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MANAGING EDITOR
Minx Avrabos I minx@saiee.org.za

TECHNICAL EDITORS
Derek Woodburn
Jane-Anne Buisson-Street
Dr Michael Grant

CONTRIBUTORS
M Bazilian
N Erasmus
J van Werkhoven
C Albrecht
S Swanepoel
C du Plessis
J Buisson-Street

EVENTS
Gerda Geyer I geyerg@saiee.org.za

CPD & COURSE ACCREDITATION
Sue Moseley I suem@saiee.org.za

MEMBERSHIP & TECHNOLOGY LEADERSHIP
Ansie Smith I smitha@saiee.org.za

ADVERTISING
Avenue Advertising
T 011 463 7940 I F 086 518 9936 I E barbara@avenue.co.za

PHOTOGRAPHER
AA Photography I 083 260 3753

PUBLISHER
South African Institute of Electrical Engineers

SAIEE HEAD OFFICE
P.O. Box 751253 I Gardenview I 2047
T 011 487 3003 I F 011 487 3002
E wattnow@saiee.org.za I W www.saiee.org.za
Office Hours: 8am-4pm

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February – 'the month of love' (so they say) has many a lady secretly wishing to be wined and dined by candlelight – which might be a reality sooner rather than later if we don't do something to support (or not) the grid… alas – reality seems to be the order of the day.

The SAIEE is proud to host the very first Smart Grid Conference on the 23 – 25th of February 2015 at the Eskom Academy of Learning in Midrand, Johannesburg. Visit **www.saiee.org.za** to find more info on this conference – hence this issue of **watt**now featuring Smart Grids.

The feature article, aptly written by Morgan Bazilian, "Smart and Just Grids" highlights opportunities for sub-Saharan Africa. This you will find on page 28.

Our second feature article (pg. 42) written by Neels Erasmus and Johan van Werkhoven discusses how Fuel Cells is the "new kid on the block" for off-grid power generation.

This issue has great content and news, which will keep you turning the page.

In the March issue of **watt**now, we will start a series of articles on Nuclear Generation. Read the introductory article on page 20 of this issue and start penning your thoughts. The best letter published will win a prize!

Herewith your February issue. Enjoy the read!

Minx

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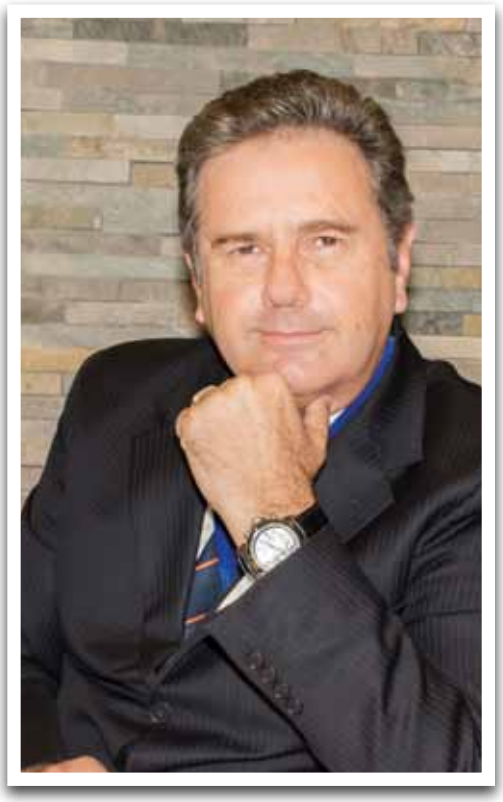

André Leo Hoffmann
2015 SAIEE President

According to the World Economic Forum held in Davos Switzerland in January, we stand on the brink of what is termed the 'Fourth Industrial Revolution', essentially a technological revolution that promises to fundamentally change the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation is expected to be unlike anything humankind has experienced before. We do not yet know just how it will unfold, but one thing is clear, it cannot be ignored or avoided. It is suggested that the response to it needs to be integrated, comprehensive and involve all stakeholders of society, from the public and private sectors to academia and civil society.

The First Industrial Revolution used water and steam power to mechanise production. The Second used electricity to introduce mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital and broadband revolution that has been occurring since the middle of the last century. This is characterised by a combination of technologies that are blurring the lines between the physical, digital, and biological systems.

The reasons given for why this transformation represents not just an extension of the Third Industrial Revolution but rather the arrival of a Fourth and distinct one are: Velocity, Scope, and Systemic Impact. The speed of current breakthroughs have no historical precedent. When compared with previous industrial revolutions, the Fourth is evolving at an exponential, rather than a linear, pace. Moreover, it is disrupting almost every industry across the globe.

We have witnessed developments in genetics, artificial intelligence, robotics, nanotechnology, 3D printing and biotechnology, to mention a few, that are all building on and magnifying each other. This is creating a foundation for a more comprehensive revolution than anything we have previously witnessed. Smart systems, homes, factories, farms, grids and cities are expected to help address problems ranging from supply chain management to climate change. The rise of the sharing economy will allow people to monetise everything from their empty house to their car (e.g. Airbnb and Uber).

While the change holds some promise, patterns of consumption, production and employment stimulated by it also pose major challenges suggesting that proactive adaptation by governments, corporations and individuals will be required. Thus the technological revolution, comes in the context of a broader set of socioeconomic, geopolitical and demographic drivers of change; each interacting in multiple dimensions and amplifying one another - A perfect storm. As entire industries adapt, most occupations are undergoing a fundamental transformation.

While some jobs are threatened by redundancy and others grow rapidly, existing jobs are also going through a change in the skill sets required. The debate on these transformations is often divided between those who predict limitless new opportunities and those that foresee massive displacement of jobs. A report coming out of the WEF has predicted that 7 million jobs could go in five years, with women losing out the most. However, the reality may be more specific to the industry, region

and occupations in question as well as the ability of various stakeholders to manage change.

The question is how organisations, government and individuals will react to these developments? Can we weather the current technological revolution by waiting for the next generation's workforce to become better prepared? It may well be necessary for organisations to take a proactive role in supporting their current workforce through re-training, and that individuals take a positive approach to their own lifelong learning.

According to WEF correspondents Klaus Schwab and Richard Samans, the current technological revolution need not become a race between humans and machines but rather an opportunity for work to truly become a channel through which people realise their full potential. To ensure that we achieve this vision, we need to become more specific and much faster in understanding the changes underway and cognisant of our collective responsibility to lead our organisations and communities through this transformative moment.

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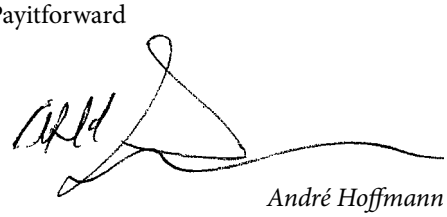

André Hoffmann
Pr. (Tech.) Eng | FSAIEE

SOURCES ACKNOWLEDGED:

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WATTSUP

ACTOM lands sizeable order

A welder works on a full-scale model that was made to facilitate achieving the optimum design for the new wind farm transformers.

ACTOM Power Transformers has received an order for a large batch of transformers for wind turbine generators (WTG's) for three new wind farms being established in the Northern Cape as part of the national renewable energy programme.

This follows the division's earlier success in designing and producing similar transformers for one of the first wind farm projects in the programme, the Kouga Wind Farm near Oyster Bay in the Eastern Cape.

The latest order is for a total of 157 x 2700 kVA pad-mounted oil-natural air-natural (ONAN) transformers. It was placed by Midrand-based Consolidated Power Projects (CONCO), the electrical balance of plant contractor for the wind farms, Noupoort, Khobab and Loeriesfontein, comprising 35, 61 and 61 WTG's respectively.

Independent power producer (IPP) Mainstream is the owner and developer of these projects.

The transformers contract was awarded in April 2015 and is scheduled for completion in mid-2016.

"In awarding the contract to ACTOM Power Transformers we took into account their success with the Kouga Wind Farm project, where the WTG transformers they supplied have proven to be efficient and reliable, so demonstrating their capability of meeting the special requirements applicable to wind farms," commented Rein Dijkstra, CONCO's Contracts Manager, Renewable Energy.

The new transformers incorporate a special feature that is new to South Africa but is well-proven abroad, especially in the US where it has been widely used for many years in wind farm and general distribution applications.

Gert Kriel, ACTOM Power Transformers' Sales Manager, explained: *"This involves making provision for accommodating the load-break switch together with current limiting fuses inside the transformer tank by mounting them under oil, in place of the usual external arrangement as applied to package transformers.*

"This has the great advantage of significantly reducing the cost of manufacture and therefore the selling price."

African Academy to include AVEVA Everything3D on engineering training courses

AVEVA recently announced that the African Academy has selected AVEVA Everything3D™ (AVEVA E3D™) for its Plant 3D design training courses from January 2016. AVEVA E3D is fast becoming the design software of choice for major capital projects around the world. AVEVA E3D has a state-of-the-art, intuitive user interface that is unmatched in the industry and is ideally suited for the rapid training of new engineers. Students who receive certification on AVEVA E3D will join a large, globally distributed community of designers that can work efficiently together on the most complex greenfield and brownfield projects.

Addressing South Africa's need for well-trained and skilled draughtspersons, African Academy offers courses such as Plant Engineering Design and Draughting, Construction Engineering Design and Draughting, and Electrical Engineering Design and Draughting. African Academy trains approximately half of all newly qualified draughtspersons in South Africa every year. *"These new courses are helping to close the skills gap between Engineers and Draughtspersons'*, said Kubera Naidoo, Managing Director, African Academy. 'Students leave the Academy fully trained and ready to work on major capital projects immediately. Our aim is to create a bridge for our students to enter the industry with marketable skills that will serve them well throughout their entire career. Working on software such as AVEVA E3D means that students will have hands-on, practical experience with state-of-the-art software that will be very attractive to employers.' It is important that students are trained on the key software within the engineering industry and the African Academy could not have made a better choice than AVEVA E3D', said Louis Khoury, SVP, Regional Operations MEA, AVEVA. 'We are proud to be associated with the Academy as it has an excellent reputation for its focus on training people in the latest engineering and design software and industry best practice. I am very confident that both the Academy and its students will be impressed by how quickly they can become proficient with our software. AVEVA E3D is used on very large complex and small specialised projects across a huge range of industries around the world. Who wouldn't want to be trained on AVEVA E3D!'

The AVEVA Academic Initiative benefits educational institutions, their students, employers, and the global engineering community. AVEVA's educational partners range from local vocational training centres to the world's most prestigious postgraduate universities.

Orange will acquire 100% of the mobile operator Cellcom Liberia

Orange.com recently announced it has entered into a firm agreement with Cellcom Telecommunications Limited to acquire, through its subsidiary Orange Côte d'Ivoire, 100% of Cellcom's Liberia subsidiary, the leading mobile operator in Liberia, with the strongest market commercial momentum.

Orange will provide its marketing expertise and world-class technical capability to further strengthen the network operator, enhance services to consumers and contribute to the economic growth of Liberia. Cellcom's founders and employees will remain involved in the business to ensure a smooth integration, support performance and continue long-standing relations with the Government of Liberia. This acquisition is part of the international development strategy of Orange, which aims to accelerate its growth by entering new emerging markets with high potential. This will enable Orange to strengthen its positions in Africa, which is a strategic priority for the Group.

Liberia is a country of over 4.3 million inhabitants, with a mobile penetration rate of 66%, lower than in many neighbouring countries. With a national mobile license and its significant market share in the country in number of subscribers, Cellcom has excellent potential for growth over the coming years.

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Full range of WEG transformers with guarantees extended to three years, with option to extend the guarantee with the WTA Service plan to five years.

Zest WEG Group announcement - we are extending product guarantees

Long gone are the days of being considered a run-of-the-mill OEM. This is the strong message being given to all industries by Zest WEG Group Africa. With WEG Brazil as its parent company, this group has its roots firmly in Africa and its commitment to the continent is without question, especially following the large investments made in 2015 in local manufacturing facilities that will be able to service countries across Africa.

Such is the confidence and level of commitment of Zest WEG Group Africa to its customer base that Louis Meiring, group CEO, announced guarantees have been extended across all WEG products. *"Zest WEG Group Africa is known for leading industry in its thinking and the decision to extend the product guarantees is, we believe, another very important first," Meiring says.*

"While the extended guarantee will cover customers for unexpected electrical and/or mechanical failures giving them absolute peace of mind, it is not going to cost them more."

Meiring says that this was a prime consideration for Zest WEG Group Africa as the organisation is well aware of the additional financial pressures that many of its customers are operating under in the current financial climate. *"By extending our product guarantees we are increasing the peace of mind that customers have with WEG products and opening the door for potential customers to examine what we know is an unbelievable value proposition."*

It is quite significant that Zest WEG Group Africa was the first equipment supplier to move from IE2 motors to IEC3 compliant motors, and a key aspect was that that change was introduced at no additional cost to its customers, thereby reducing the total cost of ownership.

"Extending product guarantees is aligned with our strategy of forming long term partnerships with customers. Continuous product improvement is ongoing at WEG and indeed at Zest WEG Group Africa's local manufacturing facilities and the benefit of this must, of necessity, be passed on to our customers allowing them to optimise their operations," Meiring says.

"We have reviewed the performance of all WEG products over an extended period and are confident that all will meet the guarantee with ease," Gary Daines, Managing Director of Zest WEG Electric, says.

Extended guarantees will vary from product to product, but all customers are still assured of the same high level of in-field support for which Zest WEG Group Africa is known.

Meiring says that Zest WEG Group Africa plans to continue its strategy of bringing innovative initiatives to market that will add value to customers' operations. *"Despite being part of a major global corporation, we have not lost the flexibility and responsiveness for which we have always been known,"* Meiring concludes.

The Myths Of Solar Debunked

Expert explains why installing solar panels may not cut your bill by as much as you hoped.

While South Africa boasts an ideal climate for the generation of solar electricity through photo voltaic (PV) panels, solar power is not an automatic 'quick fix' for home owners hoping to cut their energy bills. This is because most households use the majority of their energy during early morning and evening peak times, which unfortunately do not correlate with the peak times for solar energy generation.

This is according to Alan Matthews, Head of Home Solutions at Energy Partners – a leading energy solution provider in South Africa, who says this can lead to consumers being disappointed with the savings from their installed systems. *"The rapid growth in the home solar industry has led to many unscrupulous suppliers that promise consumers large savings, often ignoring the fact that a significant portion of the energy produced by the panels will not be utilised. These suppliers may try to sell their clients the cheapest possible solution, rather than advising them to invest in a more expensive but more effective solution".*

Luckily, the mismatch between production and consumption times can be addressed by including batteries and load management

Alan Matthews
Head of Home Solutions | Energy Partners

systems into home solar PV systems, says Matthews. *"Rapid advances in energy storage technology mean that so called 'hybrid' systems that include batteries are becoming increasingly affordable. Hybrid systems work by allowing for excess solar energy generated during the day to be stored and utilised in the evening, or in the event of a power outage."*

He explains that the latest generation of lithium-based batteries that are now available in the country are vastly superior to traditional battery technologies. *"These batteries can have a lifespan of more than 7 000 cycles, enabling them to provide a daily charge or discharge for over 10 years.*

Another important element in a residential solar solution is a load management system, says Matthews. *"These work by only switching on certain discretionary loads – like pool pumps, washing machines and geysers – when the PV system is active. That way, more consumption happens while the solar panels are generating."*

He adds that in other developed countries storage has not been as necessary, because utility companies are willing to buy back extra energy from residential consumers. *"Unfortunately in South Africa this is still not feasible in most areas as consumers get paid far less per unit fed back into the grid than is necessary to cover the cost of the system. In addition, home owners with prepaid or old mechanical meters will also be required to upgrade their standard meters to bi-directional meters at their own cost, in order to benefit from feed-in tariffs."*

"The best choice for consumers is therefore to utilise as much of the solar energy generated as possible, at least until the economics of these feed in tariffs change. This is not a difficult task – with a system that is designed to the correct size, combined with load management and some storage, it is possible to get 'self-consumption' levels up to 90%. This results in systems that will last for 20 years, but that pay themselves off in the first 6 or 7 years," concludes Matthews.

New Dual-Range Pressure Calibrators

Comtest, local distributor of Fluke test and measurement tools, has introduced a new Dual Range Pressure Calibrator for use in classified environments, offering ranges, accuracies and capabilities ideal for gas custody transfer measurements. The new Fluke 721Ex, with IECEx and Atex Ex ia IIB T3 Gb (Zone 1) ratings, is available in 14 models and can be used with a Fluke 720RTD probe for temperature measurement. Fluke has also introduced 700 series pressure test hose and pump kits which minimise the difficulty and leaks when connecting a pressure calibrator or pump to a device under test. The quick installation, without the use of tools, increases efficiency, and saves time. These pressure accessories are a best-in-class set of premium hose and No Tools Required (NTR) pressure connection accessories.

For more information visit Comtest Team at www.comtest.co.za

WATTSUP

David Matshane
CEO | M2TD

Big Business Has a Real and Positive Role in assisting Small Business Growth

Founded just six years ago in 2009, Micro Squared Technology Dimension (M2TD) Consulting, has grown from strength to strength. Driven by CEO David Matshane the company - and then some - has become a reality after just a few, short years.

The company recently signed a contract with British Telecommunications (BT) – a multinational telecommunications services company that operates in 170 countries. This is a great feat for this small yet impactful company. BT will contribute greatly to the Networking and Connectivity section of M2TD's work. This opens M2TD up to global connectivity, allowing them to manage and monitor a global footprint. With these types of collaborations and strategic partnerships, M2TD Consulting has repositioned itself as one of the fastest growing ICT SME in the country and now boasts a staff complement of 50.

"Our focus was essentially on EMC storage services and solutions when the company first started but it diversified since 2013. Today we operate within a variety of solutions: storage and backup managed services, cloud solutions, server virtualisation, infrastructure operations, data centre and virtual environments," explains Matshane.

One of M2TD's main focuses is to drive ICT services in municipalities, accelerating the offering in these areas, working on a provincial, local and municipal government level. Matshane explains that there are millions of people living within municipal boundaries all across South Africa without access to basic information and communication technology. They want to assist government in rolling out this technology across the country.

The integrated offering by this level 1 BBBEEE 100% black owned business is made possible by the strong role that the CEO plays. With a strong focus on brand positioning, services and the delivery of promises, Matshane ensures that the company presents a united front and that *"the resilience and the robustness of the company are developed from a business perspective,"* according to Matshane.

Matshane says, *"We want to show that industrial support can add incredible value and show other SMEs that they too can survive and thrive."*

Lithium Iron Phosphate batteries –a better solution

Whilst the LifePO4 battery is well known for its low weight, compact size, long life and ability to provide large currents when required, there are other benefits which are not as well appreciated.

Battery capacity is often specified as the current which will discharge the battery in 20 hours. If a lead type battery is discharged at a higher rate than the 20 hour rate, the battery will exhibit a lower capacity. The higher the discharge current, the less capacity the battery seems to have.

This phenomena does not occur with LifePO4 batteries. They are so efficient, that after years of high current discharge, the capacity remains virtually unchanged. LifePO4 batteries are much better in high discharge current applications.

LiFePO4 batteries provide a much higher level of usable capacity, compared to lead batteries. During discharge, the battery terminal voltage remains almost unchanged, right up to the point where the battery is almost fully discharged.

Compare this to a lead battery where the voltage drops steadily. The higher the discharge current, the faster the lead battery's voltage drops off. So many applications require a lead battery capacity twice what would be apparently be necessary.

In contrast, the LifePO4 battery thrives on high current discharge, and because the effective capacity does not diminish with high rates of discharge, a LifePO4 battery with a much lower amp hour rating can be chosen. This saves both weight and space, with the added bonus that the LifePO4 will outlast the lead battery many years.

Trying to charge a lead battery faster than you should, just makes the battery hot and causes gassing. Lead batteries have to be charged frustratingly slowly. To obtain maximum charge, the battery must be charged up to an "equalisation" voltage, and then dropped back to a floating level. Typically a full charge will take all night, the current naturally tapering off as the battery becomes charged. Since a LifePO4 battery has a very low internal resistance, it can be charged at a much higher rate than a lead type. This means that the LifePO4 battery is back at work earlier and for much longer than a lead battery.

Li-Start, a division of PJ Aviation cc, is stocking LiFePO4 batteries, both engine starting and storage types. These batteries have internal Battery Management Systems to ensure constant cell balance, enabling the use of standard 3 stage chargers (without anti-sulphation stage). Storage battery versions limit discharge current, over charging and over discharging.

For information visit www.li-start.co.za.

Southern Africa Energy & Infrastructure Summit in Maputo, Mozambique from 4-6 May 2016

For 15 years EnergyNet has worked closely with the Government and stakeholders of Mozambique, Namibia, Botswana, South Africa, Madagascar and Zambia. This year, we bring these countries together in Maputo Mozambique, the Heart of Southern Africa, to celebrate regional cooperation and promote energy and infrastructure projects that require both private and public sector support to succeed.

Central agenda items include:

- United Africa – How Regional Partnerships Can Deliver Stability and Increase Investment From the Private Sector
- Mozambique: Africa's Dubai – Planning and Investment Strategies to Achieve the Construction Boom
- Energy Access for the People – Beyond the Grid Energy Solutions
- Africa Gas – In the Face of an Economic Crash, Regional Opportunities to Fast Track

Investment In Southern Africa

- Solar Energy Capacity - Scale and Price for the Region
- Wind Turbine Technology – The Growing Importance for East Africa Business
- Hydro-Power – Tackling the impact of draught on hydro power resources
- Island Power: What is the Solution for Madagascar's Energy Challenges
- South Africa: Energy Strategies as a Regional Off-Taker
- Transport Infrastructure: Ports, Rail and Road Project Showcases
- Kudu Gas – Gas Evacuation in Namibia
- Botswana – Renewable Energy Opportunities within the Industrial Roadmap
- Grid Stability: Investment in Electricity Transmission and Distribution
- The ZMZ Factor – Energy Solutions to Increase Industrial Output in Zambia, Malawi and Zimbabwe
- The Impact of Gas Success and the Potential for Downstream Petrochemical

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Down into the Belly - The Ingula Pump Storage Project Site Visit

The beautiful landscape created by the rolling Drakensberg mountain range in the Ladysmith area of KwaZulu-Natal leaves a person breathless. This region gave Eskom the most ideal place to for the Ingula Pump Storage Scheme; a project which was on the cards since the 1980's. Multiple sites across the length and breath of the country had been earmarked but the Ingula site proved to be the best place given the multiple and competing criteria that were considered.

The Ingula Pump Storage project site was the latest site visit organized by the SAIEE's Power and Energy Section (PES). The visit offered a marvellous demonstration of the various engineering disciplines working together in order to bring much needed power onto the grid. The tour took us under ground deep into the mountain through wide and amazing tunnels. We could definitely appreciate the amazing engineering work done by our colleagues from the Civil discipline.

Comprising of four 333MW generators, the Ingula Pump Storage is the largest pump storage on the African continent and 25th in the world. The generators acquired are unique to this project – turbine generators for pump storage projects are uniquely designed for each project individually.

The four turbine generators are at different stages of their construction. This gave the SAIEE entourage invaluable insight into the various stages of the construction process for the turbine generators.

It is also worth highlighting some of the amazing electrical technology that has been deployed in this project. The cabling system connecting the 405MVA 18/400kV Gen Transformer to the HV yard is a 400kV cabling system - this is something that is new in the Power Generation environment.

The length of the cable is 1,45 km, is the longest know installation on the continent.

The cable has a cross-sectional area of 630mm^2. The cables run through a tunnel and a Distributed Temperature Sensing (DTS) system is used in order to determine hot spots on the cable. The system's cable core is made of aluminum and was provided by the Italian company Prysmian (formerly known as Pirelli). The testing on Unit 4 has been completed and Unit 3 is currently underway.

We would like to thank our hosts for a detailed tour and for their patients when peppered by multiple questions. We are proud to say that Ingula can be a project that we, as engineers, and broadly as a country, can be proud of.

DEHN AFRICA answers industry call for a seminar giving a comprehensive approach to lightning protection

In response to massive industry interest, DEHN AFRICA (Pty) Ltd, the local subsidiary of Germany-based lightning and surge protection, earthing components and safety equipment manufacturer, DEHN + SÖHNE, recently ran a two-day seminar that offered attendees a fully comprehensive approach to lightning protection. The first seminar ran at the end of last year at the Indaba Hotel & Conference Centre in Johannesburg; with further events scheduled for Namibia, Cape Town and Durban early 2016.

The course was endorsed by the South African Institute of Electrical Engineers (SAIEE), which approved two CPD credits for all those who attended. It was aimed at consultants and engineers in the fields of electrical and electronic project design, safety, instrumentation and control, mechanics, construction, and civil engineering, along with architects, quantity surveyors, and IT specialists.

Delivered by Alexis Barwise, the managing director of DEHN AFRICA, the seminar took delegates through:

- The characteristics of lightning, how it is formed and the types of flashes that exist; along with the types of risks and damage associated with a lightning strike.
- How to assess the risks associated to a structure/building/plant and to apply mitigation methods in order to protect personnel, the structure and its equipment.
- Designing a compliant and effective lightning protection system (LPS) including all the elements of an LPS (air-termination systems, down-conductors, earth-termination system, separation distance and equipotential bonding).
- Selecting compliant lightning and surge protection devices through understanding the full requirements of these devices and other applicable standards; along with the certification of an LPS using the SANS installation safety report.

Aside from the theoretical information, the 50 delegates that attended the seminar were also given access to real life scenarios, which they could discuss and apply the knowledge gained from the training.

Schneider Electric Announces Micro Data Centre Wins Award

Schneider Electric, the global specialist in energy management and automation, received a prestigious DatacenterDynamics Leaders EMEA Award in the Modular Deployment category for the state-of-the-art customized prefabricated data centre installed at Sagrada Familia, Barcelona, Spain. The Award was made at an evening ceremony held at London's Lancaster Hotel and hosted by television personality, Alexander Armstrong.

Receiving the Award, Fernando Villa, CIO for Sagrada Familia said, *"The security of our IT operations is vital. To ensure adaptable and scalable infrastructure in a period of transformation meant we needed to think laterally. The Micro data centre supplied by Schneider Electric fully meets our requirements in terms of portability and adaptability with no inconvenience to tourists, construction work or the way we function as an active church. I am delighted with the Award!"*

Hal Grant, Schneider Electric, said, *"Since their launch, the DatacenterDynamics Leaders Awards have become the 'Oscars' of our industry. We're very pleased therefore to receive this accolade - it is a great credit to the team of people who worked on this project both at Sagrada Familia and within Schneider Electric."*

Davide Ortisi (left), Product Marketing Manager, Prefabricated Data Center Modules, Schneider Electric, and Fernando Villa, CIO Sagrada Familia.

SAIEE pays it forward with future engineers at UJ TechnoLab

A recent interview on Talk Radio 702 confirmed that when engineers graduate, they are still the top earners in South Africa as compared with new graduates in other disciplines.

The University of Johannesburg's Faculty of Engineering and the Built Environment (FEBE) wants more teenagers to consider engineering, and UJ TechnoLab housed in the School of Electrical Engineering on Kingsway Campus at Auckland Park is working with schools to create awareness of the exciting career opportunities awaiting future engineers.

UJ TechnoLab offers a range of engineering-related activities designed to encourage and educate young people, including robotics, electronics workshops, competitions and outings. The ability to think creatively and solve problems is not just a requirement for future engineers, creative play is a developmental requirement for all children. UJ TechnoLab welcomes learners from Grade Five onwards to visit the university where they can participate in free early learning workshops that consist of Fischer Technik and LEGO building challenges designed to develop basic motor skills.

UJ TechnoLab Holiday Clubs allow groups of up to 20 learners to participate in workshops about electricity, solar energy, space travel and robotics. UJ TechnoLab organises the annual carbon dioxide canister rocket car competition for high schools every year, where teenagers can build their own aerodynamic drag racer and learn more about Bloodhound the world's fastest car that is expected to visit South Africa in 2016.

For high school, college and university students Shell Eco-marathon offers to opportunity to build an energy efficient petrol or electric vehicle and participate in a competition every year that offers participants the opportunity to bring their schools prestige by setting a new record for energy efficient engineering.

For teenagers that have participated in the LEGO robotics competitions, and are not sure how to get involved in learning about the electronic systems found in robots, the RobotScience project at UJ Technolab is the next step.

The RobotScience project was started by Michael Ettershank in 2008 as a part time activity to improve the lives of teenagers. Returning to South Africa from the USA where he worked for a software company, Ettershank realised education opportunities from teenagers was way behind that of more developed countries and

so he got started with a home made robot and a three page website and a dream. After training in private schools for several years the RobotScience project with the support of the Department of Basic Education trained a group of teenagers from Soweto who built their own robots at Sci-Bono Discovery Centre at Newtown in 2012.

In 2013 two teenagers trained by RobotScience were placed second at the World Robotics Olympiad (WRO) in Jakarta, Indonesia, with their "cave explorer" robot. Ettershank trained Dylan Rheeders and Marco Pretorius for two years,and then at Jakarta they beat the German team sponsored by multinational car-maker BMW. First place at WRO 2013 went to a team from the United Arab Emirates, where the that government pumps millions of dollars of oil money into their education system every year in the hope of creating a home grown high-tech industry.

In 2014 the RobotScience project became a part of UJ TechnoLab with a small grant from the Shuttleworth Foundation, and in 2015 this project became a full time programme at TechnoLab.

The South African Institute of Electrical Engineers, recognising the need to support youth from disadvantaged communities with SAIEE president Andre Hoffmann's "pay-it-forward" campaign entered into a partnership with the University of Johannesburg in 2015 to support the activities at TechnoLab. The purchase of fifty DIY robot kits for teenagers from disadvantaged communities to build, and 20 urgently required notebook computers to program them will open the doors of learning to growing numbers of young South Africans who want a better life.

With the acquisition of SAIEE support a Diepsloot high school was added to the Soweto teenagers already being trained, these groups will continue in 2016 and participate in AfrikaBot 2016 and a school from Alexandra will commence training in 2016 when the schools open. UJ TechnoLab has pledged to support and assist all schools that want to participate in AfrikaBot 2016 as well as universities that would like to implement their own low cost robotics programme in nearby schools. In addition to disadvantaged teenagers, the opportunity to participate in AfrikaBot 2016 is being marketed to all high school teenagers who are being encouraged to build their own robots. Teenagers who get "hooked" on building electronics are highly likely to go on to study electronics and become engineers which will in time help address the current shortage of engineers.

The rules for AfrikaBot 2016 will permit the use of any robotics platform, so teenagers and university students that already have Arduino, Raspberry Pi and LEGO robots can participate.

UJ TechnoLab

continues from page 17








For teenagers that do not already have a robot, the AfrikaBot kit is a low cost option with free graphics or text programming available from local supplier www.mantech.co.za at a reasonable price. The electronics from the AfrikaBot kit can be expanded as the abilities of the teenager grows into a professional control and automation system. The website www.robotscience.co.za and 300 online videos shows teenagers how to build and program the AfrikaBot.

UJ TechnoLab with the support of SAIEE is offering free weekday morning workshops for school groups, where teenagers can handle and program TechnoLab's robots and learn how easy it is to program them through the maze. There is also lots of information on the website about how schools and private individuals can enroll for privately funded training where they are guided through the process of building their own competition robot.

The University of Johannesburg holds regular Orange Carpet events, where top achieving teenagers are encouraged to bring a transcript of their Grade 11 results and put themselves in line to receive full or partial funding to help pay for their engineering studies. wn

FOR MORE INFO, CONTACT:

Estelle Momberg: UJ TechnoLab Holiday Clubs - estellem@uj.ac.za or
Michael Ettershank: Robotics and AfrikaBot - michaele@uj.ac.za.


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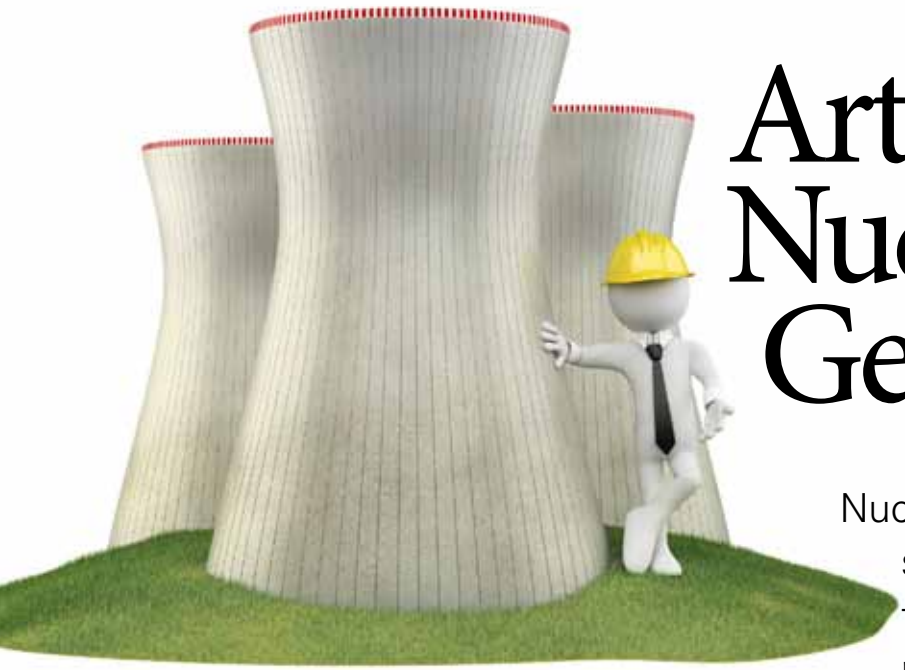


Articles on Nuclear Generation

Nuclear has become a popular subject in this country but there seems to be a lot of misunderstanding about it.

There are media reports of nine "power stations" being planned for South Africa.

In terms of the 2010 Integrated Resource Plan by the Department of Energy (DOE), 9600 MW of nuclear generation is to be built.

Eskom were planning to install 2 additional machines of 1600 MW each at Koeberg – this should be more cost effective as a lot of the infrastructure required for nuclear generation, is already in place.

They further planned for 4 machines of 1600 MW to be installed at Tuispunt about 100 km west of Port Elizabeth. These plans may change depending on decisions made by the DOE.

This totals the specified 9600 MW, and only one and a half power stations. In addition, a figure of a trillion rand has been bandied about in the media.

To put this in perspective, the nuclear station consists of a "nuclear island" (source of steam), a conventional island (turbines and generators), and auxiliary equipment.

A coal station consists of a "coal" system, a conventional island and auxiliaries.

The final cost of Medupi will probably be about R200bn for 6 x 800 MW generators = 4800 MW. Nuclear is said to be R1000bn for twice the capacity – ie 9600 MW. That is two and a half times the cost of equivalent coal.

To give our readers more insight into the technology, **watt**now is planning to publish a series of articles, both technical and informative. These will come from experts in the field. In addition, we will look at Koeberg, which is over 30 years old, and the only nuclear power station on the African continent. We will analyse the various costs, which we hope will give the public information to gauge the fairness of the eventual successful bidder. We will invite letters commenting on our articles on the subject, and we will publish these letters. The **watt**now editorial team will choose the best letters, and the authors will be awarded prizes.

The first of the series of articles, will be published in the March issue of **watt**now. wn

Why attend the SmartGrid Conference?

what's in it for me?

WHEN
23 - 25 February 2016

WHERE
Eskom Academy of Learning, Midrand, JHB

COST
SAIEE or Endorsement Partner Member - R4,275
Non-member - R5,130

SPECIAL DISCOUNT – 20% OFF
Register before 31st January 2016 and receive a 20% discount on the conference fee

EARN
Delegates registered with ECSA will receive 3 CPD credits

TOPICS COVERED ON SMART GRIDS B
INTERNATIONAL & LOCAL SPEAKERS

- What is a Smart Grid?
- Typical Strategies & Business Cases
- The Role of Telecommunications
- Cyber-security
- The Internet of Things
- Diagnostics, Self-healing and Reliability
- The use and Integration of Renewable Energy Resources
- The Role of Data Analytics
- The Role of Protection, Control and Operations
- The Concept and Benefit of Smart Metering
- Demand Side Management, Smart Buildings and Home Automa
- Machine-to-Machine (M2M) Communications
- Micro Grid Applications

SAIEE

SmartGri
CONFERENC

SAIEE Smart Grid Conference 2016

The South African Institute of Electrical Engineers will be hosting a Smart Grid Conference on 23rd to 25th February 2016, at the Eskom Academy of Learning in Midrand Johannesburg. The Conference will provide a platform for industry to discuss cutting edge innovations in smart grid and it's associated technologies; including addressing how the current electricity network can be converted into a smart grid. It is strongly believed that the adoption of smart grid technology within Sub Saharan Africa will provide immense benefit to the delivery of electrical energy in this Region.

The Conference will include keynote addresses, plenary presentations and panel discussions, as well as paper presentations in two simultaneous tracks.

An impressive list of international experts in the area of smart grids have been lined up for the Conference, and include the following:

PROFESSOR MASSOUD AMIN

Professor Amin is regarded as the "father of smart grids", and leads a number of extensive projects in smart grid research. Since 2003 he has served as Director of the Technological Leadership Institute at the University of Minnesota, and occupies the Honeywell/H.W. Sweatt Chair in Technology Leadership at the same University. He is also Professor of Electrical and Computer Engineering.

Prior to joining the University of Minnesota in 2003, Professor Amin held senior positions within the Electric Power Research Institute (EPRI) in Palo Alto. It was during this period that he conceived and articulated the vision of a smart self-healing grid. This is where the use of computer, communication, sensing and control technologies operate in parallel with an electric power grid to enhance reliability, increase resilience and reduce the cost of energy to consumers.

In addition to his technical leadership activities, Professor Amin maintains an active research program and has made significant contributions in predictive system identification methods, coupled with analytical and multi-domain modelling, fast simulation optimization and testing methodologies. All of these he applies to complex and large dynamical systems. Since 2003, he has given four briefings at the White House and nine Congressional briefings on smart grids. He has also served on numerous occasions as the USA delegation representative to several world engineering

and scientific congresses. He is regularly interviewed by the media including the New York Times, CNN, BBC, Washington Post and Wall Street Journal to name a few. One of Professor Amin's key area of interest is how to revitalize ageing grids and he has delivered a number of talks in this regard, including a TED presentation.

Professor Amin currently serves as Chairman of the IEEE Smart Grid Committee and also serves on the IEEE Control Systems Technical Committee on Smart Grids. He is the founding chairman of the IEEE Smart Grid Newsletter.

MR KURT E. YEAGER

Mr. Yeager, who has over 30 years of experience in the energy industry, was previously President and Chief Executive Officer of the Electric Power Research Institute (EPRI). Currently Mr. Yeager is Vice Chairman of the Galvin Electricity Initiative, which is a non-profit organization that he co-founded with Robert Galvin, after retiring from the EPRI. Mr. Yeager is also Vice Chairman of the Galvin Electricity Initiatives Perfect Power Institute which is focused on transforming the reliability and value of the USA's electricity services.

Mr. Yeager has authored over 200 technical papers and publications on energy and environmental topics, including a book entitled Perfect Power which he co-authored with Robert Galvin. He was also a convening lead author for the International Institute of Applied Systems Analysis (IIASA) "Global Energy Assessment" report to the United Nations and World Bank.

MR LEE STOGNER

Mr. Stogner is the President of the Vincula Group, a consultancy in the USA that specializes in the Internet of Things. He has over 30 years of design, consulting, project management and business development experience across a range of industries, including companies such as Digital Equipment, Fluor Corporation and Rockwell international.

Today Mr. Stogner is active in promoting the development of the Internet of Things through his participation in the IEEE Smart Grid Initiative, the IEEE Transportation Electrification Committee and as a member of the IEEE Internet of Things Initiative. wn

23 - 25 FEBRUARY 2016
ESKOM ACADEMY OF LEARNING MIDRAND JOHANNESBURG
www.saiee.org.za

SA Startups knockout the competition

South African startups Newtech Rail (Pty) Ltd and Adfire Creative M3dia's iMORPH3D app beat down the competition from the rest of central and southern Africa at the Get In The Ring entrepreneurship challenge in Johannesburg recently, to secure their places in the international Get In The Ring finals in Colombia later this year.

In an adrenalin-fuelled African final, nine of Africa's most innovative new business ideas went face to face in the boxing ring to eliminate their competitors and pitch their business ideas to a panel of judges and an audience of fans and investors.

Newtech Rail (Pty) Ltd, formed last year by Industrial engineer and VUT Director of Innovation Jan Jooste, has developed three significant power line breakthroughs set to take a chunk of a global, multi-billion dollar power industry pie. iMORPH3D is a mobile app that enables users to create their own anamorphic 3D illusions, allowing events companies, advertising agencies or consumers to create new and exciting artwork. The app, iMORPH3D, is now available in the Apple and Android app stores, so that anyone can have fun creating amazing 3D illustrations.

Get In The Ring, an innovative new format for startup pitching, pits contestants against each other in a boxing ring, where they have 30 'nerve wracking' seconds to outline components of their business plans, while an interactive audience cheers them on. The competition is brought to Africa by The REAL Entrepreneur Institute in partnership with the Dutch Embassy in Pretoria, Bhive, North West University, Heineken, Sage One Accounting, City of Jo'burg, Business Engage, Ingweno, Flexible Workspace, TomTom, Innovation Hub, Silicon Cape and Uncovering Greatness. Additional supporting sponsors include Mammoet, TU Delft, NRF, KLM and Royal Haskoning DHV.

It is a rapidly-growing international initiative launched in 2012, and is now contested by over 10,000 businesses in 80 countries. The winners will go through to the final showdown in Medellin, Colombia, in March this year.

Pitching their business cases to a panel of seasoned business executives, the contestants had only seconds to make compelling arguments in favour of their business ideas and potential returns. Judges said they were looking for staying power, passion, a clear overview of the problem the businesses were trying to solve, and crucially – an ROI for investors. Brian Walsh, founder and CEO of The REAL Success Network, noted: *"This event is not just about pitching for funding, it is also about pitching for attention. In the process running up to the finals, they will be exposed to thousands of potential partners and funders."* With the event showcasing some of the most innovative new business ideas emerging from South Africa and the rest of Africa, Tsholo Mogotsi, the Director of Economic Development facilitation for the City Of Joburg, was enthusiastic about the format, expressing the hope that the international finals of Get In the Ring could be brought to Johannesburg in future.

Steven Cohen, Head of event co-sponsor Sage One International said: *"Get in the Ring is a great fit with our business and a wonderful initiative to support small and start-up business owners. It is helping to encourage excellence and innovation among local businesses, and provide role models and inspiration for the entrepreneurs of the future."* wn

FACTS about LED Lamps

A relatively new technology, LED lighting is fertile ground for unscrupulous and opportunistic suppliers to capitalise on the absence of a compulsory local standard for LED lamps and to make performance claims that will not be met, mostly around lifespan and power-consumption.

Some facts:

- There are no **compulsory** local standards for LED lamps
- There are two standards that may be applied voluntarily by suppliers and specifiers:
  SANS 62560: South African National Standards
  IEC 62560: International Electrotechnical Commision
  There appear to be very few products that are certified against these standards.
- The "**CE**" mark appears on many products. This is a manufacturer's claim to a certain quality standard. **It is not an indication of independent, 3rd party testing.**
- The nature of LED performance claims being made cannot usually be validated by buyers, whether they be resellers, electrical contractors or users - until it's too late.

Some consequences:

- The absence of compulsory standards can result in incompatible dimensions between fittings and lamps from different suppliers - a performance and safety risk to users.
- The technology of an LED lamp and its heat-generation encourage shortcuts that compromise insulation in favour of heat dissipation - a safety risk to users.
- Plastic parts are a manufacturer's cost-saving opportunity. Inferior material will affect heat- and flame-resistance.
- The low volume of certified testing of LED lamps in South Africa does not allow much credible reference to be made to local testing and regulatory authority that will comfort buyers and specifiers.

SAFEhouse members have signed a code of conduct: Your assurance of commitment to offer only safe electrical products

SAFE HOUSE™
Suppliers you can trust

The SAFEhouse code of conduct includes:

- To offer only products that are safe
- To advise customers if any of their sold products fail this undertaking
- To recall unsafe products
- To replace unsafe products or render them safe

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

For more information contact:
Pierre Nothard Cell: 083 414 4980
Tel: 011 396 8140 | Email: pierren@safehousesa.co.za

www.safehousesa.co.za

SAFEhouse guidelines: What can you do?

- Purchase brands you can trust and satisfy yourself about the manufacturing source
- Lamps should be marked with at least the following information. If it is absent, be suspicious:
  - Mark of origin or manufacturer's name
  - Rated Voltage (V)
  - Rated Wattage (W)
  - Frequency (Hz)
- Be cautious about prices that are materially below the prices of other, similar products. Substantially lower prices are often indicators of poor quality.
- Be cautious about accepting performance claims, whether verbal or on packaging.
- Look for obvious signs of inferior quality in workmanship and materials.
- If in doubt, contact SAFEhouse for possible assistance.

As at 09/12/2015

Save the date for KITE 2017 – KZN's leading industrial exhibition

KZN Industrial Technology Exhibition (KITE) 2017, will be held once again at the Durban Exhibition Centre, from 25 to 28 July, and promises to bring high calibre visitors focused on sourcing new technology and services. With 2015 attendance figures showing that 97% of visitors were from KwaZulu-Natal, the exhibition provides an extremely targeted marketing opportunity for local companies.

Now in its 35th year, this leading industry trade exhibition has grown in both size and renown both in KwaZulu-Natal and across southern Africa. Evidence that KITE is a popular choice amongst discerning industry professionals is the feedback received from the high calibre visitor base and previous exhibitors. According to Mahendra Gangai of MAGNET: *"The show has provided a great foundation for us to showcase our diverse range of products and skills that we have on offer. It is a good foundation for networking."*

KITE is not only a portal for industry-leading technology and services, but is also a platform for knowledge sharing. This is evidenced in both the on-stand interactions between exhibitors and visitors but similarly in the free-to-attend seminar theatre sessions, which have proved to be a huge drawcard for visitors keen on learning about the latest technology, trends and legislation.

"We are thrilled that we will be launching an Industrial Indaba in 2017 to run alongside the existing trade show. This is the culmination of our ongoing relationships with government, associations and industry partners, and we feel that KITE 2017 is the perfect launch pad for the Industrial Indaba," says Charlene Hefer, KITE Portfolio Director at Specialised Exhibitions.

Another new feature for KITE 2017 is the inclusion of a Propak Africa Pavilion. This premier tri-annual exhibition is Africa's largest showcase of packaging, food processing and labelling technology and services which clearly complements the exhibitor offerings at KITE. *"Including the Propak Pavilion was a natural evolution for the KITE exhibition as there is a fair amount of synergy and overlap between the two exhibitions. We have conducted extensive research and this is clearly an initiative that wins favour with both our current exhibitors and our visitor base in KZN. In addition, it provides the Propak exhibitors with an increased footprint opportunity in the KZN region,"* says Hefer.

"Exhibitors at KITE 2017 will not only benefit from the ability to expand their potential customer database at the exhibition, but will also be able to leverage the marketing programme instituted by Specialised Exhibitions. This targeted horizontal and vertical marketing initiative provides extended brand exposure for exhibitors in the run-up to show, during the show and after the event has taken place," says Hefer.

The 2015 edition of KITE hosted 110 exhibitors from a spectrum of industries. The event provided its 5 156 visitors with an unrivalled opportunity to interact with the leading manufacturers and suppliers of high quality brands.

Boasting a visitor profile that focuses predominantly on senior management (32%) and technical/engineering specialists (41%), the exhibition clearly draws in relevant target markets. Demographics indicate that 31% of visitors were in the manufacturing sector while 27% were involved in engineering.

KITE continues to bring visitors the latest products, services and trends across a number of industry sectors, including construction equipment and material, electronic components, energy solutions, environmental solutions, heavy machinery, hygiene products and services, industrial equipment and components, IT and telecommunications manufacturing equipment, materials handling, monitoring, process control and sensors, security equipment, workwear and protective equipment, plant and facility equipment, safety equipment and machinery, tools, and industrial services.

For more information on KITE 2017, visit www.kznindustrial.co.za.

World-class smart metering competences move closer to Turkey's utilities

The demand for intelligent solutions for running a better and more efficient supply business is growing in Turkey. Now one of the world's leading suppliers of smart metering solutions, Danish Kamstrup, opens a new local subsidiary in Istanbul to provide better support and to be closer to their Turkish customers and partners. The office opening is a strategic ramp up for Kamstrup in Turkey.

Kamstrup is already represented in the smart metering market in Turkey by distributors and partners who have an excellent understanding of the Turkish market and Kamstrup has gained a good reputation through these relations.

The Danish smart metering provider is very dedicated to working intensively to improve the framework conditions in the Turkish electricity market and with a local sales team Kamstrup moves a step closer to supporting the development of a roadmap for the smart metering roll-out in Turkey.

"To create a valuable supply business for our customers and potential partners in Turkey, we need to be close to them and understand

the market and the conditions. With our many years of experience within the smart metering business, we are able to provide well proven solutions of high quality and with high performance. Something we know is very important for the Turkish utililites", says René Nygaard Jensen, Regional Sales Manager at Kamstrup.

With over 10 million intelligent meters sold around the world Kamstrup has gained extensive expertise during the last decades. In Turkey Kamstrup is already involved in several pilot projects with EnerjiSA and another project with CLK Enerji, who are responsible for providing electricity to nineteen million customers.

"Our partnership with CLK Enerji is part of a bigger pilot project run by CLK Enerji and DNV/KEMA and financial supported by the Energy Market Regulatory Agency. The performance results from this project will have great importance for developing a roadmap for the Turkish roll-out and it will be a major step towards influencing the frame work conditions", explains René Nygaard Jensen.

Kamstrup has also delivered 37.000 intelligent electricity meters to KIB-TEK in Northen Cyprus.

The new Country Manager will be Mehmet Akif Ak. He agrees on the importance of being represented locally: *"The Turkish market is financially highly regulated and the utilities need good partners and experts to improve the conditions. Smart metering is the way forward for the Turkish utilities to ensure a good business and I am looking forward to cooperating on solutions that create value for their business and their customers".*

The opening of the office in Turkey will be the 24th country, where Kamstrup is represented with a sales office.

The Student Expo South Africa 2016 not to be missed!

The Student Expo is back again and will be taking place in January, April, May and July in Johannesburg, Cape Town and Durban. South Africa's largest student focused Expo has evolved to offer an informative and stress-free student career advice experience. The Student Expo is designed to provide both current and prospective students with the necessary tools to succeed in finding professional, tertiary education as well as guide them towards a suitable working career.

The Student Expo targets more than 1000 private and upmarket government schools students (LSM 8-12) as well as top University faculty students to help them further professional careers in the legal, medical, engineering, commerce and culinary arts spheres.

The Student Expo prospective students will be able to meet with representatives from a wide range of universities to determine which school and program best meets their needs. Students will gain insight and career advice from leading field specialists to better understand the expectations and roles of their potential professions. The Student Expo aims to feed students with valuable knowledge to make educated decisions regarding their futures through discussions, presentations and a variety of interactions.

Matriculants will also have the opportunity to explore the various options for extra-curricular activities provided by the Universities, including social clubs, sports clubs and other clubs on offer.

Prospective students can learn how to secure student loans. They will also get advice on how to manage finances when living away from home, as well as meet and share information with other school leavers and parents.

Graduates will be able to explore career opportunities both locally and internationally. They may attend talks where they are given pointers on how to develop and write an effective and professional Curriculum Vitae as well as how to attend a professional interview.

Graduates will have the opportunity to meet the top Graduate Recruitment Companies in South Africa.

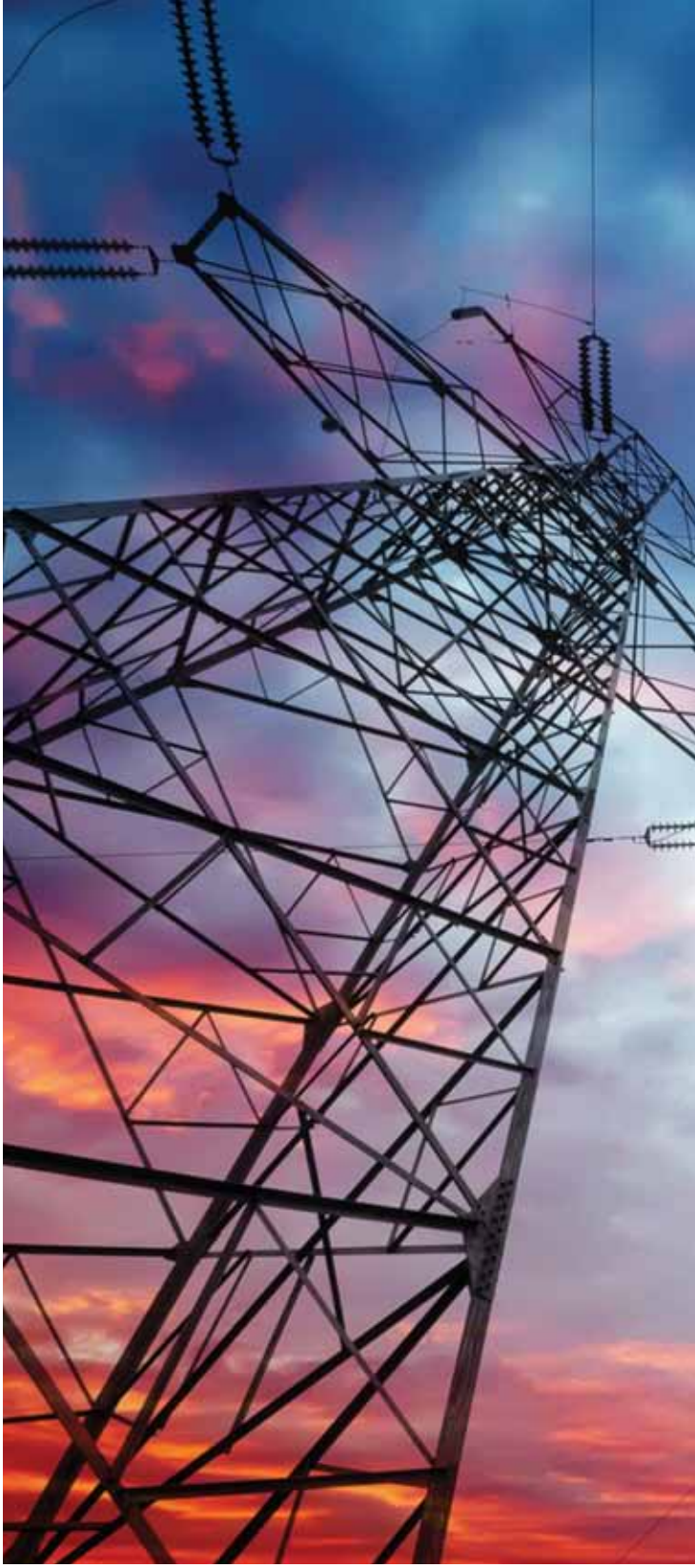
Prospective Postgraduate students will be able to meet with representatives from a wide-range of universities to determine which post graduate program best meets their needs. They will gain insight and career advice from leading field specialists to better understand the expectations and application of their further education. After the Student Expo the graduate will be better equipped to make decisions regarding their futures.

The Student Expo brings together professionals from legal and accountancy partners, entrepreneurs, engineers, doctors, scientists, renowned chefs and even overseas sailing instructors.

The Expo offers "Motivational and Educational Speaker" forums and students will have the opportunity to ask questions with concerns of where to go and what to study. Students will interact with tertiary institutions and find out more about courses on offer and how to apply for them.

Employment agencies will be available to assist post-graduate students with career choices as well as finding them their first jobs. Come join the Student Expo that offers something for everyone!

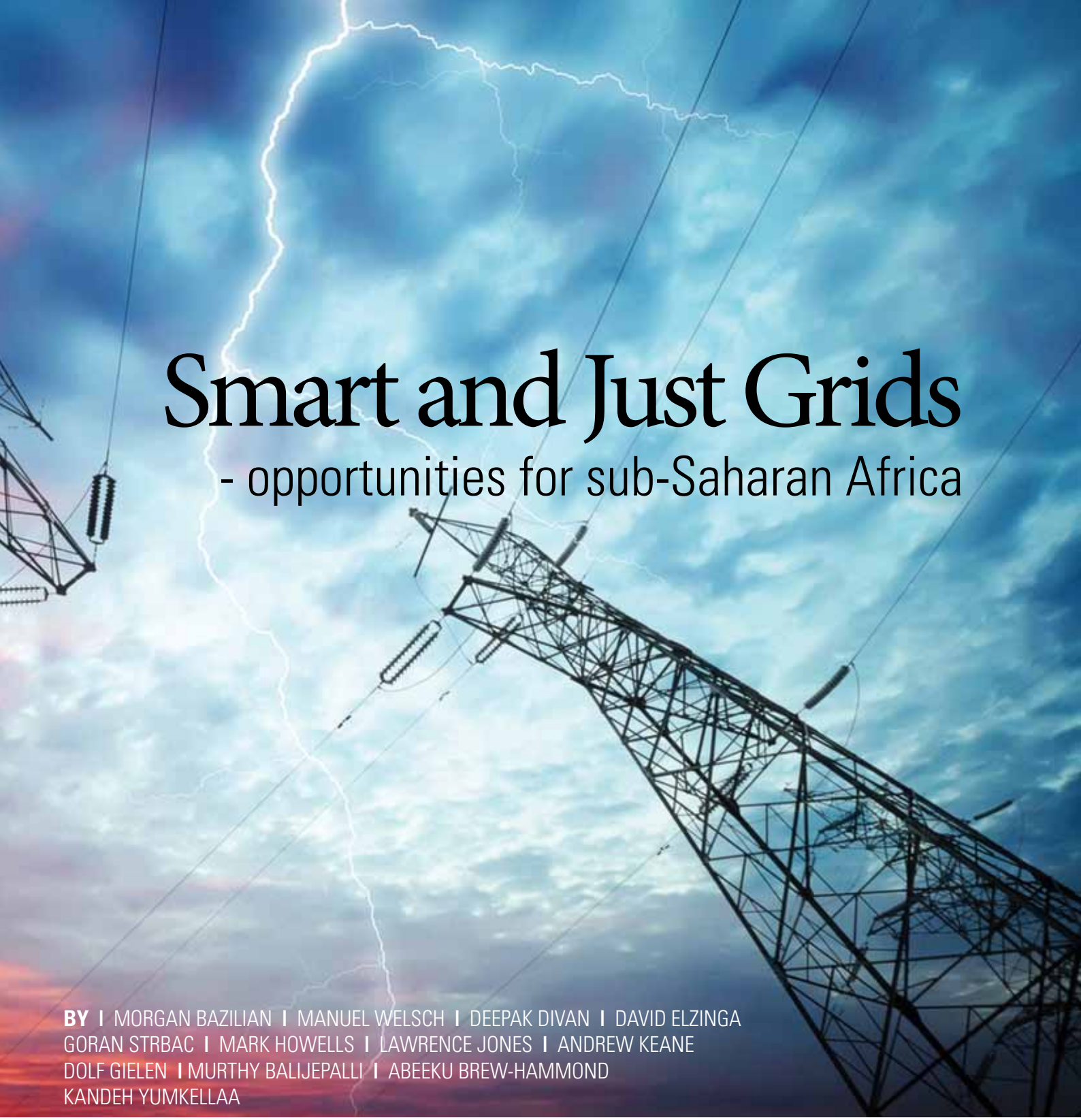
For more info,
info@youniqueconcepts.co.za



In 2009, an estimated 585 million people had no access to electricity in sub-Saharan Africa. Unlike many other regions of the world, under current assumptions, that figure is expected to rise significantly by 2030 to about 652 million – an unsustainable and unacceptable situation.

National governments and regional organisations have identified the urgent need for accelerated electrification rates. Responding to this need will require innovative and effective energy policies. The way future power systems are planned, designed, constructed, financed and operated will have a significant impact on how effectively these aspirations are delivered.

According to the International Energy Agency (IEA) reference scenario, Africa's final electricity consumption is expected to double between 2007 and 2030 from 505 to 1012 TWh (IEA 2009). Over the same time period, the United Nations (UN) Secretary-General's Advisory Group on Energy and Climate Change (AGECC) has proposed that the UN System and Member States commit to ensuring universal access to reliable, affordable and sustainable modern energy services by 2030 (AGECC 2010). To meet this goal, massive electricity infrastructure development will be required in the short- and medium-term.



Smart and Just Grids

- opportunities for sub-Saharan Africa

BY | MORGAN BAZILIAN | MANUEL WELSCH | DEEPAK DIVAN | DAVID ELZINGA
GORAN STRBAC | MARK HOWELLS | LAWRENCE JONES | ANDREW KEANE
DOLF GIELEN | MURTHY BALIJEPALLI | ABEEKU BREW-HAMMOND
KANDEH YUMKELLAA

The IEA (2010) estimates that achieving universal access to electricity by 2030 will require additional power-sector investment of USD 33 billion per annum on average, much of which is needed in sub-Saharan Africa. Efficiency improvements, demand management, optimal generation planning, improved grid operation and increased electricity trade across sub-Saharan African countries will be essential for minimizing the volume of investments needed (UN-Energy Africa 2008). We propose that specific elements of current and emerging Smart Grid concepts, systems and technologies may make an important contribution to improving equitable and just access to electricity services in sub-Saharan Africa (Bazilian, Sagar, et al. 2010).

ELECTRICITY IN SUB-SAHARAN AFRICA

The energy sector in sub-Saharan Africa is characterised by significant challenges including: low energy access rates,

Smart & Just Grids

continues from page 29

electricity costs as high as USD 0.50/kWh, insufficient generation capacity to meet rapidly rising demand, and poor reliability of supply (WB 2008). The estimated economic value of power outages in Africa amounts to as much as 2% of GDP, and 6-16% in lost turnover for enterprises (WB 2009).

In 2009, around 585 million people in sub-Saharan Africa (about 70% of the population) had no access to electricity (IEA 2010). This figure is expected to rise significantly to about 652 million people by 2030. Urban centres in sub-Saharan Africa are covered by varying electricity quality levels from national and regional grids, but rural coverage is particularly uneven and inadequate (Parshall et al. 2009) - 80% of those without access to electricity live in rural areas (IEA 2010).

In 2007, sub-Saharan Africa produced 390 TWh of electricity, of which South Africa alone produced almost 70% (AfDB, AU, and UNECA 2010). For a sense of scale, with 68 GW, the entire generation capacity of sub-Saharan Africa is no more than that of Spain. In addition, sub-Saharan Africa's average generation capacity was only about 110 MW per million inhabitants in 2007, ranging from less than 15 MW per million inhabitants in Guinea-Bissau and Togo, to 880 in South Africa, and up to 1,110 in the Seychelles (EIA 2010). By comparison, the generation capacity in the European Union is about 1,650 MW per million inhabitants, and in the U.S. it is 3,320.

Africa's energy resources are characterised by oil and gas reserves in North and West Africa, hydroelectric potential in Central and Eastern Africa, and coal in Southern Africa. Hydropower in sub-Saharan Africa has an enormous exploitable potential (WEC 2005): it currently accounts for 45% of sub-Saharan Africa's current electricity power generation (AfDB 2008), which represents only a fraction of the commercially exploitable potential. In addition, sub-Saharan Africa has abundant solar potential (Huld et al. 2005), and biomass is used extensively for household use, with prospects for increased commercial exploitation and electricity production (UNIDO 2009).

Expanding access to national electricity grids often constitutes the cheapest option for providing services. However, decentralized power, often based on renewable energy sources, is likely to be an important component of any significant expansion in electricity access, especially for rural and remote areas (Deichmann et al. 2010). Both system types can benefit from aspects of Smart Grid technologies.

REGIONAL AND NATIONAL INITIATIVES

The significant need for accelerated electrification rates has been identified by regional economic communities and national governments. In 2007, the Africa-EU Energy Partnership was launched (AUC and EC 2008; AUC and EC 2007) to support regional energy strategies, policies and targets. These regional ambitions are largely underpinned by national electrification policies, with more than 75% of sub-Saharan countries having defined targets for electricity access (WHO and UNDP 2009). The importance of regional and national electrification initiatives is clearly understood at the policy level. The priority is to translate this understanding into provision of electricity services 'on the ground'.

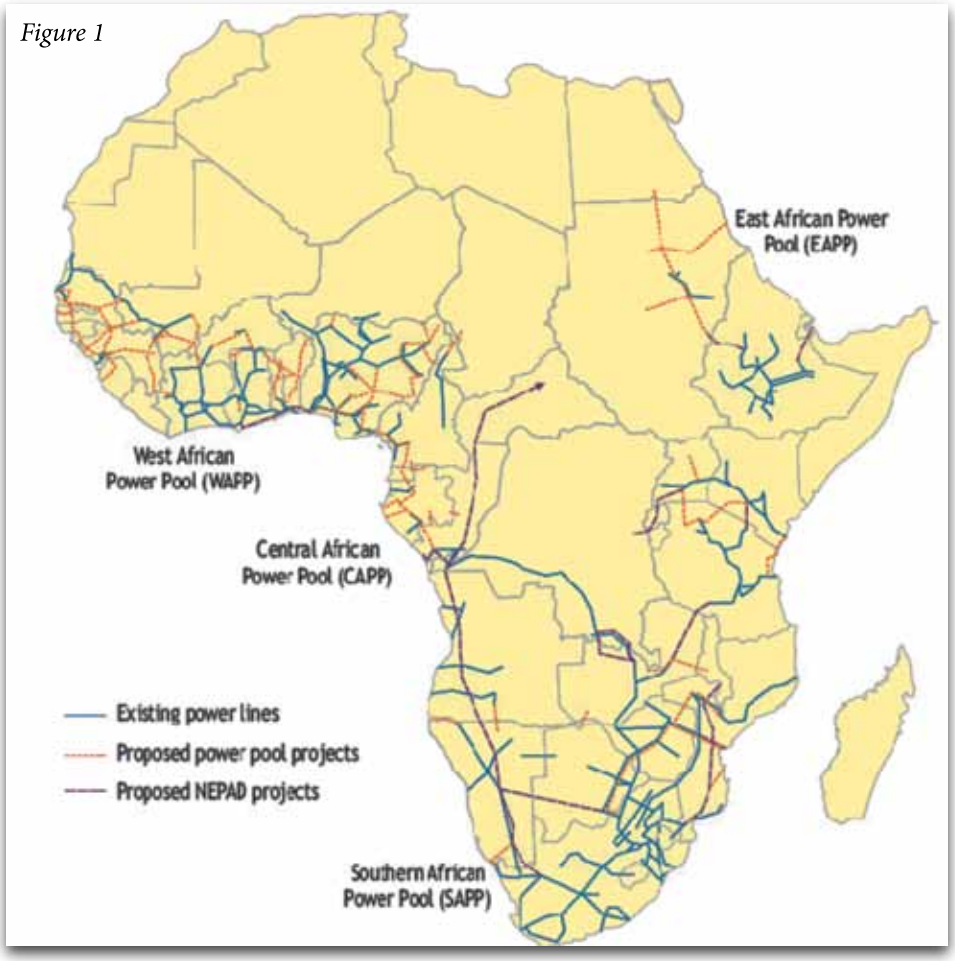
REGIONAL POWER POOLS AND REGULATORY AUTHORITIES

In addition to regional economic communities and national governments, the main actors for implementing electrification plans are the regional power pools and utilities. Regional power pools were established under the auspices of Regional Economic Communities to create competitive markets and improve delivery services to customers (L. Musaba and P. Naidoo 2005). They comprise the Southern, West, East and Central African Power Pools (the SAPP, WAPP, EAPP and CAPP, respectively), all at different stages of development (IEA 2008a).

The SAPP provides the most advanced example of a regional power pool (Gnansounou et al. 2007) in sub-Saharan Africa: it was created in 1995 as a result of electricity trading in Southern Africa, which began in the early 1960s (Sebitosi and Okou 2009; SAPP 2008). The creation of the WAPP followed in 1999 (ECOWAS 1999; ECOWAS 2007), with the CAPP in 2003 (L. Musaba and P. Naidoo 2005) and the EAPP in 2006 (COMESA 2009b). After the regional power pools were created, regional electricity regulators were established by the Southern African Development Community (SADC), the Economic Community of West African States (ECOWAS) and the Common Market for Eastern and Southern Africa region (COMESA).

Figure 1 provides an overview of the grid extensions foreseen by the regional power pools and utilities, with proposed projects showing the scale of opportunity for optimizing infrastructure design and delivery. It is clear that sub-Saharan Africa's national grids are not well interconnected.

Figure 1



A SMART GRID APPROACH

Smart Grids combine a range of innovative tools and practices supported by novel business models and regulatory frameworks to help ensure a reliable, secure and efficient supply of electricity services.

While there is strong consensus on this overall objective, the precise scope of the term Smart Grids is interpreted differently according to perspective and environment and it continues to evolve. A common functional and technical definition has yet to emerge (Brown, Technol, and Raleigh 2008). For our purposes, Smart Grids is a broad concept that covers the entire electricity supply chain and is characterised by the use of technologies to intelligently integrate the generation, transmission and consumption of electricity (MEF 2009). Thus, the elements of Smart Grids are part of a continuum of power sector tools and technologies.

DEFINING THE TERM

The Electric Power Research Institute (EPRI 2009) defines Smart Grid as, *"a modernization of the electricity delivery system so it monitors, protects and automatically optimizes the operation of its interconnected elements – from the central and distributed generator through the high-voltage network and distribution system, to industrial users and building automation systems, to energy storage installations and to end-use consumers...and their devices"*. Zibelman (2007) describes Smart Grids as an evolution of conventional grids in areas such as:

- Transitioning the grid from a mostly unidirectional radial distribution system to a multi-directional grid
- Converting from an electro-mechanical system to a primarily digital one
- Moving to an interactive grid that actively involves end-users (or at least improves data and flexibility of end-users)

Much of the literature focuses on how Smart Grids can help establish a two-way flow of information between supplier and user to increase the efficiency of network operations (ETP SmartGrids 2006; DOE 2008; Larsen 2009; ROA 2009; Battaglini et al. 2009; Willrich 2009; Doran et al. 2010). The European Technology Platform (ETP) outlined the notion of Smart Grids (ETP SmartGrids 2010) in a similar manner through the following elements: optimizing grid operation, use and infrastructure; integrating large-scale intermittent generation; information and communication technology; active distribution networks; and new market places, users and energy efficiency. The U.S. Energy Independence and Security Act (2007) emphasised: full cyber-security, smart technologies and appliances, timely consumer information and control, and standards for communication and interoperability. It is thus clear that well-informed and robust regulation is a key foundation for all aspects of Smart Grids.

TECHNOLOGIES

While Smart Grids are composed of complex and integrated systems, they often build on proven advanced technologies. Related technologies can generally be

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divided into those linked to physical power, data transport and control, and applications (Larsen 2009). The National Energy Technology Laboratory has identified and grouped many Smart Grid technology components (NETL 2007; NETL 2009):

- Integrated communications, including Broadband over Power Line (BPL), digital wireless communications or hybrid fibre coax;
- Sensing and measurement, including advanced protection systems, wireless, intelligent system sensors for condition information on grid assets and system status, and Advanced Metering Infrastructure (AMI);
- Advanced components, based on fundamental research and development, including Unified Power Flow Controllers (UPFC), Plug-in Hybrid Electric Vehicles and Direct Current micro-grids;
- Advanced control methods, to ensure high quality supply, including advanced Supervisory Control and Data Acquisition (SCADA) systems, load and short-term weather forecasting, and distributed intelligent control systems for Smart Grids to become self-healing;
- Improved interfaces and decision support, to reduce significant amounts of data to actionable information, including online transmission optimisation software, enhanced GIS mapping software and support tools to increase situational awareness.

Many countries are engaged in pilot projects to test such Smart Grid technologies, for example: the island of Jeju, South Korea (Baker & McKenzie and Austrade 2010; KSGI 2010); Yangzhou, China (Xu et al. 2010); Yokohama, Japan (Hosaka 2010); Boulder, Colorado, U.S. (Battaglini et al. 2009); the TWENTIES (EC 2010) and EcoGrid EU projects in the European Union (Danish Technological Institute 2009; EcoGrid EU 2010); and planned smart grid applications for Masdar City, United Arab Emirates (Masdar 2010).

Due to their strong reliance on communication protocols, Smart Grids need logical (computer) security as well as the physical security required by conventional grids, which previously constituted the main security concern (Doran et al. 2010). This will provide obstacles to all countries, but especially those without strong governance systems in place.

COSTS AND BENEFITS

The scale of investment required to enhance today's grids to meet the demands of future power systems is considerable. Based on the IEA's New Policies Scenario, total investment in transmission and distribution is expected to reach USD 7.0 trillion (in year-2009 dollars) for the period 2010–2035 (IEA 2009). According to the Brattle Group (2008), the U.S. electric utility industry is expected to invest USD 1.5–2.0 trillion in infrastructure within the next 20 years. Likewise, in East Africa alone, billions of dollars are required for supply and transmission infrastructure over the next two decades (BKS Acres 2005).

In OECD countries, a significant share of these investments is expected to target the implementation and deployment of Smart Grids. However, the detailed monetary implications are not yet fully understood (IEA 2010) and cannot solely be reduced to infrastructure investments. Smart Grids redefine the roles of power sector stakeholders. Developing the required human and institutional capacities to best respond to stakeholder needs and responsibilities will be essential for their successful implementation.

Smart Grids help to dynamically balance and optimize generation, delivery assets and loads. Associated key technical benefits include: improved reliability and resilience, cost-effective integration of variable resources and loads, increased efficiency of system operation, and optimised utilisation of both generation and grid primary assets. Smart Grids may deliver these benefits at potentially lower overall cost than would be possible under business-as-usual assumptions. In more detail, some of the benefits include:

Loss reduction: In current transmission and distribution systems, losses amount to approximately 9% of the electricity produced worldwide (IEA 2008b; IEA 2010). While Africa's average losses of 11% are close to the global average (IEA 2010), many countries in sub-Saharan Africa are characterized by much higher system losses of up to 41%, including non-technical losses (UN-Energy Africa 2008). Higher technical losses are due to less efficient and poorly maintained equipment; higher non-technical losses are due to theft (IEA 2003). Smart Grid technologies can help minimise technical losses in transmission by facilitating more effective reactive power compensation and voltage control, for example. They can address distribution losses through adaptive voltage control at substations and line drop compensation to levelize feeder voltages based on load (EPRI 2008). Non-technical losses such as power theft can be partially addressed with the help of smart metering infrastructure (M. Scott 2009).

Peak demand reduction: Active management of consumer demand through smart appliances and equipment will

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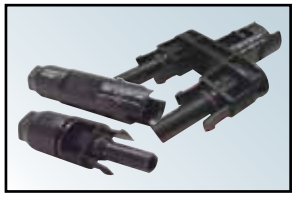

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Fax: (011) 879-6603

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Fax: (021) 594 7130

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reduce the need for spinning reserve (DOE 2003) and expensive electricity supply to satisfy peak demand (GridWise Alliance 2010). This could be achieved using demand response programmes (Medina, Muller, and Roytelman 2010). A reduction of 1% in peak demand could result in cost reductions of 4%, equalling billions of dollars at system level (Doran et al. 2010).

Quality of supply: Smart Grids can significantly contribute to reducing costs of grid congestion, power outages and power quality disturbances. They do this by increasing the reliability and quality of supply for consumers with high requirements, while providing less reliable and lower quality power at reduced costs for consumers with lower requirements (IEA 2010). Increasingly efficient automated operations will also help address and anticipate disruptions (GridWise Alliance 2010).

Latent network capacity: A greater role for demand, and more sophisticated asset management and operation, can help enable the release of latent network capacity by building on advances in equipment monitoring and diagnostics as well as supportive standards (U.K. House of Commons 2010). Technologies such as power flow control can have a huge impact on the effective utilization of network capacity under normal and contingency conditions.

In addition to technical benefits, potential benefits for the overall economy include:

Climate change mitigation: Direct and indirect benefits of Smart Grids offer the potential for yearly emission reductions of 0.9–2.2 Gt CO_2 per year by 2050 (IEA 2010). Direct benefits include reduced losses, accelerated deployment of energy efficiency programmes and direct feedback on energy usage. Indirect benefits include greater integration of renewable energy and facilitation of electric vehicles.

Job creation: Smart Grids should help trigger new investments and create new jobs. McNamara (2009) estimates that Smart Grid incentives worth USD 16 billion in the U.S. could trigger associated projects amounting to USD 64 billion. This would result in the direct creation of approximately 280,000 positions and the indirect creation of a substantially larger number of jobs.

Many of these potential Smart Grid benefits would be valid for sub-Saharan Africa, yet the concept and associated policies require refinement to optimise the cost/benefit balance in a sustainable manner.

SMART AND JUST GRIDS FOR SUB-SAHARAN AFRICA

Employing a subset of the advances in power systems provided by Smart Grids may enable sub-Saharan African countries to leapfrog traditional power systems to reach more effective solutions. This could accelerate national and regional electrification time-frames, while improving service and minimising costs and environmental impact. We introduce the term Just Grids to reflect the need for power systems to contribute towards equitable and inclusive global economic and social development. Given the specific needs of sub-Saharan Africa, it is obvious that a Smart Grid approach for this region cannot simply be a copy of practices in industrialised countries - the starting point, challenges and opportunities are too different. We consider how a redefined Smart Grid concept might usefully be implemented in sub-Saharan Africa.

REDEFINING THE CONCEPT

We broadly define the concept of Smart and Just Grids for sub-Saharan Africa as one that embraces all measures in support of immediate and future integration of advanced two-way communication, automation and control technologies into local, national or regional electricity infrastructure. The concept aims to optimise grid systems and their operation, integrate high levels of renewable energy penetration, and improve the reliability and efficiency of electricity supply. In addition to being smart, socially just power systems are required in sub-Saharan Africa in order to guarantee access to modern energy services without marginalizing the poor.

In the future, Smart and Just Grids for sub-Saharan Africa could provide similar functionality to Smart Grids in industrialised countries at full deployment, even though they are likely to follow a different pathway and timeframe. The diversity of the electrification status in sub-Saharan Africa means that lessons learned from other regions may be directly applied in certain areas, while tailored solutions will be required for others. Constraints such as: a lack of good governance, limited investment capital, largely inadequate infrastructure, and a gap in well-trained power sector personnel are likely stifling innovative practices that could already be occurring organically. While the costs for massively upgrading existing grids to Smart Grids may not be justifiable, the business case when investing in new infrastructure is significantly better, offering significant potential opportunities for sub-Saharan Africa. It will therefore be essential to

prioritise specific smart solutions based on clearly defined functionalities that help reduce costs, promote economic growth and improve long-term sustainability.

We next characterise the approach to realising a Smart and Just Grid system into several elements and attempt to conceive of their application in sub-Saharan Africa.

Smart policies: Simplifying requirements for rural electrification schemes, defining common ground rules for integrating technologies and business practices, balancing cost recovery mechanisms for utilities, identifying better ways to support effective demand-side management, and developing new policies to support the integration of distributed generation. All such policies would need to be underpinned by well- defined performance goals and transparent metrics to ensure effective monitoring of anticipated benefits.

Focus for sub-Saharan Africa: Leveraging international Smart Grid frameworks, legislation, regulation and standards, and adjusting them to the sub-Saharan African context will be essential. New policies may need to diverge from international precedent, in order to prioritize access to affordable electricity services for the poor, respond to rapid demand growth and urbanisation, and reduce theft of electricity and utility assets. Such policies should enable access through flexible, no-regret electrification strategies that accommodate expansions of stand-alone systems, mini and national grids, and that support their integration.

Smart planning: Adjusting the grid to local circumstances and developing design principles that ensure an effective inter-operability of existing and new grids, leading to even smarter networks over time.

Focus for sub-Saharan Africa: A balanced approach between regional grid integration, national grid enhancements and decentralised mini-grids is required. While smart mini-grids, such as those described in (Katiraei and Iravani 2006), may provide a short-term solution to rural electrification needs, their future integration into national and regional grids and vice-versa needs to be an integral consideration of power system planning.

Smart systems and operations: Guaranteeing the security and quality of supply through smart automation and control arrangements, building on load management and integration of distributed energy sources, for mini, national and regional grids, as shown in Ruiz et al. (2009).

Focus for sub-Saharan Africa: Country and locally appropriate supply quality standards will need to be derived. These may initially be less stringent than current practices in industrialised countries and may vary by class of service. Increasing the grid's load factor through demand side management may also significantly help reduce costs, especially for rural electrification schemes (Matly 2010).

Smart technologies: Deploying proven smart technologies, optimising inter-operability with emerging technologies, and developing future solutions to best address electrification needs (Massoud and Wollenberg 2005; You et al. 2002).

Focus for sub-Saharan Africa: The technology deployment path will vary widely at regional and country levels due to diverse needs and goals of different societies and markets. Defining these technology pathways and markets and verifying them through pilot projects will be important first steps.

Smart people: Building stakeholder capacity to facilitate the transition to Smart Grids, to operate the grids, and to attract and actively engage the private sector and consumers so that as many people as possible profit from the transition.

Focus for sub-Saharan Africa: Educating consumers in sub-Saharan Africa about efficient electricity use whilst moving towards Smart Grids will be essential, especially for those who previously had no access. Training tools and materials about state-of-the-art power systems will also need to be widely disseminated. Specific attention needs to be paid to the training of off-grid communities so they can manage and maintain mini-grid systems in a sustainable fashion.

Responsibility for ensuring that grids are smart and just falls mainly on governments and utilities as a public good. The following Just Grid characteristics are especially relevant to sub-Saharan Africa:

Just access: Ensuring universal access to electricity by:

- Encouraging electricity to be tapped-off from larger grid extension projects to local customers en-route. Connections for large consumers are often the primary driver for grid extensions. Such extensions may offer a great opportunity to connect the under-served at the same time;
- Using grid technologies that can cope with fluctuating supply and demand

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in rural areas and thus increase supply quality of supply, for example by building on strategic load control and management instead of conventional load shedding;
- Focusing on accelerated access to key electricity services rather than just on access to electricity.

Doing this in a 'smart' way may help governments deliver on their development agendas more effectively and at lower cost;
- Expanding service delivery under resource constraints by increasing the efficiency of electricity supply and use;
- Creating additional revenues for utilities through higher payment discipline, which would also encourage them to extend services to new customers.

Just billing and subsidies: Creating flexible tariff structures and payment schemes to ensure affordable and sustainable access to electricity services, by:
- Realising the potential of Smart Grids to help lower prices of electricity services by optimizing the utilization of grid assets, segmenting electricity markets according to reliability and quality requirements, minimising technical and non-technical losses by promoting smart and efficient appliances, and increasing cost-effective integration of renewable energy in remote areas;
- Providing additional support programmes to identify and foster productive uses of electricity to help ensure that low-income consumers can pay;
- Allowing for targeted subsidies through integrated smart billing to support 'basic' services such as food refrigeration, as opposed to 'luxury' services, like television.

There is clearly a vast array of Smart Grid elements available to support our redefined concept. They are not all immediately relevant, however, and some are either not developed enough or too expensive to be usefully deployed in the sub-Saharan African context in the short- to medium-term. Incorporating promising elements of future Smart and Just Grids in sub-Saharan Africa will require more than improved functionality, as has been observed with the adoption of other disruptive innovations (Christensen and Raynor 2003). A commercially successful business model including pricing, cost structure and sales process is key for a successful transition (Anthony 2004).

OPPORTUNITIES FOR LEAPFROGGING

The opportunity for Smart and Just Grids to leapfrog traditional power systems may mean that they can offer even more exciting opportunities to developing countries than to industrialised ones. While some components of Smart Grids are a good basis for leapfrogging in the short-term, others will be essential for setting the preconditions required today for enabling a transition to smarter networks as the technologies mature in the future.

Avoiding technology lock-in will be crucial, as the economic lifetime of electric power equipment can be longer than 50 years (DOE 2003; ESMAP 2007). Thus, the faster the transition to the required enabling environments, the better.

EFFECTS ON ENERGY PLANNING

The concept of Smart and Just Grids needs to be well integrated into national and regional energy planning in order to take advantage of the possible opportunities for technological leapfrogging. Traditional electricity planning took demand growth as a given and only considered supply side options (Graeber, Spalding-Fecher, and Gonah 2005). This traditional 'predict and provide' (Strbac 2010) approach – predicting electricity requirements and designing the power systems accordingly – is adopted in sub-Saharan models such as the SAPP expansion plan (Bowen, Sparrow, and Yu 1999) and the East African Power Master Plan Study (BKS Acres 2005).

Development is no longer considered to be solely linked to steady energy demand growth (COMESA 2009a). Due to sustainability considerations, energy planning increasingly considers demand-side options (Shrestha and Marpaung 2006), social and environmental aspects, and associated costs (WB 2008; COMESA 2009a). The complex nature of modern electricity planning requires an approach that satisfies these often- conflicting goals (Swicher, Jannuzzi, and Redlinger 1997) as part of integrated resource planning (IRP) (D'Sa 2005).

With a Smart Grid approach, planning increases in complexity as the grid evolves into an active layer between supply and demand. Planning for smart grids becomes an intricate exercise due to uncertainties about off-grid and distributed energy generation connections, as well as uncertainties about demand growth (MEF 2009).

In addition to optimizing electricity systems from a technical perspective, Just Grids need to be optimized from a development perspective. Ensuring services for marginalized and rural communities will often not be the most cost-effective

solution, so new constraints (or different objective functions) need to be added to traditional least-cost optimisation models.

The required expansion and adaptation of the traditional approach to energy planning needs to include a more active role for demand, linkages with storage, and the integration of mini-grids into plans for grid expansion. An example of this – though limited – is presented in Howells et al. (2005). In addition, modern energy planning needs to balance sustainable development plans carefully with regional energy integration and national and local Smart Grids. The importance of complex multi-criteria decision making will consequently continue to increase (MEF 2009; Hobbs 2000).

EFFECTS ON REGULATION AND DESIGN PRACTICES

Present regulation often rewards utilities for delivering network primary assets rather than improving performance through more sophisticated management and advanced network technologies. Thus, regulation can hinder Smart Grid developments that do not focus on investments in network assets.

Most current network design and operation practices centre on the historic deterministic N-1 approach that was developed in the late 1950s (Willis 2004). This has broadly helped deliver secure and reliable electricity services, alongside various other traditionally applied redundancy measures. These approaches can, however, impose major barriers for innovation in network operation and implementation of technically effective and economically efficient solutions that enhance the utilization of grid assets. Yet, the existing network and its standards are commonly taken as granted in research work, thus constraining the applicability of diverging approaches (Khator and Leung 1997).

While the "natural laws of transmission and distribution" described in Willis (2004) still apply, the future grids required in sub-Saharan Africa may offer fertile ground for a radical departure from such traditional regulation, grid design and operation practices, because of the significant infrastructure building requirements in the region.

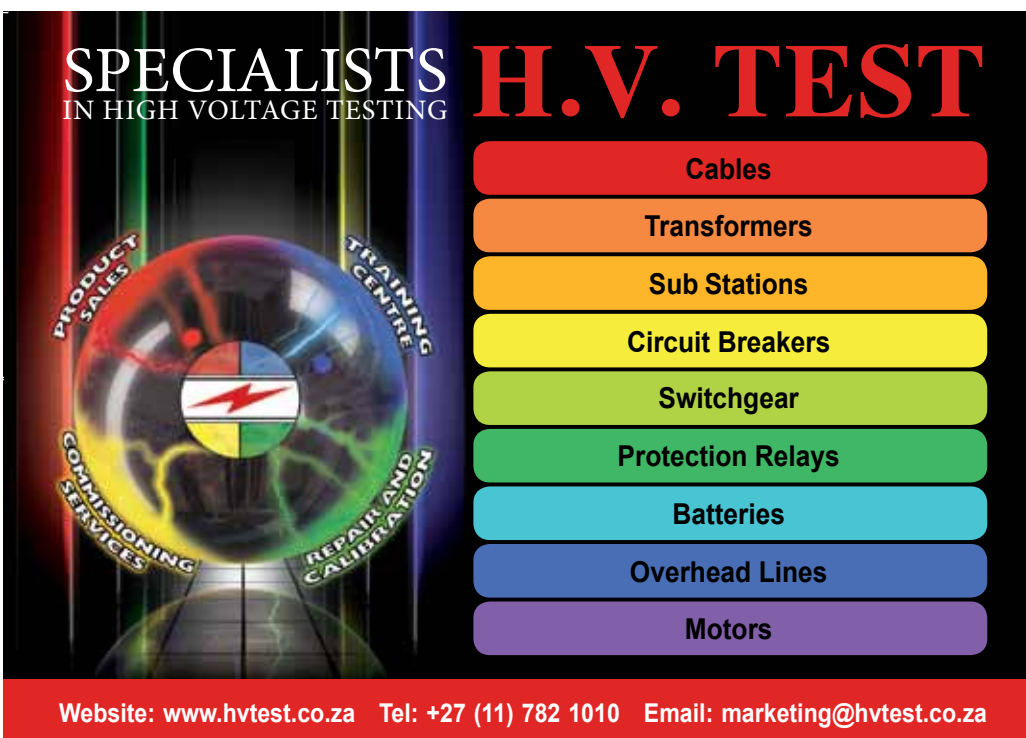
For example, Divan (2007) demonstrates significantly higher network capacity while meeting N-1 contingency constraints using economical distributed power flow control devices. Even higher utilisation is realized if the N-1 constraint is dropped. A relaxation of power quality and reliability standards based on the advances of Smart Grids may therefore enable sub-Saharan Africa to profit from the associated significant cost savings potential.

Future network regulation and design is therefore required to facilitate the implementation of the economically best solutions. This will occur by balancing asset- and performance-based options, particularly those that involve responsive demand, generation and advanced network management techniques.

In sub-Saharan Africa, novel regulatory regimes will need to incentivise innovative ways of enhancing access to the grid.

EFFECTS ON OVERALL MARKET DESIGN

Innovation is required not only in technologies and regulation, but also in market models. Information systems infrastructure will help facilitate a shift to distributed control, with demand response becoming a key resource for delivering network flexibility and control. This will require significant changes in electricity market design principles, with a move away from traditional single-sided competition in large-scale generation.



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Ultimately, a cost-effective system requires all players to interact competitively, optimising demand and supply (Strbac, Ramsay, and Moreno 2009). This would require a competitive, user-centred distributed energy marketplace based on real-time prices designed to integrate wholesale and retail energy markets.

While such markets are still mostly conceptual, in time, it will be important to understand and integrate demand into system design and operation for sub-Saharan Africa, supported by user-centric market models. This approach will be critical for enhancing access to electricity services, especially given the magnitude of the economic value of associated benefits such as enhanced asset utilization and improved operational efficiency.

TRANSMISSION AND DISTRIBUTION SYSTEMS

Crucial benefits of electricity grids result from a diversification of both demand and supply. National distribution networks of several thousand households are usually large enough to profit from demand diversity and associated significant savings in supply capacity requirements (Strbac, Jenkins, and Green 2006).

Larger transmission networks are required to profit from diversification of supply (Bazilian and Roques 2008) by exploiting regional energy resources and infrastructure. Transmission expansions can significantly enhance the ability of the system to minimise fluctuations in demand and supply, increase the availability of back-up capacity (ECF 2010), and minimise the required spinning reserve. This is especially true when accommodating increased levels of intermittent renewable generation.

Critical voices like Sebitosi & Okou (2009) however regard grand infrastructure plans to link up the African continent's power grids as obsolete in the age of Smart Grids. Some aspects of this view are mirrored in the U.S. by Cavanagh (2008)67 and Fox-Penner (2005), who emphasise the importance of focusing on regional and sub-regional grids. However, as an example, high-capacity transmission corridors are still expected to form the backbone of the U.S. grid in 2030 (DOE 2003).

Sebitosi & Okou (2009) further suspect that super grids would *"largely serve to extract untapped natural resources from the less developed to the more industrialized members"*. An example they cite comprises high voltage direct current (HVDC) lines to integrate renewable energy from North African countries into the European power system (Battaglini et al. 2009; DESERTEC Foundation 2009). Such plans seem to be the main focus of current discussions on modern grid investments in Africa. It remains to be seen to what extent the underserved in Africa will profit from such initiatives.

APPLYING THE CONCEPT

Particular elements of Smart and Just Grids will offer tangible and direct benefits in the short-term. Their application will serve to test and enhance the concept in the sub-Saharan context, and help us understand how to expand its scope in the future. These elements include:

Transmission and substation design: Especially for longer transmission lines, the scale of technical losses can become considerable. Smart Grids can help reduce such losses, for example by improved power lines and transformers, as well as implementing regular maintenance schemes (Niez 2010). Wide-area monitoring and control can support the accurate information required for real-time decision making to respond better to disturbances within the system (SCE 2010). This will enhance utilization of primary grid infrastructure and contribute to a more efficient system operation. Some of the required advanced transmission technologies may target the more developed existing grids in sub-Saharan Africa, and may be disproportionate in areas with limited grid coverage.

Distribution system design: Distribution automation technologies can help improve power systems by extending intelligent control (SCE 2010). For example, smart sensors and flexible and intelligent switches and interrupters at critical points on distribution circuits will minimize the extent of outages and increase the speed of restoration, while keeping cost increases at a minimum. Smart distribution technologies allowing for increased levels of distributed generation will be especially important for addressing rural electrification needs and minimise connection costs. The planning and design of these networks will require full horizon planning, i.e. a 20 year plus period. The development of these grids will be atypical but existing work on distribution planning may provide a canvas from which to work (Fletcher and Strunz 2007).

Non-technical losses in developing countries can often be attributed to uncollected debt, tampered meters and inconsistencies in billing due to corrupt meter readers or illegal connections (Niez 2010; Zheng 2007). Power theft often contributes significantly to overall system losses in developing countries, reducing the economic performance of utilities.

High-voltage distribution lines can help prevent illegal connections and improve power quality and reliability (Niez 2010). Smart metering infrastructure with an independent transformer-loading based validation process can help reduce theft further. Additionally, meter-based tariffs incentivise an efficient use of electricity, which can result in considerable load reduction.

Smart mini- and micro-grids: Mini-, and especially micro-, grids with high shares of renewable energy are generally complex to implement, primarily because of fluctuating generation and a low load factor. The task of maintaining adequate power quality becomes a challenge, for example due to spikes associated with the starting current of motor loads (Makarand, Mukul, and Banerjee 2010) or the need to provide some form of back-up power. Smart components can help cushion such effects and better balance the overall system, through integrating new demand side management options. Costs of such systems may be further cut through the implementation of (DC) micro-grids, especially when combined with photovoltaic generation. While losses can be reduced through saving layers of DC/AC power conversion, the more expensive protective devices required for fault management and control, such as coordinated power converters, add complexity and outweigh some of the potential savings.

Demand side management: Demand side management options for large consumer loads, like load control switches at industrial or institutional facilities, can contribute to optimising the quality of energy services and reducing load-shedding. This usually affects the poorest electricity consumers the most. Radio-controlled interruptible institutional water heaters or water pumping systems constitute just two examples for such load control. At the household level, smart appliances could also contribute. For example, smart refrigerators that hold enough thermal storage to withstand interruptions or avoid power use during peak loads could be deployed. Smart Grids would further allow the prioritisation of consumer loads according to public importance, guaranteeing a higher security of supply for buildings such as hospitals rather than for enterprises or households. As shown in Jazayeri et al. (2005), due consideration of price and system security is essential. As part of such load management, a Just Grid could ensure reliable and low-cost access for the poor during off-peak hours, for activities such as cooking, while curtailed access would be provided during times of higher demand. This could also encourage people to adopt energy-efficient practices for peak times, either because of higher tariffs or dependency on batteries.

Local charging stations: While rural electrification is a priority in many countries, it cannot be entirely equated with electricity access for the poor, as millions of people live near the grid but cannot afford a connection (Meier 2001; WB 1995). For these people, charging stations ensure a minimum level of access to electricity services, for example, for charging lanterns or batteries to power their radio or TV. Elaborating a successful business model for battery charging services at these stations may further contribute to increased power quality and reliability in mini-grids, by compensating power flow and voltage fluctuations. Charging stations could further minimise or eliminate the running of back-up diesel generators and spawn local businesses and jobs. Another possibility would be the introduction of electric bicycles for taxi services; these could be charged at stations during off-peak hours, combining income generation with demand side management.

Billing schemes: As many Smart Grid components build on ICT, they might profit from 'piggybacking' on future telecom service expansions, such as the provision of electricity consumption information via mobile phones. Charging prepaid consumption credits via mobile phones using scratch cards or comparable devices may help address the specific needs of the poor and reduce administrative costs related to meter readings and billing. A basic time-of-use pricing scheme at household level may easily be introduced in sub-Saharan Africa to help balance demand. Conceivably, tariffs may even be delineated by service to allow for targeted subsidies. For energy-intensive industries, real-time pricing may be considered. In addition, on-bill financing of energy-efficient appliances may be an important tool to help consumers overcome high upfront costs.

Information systems architecture: Smart data management tools will help utilities distil relevant information in a manageable and understandable format. Diagnostic software will further help monitor the health of grid assets, predict problems in power distribution, and initiate corrective action. The required architecture must ensure inter-operability and enable a smooth transition from existing to future power systems (SCE 2010). Special attention to security issues will be required in countries with limited robust governance regimes.

Smart & Just Grids

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User-friendly interfaces, such as cell-phone billing and transparent metering, will be equally important to engage customers successfully.

ENSURING COORDINATED ACTION

Regardless of which specific aspects of Smart and Just Grids for sub-Saharan Africa are pursued, international cooperation will be essential. Such cooperation would further benefit from the close involvement of organisations such as existing Smart Grid alliances in industrialised countries (e.g. ETP Smart Grids, GridWise Alliance) and nascent bodies like the International Smart Grid Action Network or the Global Smart Grid Federation, both announced at the First Clean Energy Ministerial (2010). South–South Cooperation should form an integral element of the required international action as many sub-Saharan African countries face similar challenges to the developing and emerging economies of countries such as India.

More specifically, Smart and Just Grids for sub-Saharan Africa can profit from international cooperation in the following areas:

Analysis of potential and roadmaps: Identify sub-Saharan Africa's potential to profit from Smart and Just Grids, including an assessment of associated costs and benefits. Develop a road map up to 2030 including identification of technology solutions that can be rapidly and cost-effectively deployed in the short-term. This roadmap could be aligned with similar efforts by the IEA.

Country assessments: Provide international support for preliminary assessment of the power sectors and their needs, focusing on policy, regulatory, legal, institutional and commercial frameworks, energy planning tools, transmission and distribution system design, operational modalities, technologies and technical standards. Based on this assessment, develop country-specific business and development cases for Smart and Just Grids, with clearly defined technology transfer routes. Prioritise investments in specific smart elements with clearly defined mechanisms for return on investment.

Power system design: Develop and deploy internationally supported open-source or widely available modelling tools and capacities for power system design and operation.

Adjust power system design to the specific context: simple planning tools can address urgent electrification needs in, for example, post- conflict areas; more sophisticated tools are required to upgrade extensive existing power systems to Smart and Just Grids. It is critically important that the architecture developed enables future system upgrades without adding significant costs during early implementation stages.

Pilot projects: Implement joint pilot projects based on identified fast-track solutions. As the deployment of smart electricity systems redefines the roles of stakeholders, these pilot projects will help understand stakeholder behaviour within these redefined roles and test the markets before engaging in massive rollouts. Remote rural electrification schemes with higher penetration rates of renewable energy sources would serve as a particularly good starting point for testing the concept of Smart and Just (mini-) Grids.

Enabling environments: Help promote supportive policy, regulatory, institutional, legal and commercial frameworks, including the required codes and standards. Sub-Saharan Africa especially can profit from ongoing efforts in industrialised countries to adjust related network standards.

Additionally, legislation precedents can be employed to help reduce electricity theft. Further, international design competitions supported by financial reward could support business case development by helping to highlight challenges and develop innovative solutions.

Capacity-building initiatives: Based on skills assessments, train key stakeholders such as Ministries in charge of energy issues, power pool representatives, energy regulators and national system operators on the Smart and Just Grid concept. Developing the asset management capacities of African utilities and energy entrepreneurs to maintain technical systems and equipment will be vital for ensuring the sustainable deployment of Smart and Just Grids.

Concerted international efforts to develop centres of competency in power engineering for selected sub-Saharan African countries will help build up the required regional and national expertise.

For a successful transition towards smart and just energy systems, such international cooperation will need to be complemented by close engagement with regional and national stakeholders, from policy and institutional levels to generators, consumers, power equipment manufacturers and ICT providers. While Smart and Just Grids require strong public commitment, including funding, the private sector as the main engine of economic growth has

an essential role in supporting related initiatives in sub-Saharan Africa. Creating reliable investment environments will help to engage all key players effectively.

CONCLUSION

Sub-Saharan Africa is characterised by significant electricity-related challenges in terms of resources, infrastructure, cost and sustainability. A number of regional and national energy strategies, policies and targets aim to address these challenges and accelerate electrification rates, although they have yet to translate into significant implementation measures. Finding ways to enhance future power systems represents a key task for governments, regional power pools and utilities. Some approaches may enable sub-Saharan Africa to leapfrog traditional power systems practices and move to Smart Grid elements in the short term. Others will require preconditions to be established in order to avoid technology lock-in and ensure compatibility with new concepts and technologies in the future.

We have described an augmentation of the concept of Smart Grid and presented a broad definition of Smart and Just Grids for sub-Saharan Africa, embracing the need to guarantee inclusive access to modern energy services without marginalizing the poor. This refined concept will need to be carefully integrated into national and regional energy planning, regulation and markets, in order to balance the costs and benefits of regional grid integration with those of national and local Smart Grids.

We have further identified some elements of Smart and Just Grids that offer tangible and direct benefits in the short-term. Exploring the concept of Smart and Just Grids by implementing these elements and suggested areas for international cooperation will be essential for realising significant future benefits. These will go well beyond improved voltage and frequency control.

From an economic perspective, reliable energy supply through Smart and Just Grids will help foster economic growth. From an environmental perspective, Smart Grids will support and accelerate a cost- effective transition to low-carbon economies by lowering greenhouse gas emissions. Finally and most importantly, from a societal perspective, access to electricity is a prerequisite towards development as it is linked to many aspects of the development agenda, including access to better health services, education and security.

The massive electricity infrastructure requirements in sub-Saharan Africa offer a unique opportunity to learn from grid developments in industrialised countries and move forward without necessarily repeating all previous development stages. We should take advantage of this significant opportunity to ensure that sub-Saharan Africa's future grid is designed in a way that is both smart and just.

ACKNOWLEDGEMENTS

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Earn CPD Credits

Fuel cells, the "new kid on the block" for off-grid power generation

In the last couple of years fuel cell technology, a source of clean energy, has become a viable option for power generation. Fuel cells utilise renewable resources as a source of fuel that can either be supplied in gas form or electrolyte mixtures.

This is the reason the field of power generation using fuel cells is a topic that is researched, implemented and tested in various institutions and companies across the world today. Many of these research projects into fuel cell technology are of a research and development (R&D) nature. This is evident in the large number of papers and articles published in recent years.

The market development project by Anglo American Platinum in partnership with Ballard Power Systems Inc., demonstrates fuel cell micro-grid technology for rural electrification at the Naledi Trust community, situated on the outskirts of Kroonstad, South Africa. Kroonstad is located in the Free State Province and is situated approximately 180 km from Johannesburg's CBD. This is a field trial that will run for a period of approximately 32 months and is expected to conclude at the end of March 2017.

The Naledi Trust community has been without grid power for a number of years. The community

In recent years renewable energy has become a worldwide favourite subject in the field of electric power generation. Solar power generation has become a very popular source of power for off-grid applications in various sectors. These include agriculture, telecommunication, residential, rural as well as grid-tie applications as found in the Northern Cape Province, South Africa. Wind as a source of power generation is also a viable option. Wind farms are mostly found in the coastal areas of the Eastern Cape Province, South Africa.

BY | NEELS ERASMUS | PR. ENG
JOHAN VAN WERKHOVEN | PR. ENG | SMSAIEE

load consists of 34 houses. The objective of this field trial is to test the feasibility and reliability of fuel cell technology,in the form of the Ballard ElectraGen™-ME (EGME) fuel cell system as replacement for grid power. A battery bank is the secondary power source and will be charged by means of the fuel cells as the primary power source.

The load profile for the Naledi Trust community was estimated using statistical data for similar communities in South Africa, as well as using the living standards measure (LSM) as given in the NRS 034-1:2007. There are two main seasonal curves, namely summer and winter, which can be used for approximations of possible consumer loads. These two curves can be grouped into two main sets of data consisting of weekday and weekend (Saturday and Sunday) curves. The weekend winter curves were used for the community load approximations and are indicated in figure 1. The hourly kWh averages incorporate additional estimation factors to account for possible spikes in the community load.

The power generation plant, also referred to as the power generation module (PGM), utilises 3 x 5 kW Ballard EGMEs, a 48 Vdc battery bank and inverters. The PGM has a surface area of approximately 400m^2 and supplies the Naledi Trust community that comprises of a surface area of approximately 70 000 m^2. The existing infrastructure for the power reticulation was utilised for the project.

The total inverter capacity for the PGM is 60 kVA, although for this field trial the total installed generation capacity is

Fuel Cells

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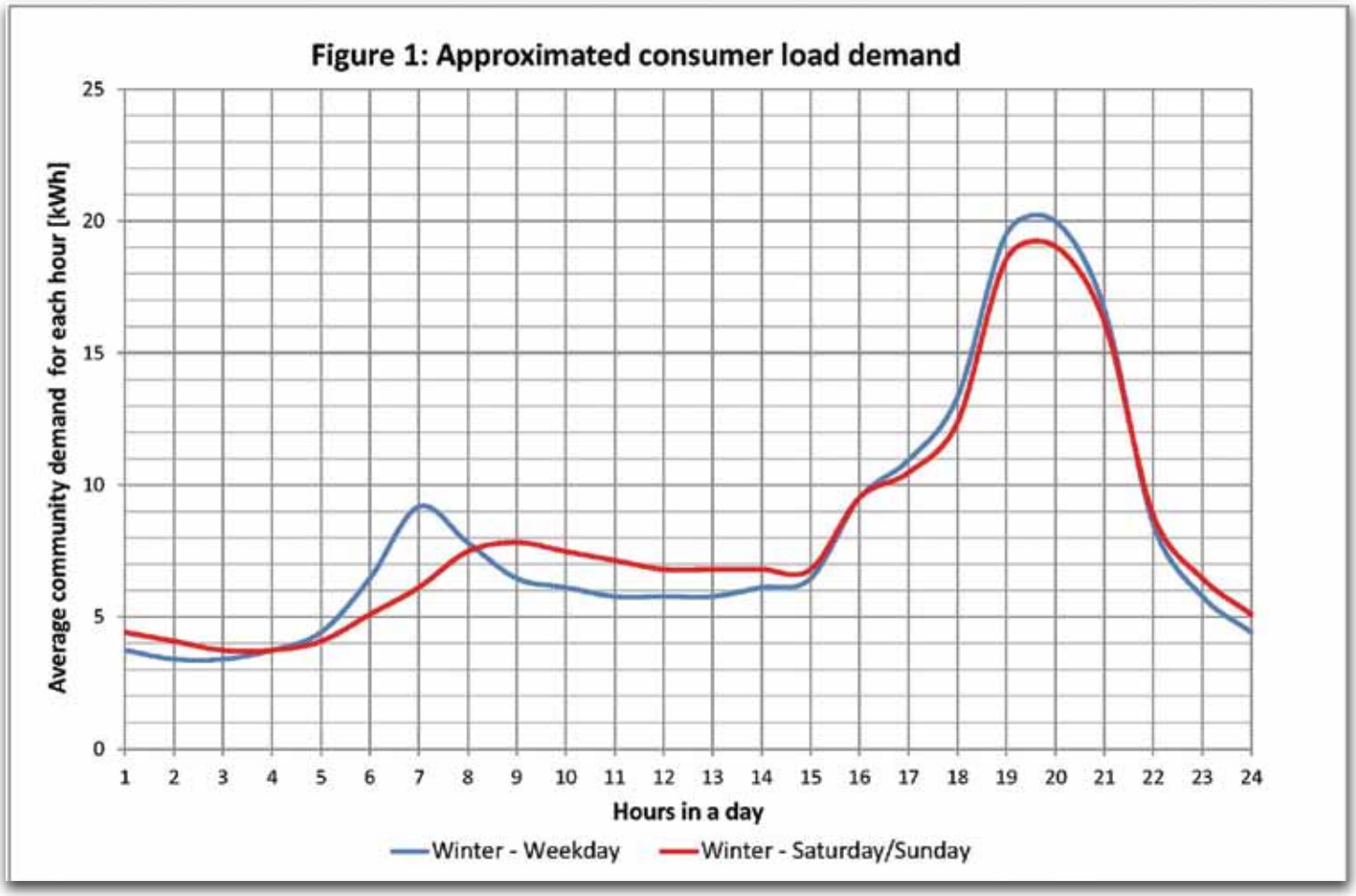

sufficient to supply 15 kW beginning of life continuously. The secondary storage (battery bank) capacity is sufficient to supply up to 10 kW for three to four hours during peak consumer load times. The simplified flow diagram is provided in figure 2.

The Ballard EGMEs each have two 2.5 kW stacks utilising proton exchange membrane (PEM) technology and use platinum as a catalyst to facilitate chemical reactions in the stacks. The EGMEs use HydroPlus™ fuel that is a mixture of de-ionised water and methanol. The HydroPlus™ is stored in a 14 000 litre tank and is gravity fed to each EGME. The nominal output voltage of each EGME is 48 VDC with a maximum voltage of 55.8 Vdc. The main advantages the EGMEs have on diesel generators are the considerable reduction in CO_2, CO, NO_x and SO_x emissions as well as reduced sound emissions.

The battery bank consists of 24 x 2 Vdc, 1520 Ah vented lead acid deep cycle cells, which is used as a secondary power source for peak load times. The battery bank is connected in parallel with both the three EGMEs and the inverters. The EGMEs not only supply the consumer load with power, but will also charge the batteries when the consumer load is less than 15 kW.

The PGM has a bank of 6 x 10 kVA installed inverters supplying power to the consumer load, with one additional 10 kVA inverter supplying power only to the plant auxiliary loads. The inverter bank is configured to supply single phase power at a nominal 230Vac. The inverter bank has one master inverter that synchronises all the inverters in the bank.

The R&D nature of the project requires measuring and recording of data. The PGM is designed in order for all relevant AC/DC voltages and currents to be recorded. Other plant wide parameters recorded include the relative humidity, temperature, battery bank temperature and all relevant HydroPlus™ fuel flows and levels. A programmable logic controller (PLC) in the plant monitors all the plant wide

parameters for control as well as activation of various safety circuits under specified conditions.

The individual community loads are monitored, recorded and controlled independently from the PGM. The devices used are CONLOG pre-paid meters and are similar to ones used by the Moqhaka local municipality in Kroonstad. The other system used for monitoring, recording and control are devices from UtilLabs. These devices can be monitored on a web-based dashboard, which could be used not only for emergency load shedding but also for disconnecting individual consumers for non-compliance if required. This can be done either manually from the dashboard or set to automatically disconnect consumers at specified set points.

This project will be analysed not only by Anglo American Platinum and Ballard Power Systems Inc. but also by various universities from across South Africa. This project will be an effective trial to analyse the reliability and viability for off-grid power generation utilising fuel cell technology. This R&D project will demonstrate if fuel cells used for primary power generation can be classified as the *"new kid on the block"* in the world of alternative energy.

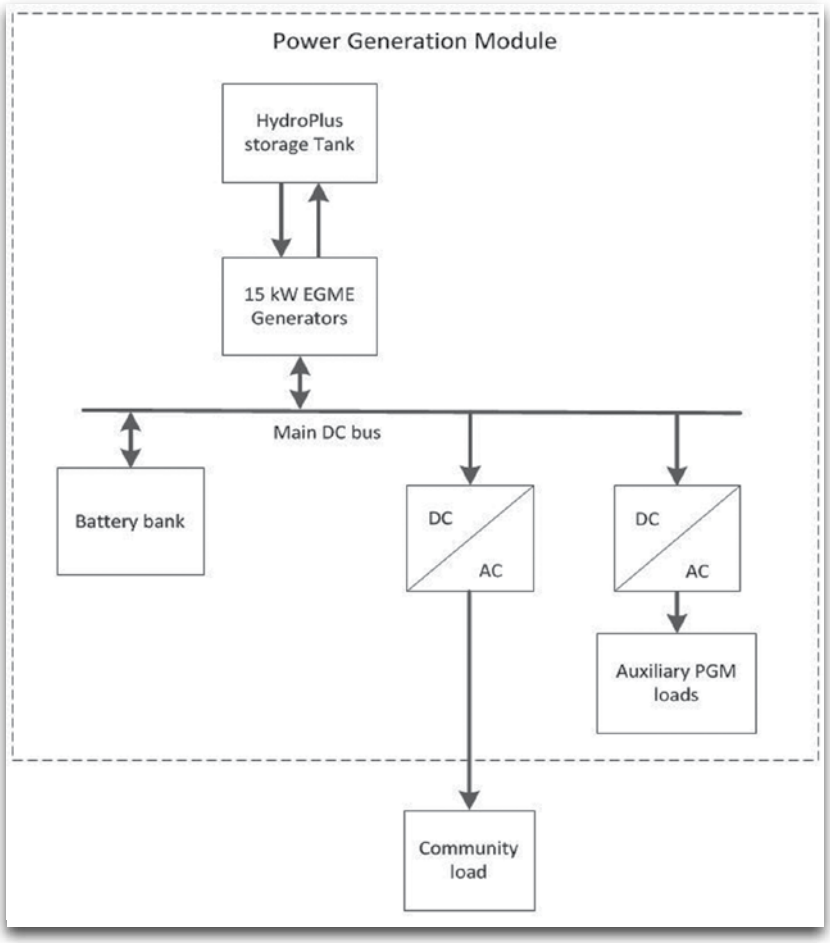

Figure 2: Simplified PGM flow diagram

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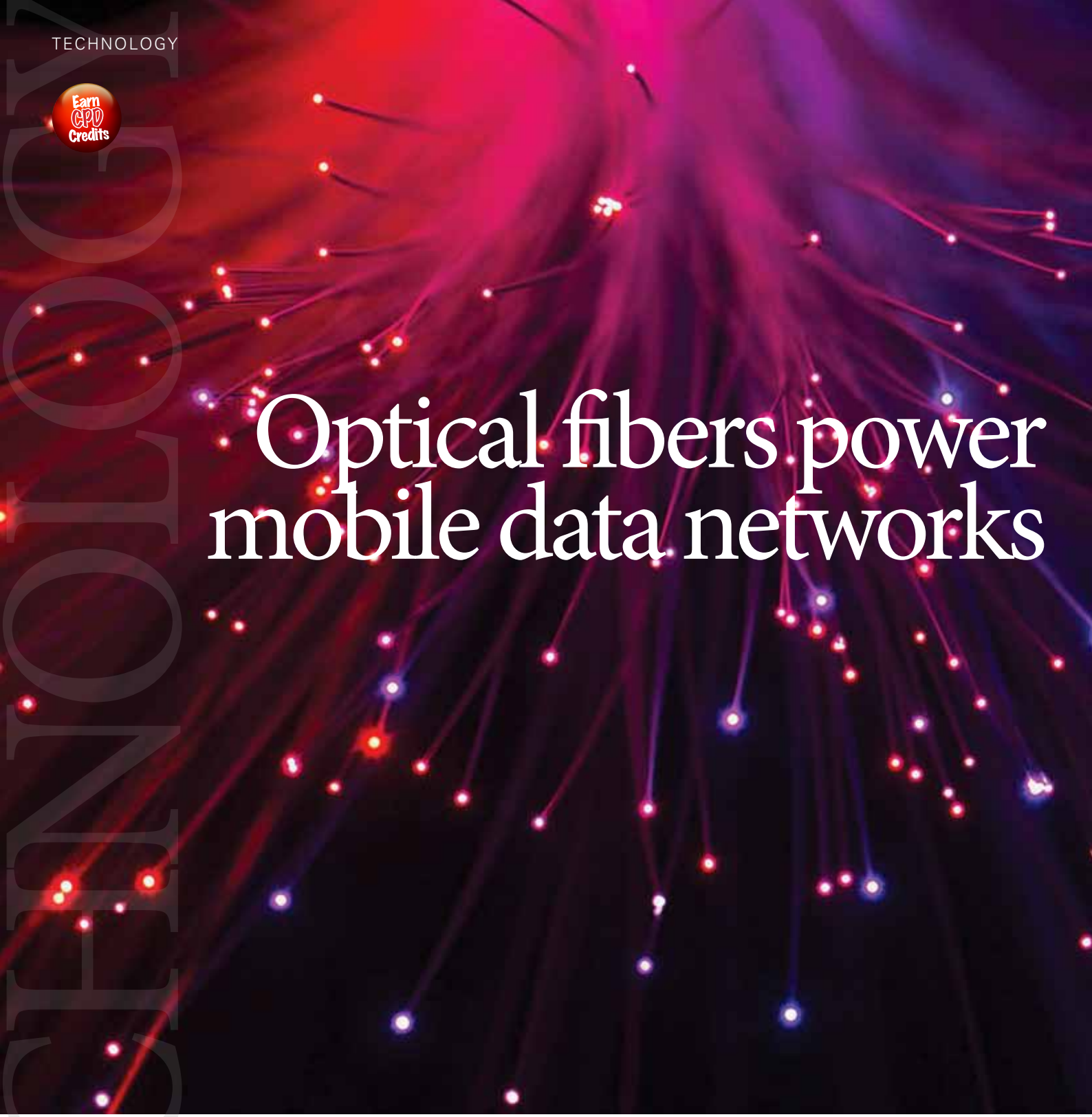
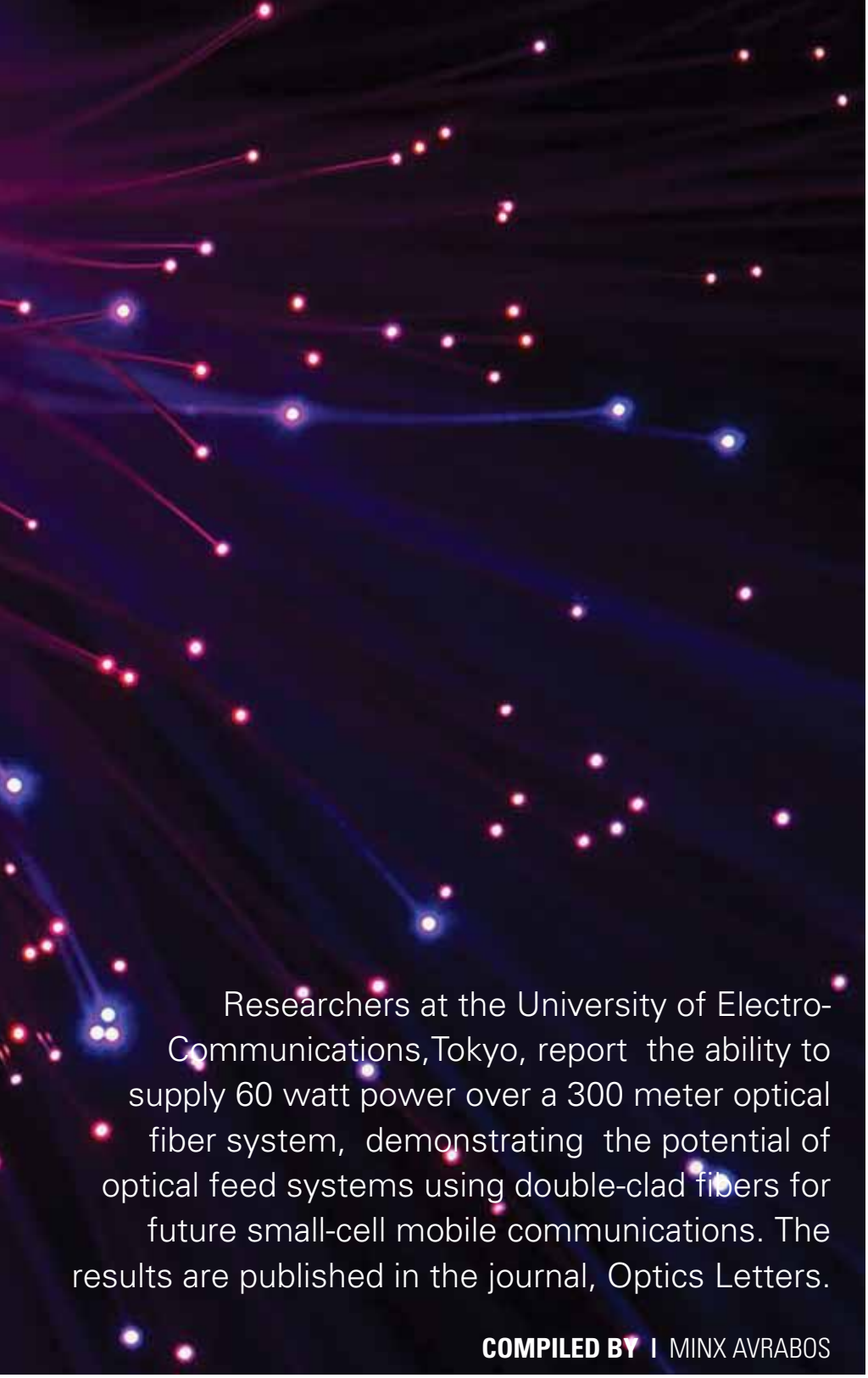


Optical fibers power mobile data networks

Increased data use is placing greater demands on the radio antenna units which transmits data to mobile devices. Supplying power to these antenna units by the same optical fibre systems that transmit data signals, could improve and simplify these infrastructures if the power supply can be increased. Now Motoharu Matsuura, Hidehito Furugori and Jun Sato at the University of Electro-Communications have demonstrated the ability to supply 60 W over a 300 m test fibre system, exceeding the power supplied in previous work and emphasising the potential of the approach.

Power supply over fibre is limited by the power transmission efficiency, which is impeded by the



Researchers at the University of Electro-Communications,Tokyo, report the ability to supply 60 watt power over a 300 meter optical fiber system, demonstrating the potential of optical feed systems using double-clad fibers for future small-cell mobile communications. The results are published in the journal, Optics Letters.

COMPILED BY | MINX AVRABOS

large fraction of power fed into the optical link that is lost as heat during transmission. As a result, restrictions on power feed levels are needed to prevent waste heat damaging optical components in the link.

Matsuura and colleagues had demonstrated that they could bundle together two multimode fibres for transmitting power with a double clad fibre for transmitting the data. This bundle was tapered and fused to a double clad fibre output. However, power was lost in the tapered fibre bundle divider due to the lower cross-sectional area occupied by fibre in the cluster bundle. As a result the overall power transmission efficiency was only 20% limiting the power that could be fed into the link to just 40W.

Increasing the number of multimode power-carrying fibres to six optimised the cross-sectional area of fibre in the bundle cluster without introducing other limitations, thereby maximising the power transmission efficiency. In their report the researchers conclude, *"These results demonstrate that optical feed systems using double-clad fibres have high potential for practical use in future small-cell mobile communications."*

MOBILE DATA NETWORKS

Radio antenna units wirelessly transmit data from a central station to mobile devices at radio frequencies. The central station transmits data to the antenna units using radio over fibres.

The power for the radio antenna unit is usually supplied by the mains but the proposed power over fibre could simplify the power supply. In addition power over fibre would leave the antenna units invulnerable to interruptions in mains power supply, such as during lightning damage. While power-over-fibre options have attracted the attention of researchers, so far the power available over fibre has been limited.

TEST SYSTEM DETAILS

The researchers tested their fibre cluster of power and data fibres in a bidirectional system consisting of a central station and a radio antenna unit linked by a double clad fibre.

A laser diode with direct electrical modulation from a signal generator produced test signals at 1550 nm to the standard specifications of the Institute of Electrical and Electronics Engineers (IEEE) for the wireless local access network (WLAN) used in wi-fi (specifications IEEE 802.11 g). Commercial laser diodes

Optical Fibres

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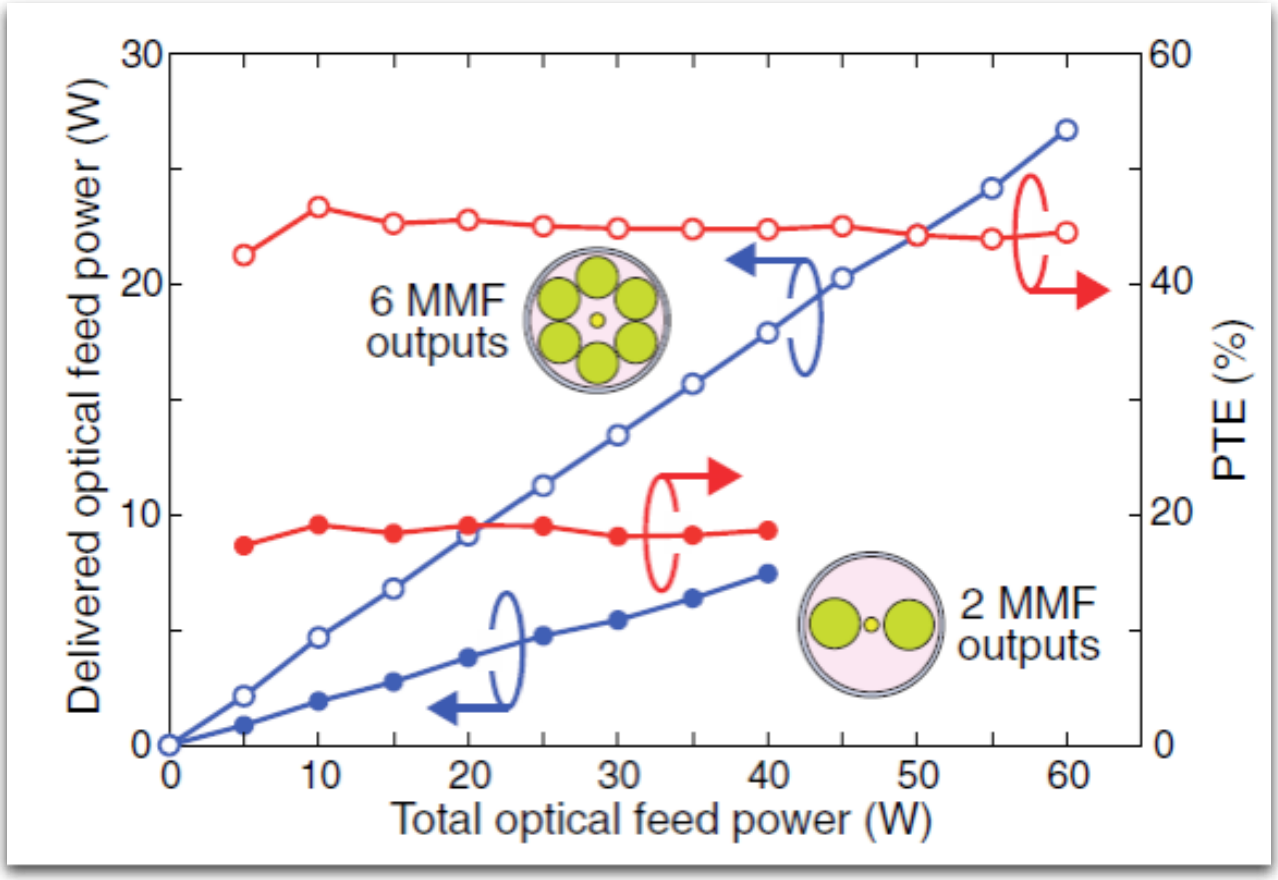


Delivered optical feed power and power transmission efficiency (PTE) as a function of total optical feed power launched from the two high-power laser diodes. The solid circles show the results of our previous scheme with a tapered fibre bundle divider consisting of two multimode fibre (MMF) outputs, while the open circles show the results obtained from this work with a tapered fibre bundle divider consisting of six MMF outputs. The insets illustrate how using a greater number of narrower MMFs leaves less empty space and increases their total cross-section.

also fed the optical power.

An erbium-doped fibre amplifier boosted the signal and increased the power level of the data signal for the transmission. The system also included elements to reduce the noise, including bandpass filters and cladding mode strippers.

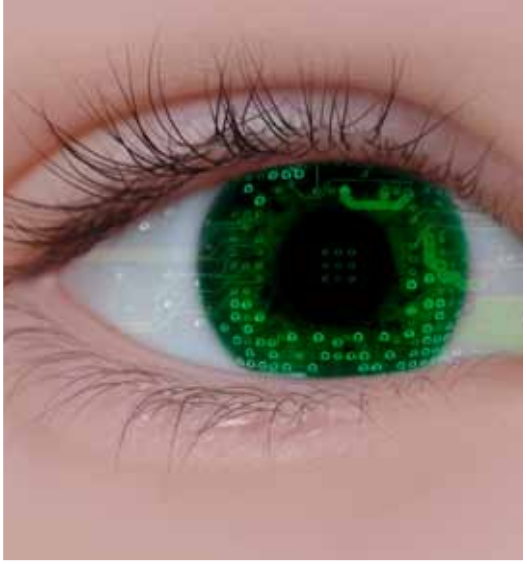
The multimode fibres and the double clad fibre in the fibre bundle cluster input were tapered and fused to a 300m double clad fibre transmission output. The double-cladding prevents crosstalk. Expense prohibited use of a longer output double clad fibre in the test system. Double clad fibres are usually commercially produced for use as gain media, for which they do not need to be much more than 100m long.

CROSS-SECTIONAL COMPROMISE

The researchers identified the combined cross-sectional area of the two multimode fibres as the limiting factor for power transmission efficiency.

The two multimode fibres left empty space in the bundle cluster that was unoccupied by fibre, so that the total fibre cross-section was smaller than that of the double clad fibre it fused to, making power transfer inefficient. Using a greater number of narrower multimode fibres increases their filling factor within the bundle and hence their combined cross-sectional area.

However this also means each fibre is narrower, and this reduces the power-handling capability of each fibre. The researchers determined that a bundle of six multimode power-handling fibres gave the optimum compromise between the two limiting factors. wn



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F 086 537 3589

E wayne@bergmanfisher.co.za

The consulting engineering industry, and particularly that in the "Built Environment" is, we believe, under threat as viable businesses and their ability to render quality services.

BY | CLIVE ALBRECHT
PR.TECH (ENG) | PR TECHNI ENG

This is as a result of the decision by National Treasury and the Competitions Board requiring consultants to tender for work using standard procurement policies.

There are three main issues:

- Engineering practices are being forced to tender for work, offering their services at large discounts in order to win tenders. This impacts their ability to give each project the time and the level of experience required.
- The process of preparing and submitting tenders is time consuming and thus impacts on productivity. In our industry there is as little as a 1 in 5 chance of winning a tender. The quality of the tender documentation exacerbates this problem.
- The adjudication of the tenders is carried out by procurement specialists who have little or no understanding of the technical requirements of the project or of how to evaluate the experience required to carry out the work.

The net effect of the current tendering environment is that mentoring cannot take place as it did previously. Mentees are now sent to site alone or else have to stay in the office to save on costs. Lesser experienced staff members are often sent to site or to project meetings. Designs by less experienced members of staff cannot be checked in detail because discounted fees means discounted amounts of time available to apply to a project.

PROBLEMS RELATED TO TENDERING

A number of issues arise out of appointing consulting engineering practices on a tender basis. These include:

- Reduced income and loss of profits due to large discounts required to win tenders
- Incorrect pricing due to poor documentation increasing the risk of loss of income
- Additional services where these are inherent in the project are not allowed for in the pricing structure

Consulting Engineering and tendering – where to next

- Disconnect between consultant's contract and contractor's contract
- No income is generated while tendering
- The consulting environment becomes unattractive to job seekers as salaries become uncompetitive when compared to other markets
- Difficult to spend time on training when the focus is wholly on cost savings in order to survive
- Short cuts are inevitable in order to cover costs
- The increased risks will eventually impact on the cost of Professional Indemnity insurance.

TENDER DOCUMENTATION

Tender documentation is generally very poorly compiled with typical inadequacies and irregularities including:

- Poor description of scope of work required
- No location given as to where the project is
- No duration of the project pertaining to the consultants appointment
- No description of how the tenders will be adjudicated
- No information on whether the project is a green fields one or an upgrade of existing facilities

Where to next?

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- Poor cost estimates on the value of the works or whether the estimates are for the whole works or the discipline in question
- Poor definition of how disbursements will be paid for normal and additional services and travel if projects run over the contract period
- No information how the tendered values will be adjusted in the event of delays to the appointment of consultants and subsequently contractors
- Price summaries often do not include for additional services as per the ECSA guidelines and are vague on disbursement costs
- Many clients do not understand the extremely complicated fee guidelines set out by ECSA since 2013 and therefore still use to the 2012 fee scale model
- Insisting on the formation of joint ventures or consortia and then limiting the scarce skills to one consortium This skews the fee discounts and earnings of each individual discipline as order of difficulty is not taken into account

In brief it is impossible to accurately calculate the costs of doing business and therefore submitting rational tender prices for the various projects on tender. All of these issues often lead to contractual disputes after appointment which in turn saps productivity in trying to resolve such issues.

ADJUDICATION OF TENDERS

Appointments of consultants are more often than not based solely on price without any consideration been given to:

- Experience of the practice and its personnel and their capacity and resourcesto provide the services required
- Quality and performance on previous projects
- Whether the appointed consultant actually has a department of competent personnel in the discipline being advertised and therefore not sub-letting the discipline to other consultants
- Whether the appointed practice actually has a legitimately staffed office in the province with the relevant skills
- Whether the personnel are registered with the engineering council
- Whether the practice carries sufficient professional indemnity insurance

Mostly personnel compiling and adjudicating tenders are not technical personnel and therefore cannot adjudicate on technical ability.

Subsequent to the appointment there are generally no client personnel to judge whether the appointee is competent or then has competently concluded the work appointed for.

PROBLEMS ASSOCIATED WITH TENDERING

A number of issues arise out of appointing consulting engineering practices on a tender basis. These include:

- Reduced income and loss of profits due to large discounts required to win tenders
- Incorrect pricing due to poor documentation increasing the risk of loss of income
- Price summaries not inclusive where these are inherent in the project
- Disconnect between consultant's contract and contractor's contract
- Consultants only have their time and skills to sell
- The consulting environment becomes unattractive to job seekers as salaries become uncompetitive when compared to other markets
- Difficult to spend time on training when the focus is wholly on cost savings in order to survive
- Short cuts are inevitable in order to cover costs
- The increased risks will eventually impact on the cost of Professional Indemnity insurance.

It is our opinion that, should the current trend continue, the consulting engineering industry will dwindle to a point where it will no longer be able to provide the services required by those clients who rely on consulting engineers, as they do not have the in-house expertise to undertake the work themselves.

Many questions arise from these experiences. Should the roster system be re-introduced, should the tender system be restructured is such manner that it is more equitable to all tendering parties or maybe are there alternative ways of appointing consultants that could be considered?

It would be very interesting to hear what other consulting practices in all disciplines and all provinces are experiencing and what they believe the solutions may be.

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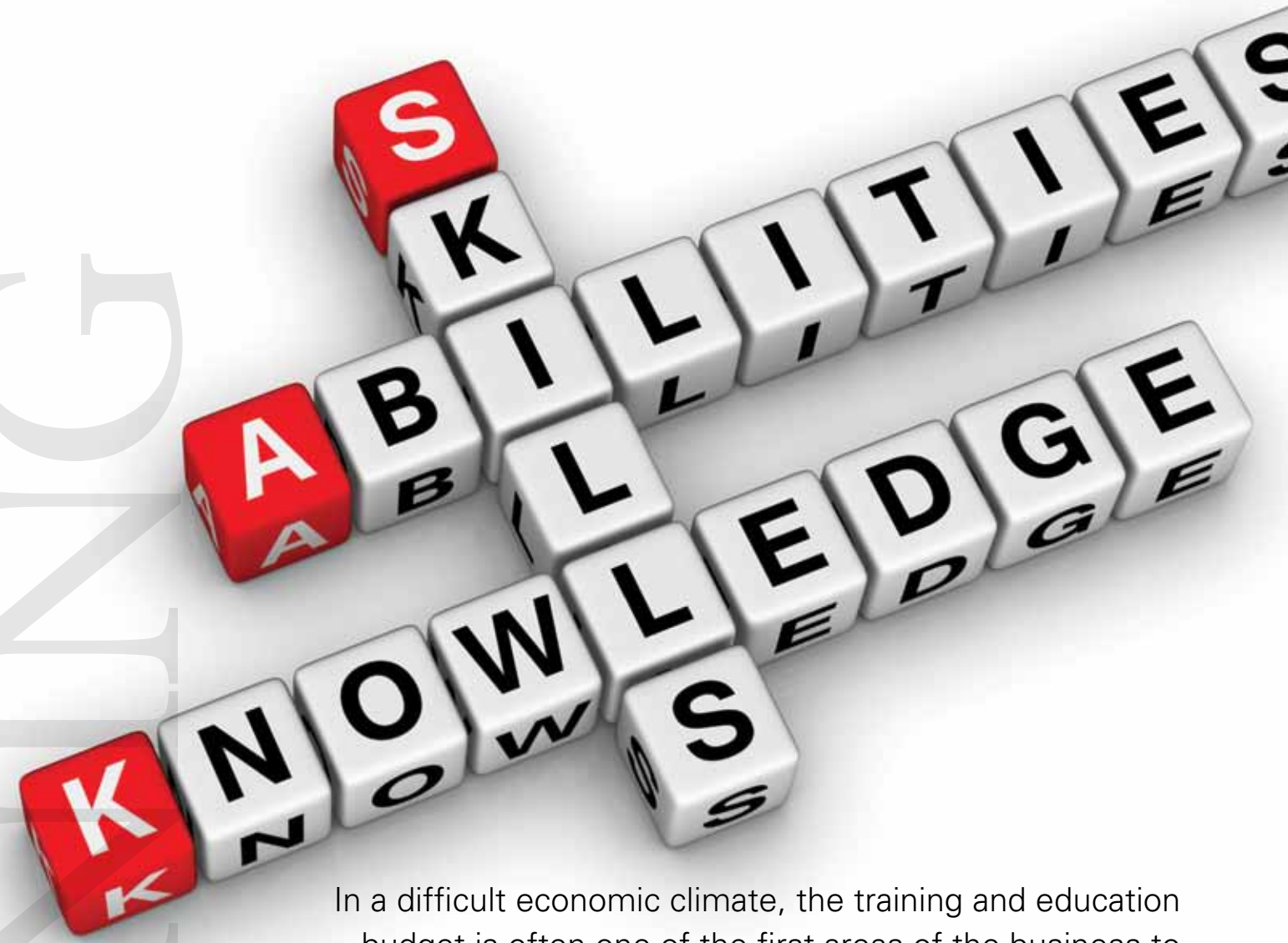

In a difficult economic climate, the training and education budget is often one of the first areas of the business to suffer cutbacks. After all, training can be expensive, takes people away from the work they're paid to do and often delivers benefits that can be hard to quantify.

It's worth remembering that every business with a payroll in excess of R500,000 pays a Skills Development Levy to the government for each employee and can claim back a portion of that amount in the form of training grants. Why leave that money on the table when you can use it to improve the performance of your workforce?

Here are some of the ways that an investment in training can pay off.

IMPROVE EMPLOYEE PERFORMANCE

The most obvious reason to invest in training employees is that it will help them to become more efficient, productive, effective and informed. Depending on the training, they'll be: able to answer technical questions from customers without asking a colleague; more skilled and hence faster at doing their work; better equipped to make good business decisions; or able to add new tasks and duties to their job description.

Invest in training your employees

6 WAYS IT WILL PAY OFF FOR YOUR BUSINESS

BY | SANDRA SWANEPOEL | SAGE

RETAIN TALENT AND IMPROVE COMPANY MORALE

Most employees want to feel valued by the company they work for. Giving them possibilities for self-improvement is one of the best ways you can help your people feel that you appreciate their talents and hard work. Offering the right training opportunities to your employees will help you to retain your best talent and improve morale throughout your organisation.

BOOST CUSTOMER SERVICE

One of the best reasons for investing in training and development is the halo effect it will have for customer service. Not only does training equip your people with skills and knowledge to enable them to do their jobs better, it also improves their job satisfaction.

Happy employees usually mean happy customers. Whether you're training your people to use your systems more effectively, educating them in ethics or law, or helping them develop softer skills such as negotiation and sales techniques, your customers will benefit.

COMPLY WITH REGULATIONS AND LAWS

There are two aspects to consider here. The first of these is that staff may need to be trained in the laws and industry regulations that govern your business so that they can comply. For example, the company's consumer-facing staff might need to understand what the Consumer Protection Act says about customer service, while the payroll team will need constant training to keep ahead of a changing tax environment.

The other point to consider is how training and development can help you comply with employment equity and black economic empowerment codes. A good training and development programme can help you to build a representative workforce that meets the needs of these laws and regulations.

CREATE CAREER PATHS AND SUCCESSION PLANS

Your employees will want to feel as though there is a roadmap for their future with your business. By mapping out a training and development programme for them spanning a couple of years, you can help them to plan their career in your organisation. Taking this medium term view of career development for your staff will also help you to create succession plans for key roles in the organisation. Thus, you'll be in a good position to promote from inside the company when a key person leaves or moves up the ladder.

COMPANY-WIDE CONSISTENCY

Most employees have some gaps in their skills base, experience and knowledge. The more proactive ones will go out and finding training and mentoring to close these gaps. Others will rely on colleagues to help them complete certain tasks. Either way, the result is inconsistent performance.

A good training strategy will help harmonise your skills base so that employees can fill in for each other when necessary or work on their own without constant help and supervision from others. A structured programme will ensure that each employee has a consistent approach and set of skills to draw from. WN

IN MY OPINION : CHARMAINE DU PLESSIS

African cities adopting the Smart City concept

Africa is moving toward Smart City Technology in order to enhance the performance and quality of urban services. This transformation aims to achieve tangible benefits at municipal, provincial and national levels.

BY I CHARMAINE DU PLESSIS **I** JOURNALIST

The demand of the inner-city population is influencing the more interconnected approach to city development. These demands along with rapid metropolitan migration is resulting in a strain on existing transportation and infrastructure networks.

ALE, marketed under the brand Alcatel-Lucent Enterprise, a leading provider of enterprise communications solutions and services, advises that building a Smart City extends beyond the technology, it is about Information and Communication Technology innovation.

Smart Cities make use of digital technologies to improve the functioning of city services. The main objective is to enhance the administration of urban flows by enabling real time responses to challenges. Factors such as technological, economic and environmental changes have influenced the movement to 'smart' urban growth. Amsterdam, a leading Smart City is a successful example of the public private partnership focused on using the city as an urban laboratory for the use of new mobility solutions, open data and improved quality of life for all citizens and visitors.

The collaboration has to date supported more than 40 Smart City projects from the development of home energy storage for integration with a smart grid to Smart parking.

People are the focal point of the Smart City concept, however, the model requires the involvement from all parties. The success of this ideal not only relies on a commitment from government, it also entails the collaboration of the private sector as well as the engagement from citizens.

The most significant benefit of a Smart City is to drive economic development by delivering a

high quality life for all. *"These sustainable advancements aim to improve the basic service provision of electricity and water, as well as offer citizens the ability to easily move within cities across private and public transport.*

Smart Cities also set out to offer superior healthcare and education to all citizens by addressing service delivery challenges. *"The main emphasis of a Smart City is to offer a safe public environment,"* explains Ravin Naidu, Regional Director Southern Africa.

Super cities such as Hong Kong, London and New York are at the forefront of this technology with African cities now following. *"Although it is difficult for African cities to compare, adopting the ideology and technology supporting the Smart Cities concept, we foresee that in the future Africa will be able to compete on a global level,"* explains Naidu.

African cities will not have to endure the high costs associated with the upkeep of legacy infrastructure and systems which is a major advantage of technological adoption.

This enables them to start leapfrogging their more advanced peers. *"With the rise in foreign investment in Africa, great leaps forward are likely to happen in main African technology centres,"* Naidu concludes. wn

WATT?

EXPERT INDUSTRY ADVICE

WATT? is a forum related specifically to the industrial and commercial electrical sector.

Do you have any burning questions, topical issues or points of interest about the electrical industry, from the perspective of a contractor, supplier or professional service provider? Submit your comments, thoughts, ideas, suggestions or questions for the attention of our industry experts, and these will be addressed in a future issue of the magazine. This is your forum, and we would like to hear from you!

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?

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?'.

We look forward to hearing from you.
- Ed

QUESTION ONE

Typically, when would one consider it beneficial to use a VSD or Soft Starter for energy savings?

ANSWER ONE

With environmental regulations becoming more stringent and energy bills remaining high ensuring that motors run as efficiently and smoothly as possible has become a key concern for engineers and designers across different industrial sectors. Motor control devices, such as soft starters and variable speed drives (VSD), can both offer an answer to such challenges. Depending on the application, soft starters and VSDs can help cut energy consumption and reduce associated costs by effectively controlling the electricity flow.

Electric motors are the largest individual source of energy use, accounting for about 45% of the world's total electricity consumption and 70% of the industrial energy demand1. (These figures are based on international research. In South Africa the published Electric Motor consumption figures have been even higher.) With these figures in mind, new environmental regulations have been adopted internationally. For example, in the EU, the 2005/32/EC Ecodesign Directive now stipulates that motors with a rated output of 7,5-375 kW shall not be less efficient than the IE3 standard or IE2 if equipped with a VSD.

To save energy and comply with current regulations ensuring that motors, and the pumps that are driven by them, are durable and reliable is as vital as improving their energy efficiency. VSDs and reduced voltage soft starters can both be used to protect expensive equipment and extend the life of the motor and coupling devices. However, choosing between a VSD and soft starter will depend on a number of factors including the type of application, mechanical system requirements and costs; both for initial installation and over the lifecycle of the system.

QUESTION TWO

What does a Soft Starter do and what are its benefits?

ANSWER TWO

When accelerating an AC motor to full speed using a full voltage connection, (i.e. Direct on Line or DOL starting) a large starting and inrush current will be required. Starting current is typically 6 to 8 times motor nominal current and inrush current is typically 10 to 20 times. It is important to note that starting current duration continues for the time it takes to accelerate the load to full speed whereas inrush current only applies to the first half cycle of current drawn, i.e. 10 mSec. As the torque of the AC motors is generally uncontrolled, the result could be a high torque or shock load, potentially causing wear and tear that may reduce driven equipment and even motor lifetime.

By using semiconductor devices to temporarily reduce the motor terminal voltage, reduced voltage soft starters limit the initial starting current and also the mechanical shock associated with motor start-up. By gradually increasing the motor terminal voltage, a soft starter produces a more regulated motor acceleration up to full speed and is also capable of providing a gradual ramp to stop, where sudden stopping may create problems in the connected equipment. This helps protect the motor and connected equipment from damage.

Such features make soft starters ideal for applications where speed ramping and torque control are required when starting or stopping and where high starting currents associated with starting a large motor need to be limited to avoid supply network issues or penalty charges. Soft starters are also advantageous for many other applications, including conveyors, belt-driven systems, gears and couplings, where gradually controlled starting is needed to avoid torque spikes and tension in the mechanical system associated with normal equipment start-up. They are also ideal for avoiding pressure surges or 'hammering' in piping systems when fluid changes speed too rapidly.

One of the key benefits of choosing a soft starter over a VSD is cost. Soft starters are a more economical choice for applications

WATT?

continues from page 59

that only require torque limiting control during motor start-up. Additionally, they are often preferable in applications where space is a concern, as they are typically smaller than comparable VSDs.

QUESTION THREE

What does a VSD do and what are its benefits?

ANSWER THREE

A VSD, sometimes referred to as inverter, is a motor control device that controls the speed of an AC induction motor. It converts constant frequency and voltage input power to adjustable frequency and voltage to control the speed of the motor. As such, it operates during the start and stop cycle, as well as throughout the run cycle and can be used wherever complete speed control is required and, more importantly, when saving energy is the ultimate goal. Additionally VSDs have many motor protection, communication and automation functions.

Centrifugal equipment such as fans, pumps and compressors follow a general set of speed affinity laws, which define pressure change in relation to speed or flow and power change in relation to flow. Based on such laws, flow changes linearly with speed while pressure is proportional to the square of speed or flow while the power required is proportional to the cube of the speed or flow. In other words, if the motor speed drops the power drops by the cube. Traditionally, mechanical valves are used to control the flow while the electric motors always operate in nominal speed, meaning that a significant amount of electrical power inevitably goes to waste.

By reducing peak energy demand and power when not required, VSDs help motors significantly increase energy efficiency contributing to energy savings of between typically 40% and 60%. With fully adjustable speed and an ability to provide smooth control, their energy savings capability is most suitable for pump and fan applications. However, applications such as conveyors, elevators and escalators can also save significant energy if VSD driven. VSDs also play a key role in maintaining the speed of manufacturing and industrial equipment such as mixers, grinders and crushers.

Another key advantage of using VSDs is that they come with a variety of features and options to ensure ease of use and versatility to suit a wide range of applications. Some of the latest VSDs available on the market are equipped with self-diagnostics and communication devices, advanced overload protection, PLC-like functionality and software programming, digital inputs/outputs (DI/DO), analogue inputs/outputs (AI/AO) and relay outputs.

QUESTION FOUR

How does one choose between the two technologies?

ANSWER FOUR

While soft starters and VSDs can both play a key role in protecting the motor and connected equipment, ultimately making the right choice often depends on the user's specific needs.

Soft starters are generally smaller and less expensive than VSDs, especially when it comes to large horsepower applications. They can also offer a more cost effective solution whenever constant acceleration and torque control is not necessary, such as applications that only require current control during start-up.

In contrast, a VSD can be more expensive initially but it can contribute to dramatic energy savings in the long term. In doing so, it can help users across different industries comply with current environmental regulations while providing operating cost savings over the life of the equipment for a significantly lower total cost of ownership (TCO).

Speed control is another important advantage when choosing a VSD because it ensures consistent acceleration time and accurate speed control throughout the entire operating range of the motor, not just during start-up. Finally, VSDs can also provide more flexible functionality than soft starters, including digital diagnostic information. wn

Answers provided by Zest WEG Group

calendar

FEBRUARY | MARCH

FEBRUARY 2016

1-3	Intl Conference on Information & Industrial Electronics (ICIIE 2016)	Cape Town	www.iciie.org
11	SAIEE Western Cape Centre AGM	Cape Town	www.saiee.org.za
16-17	Africa Energy Indaba 2016	Sandton, Johannesburg	africaenergyindaba.com
17	Electric Cables Jointing & Termination	Johannesburg	roberto@saiee.org.za
17-18	Incident Investigation & Management	Johannesburg	roberto@saiee.org.za
23-25	SAIEE Smart Grid Conference	Midrand, Johannesburg	www.saiee.org.za
24-25	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za

MARCH 2016

1-2	Design Of Economical Earthing Systems For Utility Installations	Johannesburg	roberto@saiee.org.za
9-10	Advanced Microsoft Excel For Engineers	Johannesburg	roberto@saiee.org.za
15-16	Power & Electricity World Africa Conference & Expo	Sandton, Johannesburg	www.terrapinn.com
16	Power Transformer Unit Protection And Testing	Johannesburg	roberto@saiee.org.za
17	Power Transformer Operating And Maintenance	Johannesburg	roberto@saiee.org.za
23	SAIEE AGM	Johannesburg	geyerg@saiee.org.za

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February

Movers, shakers and history-makers

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

1 FEBRUARY

1983 Matthews, Tansil and Fannin obtained a patent for a digital voice mail system.

2 FEBRUARY

1869 James Oliver invented the removable tempered steel plough blade

3 FEBRUARY

1948 The first of Cadillac's next generation of car design was unveiled – the era of the tailfin.

4 FEBRUARY

1824 J. W. Goodrich introduced the world to the first rubber galoshes (rubber overshoes).

5 FEBRUARY

1861 Samuel Goodale patented the first moving picture peepshow machine which was used to display pictures, objects or people viewed through a small hole or magnifying glass.

6 FEBRUARY

1964 The British and French Governments announced their commitment to build a tunnel under the English Channel.

7 FEBRUARY

1964 The Beatles arrived on their first visit to the United States, where thousands of fans greet them at Kennedy Airport in New York in what was described as Beatlemania.

8 FEBRUARY

1916 Charles Kettering patented a self-starting automobile engine.

9 FEBRUARY

1966 It was announced that a Prototype Fast Reactor (PFR) was to be built at Dounreay Power Station on the north coast of Scotland. This reactor would be the first of its kind and would be 5 times more efficient than any other reactor in use at the time.

10 FEBRUARY

2006 An ancient Egyptian tomb has been discovered in the Valley of the Kings by a team of University of Memphis archaeologists. This is the first since King Tutankhamen's was found in 1922.

11 FEBRUARY

1975 The British Conservative Party has elected their first women leader, Margaret Thatcher who would become the first woman to head any British political party.

12 FEBRUARY

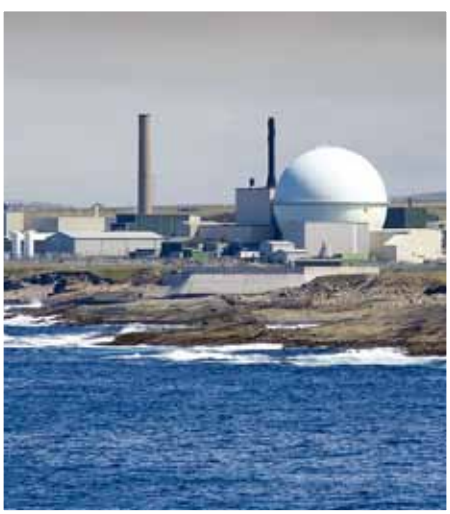
1974 Stephen Kovacs received a patent for a magnetic heart pump.

13 FEBRUARY

1979 Charles Chidsey received a patent for male baldness solution developed from a drug used to treat high blood pressure.

14 FEBRUARY

2006 English Members of Parliament



voted to ban smoking from all pubs and private members' clubs in England.

15 FEBRUARY

1931 The first Dracula movie was released.

16 FEBRUARY

1880 The American Society of Mechanical Engineers (ASME) was founded when forty engineers from eight states meet in New York City in the offices of American Machinist.

17 FEBRUARY

1600 Italian philosopher Giordano Bruno was burned at the stake in Rome after being accused of heresy for advocating the theory that the Earth revolves around the Sun.

18 FEBRUARY

1913 English Chemist, Frederick Soddy, introduced the term "isotope" to describe atoms of the same element that have different atomic masses.

19 FEBRUARY

1971 The first warrant to search a computer was issued in San Jose, California. The search would ultimately lead to a conviction for theft of trade secrets.

20 FEBRUARY

1937 The first successful automobile-airplane hybrid, the Arrowbile, was completed. The vehicle had a top speed of 120mph in the air and 70mph on the ground.

21 FEBRUARY

1878 The first telephone directory was issued by the New Haven Telephone Company, Connecticut. It consisted of twenty-one names and their telephone numbers.

22 FEBRUARY

1916 Ernst Alexanderson was issued with a patent for a selective radio tuning system.

23 FEBRUARY

1455 This is traditionally accepted as the anniversary date for the publication of the Gutenberg Bible, the first book printed using movable type (which made use of movable components to reproduce the elements of a document, typically individual letters or punctuation).

24 FEBRUARY

1998 The soundtrack of the Lost World: Jurassic Park video game, the first video game to reach market that featured a full orchestral soundtrack, was released on CD.

25 FEBRUARY

1902 John Holland was granted a patent for a submarine.

26 FEBRUARY

1930 The first red and green traffic lights were installed in New York City, following the lead of Detroit in 1920. Red-green colour-blind drivers were left to guess when to go, as there were no uniform standard of order for the lights.

27 FEBRUARY

1964 The Italian government announced that the Leaning Tower of Pisa was in serious danger of collapsing in an earthquake or storm and asked for suggestions on how to save one of Italy's top tourist attractions. The work to save the Tower began in 1999 and was completed in December 2001.

28 FEBRUARY

1939 The erroneous word "dord" was discovered in the Webster's New International Dictionary, Second Edition. It comes from D or d, the abbreviations for density.

29 FEBRUARY

2004 The Lord of the Rings: The Return of the King, a film directed by Peter Jackson, won eleven Academy Awards. wn

SAIEE COUNCIL MEMBERS

GRADE	NAME & SURNAME	CONTACT DETAILS	EMAIL ADDRESS
President	Andre Hoffmann	011 783 9330	andreleohoffmann@gmail.com
Deputy President	T.C. Madikane	031 536 7300	tc@igoda.co.za
Senior Vice President	Jacob Machinjike	011 800 3539	Jacob.machinjike@eskom.co.za
Junior Vice President	Dr Hendri Geldenhuys	084 625 5522	GeldenHJ@eskom.co.za
Immediate Past President	Dr. Pat Naidoo	071 312 0111	pat@patnaidoo.co.za
Honorary Treasurer	Viv Crone		vivcrone@gmail.com
Honorary Vice President	Max Clarke	011 476 5925	mppc@mweb.co.za
Past President	Stan Bridgens	011 487 9048	s.bridgens@saiee.org.za
Past President	Mike Cary	011 894 3704	carymbc@netactive.co.za
Past President	Ron Coney	011 564 2349	rongconey@gmail.com
Past President	Viv Crone		vivcrone@gmail.com
Past President	Mike Crouch	011 728 2852	michaelac@intekom.co.za
Past President	John Gosling	011 651 6266	gosling@worldonline.co.za
Past President	du Toit Grobler	083 666 6855	du.toit.grobler@gmail.com
Past President	Rod Harker	021 553 2632	raharker@telkomsa.net
Past President	Dr. Angus Hay	011 585 0490	angus.hay@neotel.co.za
Past President	Ian McKechnie	012 663 4804	ianmac@gafrica.com
Past President	Andries Tshabalala	011 820 5094	andries.tshabalala@actom.co.za
Past President	Paul van Niekerk		paulvn@telkomsa.net
Fellow	Lt. Col. Bill Bergman	011 346 0395	william@bergman.co.za
Fellow	Hermann Broschk	011 728 4071	hbroschk@absamail.co.za
Fellow	Jane-Anne Buisson-Street		buisson@mweb.co.za
Fellow	Viv Cohen	011 485 2567	vivcohen@telkomsa.net
Fellow	George Debbo	012 991 3748	george.debbo@gdtelecom.co.za
Fellow	Prof. Jan de Kock	018 299 1970	Jan.Dekock@nwu.ac.za
Fellow	Sy Gourrah	083 321 5526	sgourrah@gmail.com
Fellow	Prof Sunil Maharaj	012 420 4636	Sunil.maharaj@up.ac.za
Fellow	Collin Matlala	011 997 8900	matlalac@global.co.za
Fellow	Prince Moyo	011 800 4659	prince.moyo@eskom.co.za

SAIEE COUNCIL MEMBERS

GRADE	NAME & SURNAME	CONTACT DETAILS	EMAIL ADDRESS
Fellow	Prof. Jan-Harm Pretorius	011 559 3377	jhcpretorius@uj.ac.za
Fellow	Prof. Rex Van Olst	011 717 7220	Rex.VanOlst@wits.ac.za
Fellow	Dries Wolmarans	011 793 9335	dwol@mweb.co.za
Fellow	Derek Woodburn	011 609 5013	woodb1@mweb.co.za
Senior Member	M. Chauke	012 661 2346	chaukemx@gmail.com
Senior Member	John Dal Lago	011 800 2657	John.dallago@eskom.co.za
Senior Member	Theuns Erasmus	016 960 2496	theuns.erasmus@sasol.com
Senior Member	Mpumelelo Khumalo	011 800 6023	khumalp@eskom.co.za
Senior Member	Phillip Konig	011 239 5348	PKonig@hatch.co.za
Senior Member	Nishal Mahato	011 629 5341	mahathn@eskom.co.za
Senior Member	Hope Mashele	011 312 9902	hope.nga.mashele@gmail.com
Senior Member	Prof. Johan Meyer	011 559 3880	estherl@uj.ac.za
Senior Member	James Motladiile	011 629 5172	james.motladiile@eskom.co.za
Senior Member	Amelia Mtshali	011 871 2625	MtshalHA@eskom.co.za
Senior Member	Patrick O'Halloran	011 490 7485	pohalloran@citypower.co.za
Senior Member	William Stucke	011 566 3009	wstucke@icasa.org.za
Member	Refilwe Buthelezi	011 682 0972	schilwane@gmail.com
Member	Wayne Fisher	011 679 3481	wayne@bergmanfisher.co.za
Member	Thavenesen Govender	011 629 5738	thavenesen.govender@eskom.co.za
Member	Dr. Mike Grant	011 717 7256	michael.grant@wits.ac.za
Member	Prudence Madiba	011 800 4212	Prudence.madiba@eskom.co.za
Member	Dr. Nicholas West	012 656 1266	njwplasma@gmail.com
Chairman - E&S Section	Gift Mphefu		
Chairperson - Power Section	Max Chauke	012 661 2346	chaukemx@gmail.com
Chairman - Historical Section	Max Clarke	011 476 5925	mppc@mweb.co.za
IEEE Representative	Prof Willie Cronje	011 717 7224	willie.cronje@wits.ac.za
RMWG Representative	Mario Kuisis	011 326 2708	mario@martec.co.za

Bloemfontein Centre

Chairman | Dr Ben Kotze

Postal Address | Univ. of Technology Free State Private Bag X20539 Bloemfontein 9300
T|051 507 3088 **E**|bkotze@cut.ac.za

Eastern Cape Centre

Chairman | Antony Falconer

Postal Address | PO Box 494 Port Elizabeth 6000
T|041 405 6122 **E**|afalconer@aberdare.co.za

Gauteng Central Centre

Chairman | Maanda Ramutumbu

Postal Address | Eskom Enterprises Park, Corner Leeukop & Simba Road, Sunninghill
T|011 800 6356 **E**|RamutuM@eskom.co.za

Kwa-Zulu Natal Centre

Chairman | Vincent Tiedt

Postal Address | SMEC SA 2 The Crescent Westway Office Park Westville, 3629
T| 031 277 6686 **E**| vincent.tiedt@smec.com

Mpumalanga Centre

Chairman | Ludolph de Klerk

Postal Address | Proconics Headquarters Kiewiet street Secunda 2302
T|017 620 9698 **E**|ludolph.deklerk @proconics.co.za

Southern Cape Centre

Chairman | Paul van Niekerk

Postal Address | PO Box 2487 Plettenberg Bay 6600
T| 044 535 0035 **E**|paulvn@telkomsa.net

Vaal Centre

Chairman | Danver Jacobs

Postal Address | 38 Rembrandt Street Sasolburg 1947
T|016 960 5104 **E**|danver.jacobs@sasol.com

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