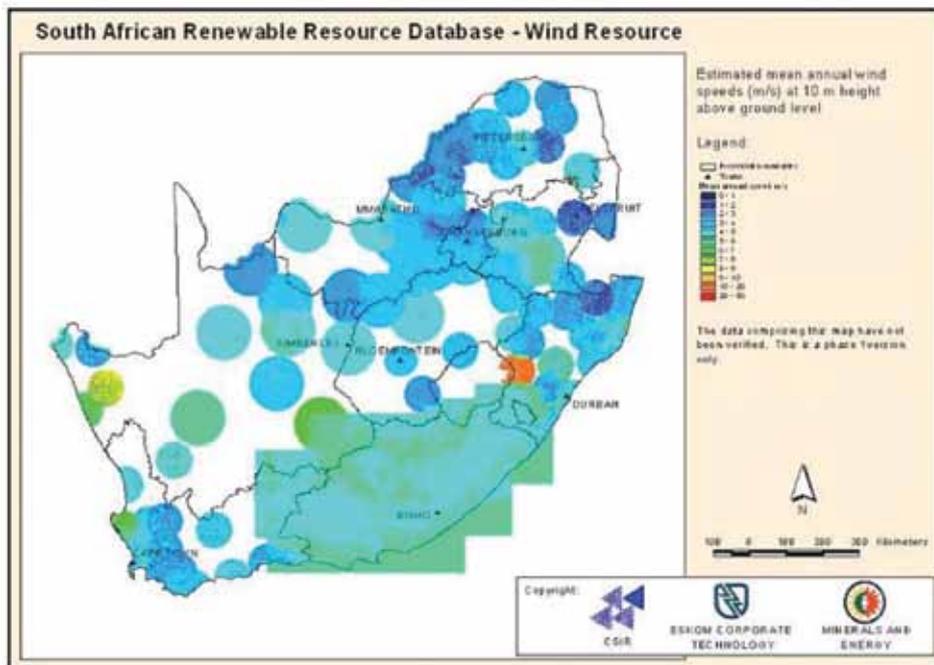
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and the use of the MM5 model in producing a detailed wind climatology for South Africa in the context of wind power applications.

In terms of the resultant mesoscale wind atlas of South Africa, a significant inland wind resource was discovered over the Northern, Western and Eastern Cape Provinces, which was previously unknown. Hagemann puts forward the case that South Africa's wind resource is higher than some previous studies have suggested, and is comparable to some of the windiest markets in the world.

The study modelled wind speeds across the country at various heights above ground and carried out the GIS-based scenario analysis for South African wind power penetration as per Table 1 below.

All of the scenarios show that South Africa has a very high wind resource and that even under the low case, substantial wind energy generation is feasible. Based on the work done by Hagemann a map of average annual wind speeds at 10 m above ground level for South Africa is given in Figure 2.



Current Wind Atlas for South Africa

DEPARTMENT OF ENERGY/ESKOM/CSIR WIND ATLAS FOR SOUTH AFRICA

The current wind atlas, a joint DoE, Eskom and CSIR initiative, is far from being adequate and is compiled from modelling that was done under two separate projects.

Extract from CSRI Science Real and Relevant Conference 2010 – Wind Atlas for South Africa. The availability of the wind is another factor to be taken into account. This varies from Country to Country as seen in the introduction where Denmark plans on close to 100% availability to South Africa where the estimates vary from 25% to 35%.

CASE	ASSUMPTIONS	RESULT
Low case	All sites within 3 km of existing infrastructure (66+ kV grid, roads); 60 m hub height; minimum of 35% capacity factor	20 TWh of feasible annual electricity generation corresponding to approx. 6 GW of installed wind power capacity
Central Case	All sites within 4 km from existing infrastructure; 60 m hub height; minimum of 30% capacity factor	80 TWh of feasible annual electricity generation, corresponding to approx. 26 GW of capacity
High Case	All sites within 5 km from infrastructure; 100 m hub height; minimum of 25% capacity factor	157 TWh of feasible annual electricity generation corresponding to approx. 56 GW of capacity

Table 1: Scenarios for wind development by Hagemann (2008)



Generally 27% is accepted as a equitable figure. If there is no storage the effective availability can drop to 10%.

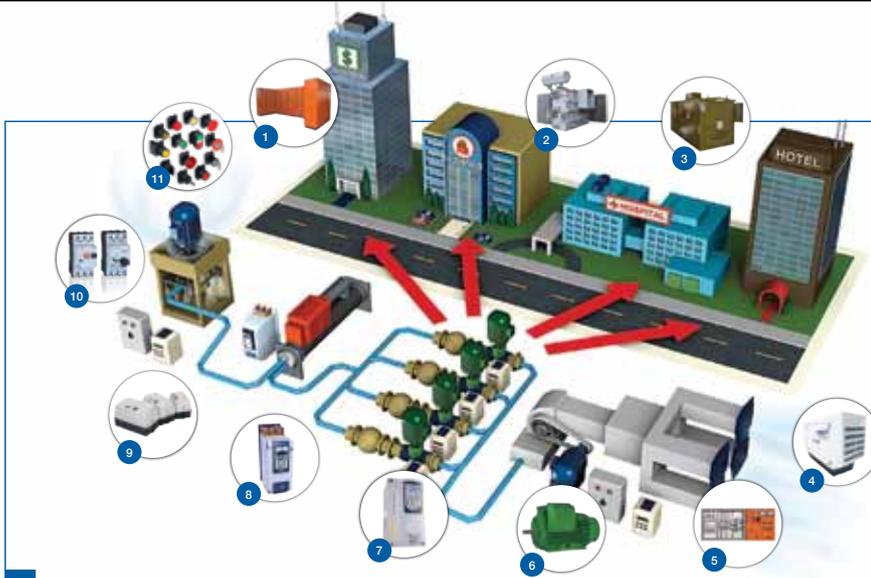
DETERMINING THE SIZE OF THE TURBINE

A wind turbine is a device that converts kinetic energy from the wind into electrical power. The result of over a millennium of windmill development and modern engineering, today's wind turbines are manufactured in a wide range of vertical and horizontal axis types. The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Slightly larger turbines can be used for making contributions to a

domestic power supply while selling unused power back to the utility supplier via the electrical grid. Arrays of large turbines, known as wind farms, are becoming an increasingly important source of renewable energy and are used by many countries as part of a strategy to reduce their reliance on fossil fuels.

A quantitative measure of the wind energy available at any location is called the Wind Power Density (WPD). It is a calculation of the mean annual power available per square meter of swept area of a turbine, and is tabulated for different heights above ground. Calculation of wind power density includes the effect of wind velocity and air density.

The amount of wind for a site determines the optimum size of turbine. Installing a 5 MW unit in a site which has only 3 MW capacity will probably yield less than 3 MW, as the efficiency will drop. Not all the energy of blowing wind can be harvested, since conservation of mass requires that as much mass of air exits the turbine as enters it. Betz's law gives the maximal achievable extraction of wind power by a wind turbine as 59% of the total kinetic energy of the air flowing through the turbine. Further inefficiencies, such as rotor blade friction and drag, gearbox losses, generator and converter losses, reduce the power delivered by a wind turbine. Commercial utility-connected turbines deliver 75% to 80% of the Betz limit of power extractable



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The Zest WEG Group, a subsidiary of leading Brazilian motor and controls manufacturer WEG, started out as a South African company and maintains its strong commitment to contributing to the development of the African region. By leveraging best practice

engineering and manufacturing capabilities, the group is able to offer a range of standard off-the-shelf products as well as end-to-end energy solutions.

An in-depth understanding of the requirements for HVAC applications, access to quality product solutions and years of experience have ensured that the Zest WEG Group service offering is fit-for purpose. From single product installations to individually customised solutions, which are application specific, the latest technology is used to ensure optimum performance and reliability without

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Wind Power in SA

continues from page 33

from the wind, at rated operating speed. Efficiency can decrease slightly over time due to wear. Analysis of 3128 wind turbines older than 10 years in Denmark showed that half of the turbines had no decrease, while the other half saw a production decrease of 1.2% per year.

To determine the size of the turbine, at least one year of wind measurements at the site should be made. Alternatively, the Wind Atlas can be used. In addition, there is an international specification IEC 61400 to assist with the specifying, and purchasing of the turbine:

IEC 61400

IEC 61400 is a class of IEC international standards regarding wind turbines.

The 61400 is a set of design requirements made to ensure that wind turbines are appropriately engineered against damage from hazards within the planned lifetime. The standard concerns most aspects of the turbine life from site conditions before construction, to turbine components being tested assembled and operated.

Wind turbines are capital intensive, and are usually purchased before they are being erected and commissioned. Some of these standards provide technical conditions, verifiable by an independent, third party, and as such are necessary in order to make business agreements, so that wind turbines can be financed and erected. IEC started standardizing international certification on the subject in 1995, and the first standard appeared in 2001.

The common set of standards sometimes replace the various national standards, forming a basis for global certification.

WIND CLASS/ TURBULENCE	ANNUAL AVERAGE WIND SPEED AT HUB- HEIGHT (M/S)	EXTREME 50-YEAR GUST IN METERS/ SECOND (MILES/HOUR)
Ia High wind - Higher Turbulence 18%	10.0	70 (156)
Ib High wind - Lower Turbulence 16%	10.0	70 (156)
IIa Medium wind - Higher Turbulence 18%	8.5	59.5 (133)
IIb Medium wind - Lower Turbulence 16%	8.5	59.5 (133)
IIIa Low wind - Higher Turbulence 18%	7.5	52.5 (117)
IIIb Low wind - Lower Turbulence 16%	7.5	52.5 (117)
IV	6.0	42.0 (94)

Table 2: The extreme wind speeds are based on the 3 second average wind speed. Turbulence is measured at 15 m/s wind speed. This is the definition in IEC 61400-1 edition 2.

Small wind turbines are defined as being of up to 200m² swept area and a somewhat simplified IEC 61400-2 standard addresses these. It is also possible to use the IEC 61400-1 standard for turbines of less than 200m² swept area.

WIND TURBINE GENERATOR (WTG) CLASSES (IEC 61400-1 ED.2)

Wind turbines are designed for specific conditions. During the construction and design phase assumptions are made about the wind climate to which wind turbines will be exposed, Turbine wind class is just one of the factors which need to consider during the complex process of planning a wind power plant. Wind classes determine which turbine is suitable for the normal wind conditions of a particular site. Turbine classes are determined by three parameters - the average wind speed, extreme 50-year gust, and turbulence.

Turbulence intensity quantifies how much the wind varies typically within 10 minutes. Because the fatigue loads of a number of major components in a wind turbine are mainly caused by turbulence, the knowledge of how turbulent a site is, is of crucial importance. Normally the wind speed increases with increasing height. In flat terrain the wind speed increases logarithmically with height. In complex terrain the wind profile is not a simple increase and additionally a separation of the flow might occur, leading to heavily increased turbulence.

CONCLUSION

Using the information above applied to a practical example: What would be the size of a wind farm to provide the equivalent power to Medupi? Medupi is rated at 6 x 800 MW = 4800 MW. Assume a turbine size of 3 MW (this is about the average



size of turbines currently being installed.)
 Number of required wind turbines
 therefore would be $4800 / 3 / .27 = 5926$.
 If you apply the 10% non- storage factor
 this figure would be 16000. If you apply
 the land requirements as discussed above,
 taking a conservative figure of 40 hectares
 per turbine, one would require 2370 square
 kilometres. or in the 10% availability case,
 6400 square kilometres. **Wn**

ACKNOWLEDGEMENTS

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We asked this group to review and rate a range of nuclear technologies – from ongoing innovations to existing technologies, such as dry fuel storage, through to technologies still in development, such as a new generation of reactor types. Given the breadth of innovation in the field, a number of these technologies are grouped for necessity, such as all so-called ‘generation IV’ reactor technologies.

The Nuclear Perspective

- Lloyd's Register Technology Radar

The results used in this report come from a Lloyd's Register survey conducted in November 2016 by Longitude Research. Of the 583 total respondents from across the low carbon sector, 154 identified themselves as operating in nuclear; this is the group we refer to here as 'nuclear respondents'.

The makeup of this group is as follows: 44% are energy utilities; 21% are distribution system operators; 21% are supply-chain manufacturers; 9% are other companies in the supply chain, such as engineering or service providers; and 5% are operators. Meanwhile, 17% of nuclear respondents come from the Middle East; 22% from North America; 10% from Asia Pacific; and

51% from Europe. And 61% are C-level, with the remainder occupying other senior positions.

Please note that where graphs do not add up to 100 percent, this is due to rounding or questions where respondents were able to select multiple answers.

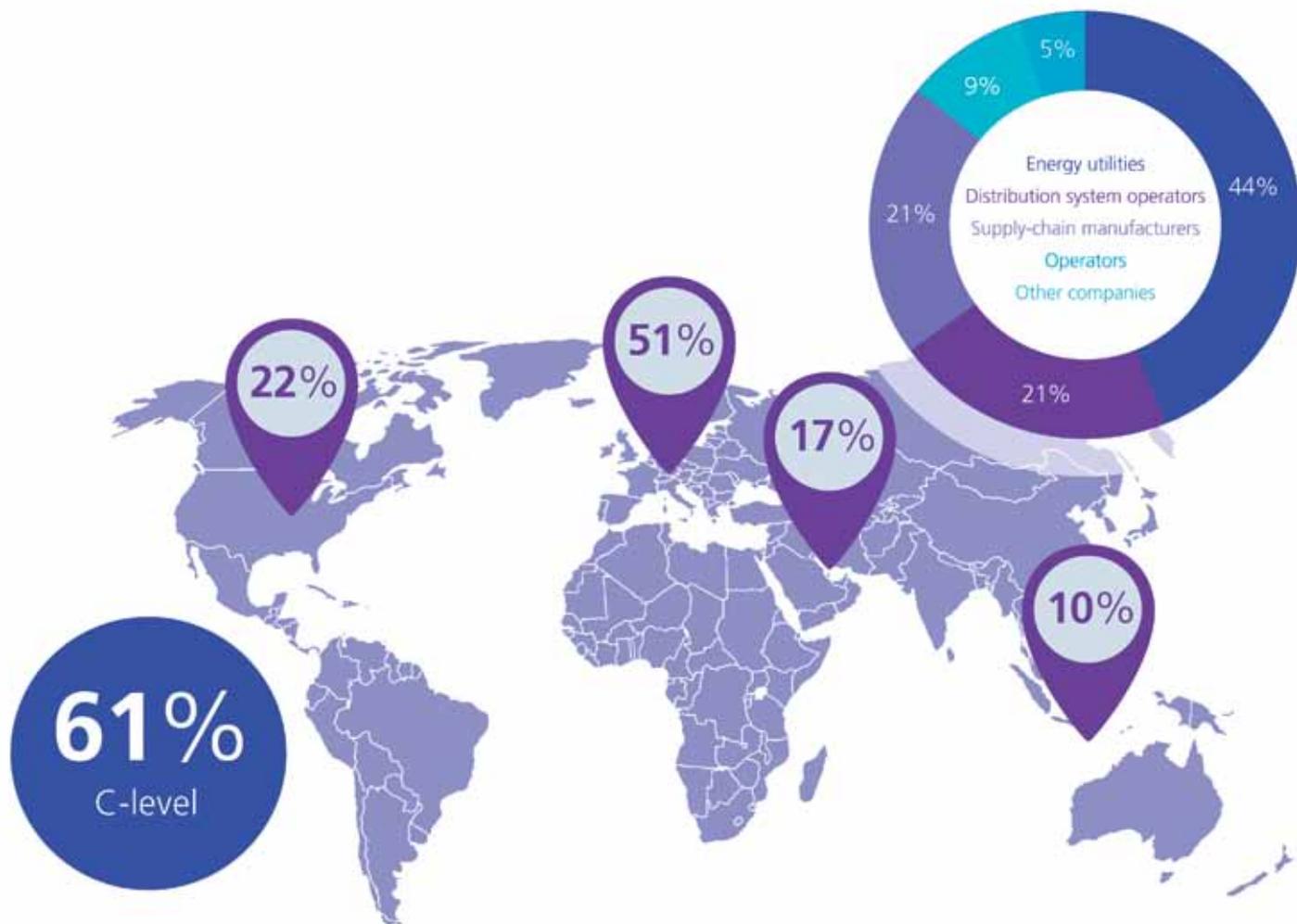
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ABOUT THE RADAR SERIES

Global research, sector insights and in-country reports and industry surveys form part of the Technology Radar series managed by the energy business of Lloyd's Register. The reports combine Lloyd's Register's expert knowledge with third-party insights, to provide data-driven findings on the role of innovation, technology, safety and sustainability in the current and future energy industry. Lloyd's Register role is to ensure that they provide that independent viewpoint to help government, energy producers, manufacturers, regulators and policy makers to the energy industry extract energy safely, and to deliver energy sustainably, with minimal risk to people and to the environment, and in socially responsible ways. They recognise that true value can be created by nurturing stakeholder relationships, based on trust and understanding. LR is addressing industry's most significant technology and sustainability challenges by interacting and working with energy stakeholders on an ongoing basis. Through interviews with senior industry practitioners and surveys of energy professionals, the Technology Radar series provides a compelling insight on latest industry thinking, trends and insights.

The Nuclear Perspective

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KEY FINDINGS

Nuclear’s role in the low carbon landscape

Despite some uncertainty as a result of geopolitical events, delegates at November’s COP22 meeting in Marrakech concluded the conference with the confident declaration that the “extraordinary momentum on climate change worldwide ... is irreversible”.

Following the groundbreaking commitments made in Paris a year earlier, the UN has finally moved from negotiation to implementation. Although the path to decarbonisation is far from being free

of obstacles, the appetite for low carbon power generation is strong, and the move away from fossil fuels is under way.

RENEWABLE ENERGY SOURCES

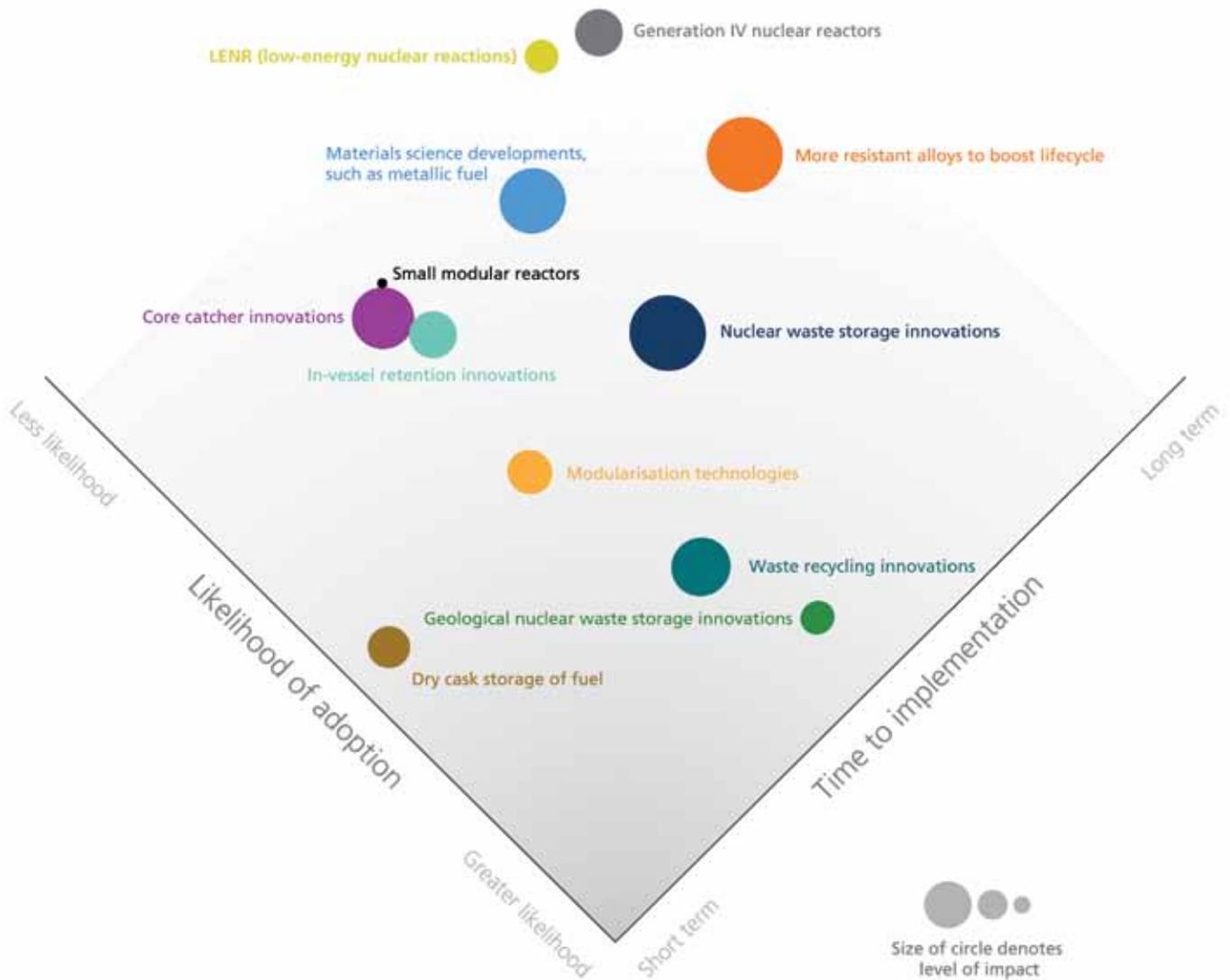
such as wind and solar, are now reaching cost parity with their fossil fuel-based alternatives, but intermittency is a challenge that has yet to be solved. While oversupply can to some extent be traded through regional grids, baseload power is still needed for when the wind fails to blow, or the sun fails to shine.¹

The important role that nuclear power can play in reaching the UN’s climate change

reduction targets is well recognised – a joint NEA/IEA Nuclear Technology Roadmap concluded that global nuclear capacity must have increased by 2.3 times by 2050 (from about 400GW to about 1,000GW) in order to reach planned carbon reduction targets.²

Construction around the world is ramping up to reach this ambitious target. There are currently 450 nuclear reactors operating in 30 countries around the world, with a further 60 new nuclear plants currently under construction in 15 countries³ – although a lot more will have to be built if the target is to be reached in time.

Nuclear technology radar



In an atmosphere in which governments are committed to lowering their dependence on fossil fuels, nuclear is a key low carbon option for baseload power generation.

“Nuclear should be working hand in hand with renewables,” says Lady Barbara Judge CBE, Chairman of the Institute of

Directors and Chairman Emeritus of the UK Atomic Energy Authority. “You can’t have renewables alone – they don’t provide baseline generation – but we could do them together, and that would be a good thing.”

Professor Richard Clegg, Foundation Chief Executive of the Lloyd’s Register

Foundation, believes that the agreement that came out of COP21 served as a catalyst for evaluating awareness of decarbonisation and energy security – and is leading to more countries contemplating nuclear as a viable low-carbon power source. “People are essentially looking over the edge of the cliff and thinking, ‘I don’t want to go there,’

The Nuclear Perspective

continues from page 39

and so they begin to think differently about all the options, including nuclear," he says.

The first Lloyd's Register Technology Radar – Low Carbon shows that innovations in nuclear could make the sector an even more attractive prospect for governments and energy utilities. However, while some technologies such as Small Modular Reactors (SMRs) are talked about as having huge potential to change the sector, our research shows that many executives in the nuclear sector believe that the greatest possibilities lie elsewhere.

Our survey also shows that opinions on the future of nuclear vary across markets and geographies, but the sector is united in its belief that it will play a key role in the low carbon landscape. This report details this year's key findings for the nuclear sector.

Respondents were asked to rate a number of technologies – including both brand new technologies, and ongoing advances in existing technologies – in terms of their potential impact on the nuclear sector, the amount of time it would take for these technologies to hit the market, and how likely they are to be adopted once they do. Our key findings are presented below.

FINDING 1

Appetite is limited for small modular reactors, but is strong for further innovation in modularisation

When costs are levelised across the lifecycle, nuclear is one of the most cost-effective methods of power generation.⁴ Indeed, OECD (Organization for Economic Cooperation and Development) research shows that nuclear is the lowest levelised cost option for power generation for all

OECD countries under certain capital cost projections.⁵

Regional differences in the cost of capital for nuclear projects mean that while cost can be a challenge for greenfield nuclear projects in Europe and North America, it is seen as less of an issue in Asia, where economies of scale, lower labour costs and more recent experience in building reactors all have an impact. In economies where financing traditional greenfield projects is seen as challenging, SMRs are often cited as the future because their size and the fact that they are ready to install keep investment costs low.

A number of the experts we interviewed for this report predicted that SMRs would rank highly in terms of the innovations with the largest impact, but this turned out not to be the case. In fact, respondents to our survey predicted that SMRs have a low likelihood of eventual take-up, and will have a minimal impact when they do arrive.

However, this isn't stopping governments from investigating the potential of the technology, according to Tom Greatrex, Chief Executive of the Nuclear Industry Association and former shadow energy minister in the UK. "Small modular reactor technology could potentially provide flexible low carbon generation, which would complement baseload from larger nuclear plants," he explains. "There is a very strong interest in the technology being shown right now," he adds. "And the UK government are running a competition which might have a quite significant impact in the medium term."

One explanation for respondents' lack of enthusiasm for SMRs is that modularisation technologies were also included on the

list: respondents seem to favour the technologies that make SMRs possible – rather than the SMRs themselves.

Modularisation technologies, respondents predict, will hit the market sooner than fully fledged SMRs. They also see these technologies as more likely to be adopted, and expect them to have a much larger impact on the sector.

This chimes with opinions from the sector. "There will be challenges for SMRs to deliver on all of their promise and be the radical change to the industry that people are hoping," says Daniel Grosvenor, Head of Energy, Advisory Corporate Finance at Deloitte UK. "However, the focus on modular and more efficient construction techniques and building the UK supply chain could make a real difference across the sector."

Indeed, many in the industry seem to believe that the potential for nuclear to work as a distributed power source – with SMRs installed individually to meet regional energy demand – is limited. One reason for this is safety and public opinion.

"Nuclear power stations have to have armed guards," says Mark Barrett, Professor of Energy and Environmental Systems Modelling at UCL. "The idea of having lots of little nuclear power stations dotted around the country seems a pretty large safety risk."

Even proponents of modular nuclear technology believe that distributed generation is much less likely to happen than the use of modular reactors to build large-scale nuclear facilities in phases, obtaining financing one project phase at a time, which will lead to more sustainable large-scale development projects.

How technology is transforming the nuclear power sector

Nuclear will continue to play an important role in the transition to a low carbon future – and a new generation of technologies is reshaping the sector.



Lloyd's Register's Technology Radar reveals uncertainty around the disruptive potential of SMRs, but modularisation technology could be the next big thing in power plant design



New ceramic fuels and silicon carbide reactors will dramatically extend the operational lifespan of nuclear facilities

Generation IV reactors could change the way we think about nuclear waste and how to store and dispose of it – above or below ground? 12% say waste is the biggest challenge for nuclear after cost



17% say deployment is the biggest challenge after cost



Research shows that nuclear is now one of the cheapest options for power generation when lifecycle costs are taken into account

Aside from cost, what do you think is the most important barrier to progress in introducing nuclear?

14% Regulations too stringent

13% Public opinion

12% Waste

The Nuclear Perspective

continues from page 41

FINDING 2

Materials science developments could reshape the sector

Developments in materials science stand to have a profound impact on the nuclear sector. Both reactors and reactor cores could look drastically different in the future thanks to new materials such as metallic fuel or silicon carbide, which will boost their strength, working life and resilience.

The Lloyd's Register Technology Radar – A Nuclear Perspective shows that advances in materials science represent a mid-term technology development that could be significant.

“Most fuel used today is uranium oxide – a ceramic fuel – and, while it is safe and effective, we’re finding that its performance tops out at around two years inside the reactor,” explains David Scott, Advisor to the Chairman at the Abu Dhabi Executive Affairs Authority and a director on the boards of several firms operating in the nuclear industry. *“You start having fuel degradation, which causes operational problems.*

This imposes a limit on how long you can operate without having to refuel, and how much energy you can load into the reactor at the beginning of the process. However, metallic or other alternative fuel designs could be available within the next decade for large land-based reactors, with major implications for operating cycles and safety.”

Experts believe that, in the longer term, materials science developments such as silicon carbide could have major implications for reactor design, thanks to its high heat resistance and strength.

FINDING 3

Nuclear waste disposal: two diverging options

Countries such as France, the UK and the US, which have the longest nuclear histories, first devised their strategies for dealing with nuclear waste in the 1950s – at the height of nuclear weapons testing – and have not significantly revised them since.

So there is plenty of room for improvement. Respondents to the Lloyd's Register Technology Radar say that nuclear waste disposal innovation, for example, would have a considerable impact and a good likelihood of implementation – but would have to appear in the longer term.

The expectation that these innovations will only emerge in the long term speaks to the scale of the challenge ahead. *“Countries today design waste disposal locations to meet the demands of the current waste stream, which is highly radioactive and will be for thousands of years,”* explains David Scott. *“That imposes a set of engineering requirements that are quite daunting and expensive, which is the reason why so many countries have failed to address the problem fully.”*

However, as Scott points out, designing waste facilities at the same time as plants may not be the best approach: time may bring with it new innovations that improve both safety and costs.

The next generation of nuclear reactor technology, otherwise known as ‘generation IV nuclear’, could also affect the future of waste disposal. Many of the latest reactor designs can

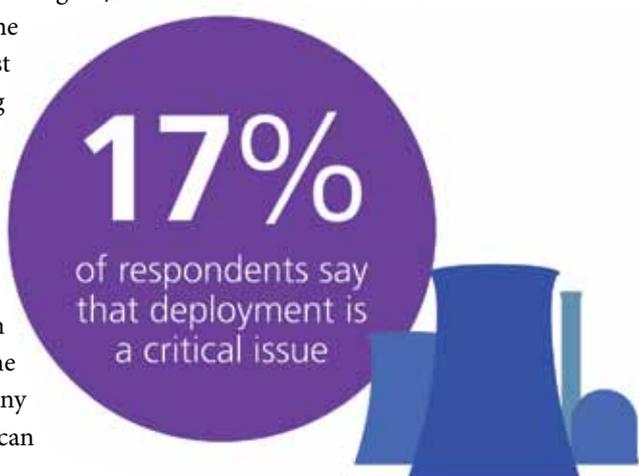
achieve ‘deep burn’ of nuclear fuel – leading to a smaller and much shorter-lived waste stream. The potential of these next-generation reactors has led some industry experts to advocate the adoption of dry-cask surface storage of nuclear waste. What is currently unusable and designated as waste may one day be usable as fuel – much better than, they argue, to store it in a location that is easier to access than traditional geological disposal solutions.

FINDING 4

Deployment is a key challenge

“The industry operates on boom-and-bust cycles: although extremely rare, nuclear accidents have happened and inevitably cause a drop in appetite for nuclear energy, and so construction halts around the world,” explains David Scott. *“It’s in the boom cycles where experience in deployment is gained, capabilities are improved and supply chains are matured. But in the bust cycle, all of that atrophies.”*

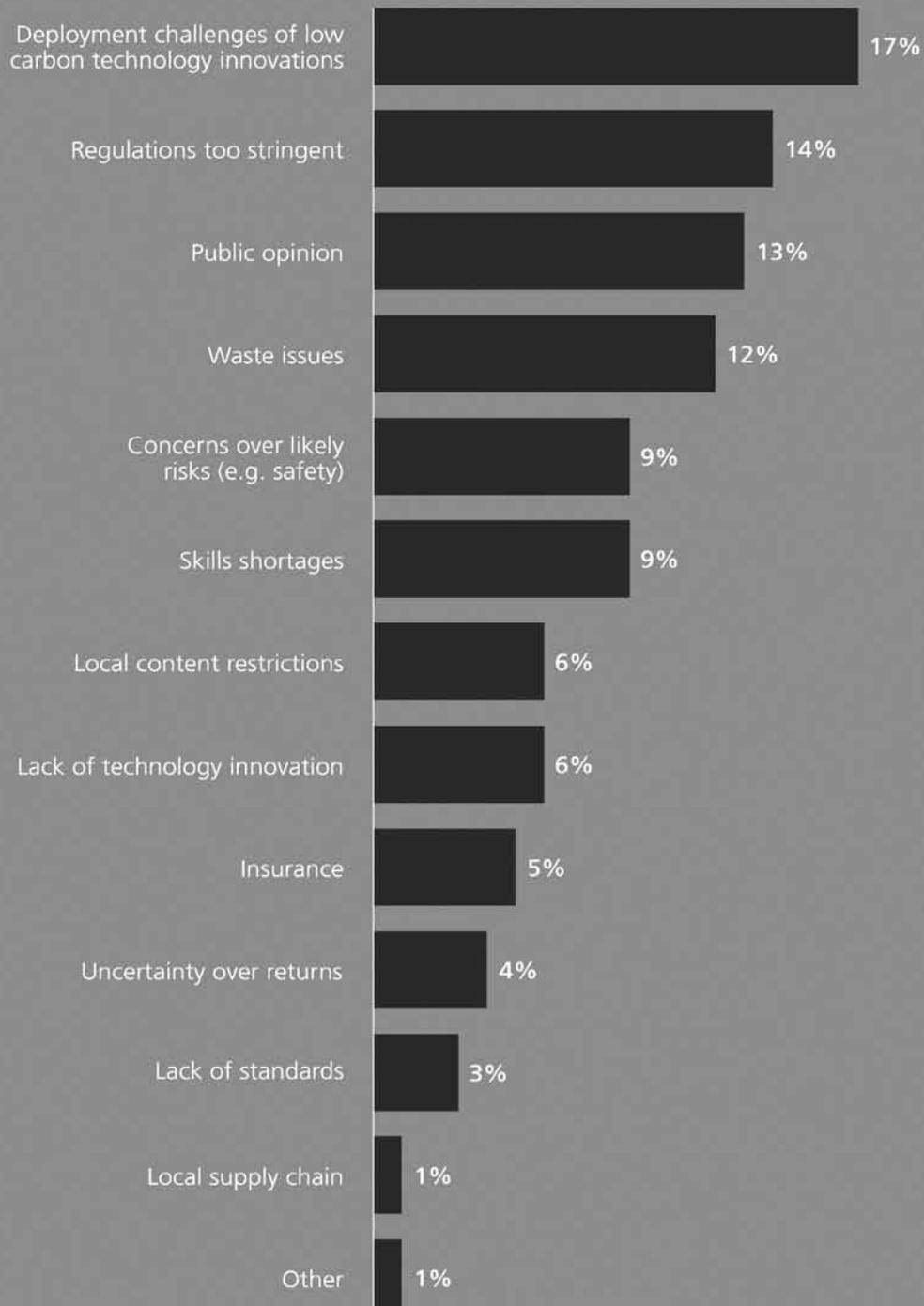
As a result, many green field nuclear projects have been significantly off schedule and over budget: EDF's Flamanville plant in northern France, for example, has seen its total costs increase by €7.2 billion from the original plans, and its completion is now delayed by at least six years.⁶



17%

of respondents say that deployment is a critical issue

In your opinion, aside from cost, what do you think is the most important barrier to progress in introducing nuclear?



The Nuclear Perspective

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However, deployment appears to be less of a challenge for Asian respondents, with only 7% highlighting it as a major barrier compared with 18% in Europe and 21% in North America. This could be as a result of the economies of scale that have been built up in key Asian markets in recent years. In China alone, for example, there are 20 nuclear power units currently under construction,⁷ providing a strong core of skills and expertise to tap into. In addition, the UAE has four nuclear plants being developed, which are running on time and to budget.⁸

This also highlights that deployment risk can be mitigated through better resilience in the supply chain, and that by building and maintaining deployment capability, project and budget overruns – which have been a challenge in Europe in particular – can be minimised.

FINDING 5

Public opinion is still a major challenge in some markets

Public opinion remains a major challenge for the nuclear sector:

It is cited in our survey as the third most common major barrier to progress after deployment challenges and too strict regulation.

In 1998, Germany began a programme to phase out its nuclear generation capacity. This plan was halted in 2009 but restarted in 2011 following the Fukushima disaster, and eight reactors were immediately shut down.

That decision continues to be in line with public opinion: a 2015 survey showed that more than four out of five people in Germany were still in favour of the decision to phase out nuclear power.⁹

Professor Clegg acknowledges this: *“The future of nuclear isn’t all about engineering and technology,”* he says. *“That’s a big part of it, but the licence to operate from society, public tolerance, understanding and confidence are as important as the economics or the technology itself.”*

According to our survey, public opinion is seen as more of an issue in North America (where 16% cite it as a major barrier) and Europe (17%) than in Asia Pacific (9%) or the Middle East (6%). In Asia, the waste issues are seen by respondents as a much more critical issue than public opinion – although waste disposal issues often feature in the negative press that nuclear receives in western markets.

Although in the low carbon context nuclear is sometimes discussed as a stop-gap solution until renewables’ intermittency issues can be solved, in fact, its potential as a low carbon power source is much greater than this. Given developments in efficiency and lifecycle and the fact that in many parts of the world, nuclear is now the cheapest power generation option, it should form a critical and permanent component of the low carbon agenda. **wn**

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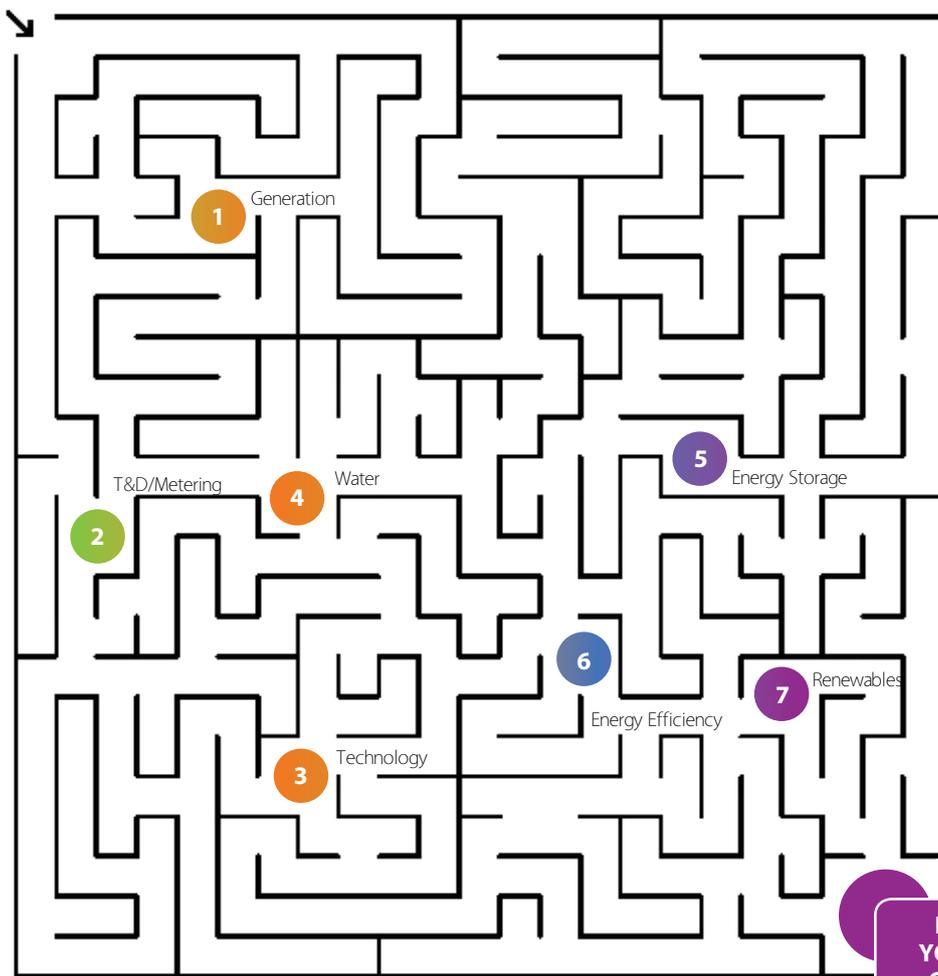
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Huge effort is being put into quantum computer research. This promises to be a leap into the future like present supercomputers being compared to Babbage's mechanical gearbox computer.

The expected performance of quantum computing could perform in seconds what would take thousands of years by present supercomputers. It has even been suggested that performance could be millions of times faster than this.



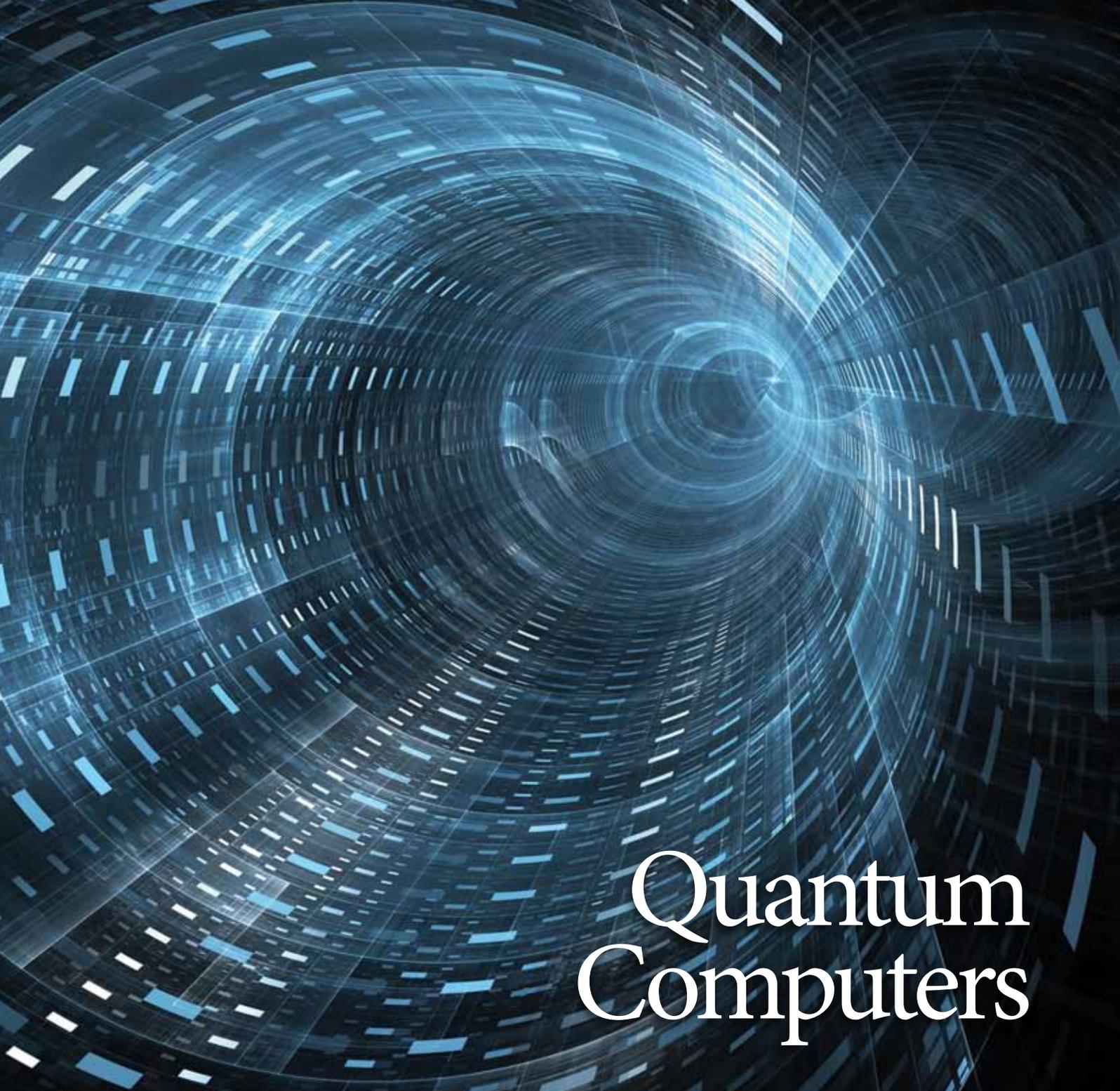
BY I D BASSON

The earliest computers date from ancient times in the form of the abacus, which remain in use in some eastern countries. These consisted of beads threaded on wires and mounted in a frame.

They were very useful in business for arithmetic calculations without needing to put pen to paper. All modern digital computers use a basic architecture of

binary digits. Binary digits have values of either 1 or 0, which can also be regarded as yes-no, on-off, true-false etc.

Some early computers used octal grouping of six bits per byte having a value range of 0 to 63. This was very restrictive and required using a very limited character set. All computers now use 8-bit hexadecimal bytes having a value range of 0 to 255.



Quantum Computers

Hexadecimal bytes are used in every aspect of data processing – data storage, program instructions, data transmission, images, colour specification – everything. Four bytes form a word of 32-bit memory.

Computer instructions may utilise a half-word for simple register instructions or up to two words for instructions requiring memory addresses. Floating

point numerical data may use two, four or more words. The table compares decimal, binary, octal and hexadecimal storage. The only difference between binary, octal and hexadecimal is in the grouping.

Binary arithmetic and logic is the simplest form of numbering and is easily explained and understood without the aid of abstruse mathematics – quantum computing is not.

I can remember an incident while attending an elementary lecture on octal arithmetic. A maintenance technician entered the room and noticed on the board the calculation $3 \times 4 = 14$. His look of dismay must have left him with little hope for the future of the computer programmers.

The earliest electronic computers used small ferrite cores for storing bits magnetically.

Quantum Computers

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DECIMAL	BINARY	OCTAL	HEXADECIMAL
0	0	000 0	0000 0
1	1	001 1	0001 1
2	10	010 2	0010 2
3	11	011 3	0011 3
4	100	100 4	0100 4
5	101	101 5	0101 5
6	110	110 6	0110 6
7	111	111 7	0111 7
8	1000	001 000 10	1000 8
9	1001	001 001 11	1001 9
10	1010	001 010 12	1010 A
11	1011	001 011 13	1011 B
12	1100	001 100 14	1100 C
13	1101	001 101 15	1101 D
14	1110	001 110 16	1110 E
15	1111	001 111 17	1111 F
16	10000	010 000 20	0001 0000 10
17	10001	010 001 21	0001 0001 11
18	10010	010 010 22	0001 0010 12
19	10011	010 011 23	0001 0011 13
20	10100	010 100 24	0001 0100 14

Table 1

This 'core storage' consisted of huge numbers of tiny ferrite beads threaded into a mesh of fine wires by nimble fingered ladies. Diagonal wires threaded through the mesh were used for reading the data. Ferrite storage was in use from 1955 to 1975. Since then, developments in volatile memory (DRAM, SRAM etc.) and non-volatile memory (PROM, EPROM etc.) have improved in speed and capacity by factors of millions.

The present world record for supercomputer processing speed is held by China – speeds given in petaFLOPS. (1 PFLOPS = 10¹⁵ floating point operations per second – 3 300 operations in the time taken by light to travel one millimetre.)

June 2016	Sunway TaihuLight	93
2013	Tianhe-2	33,86
2012	Cray Titan	17,59
2012	IBM Sequoia	17,17
2011	Fujitsu K	10,51

Currently the supercomputer (ALMA Correlator) at Chile's ALMA interferometer array requires 17 petaFLOPS. It is expected that the SKA interferometric array will require processing in the exaFLOPS (10¹⁸) range at its supercomputers in Cape Town and Perth.

One may well ask what applications will require the immense processing power of quantum computers.

An obvious target application is in encryption cracking where an exceptionally large number comprising hundreds of digits, which is the product of two exceptionally large prime numbers, must be factorised into primes. Conventional computers are unequal to this task. There are no fundamental obstructions to the development of quantum computing.

New possibilities will be opened up for mathematical model simulations for engineering design. There will also be the potential to create new materials and medicines, as well as solve long-standing scientific and financial problems. Another application could be in meteorological processing. Doubtless, when quantum processing becomes available, new applications will emerge.

With quantum computers, information will be stored and processed at subatomic level with speed and information density beyond human comprehension. The benefits of quantum computers will be great indeed.

Binary digits (bits) can have only two values, 0 and 1. Quantum binary digits (qubits) are of quaternary nature and have values of 0, 1, or a quantum superposition of these. A three bit binary number can have a single value of from 0 to 7, a sequence of three qubits can be in a quantum superposition of 8 states. As the sequence of qubits increases the numbers become astronomical. The great promise of quantum computing is the massively parallel processing of tasks millions of times faster than can be achieved by conventional computers. Another line of research in the quest for massively parallel computing is molecular computing which will utilize DNA molecules for processing and storage.



The organisation and complexity of all living beings is based on a coding system functioning with the four key components of the DNA molecule. Because of this, the DNA is well suited as a medium for data processing. A DNA molecule is not 'alive', it is only a specification for a life form. It has been estimated that a DNA-computer with one litre of fluid containing six grams of DNA could potentially have a memory capacity of 3072 exabytes. The theoretical maximum data transfer speed would also be enormous due to the massive parallel processing of the calculations - possibly 1000 petaFLOPS could be achieved. In some respects the DNA molecule is similar to a Turing machine except that it uses four base units instead of two.

On 3 March 2017 it was announced that researchers could store data in DNA strands with 100% accuracy. In a single gram of DNA, 215 petabytes were stored with perfect decoding and retrieval. According to the study, data stored in DNA strands can last for tens of thousands of years. DNA fountain coding was used allowing retrieved files to be pieced together even if small sections of data were lost. Retrieval is however not fast. It takes about 24 hours to decode 2 megabytes of data. It will also be necessary to greatly reduce the cost.

Scientists at the University of Sussex have invented a ground-breaking new method that puts the construction of large-scale quantum computers within reach of current technology.

Quantum computing on a small scale can be carried out using trapped ions and aligning individual laser beams onto individual ions with each ion forming a quantum bit. This would however be impracticable

for billions of quantum bits. Scientists at Sussex have invented a simple method where voltages are applied to a quantum computer microchip to the same effect.

Professor Winfried Hensinger commented: *"This development is a game changer for quantum computing making it accessible for industrial and government use. We will construct a large-scale quantum computer at Sussex making full use of this exciting new technology."*

Dr Seb Weidt, part of the Ion Quantum Technology Group said: *"Developing this step-changing new technology has been a great adventure and it is absolutely amazing observing it actually work in the laboratory."*

Some 75 years ago, Italian physicist Ettore Majorana hypothesized the existence of exotic particles that are their own antiparticles. These have come to be known as majorana fermions. These are difficult to obtain as they have to occur in pairs which will reunite as an electron. Majoranas could potentially be used as information units for a quantum computer.

An experiment by physicists at the Swiss Nanoscience Institute and the University of Basel's Department of Physics has confirmed their theory that majorana fermions can be generated and measured on a superconductor at the end of wires made from single iron atoms.

An atomic force microscopy image has been made at the end of a mono-atomic iron wire showing clearly the individual iron atoms with the majorana fermions at the end.

The atoms are evaporated onto a

superconductor where they form single atom wires of up to an astonishing 70 nanometres in length.

Despite the distance between them, the two majoranas on the ends of the wires are still connected. Together, they form a new state extended across the whole wire that can either be occupied ("1") or not occupied ("0") by an electron. This binary property can then serve as the basis for a quantum bit (qubit) and means that majoranas, which are also very robust against a number of environmental influences, are promising candidates for creating a future quantum computer.

In 2012 scientists at the Kavli Institute of Nanoscience at the Delft University of Technology and the Foundation for Fundamental Research on Matter succeeded for the first time in detecting a majorana particle. The device used was made of an indium antimonide nanowire, covered with a gold contact and partially covered with a superconducting niobium contact. Two majorana fermions are formed at the end of the nanowire. Electrons enter the wire from the gold contact and meet the majorana fermion on the way. If the electron has the wrong energy it is reflected back into the contact. If it has the right energy it can go through the majorana fermion via a special interaction.

It has been suggested that majoranas could well constitute the mysterious 'dark matter' of the universe.

The University of Cambridge is leading a project to build energy efficient, high performance Supercomputers called Superspin. This will attempt to marry research into electron spin with research

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Paul Adrien Maurice Dirac (1902-1984)

on superconductive materials. The goal is to produce prototype logic and memory devices by 2021 for use in a generation of super computers that are capable of crunching vast amounts of data at a fraction of the energy cost of today's super computers.

Theoretical work on quantum computers will rely heavily on the quantum mechanics developed by Paul Dirac.

Paul Adrien Maurice Dirac (1902-1984) was born to Charles Adrien Ladislas Dirac and Florence Hannah née Holten. His Swiss father was a French teacher who worked in Bristol.

Dirac completed his degree in Electrical Engineering at the University of Bristol in 1921 which was followed by a BA in mathematics.

He began his studies at Cambridge in 1923 where he wanted to undertake research into general relativity. At the time a new theory was required as classical physics could not explain the behaviour of atoms and electrons. Dirac was given a proof of a paper by Heisenberg to read in the summer of 1925. The significance of the algebraic properties of Heisenberg's commutators struck Dirac when he was out for a walk in the country. He realised that Heisenberg's uncertainty principle was a statement of the non-commutativity of the quantum mechanical observables. He realised the analogy with Poisson brackets in Hamiltonian mechanics. This similarity provided the clue which led him to formulate for the first time a mathematically consistent general theory of quantum mechanics in correspondence with Hamiltonian mechanics. Sir William Rowan Hamilton (1805-1865) developed his Hamiltonian function in 1835 which would become indispensable in quantum mechanics a century later. Hamilton is said to have shown immense talent at



a very early age. Astronomer Bishop Dr John Brinkley remarked of the 18 year old Hamilton, *‘This young man, I do not say will be, but is, the first mathematician of his age.’*

Dirac’s widely acclaimed theory included the wave mechanics of Schrödinger and the matrix mechanics of Heisenberg. Dirac’s work was held in very high regard by Heisenberg.

Dirac was awarded a Ph.D. in 1926 for his doctoral thesis Quantum Mechanics after which he went to Copenhagen to work with Niels Bohr. Accepting an invitation from Ehrenfest, he spent a few weeks in Leiden on his way back to Cambridge. He also made several visits to the Soviet Union. He laid the foundations for Quantum Electrodynamics ‘QED’. In 1928 he found a connection between relativity and quantum mechanics - his famous spin- $\frac{1}{2}$ Dirac equation which could explain the mysterious magnetic and ‘spin’ properties of the electron.

Electron spin and entanglement could well be of major significance in the functioning of quantum computers. In quantum mechanics, spin is an intrinsic form of angular momentum carried by elementary and composite particles. This complex matter is unlike the idea of a spinning top and will not be dealt with here. Spin is an essential part of Dirac’s relativistic quantum mechanics derived in 1928.

In 1929 Dirac made his first visit to the United States, lecturing at the Universities of Wisconsin and Michigan. After the visit, along with Heisenberg, he crossed the Pacific, lectured in Japan and returned home via the Trans-Siberian Railway. Dirac

was not known for his social graces. While on board ship, Heisenberg urged him to take part in the social activities, saying that there were plenty of nice girls to dance with. Responding with mathematical logic, Dirac replied: *“How can you know beforehand that the girls are nice?”* Dirac was known to feel extremely uncomfortable in social small-talk situations.

Dirac used his famous equation to predict the existence of the antiparticle to the electron, the ‘positron’. All fermions are now known to have antiparticles. Dirac was appointed as a Fellow of the Royal Society in 1930.

In 1930 Dirac published his classic book *‘The Principles of Quantum Mechanics’* and for this work he was awarded, jointly with Schrödinger, the Nobel Prize for Physics in 1933. He at first thought to turn down the prize due to his dislike of publicity, but when it was pointed out to him by Lord Rutherford that he would receive far more publicity if he declined this great honour and large sum of prize money, he decided to accept it.

Dirac was regarded by his friends and colleagues as unusual in character. Albert Einstein said of him: *“This balancing on the dizzying path between genius and madness is awful”*.

Dirac was appointed Lucasian Professor of Mathematics at the University of Cambridge in 1932, a post that he held for 37 years. In 1933 he published a pioneering paper on Lagrangian quantum mechanics.

Dirac married Margit Wigner (Eugene Wigner’s sister), in 1937.

A memorial meeting was held at the University of Cambridge on 19 April 1985, of which P. Achuthan, reviewing the papers presented wrote:

“... we vividly see everywhere the brilliant imprints of Dirac, unifier of quantum mechanics and relativity theory. Each of the pieces is not only in praise of an exceptionally gifted intellect but also places on record how deeply and abidingly the human mind can delve into the realms of mathematical insight and modelling, keeping intact the spirit of beauty and clarity of a creative genius. Only a few Nobel laureates ever can compare as well with this giant of mathematical sciences in whose demise the world of original thinking certainly has lost one of the most precious souls, retaining fortunately still the glory for others to sing and emulate for a long time to come.”

In November 1995, a plaque commemorating Paul Dirac was unveiled in Westminster Abbey. The memorial address was presented by Professor Stephen Hawking who succeeded Dirac as the incumbent of the Lucasian Chair of Mathematics at Cambridge.

Professor Hawking summed up with: *“Dirac has done more than anyone this century, with the exception of Einstein, to advance physics and change our picture of the universe.”*

Mathematical scientist Dirac who introduced the bra-ket notation must not be confused with artist Dirac who produced a bra-less sketch of Kate Winslet for use in the movie ‘Titanic’.

A major motivation for the development of quantum computers is in the establishment of uncrackable encryption of secret

Quantum Computers

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The bra-ket notation introduced by Dirac in 1939 has come into widespread use and is used to explain almost any phenomenon in quantum mechanics.

The notation consists of a left part: bra $\langle |$
And a right part: ket $| \rangle$

The expression $\langle \phi | \psi \rangle$ is typically interpreted as the probability amplitude for the state ψ to collapse into the state ϕ . Used with two vectors, this implies the inner product of the vectors.

The nabla ∇ introduced by Hamilton, and named by Maxwell due to its resemblance to a harp, has come into widespread use. Quaternions, discovered by Hamilton, were indispensable to Maxwell's electromagnetic theory and also came into widespread use.

The nabla, when taken as a dot product with itself gives the Laplacian, using Cartesian coordinates:

$$\nabla \cdot \nabla \psi = \frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2}$$

The time-dependant Schrödinger equation for a single non-relativistic particle:

$$i\hbar \frac{\partial}{\partial t} \Psi(r, t) = \left[\frac{-\hbar^2}{2\mu} \nabla^2 + V(r, t) \right] \Psi(r, t)$$

becomes: $\hat{H} | \psi(t) \rangle = i\hbar \frac{\partial}{\partial t} | \psi(t) \rangle$

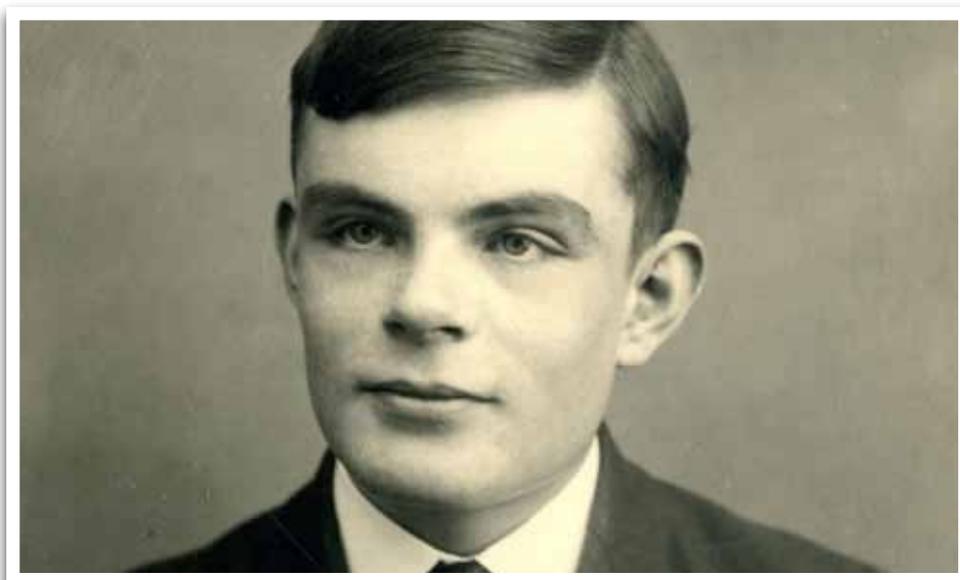
when expressed in bra-ket and Hamiltonian notation.

military and civilian messages. This was also the primary motivation for the development of electronic computers at the time of WW2.

Computer pioneer Alan Mathison Turing (1912-1954) made a bridge between the logical and physical worlds, thought and action, which crossed conventional boundaries. Turing built on the work of mathematician Gödel proposing a hypothetical Turing machine which was in fact a computer program at a time when computers did not yet exist. The universal Turing machine describes a computer which could be programmed to perform an unlimited variety of functions and even function like a brain. Turing's contribution to the development of computer science is immense. Turing is widely considered to be the originator of theoretical computer science and artificial intelligence.

Turing showed signs of genius from a very early age. After initial schooling, Turing, aged 13 went on to Sherborne School in Dorset. Determined not to be delayed by the 1926 general strike, Turing cycled 96 km to Sherborne stopping overnight at an inn on the way.

The choice of school was not ideal as the school emphasized a classical education with less focus on science and maths. This school, dubbed Brookfield, received much prominence on the silver screen in the 1969 movie 'Goodbye Mr Chips' with Peter O'Toole and Petula Clark. The writer of this article, fascinated by the movie, went to visit Sherborne School as well as the Greek temple ruins at Paestum in southern Italy. After Sherborne, Turing studied at King's College, Cambridge, where he gained first-class honours in Mathematics, and in 1935 now aged 22, was elected a Fellow of King's.



Computer pioneer Alan Mathison Turing (1912-1954)

In 1928 mathematician David Hilbert posed three mathematical challenges which had their origins as far back as Leibniz. Gödel managed to disprove the first two in 1934 but the third, the Entscheidungsproblem (Decision problem) remained. Turing managed to disprove this in terms of his Turing Machine and Halting Problem, a prestigious mathematical achievement. Turing's Halting Problem stated that it is impossible for a Turing Machine to know algorithmically within itself if the program will eventually halt or run indefinitely. Another program analysing the program can decide it if will eventually halt. Einstein had a similar idea when he stated: *"The problems that exist in the world today cannot be solved by the level of thinking that created them"*.

A major boost to the development of computer science came with WW2 when the decipherment of encrypted enemy messages became of paramount importance. Initial work was done in co-operation with Polish cryptographers who

had done much work with the Enigma machines but this came to an end with the invasion of Poland. Turing worked for the Government Code and Cypher School at Bletchley Park, Britain's codebreaking centre. He devised techniques for speeding the breaking of German ciphers including improvements to the pre-war Polish 'bombe' method, an electromechanical machine that could find settings for the Enigma machines. Turing played a pivotal role in cracking intercepted code messages that enabled the Allies to defeat the Nazis in many crucial engagements, including the Battle of the Atlantic.

By late 1941, Turing and his fellow cryptanalysts were frustrated. Building on the work of the Poles, they had set up a good system for decrypting Enigma signals but they had too few people and 'bombes' to handle all the signals. They had considerable success in reducing shipping losses but needed more resources urgently. Breaking all the rules, they wrote directly to Prime Minister Churchill emphasizing

their requirements and the service that they could provide. Churchill wrote a memo to General Ismay which read: *"ACTION THIS DAY. Make sure they have all they want on extreme priority and report to me that this has been done"*. The cryptographers noticed almost from that time their problems started disappearing and more than two hundred 'bombes' were in operation by the end of the war.

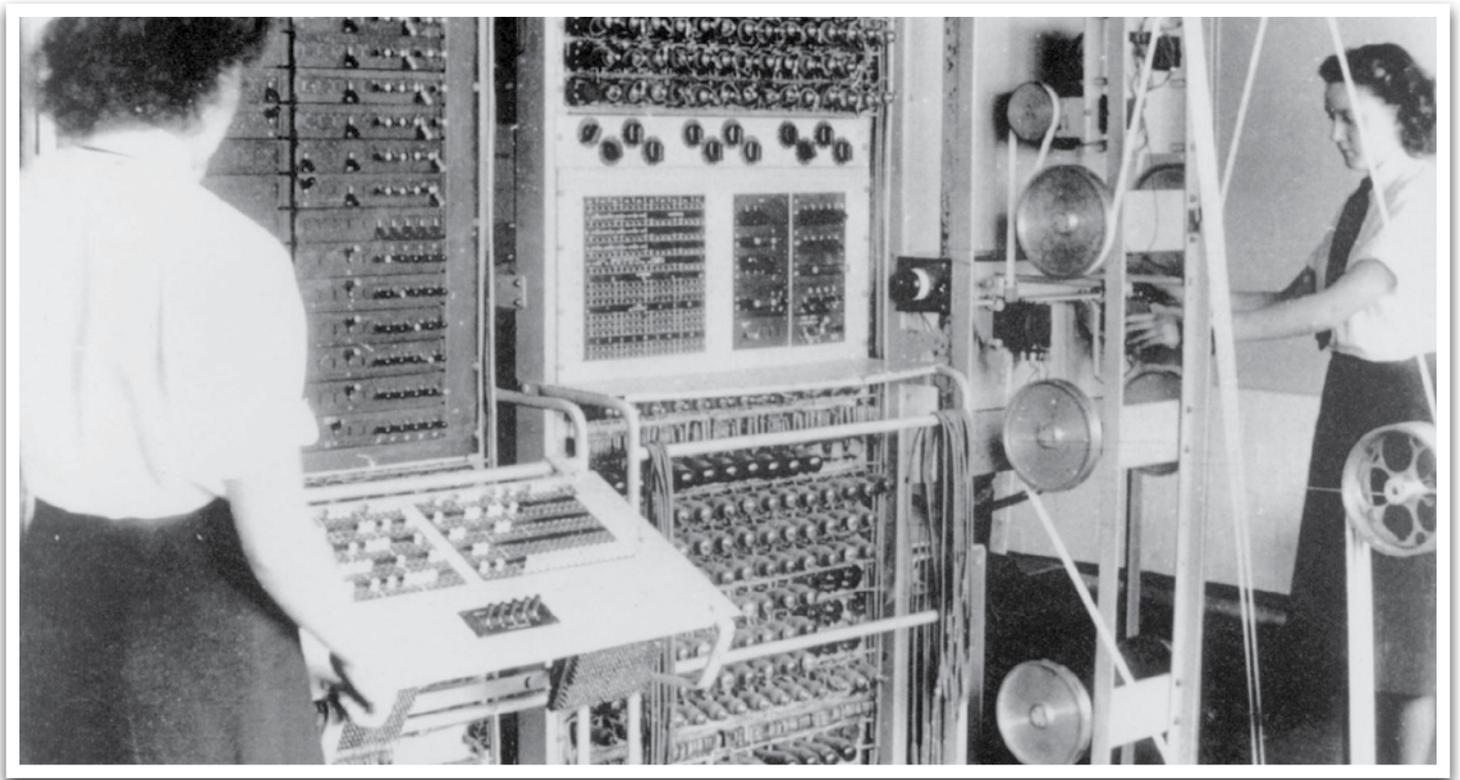
The 20-year old Jane Fawcett deciphered a message in May 1941 which revealed the location of the Nazi battleship Bismarck while it was being hunted in the Atlantic. An earlier intercepted message revealed that the Bismarck had put to sea. The ship was later spotted by a Catalina reconnaissance aircraft. HMS carrier Ark Royal sent several Swordfish biplanes armed with torpedoes to attack. One torpedo managed to damage one of the ship's rudders making it impossible to maintain a straight course. None of the aircraft were lost in the attack. The Bismarck's 2200 man crew were left with the realisation that their ship would be sunk by overwhelming forces the next day.

Thousands of shells were fired at the Bismarck but none were able to penetrate the water level armour. The ship was reduced to a burning wreck from bow to stern. The HMS Dorsetshire was sent to deliver the coup de grace by launching torpedoes at close range, but it was claimed that the ship was scuttled by the crew.

The Colossus was a set of computers developed by British codebreakers in 1943-1945 to help in the cryptanalysis of the Lorenz cipher. This was the world's first programmable electronic digital computer. This machine used thermionic valves to perform Boolean and counting operations.

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The Colossus

The machine was programmed by switches and plugs and not by a stored program.

It has been estimated that Turing's cryptanalytic work shortened the war in Europe by more than two years and saved over fourteen million lives.

What honours could be bestowed on Turing for his phenomenal achievements? He did not have a military rank but there are many civilian honours that would have been applicable – surely at least a knighthood.

Turing's life took a tragic turn for the worse. In 1952 he was charged and found guilty of what was euphemistically called 'gross indecency'. By modern standards this seems absurd and cruel. In order to avoid a prison sentence he agreed to take a course of hormone treatment which resulted in

impotence and gynaecomastia. He was also declared to be unfit to have military security clearance.

On 8 June 1954 Turing was found dead with a partly eaten apple beside his bed. He was found to have died from cyanide poisoning. No forensic testing was done on the apple.

An inquest determined that he had committed suicide but this verdict has remained in doubt.

He was in good spirits at the time and was known to use cyanide for gold electroplating. He could have easily ingested the cyanide accidentally. His biographers have suggested that he might have been re-enacting the poisoned apple scene from the 1937 Disney movie 'Snow White

and the Seven Dwarfs' which he enjoyed. Many of the cute modern children's fairy tales, which are also used for pantomimes, come from the compilation of the Grimm brothers, but the originals are grisly horror stories from ancient Norse mythology with mystical and religious connotations.

There is no connection between Turing's apple and the logo of Apple Computers. The bite in the computer logo apple was provided to make sure that people would not see it as a cherry.

In 2009, following an Internet campaign, British Prime Minister Gordon Brown made an official public apology on behalf of the British Government for "the appalling way in which Turing was treated." Queen Elizabeth II granted him a posthumous pardon in 2013. **wn**

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Comments on the 2016 IRP draft document

Generation planning essentially consists of two phases:

- Forecasting the power demand for the period
- Planning the generation mix to meet the forecast demand.

These two points are illustrated in this article.

The demand and generation information is extracted from Eskom's 2015/16 integrated report.

BY | M CARY | FSAIEE | PR ENG | SAIEE PAST PRESIDENT

ANALYSIS OF DEMAND

From Table 1, the peak demand assumption for 2020 is 44 916 MW, and the compound growth from 2020 to 2050 is 2,18%. As the 2016 demand was 34 481 MW, the 2020 demand should be 37 608 MW – not 44 916 MW. Applying 2.18% to 37 608 MW, results in a forecast demand of 71 822 MW in 2050 – 14 000 MW less than that reflected in the Table 1.

Note that a growth rate of 2,18% equates to a GDP growth of 3,5%.

2.18% is a reasonable assumed compound growth. The growth for the 20 year period leading up to 2008 was 2.3%. In recent times, the demand on Eskom has decreased, some of

the reasons being the introduction of renewable energy, decrease in economic activity and the application of energy efficiency measures.

ANALYSIS OF NEW BUILD OPTIONS

Existing generation consists of a nominal 42 810 MW. Added to this would be a further 11 machines from Medupi and Kusile – 7 920 MW, and 1 200 MW from Ingula – a total of nominal capacity of 9 120 MW.

In the thirty year period to 2050, at least four power stations are likely to de-commissioned – Komati, Camden, Grootvlei and Hendrina – a nominal 5 200 MW (installed capacity 5 800 MW).

The net current capacity, after Medupi and Kusile are completed, is therefore $42180 + 9120 - 5200 = 46100$ MW.

The total proposed new build options in Table 1 is 112 427 MW, (excluding demand response and Inga for the purpose of this comment.)

The total capacity would then be $112 427 + 46 100 = 158 527$ MW.

To be conservative, one can assume that all existing stations, excluding Medupi, Kusile and Ingula (new stations), will be decommissioned. The conservative installed capacity would then be the proposed new-build in the IRP 2016 plus new stations = $112 427 + 9 840 = 122 267$ MW.

Base Case 8.2% Discount rate

	New Build Options									CO2 Emissions	Peak Demand (MW)	Firm Reserve Margins (%)
	PV	Wind	Landfills	DR	Nuclear	OCGT	CCGT	Coal PF w FGD	Inga			
2016												
2017												
2018												
2019												
2020										253	44916	24
2021	160									264	46130	28
2022	160									268	47336	23
2023	370	200								272	48547	20
2024	440	500		1000		396				279	49656	18
2025	650	1000	15	1000		2376	732			278	51015	19
2026	580	1000	5	1000		264	1464			278	52307	19
2027	580	1000	230	1000		264	2196			276	53561	19
2028	580	1000		500		396	1464	1500		277	54567	20
2029	580	1100		1000			1464	1500		273	56009	18
2030	580	1200		1000		1716		2250	1000	274	57274	20
2031	580	1200		1000		1584		750		274	58630	20
2032	580	1000		500			732	1500	1000	278	59878	22
2033	580	1200					1464	750	500	276	61388	23
2034	580	1600		1000		1452				278	62799	22
2035	580	1600		500			1464	1500		278	64169	23
2036	580	1600		1000				1500		278	65419	21
2037	580	1400		500	1359		732	2250		277	66993	22
2038	580	1600				1848	1464	750		273	68375	22
2039	650	1500			1359		2928			267	69584	22
2040	650	1600		1000		1056	732			261	70777	20
2041	650	1600		1000	4077	792		750		236	72343	21
2042	650	1600		500			2196			233	73800	21
2043	650	1600		500						232	75245	21
2044	650	1800		500	1359					228	76565	21
2045	770	1600			2718		2196			230	78263	23
2046	790	1600		500	1359	924				225	79716	20
2047	720	1800		1000	1359		732			219	81177	19
2048	720	1600		500	2718	264				211	82509	20
2049	660	1500		500	1359					206	84213	20
2050	720	1400		500	2718					196	85804	20
Total (MW)	17600	37400	250	500	20385	13332	21960	15000	2500			

Table 1

REQUIRED NEW BUILD

To run a reliable power supply, a reserve capacity is required. The reserve capacity caters for unplanned outages, and also contributes towards the stability of the system. Reserve capacity used by various utilities varies between 10 and 15% globally. To be conservative, assume a reserve capacity of 15%. The installed capacity would then have to be:
 $71\,822 / 0.85 = 85\,000\text{ MW}$.

The additional required new build would then be:

$$85\,000\text{ MW} - 9\,840\text{ MW} = 75\,160\text{ MW}$$

The conservative new build programme proposes a total installed nominal Capacity of 122 267 MW – that is 47 107 MW more than the 75 160 MW that is required!! Is this planned for “cover” for the renewable energy when the wind does not blow and the sun does not shine?

NEW BUILD GENERATION MIX

This model is a practical proposal by the author and is intended to address the new build requirements in the above analysis. New generation should be as close to load centres as possible to minimise the capital cost and line losses of the transmission lines, required to feed the power onto the grid. Also, as mentioned above, a number of existing power stations will be decommissioned during the planning

2016 IRP Draft

continues from page 57

period, and new capacity may be located on, or next to, existing sites to reduce the cost of infrastructure.

CHARACTERISTICS OF THE GENERATION MIX

- Nuclear - needs to be built on the coast as sea water is required for cooling (especially in dry countries such as South Africa). Initial capital cost is high, but a number of authorities claim that the life-time costs are at least equal to, or less than that of coal-fuelled stations.
- Coal - there is still a healthy reserve of coal in South Africa. There is a coal field in the Waterberg north-west of the country, which currently feeds Matimba and Medupi. 90% of this field is in Botswana, but it is said to have substantial reserves. Clean coal technologies are improving all the time leading to fewer greenhouse gasses. In addition, South African coal is still relatively cheap.
- OCGT and CCGT - Open-cycle gas turbines can run on diesel. Closed cycle gas turbines run on gas, and are more efficient than their OCGT counterparts. As there is currently no known supply of gas in the country, we have to rely on imports. There are large reserves of natural gas in Moçambique, and it would therefore make sense to build gas power stations in the east.
- Wind power - if one refers to the wind map of the country, it can be seen that there is wind available on the west coast and Northern Cape, Western Cape and Eastern Cape. Turbines can vary from 1 MW to 5 MW and have to be sized to the strength of wind in the area. There are turbines up to 10 MW but these are

mainly used in off-shore installations.

- Solar power - the solar map indicates that the most solar power is available in the Northern Cape. Solar panels are however, effective throughout the country. Concentrated Solar Power has the advantage of having its own storage.
- Storage - as the availability of wind or solar power is dependent on the weather, it is essential to have power that is available, virtually on demand. Gas turbines are useful for this purpose. Pumped storage is another storage medium – during peak times water from an upper dam is run down to a lower dam through a hydro turbine generating power. In off-peak times, the water is pumped back to the upper dam using the turbines.

LOAD CENTRES

There are areas in the country where the power demand is concentrated. The below areas are estimated load centres, in decreasing order of size:

- Gauteng
- Western Cape
- Ethekwini and Richards Bay/ Empangeni
- Mpumalanga
- Eastern and Southern Cape
- Free State and Northern Cape
- Rural towns.
- Transmission line losses

GENERATION MIX IN LOAD CENTRES

Although the specific power stations are proposed to be built in or near the load centres, they will all be connected to the grid and thus will be available to the whole system.

Table 2 illustrates how the forecasted demand can be served by the various new build options that are available. **w|n**



NEW BUILD OPTIONS TO SERVICE DEMAND

POWER SOURCE	DESCRIPTION	CAPACITY	TOTAL CAPACITY	SUBTOTAL	LOAD CENTRE
		MW	MW	MW	
Nuclear	Koeberg	3 x 1200	3600		Western Cape
	Tuispunt	5 x 1200	6000		Eastern Cape
	KZN East coast	5 x 1200	6000	15600	Durban, RB
Coal	Matimba Power Station	6 x 800	4800		Gauteng
	Near Medupi	6 x 800	4800	9600	
	Gauteng				
Gas	Komatipoort	8 x 500	4000		Mpumalanga
	Middleberg	8 x 500	4000		Mpumalanga
	Majuba Power Station	8 x 500	4000		Mpumalanga
	Secunda	16 x 500	8000	20000	Mpumalanga
Wind	Northern, Western,				Free State
	Southern, and Eastern				Rural towns
	Cape, West coast		10000	10000	Transmission line losses
Solar	Northern Cape				Free State
	West Coast		10000	10000	Rural towns
Pumped Storage	KwaZulu Natal North	4 x 350	1400		Storage
	Northern KwaZulu Natal	4 x 350	1400	2800	Storage
Present new build	Medupi, Kusile	12 x 800	9600		
	Ingula	4 x 333	1333	10933	
Total rated capacity			83733	83733	
Nominal capacity	Based on power available		79546	79546	
Demand side management	LED's Energy Efficiency		5454	5454	
	Embedded generation				
Planned generation as calculated			85000	85000	

Table 2

calendar

MARCH | APRIL | MAY 2017

MARCH 2017

2	Application of LV Frequency Control to Industrial Drives	Johannesburg	roberto@saiee.org.za
7-8	Electrical Trade Expo	Cape Town	www.voltex.co.za
7-10	Managing Projects Effectively	Johannesburg	roberto@saiee.org.za
13-17	Smart Meters For Smart Grid Training	Johannesburg	roberto@saiee.org.za
14-15	Fundamentals Of Practical Lighting Design	Johannesburg	roberto@saiee.org.za
15	Power Transformer Unit Protection And Testing	Johannesburg	roberto@saiee.org.za
16	Power Transformer Operating And Maintenance	Johannesburg	roberto@saiee.org.za
22-23	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za
23-24	HV Testing And Measurements	Johannesburg	roberto@saiee.org.za
28-30	Substation Design And Equipment Selection	Johannesburg	roberto@saiee.org.za
28-29	Power & Electricity World Africa	Johannesburg	www.terrapiinn.com
29	Fluke Presentation Breakfast	Johannesburg	www.saiee.org.za
30	SAIEE Annual General Meeting	Johannesburg	www.saiee.org.za

APRIL 2017

3	Smart Meters for Smart Grid Training	Johannesburg	roberto@saiee.org.za
4	Fundamentals of developing Renewable Energy Plants	Johannesburg	roberto@saiee.org.za
11	Fundamentals of Power Distribution	Johannesburg	roberto@saiee.org.za
19	Leadership & Management Principles & Practice	Johannesburg	roberto@saiee.org.za

MAY

3	Core Financial Management Skills for Engineers	Johannesburg	roberto@saiee.org.za
9	SAIEE Charity Golf Day	Glenvista Golf Course, JHB	geyerg@saiee.org.za
10	Effective Document Writing for Engineers	Johannesburg	roberto@saiee.org.za
16	Planning Strategic Feasibility Studies	Johannesburg	roberto@saiee.org.za
16-18	African Utility Week	Cape Town	www.african-utility-week.com
17	Design of Economical Earthing Systems	Johannesburg	roberto@saiee.org.za
24	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za

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10:00-16:00

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WATT? is an opportunity for people on the ground to engage with each other and related professionals in an informative and friendly manner. This is a platform for you to discuss anything related to your particular sector, to highlight anything new, or to ask a specific question related to a technical topic or to engage in general industry issues. . Please note that we will not be considering anything related to the domestic sector, such as residential wiring.

We hope that this section of the magazine not only becomes a regular feature, but that it is widely read and distributed among your peers. Remember, it can only become a success with the full participation of our readers! Send your burning questions to minx@saiee.org.za - subject 'WATT?'.
- Ed

We look forward to hearing from you.

- Ed

The rapid pace of technological change and product development is a global trend that affects entire economies. We may have access to more information than ever before, but is this information readily understandable? Does it give us insight into the fundamental issues? Is it precise and based on technical clarity?

QUESTION ONE

What are the fundamental differences between a standard motor and a vibrator motor?

ANSWER ONE

Standard motors are used where an external load is required to be driven. Examples would be driving fans, pumps, crushers, conveyors and other such industrial equipment.

Vibrator motors, on the other hand, are used specifically, where a vibration must be generated to perform a specific task. For example, in screening vibrating energy is required to stratify material and achieve effective screening. Vibration may also be used for feeding material from one point to another, and a vibrator motor may be selected to achieve this purpose.

It is specifically important to note that in standard motors, vibration should be kept to a minimum as the energy needs to be transferred efficiently into the external load. Conversely in vibrator motors, vibration is created in order to achieve the desired action.

Because standard and vibrator motors are used in different applications; it is imperative that the customer's application needs are fully understood.

QUESTION TWO

What factors should be taken into account when selecting a vibrator motor?

ANSWER TWO

A standard motor's power rating (kW) is equivalent to the full mechanical load that is required for continuous duty for the duration of the application. For vibrator motors, the centrifugal weights, which drive the load, are integral to the motor. Therefore, the maximum power rating (kW) is only required for start up of the motion of the centrifugal weights. Once at maximum rotational speed, the power required to drive the centrifugal load for the remaining duration of the application will be significantly reduced.

In contrast to a standard motor, when buying a vibrator motor the kW rating is not the key consideration in the procurement decision. The major consideration when specifying a vibrator motor is the output force. The same kW rated motor can provide a range of output forces. For example, a 0,5 kW 4 pole motor can be supplied with centrifugal weights that provide output forces of 750 kg.f, 1 100 kg.f or 1 400 kg.f.

The selection of the desired output force is vital to the application. Should the selected force be greater than the design specification, high stress concentrations may result that could lead to structural fatigue of the equipment. Alternatively too little force generated would result in under performance of the equipment.

Consider an empty linear vibrating feeder weighing 500 kg, inclusive of the mass of the two vibrator motors. The use of two contra-

W A T T ?

rotating 0,5 kW 4 pole vibrating motors, with a centrifugal force of 1 400 kg.f each, is likely to overstress the feeder's construction, and could result in early catastrophic failure.

Counter to this, the use of two vibrator motors with a centrifugal force of 750 kg.f will result in under performance of the feeder. The optimal motors to select in this instance would have a 1 100 kg.f output providing the best compromise between performance and equipment life.

QUESTION THREE

Are vibrator motors constructed differently to standard motors, and if so, what are some of the differences?

ANSWER THREE

As vibrator motors themselves are subject to stresses generated by centrifugal weights, the design considerations for a vibrator motor are far greater than that for a standard motor.

For the same kW output, a vibrator motor requires a greater design construction, resulting in the mass of the motor being greater. To illustrate this, a 0,5 kW 4 pole standard motor weighs 13,9 kg and a 0,5kW W 4 pole vibrating motor with centrifugal force of 1 400 kg.f weighs 38 kg.

A further differentiating feature between the two motor types is the thickness of the shafts. The diameter of the shaft of a standard 0,5 kW 4 pole motor measures 19 mm. In

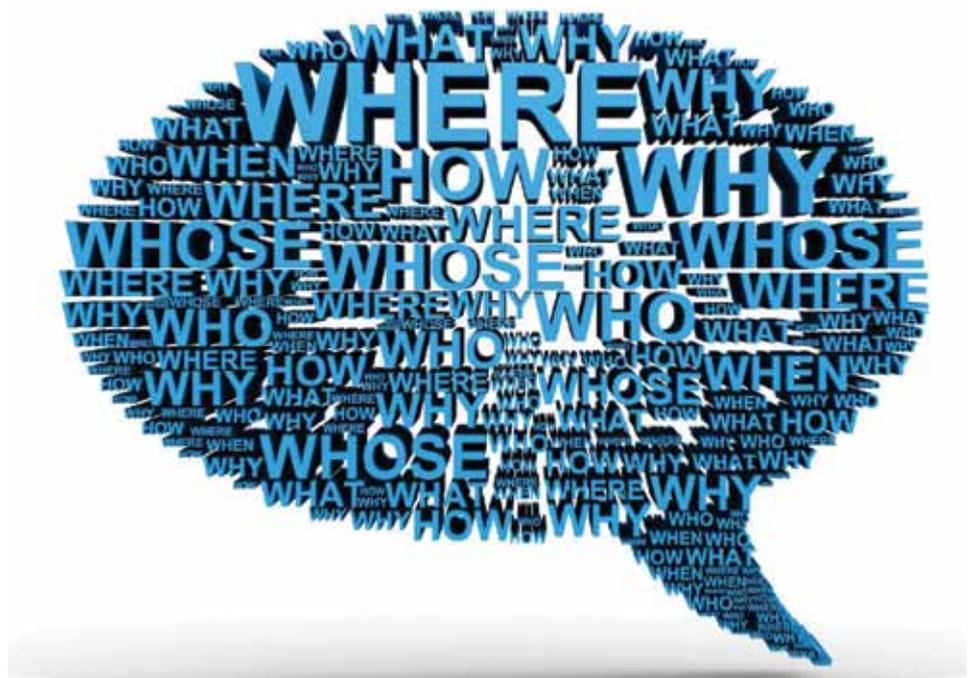
contrast, the diameter of the shaft of a 0,5 kW 4 pole vibrator motor is 32 mm. The reason for this is that the greater diameter provides for the maximum possible stiffness required to minimise the bearing race angular edge loading resulting from the centrifugal load.

In addition, standard motors are typically fitted with 6204 ball bearings, which have a radial load rating of 13,5 kN, whilst vibrator motors are fitted with NJ2306 cylindrical roller bearings which can withstand a radial load of 83 kN (figures quoted will differ depending on the manufacturer). This, again, caters for the centrifugal load.

Standard motors are designed to withstand

stresses related to the maximum torque requirement for the rated output kW of the motor. The vibrating motor is a totally enclosed unit, with all internal components subject to the full vibrating force produced. Consequently, vibrating motor frames are designed for infinite life, whilst windings, shafts and bearings are designed to cater for the stresses that are generated by the centrifugal force. The additional design specification of a vibrator motor is essential for effective performance and life of the vibrator motor.

Both a standard and vibrator motor may be supplied with power from a variable speed drive (VSD). **wn**



March

Movers, shakers and
history-makers

COMPILED BY | JANE BUISSON-STREET
FSAIEE | PMIITPSA | FMIITSPA

1 MARCH

1849 The lighthouse at Cape Agulhas, went into operation. This area is very treacherous and had been the scene of numerous shipwrecks. So, in March 1837, Colonel C.C. Michell, put in a request for the construction of a lighthouse. It took close to a decade for the Cape Council to raise the money, and construction began on 1st April 1847. Today, the Agulhas lighthouse is the second oldest working lighthouse in South Africa and was declared a national monument in 1973.

2 MARCH

1918 South Africa's biggest University, the University of South Africa (UNISA) was officially opened. Previously it was known as the University of the Cape of Good Hope (established in 1873). Today, Unisa is one of the mega universities of the world, with over 300 000 students in 130 countries.

3 MARCH

1860 Bethlehem in the Orange Free State was established.

4 MARCH

1972 The largest single construction work undertaken in South Africa, the Hendrik Verwoerd Dam (now Gariep Dam) on the Orange River, was officially opened.

5 MARCH

2005 Director Zola Maseko became the first South African to win the top prize at the Fespaco Film Festival for his film "Drum".

6 MARCH

2005 South Africa's Ernie Els sank a magnificent 18-footer for eagle-three at the last to win the Dubai Desert Classic for the third time.

7 MARCH

1952 Job Masego, a World War II veteran, died in Springs. He was a Prisoner of War in North Africa at the time, and made a bomb

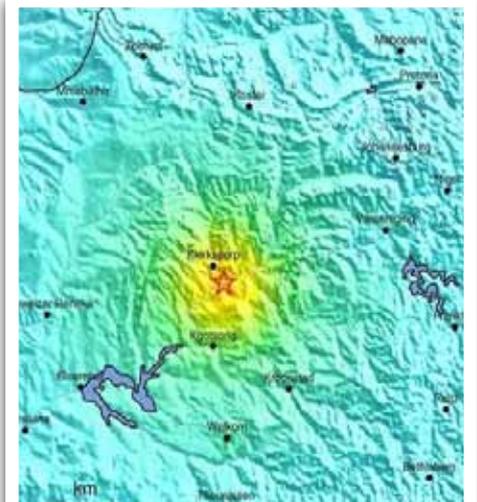
out of a condensed milk tin and gunpowder which he used, at great risk to himself, destroyed a German freighter. He was never caught. Job was awarded a medal and his bravery has been recognized by the South African Navy when they named 2 units, a Strike Craft and the Simon's Town Naval Base Wardroom, after him.

8 MARCH

1909 International Women's Day (IWD), was celebrated for the first time in New York City, USA. Historically the focus of these celebrations was the respect, appreciation of women's economic, political and social achievements.

9 MARCH

2005 An earth tremor measuring 5.3 on the Richter scale struck South Africa, with its epicentre at the Hartebeesfontein Gold Mine near Klerksdorp. An investigation into the cause found that the earthquake was related to mining.



10 MARCH

1998 Popular fast-bowler Fanie de Villiers played his last cricket match for South Africa in the 3rd Test match against Pakistan at St George's Park, Port Elizabeth. His Test Cricket career ended in the best possible way when he bowled Shoaib Akhtar, Pakistan's last man. It was his 85th wicket of an 18-test match career. South Africa won with 259 runs, and levelled the series with Pakistan 1-1.

11 MARCH

1870 King Moshoeshoe, founder and first paramount chief of the Basotho Nation, died. He is buried on Thaba Bosigo, Lesotho.

12 MARCH

1968 Mauritius officially achieved independence from Britain.

13 MARCH

2005 SA golf player and world number three, Ernie Els, scored his second victory in seven days after his third Dubai Desert Classic success the previous weekend. This time Els won the \$1.5 million Qatar Masters at the Doha Golf Club by 12-under par.

14 MARCH

1878 Dr Alexander Logie du Toit, a SA geologist and palaeobotanist, was born in Cape Town. He is considered as one of South Africa's most influential and versatile scientists; but he is most famous as a champion of the theory of continental drift.

15 MARCH

1985 The South African Associated Newspapers (SAAN) announced its decision to close the Rand Daily Mail at the end of April that year.

16 MARCH

1717 Ernst Frederik de Swart opened the first coffee house in the Cape, when permission was granted to him to serve refreshments to passengers from the ships, in his home.

17 MARCH

1820 The first 1820 settlers arrived in Table Bay on board the Nautilus and the Chapman on 17 March 1820. After the Napoleonic wars, Britain experienced a serious unemployment problem and therefore encouraged people to emigrate to the Cape colony. From there the settlers were sent to Algoa Bay, known today as Port Elizabeth.

18 MARCH

1822 Dr James Barry (allegedly a lady, Miranda Stuart) was appointed by Lord Charles Somerset as Medical Inspector of the Cape Colony.

19 MARCH

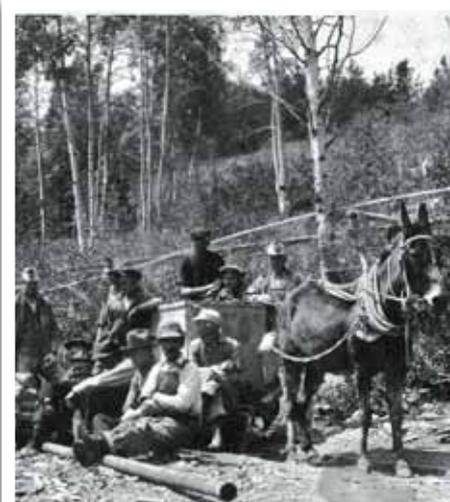
1993 Ditau Molefyané, South Africa's Junior Lightweight Champion, won the World Boxing Federation (WBF) title.

20 MARCH

1953 The Mountain Zebra is an endangered species native to South Western Angola, Namibia, and South Africa. In the 1930s only 100 of these animals remained. This situation was remedied by the establishment of a Mountain Zebra Park near Cradock, Eastern Cape which proved successful, and on this day the first foal was born.

21 MARCH

1924 African Explosives and Chemical Industries (AECI) was founded and its headquarters in Johannesburg. It was formed as the result of a merger between the South African interests of Nobel Industries of the United Kingdom and the manufacturing arm of De Beers Consolidated Diamond Mines of Kimberley. The company's primary purpose was



MARCH

continues from page 65

to provide blasting explosives and detonators to South African gold and diamond mines.

22 MARCH

1999 Thanks to Daryll Cullinan and Jacques Kallis, South Africa won their away test series by 3-2 over New Zealand, with SA being unbeaten in six series matches.

23 MARCH

1962 The South African Minister of Water Affairs announced an ambitious scheme to harness the Orange River for power and irrigation at a cost of R450 million.

24 MARCH

1882 This is that day that Dr Robert Koch astonished the world by announcing that he had discovered the cause of Tuberculosis (the bacillus *Mycobacterium tuberculosis*). To commemorate this, today is World TB Day.

25 MARCH

1961 During the All Africa Conference held in Pietermaritzburg, Nelson Mandela was appointed the Secretary of the National Action Council.

26 MARCH

1998 The first American president to visit SA, President Bill Clinton, arrived with at the Cape Town International Airport. The Clintons were hosted by President Nelson Mandela.

27 MARCH

1876 The first issue of South Africa's first daily newspaper, The Cape Times, was published in Cape Town as an English language morning. It sold for the cheap price of a penny and has been in continuous daily production ever since.

28 MARCH

1918 The Suid-Afrikaanse Nasionale Trust en Assuransie Maatskappy (South African National Trust

and Assurance Company Limited) (Santam) was established.

29 MARCH

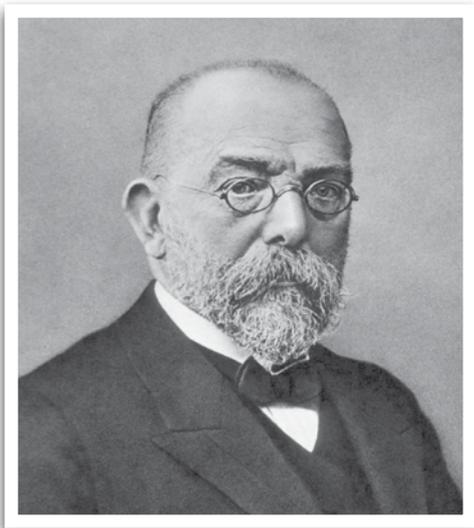
1962 The South African Minister of Defence, J.J. Fouché, disclosed that South Africa was buying supersonic Mirage III Jet Fighters and Alouette Helicopters from France to equip the South African Armed Forces.

30 MARCH

1991 African National Congress Deputy President Nelson Mandela and Inkatha leader Mangosuthu Buthelezi agree on a five-point peace plan after talks to find a way to end clashes between their supporters.

31 MARCH

1859 The building of the railway station in Wellington began. The first train from the Cape arrived 4 years later. **Wn**



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