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RENEWABLES

SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | **OCTOBER 2016**

Distributing counterfeit products results in CRIMINAL CONVICTION

After 4 years of investigation and legal procedure, in a recent landmark case Mr Abdool Kadar Omar Khan was convicted in the Specialised Commercial Crimes Court for importing **nearly 124 000 counterfeit earth leakage devices and circuit breakers**. Not only are the products counterfeit, they also do not meet compulsory specifications and are unsafe.

Miniature circuit breakers are **essential safety devices**. These counterfeit products installed in buildings will not perform their intended function.

The applicable court papers and information on how to recognise the counterfeit products are available at www.safehousesa.co.za

WE URGENTLY APPEAL TO:

- **All re-sellers concerned to recall the products from the market, including from users that may have the products installed in their buildings.**
- **The National Regulator for Compulsory Specifications (NRCS) to institute the action required in terms of its mandate to protect users.**
- **The National Consumer Commission to institute the action required in terms of their mandate to protect consumers who may be potential victims.**

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: 011 396 8140
Email: pierren@safehousesa.co.za

www.safehousesa.co.za

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

As at 08/08/2016

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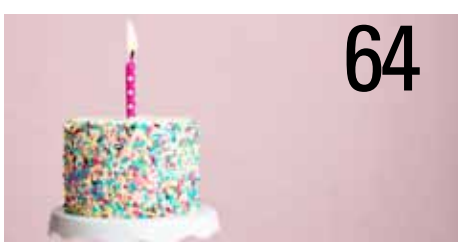

SAIEE @saiee

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October...., Jacaranda month in South Africa, promises of warmer (and hopefully) rainy days await us. Water, wind (air) and sun (fire), three of the 4 elements we need for making renewables successful.

This issue of **watt**now features Renewables. Our first feature article on page 22 discusses "Wind Trees" - imagine you can capture wind and transform it into renewable energy!

Our second feature article, written by Dr Manyage, discusses the Development of Solar Photovoltaic Plants at Eskom. This you will find on page 26.

Dr Hendri Geldenhuys wrote an article on "The Dead Grid Safety Lock" which introduces safety risks, which did not exist until the 'smart grid'. Read the full article on page 34.

Software Cost Estimation, aptly written by Dino Bougaardt, sheds light on the ripple effect if change happens within a project. Read this on page 40.

Another interesting article, written by Dudley Basson (pg 50) discusses Megascience - science and engineering at its best.

October is also the month that the SAIEE celebrates achievements with its annual Banquet. This event takes place on 21 October at the Wanderers in JHB. Contact Gerda Geyer today to book your seats. Limited space is available.

Herewith the October issue, enjoy the read!

Minx

Visit www.saiee.org.za to answer the questions related to these articles to earn your CPD points.

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TC MADIKANE
2016 SAIEE PRESIDENT

The Executive Committee took a decision this year that, going forward, the celebrations of SAIEE's long membership standing awards should take place during the day, as opposed to the tradition of awarding it in the evening at the Annual Banquet.

Our Past President's forum luncheon was held at The Country Club Johannesburg; Auckland Park in September where it was combined with the awards function.

A special award for 70 year membership in good standing was issued to Max Clark, who joined SAIEE when he was just 20 years of age. He also celebrated his 90th birthday in February. Max continues to be very active in engineering, especially his long involvement with the Association of Municipality Electricity Undertakings (AMEU), and the SAIEE. We are blessed to have a person of Max's calibre as an Electrical Practitioner.

The prestigious 65th Bernard Price Memorial Lecture, which was supposed to take place on the 20th of September at the Senate House at Wits University, was postponed due to student's demonstrations. The Cape Town and Durban events went ahead as planned and they were well attended. Thank you to all who participated. The attendees were overwhelmed by the talk of 4th industrial revolution and society, presented by Professor Tshilidzi Marwala of the University of Johannesburg. It is anticipated that the Wits function will take place towards the end of October, and a notice for the new date will be issued via the website, facebook, emails and sms.

SAIEE, as one of the Engineering Council of South Africa (ECSA)'s recognized Voluntary Associations, was invited to the 5th term ECSA Council for the inauguration of the new 2016-2020 council. I attended the function, representing SAIEE. The Minister of Public Works, Honourable Nxesi was a keynote speaker. He awarded meritorious service awards to some members of the outgoing Council. It is worthwhile noting that SAIEE members continue to play a significant role at ECSA. More than five of SAIEE's current Council members were inaugurated into the new 5th term ECSA Council, which is dominated by woman engineers. We congratulate them and we are looking forward to continue our good working relationship with ECSA.

I attended the 2nd Engineering Conference, jointly organised by Central University of Technology (CUT), SAIEE and Eskom in Bloemfontein, Orange Free State. The theme for the conference was "engineering for a better future", and the conference was well attended. The quality of papers presented was relevant and current to electrical, electronics and computer engineering field. I must commend our Chairperson for Central Centre, Dr Ben Kotze, for #makeithappen, and organising a free two day event for our members and visitors. This proved that indeed, the SAIEE is the most appropriate vehicle for ensuring that Continued Professional Development (CPD) is provided to Electrical Practitioners, not only in big cities but even in remote centres. I would also like to express our gratitude to our main sponsors, Eskom and CUT.

I visited the Durban University of Technology (DUT) and was pleasantly surprised to see more than 100 students in the a lecture hall. The DUT Student Chapter is vibrant and active, thank you to their Leadership, and the lecturers who are supporting them.

Lastly, I would like congratulate one of own, Electrical Engineer, Mr Matimba Mahange, who has recently been promoted to CEO at Barloworld Equipment South Africa. It is unusual to find electrical engineers leading engineering companies and we, as the SAIEE, are proud of Mr Mahange's achievement.

TC Madikane
Pr. Eng | FSAIEE | FSAAE

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#ThingsThatReallyMatter

WATTSUP

SAIEE commemorates 50 & 60+ year members

SAIEE Past Presidents, from left & back: Andries Tshabalala, Stan Bridgens, Viv Crone, Mike Crouch, Ian McKehnie, Bill Calder, Pat Naidoo and Pierre Ballot. Front: Bea Lacquet & TC Madikane

Stan Bridgens (CEO, SAIEE), Max Clarke (longest serving SAIEE Member in attendance) & TC Madikane, 2016 SAIEE President.

The annual SAIEE Past Presidents' luncheon took place at the Country Club, Johannesburg recently. At this event, the SAIEE thought it appropriate to honour the 60+ year members as well.

This year, instead of inviting the longstandig members to the Annual Banquet, they were invited to the Past Presidents' Luncheon.

Max Clarke, who is both the longest standing member, as well as our most vintage model of electrical engineer, attended. Max has been a member for a staggering 70 years. He is an extremely active council member, chairperson of the Historical Section (affectionately known as the Hysterical section), and vice chair of the Facilities Committee.

Each member received a lapel pin to commemorate this event, which was designed by Minx Avrabos.

Dianne Sharp & Des Smith

Bill Calder & Hermann Broschk

Corrie Green & Dirk Vermeulen

Mr & Mrs Hannes Venter

Lotte & Bruno Penzhorn

Joy & Len Gibson

Margaret & Brian Sutcliffe

Brian & Roslyn Stevens

Max Clarke & Anthony Hugo

Len Booysen & Robbie Jones

Mike & Rose Crouch

Andries Tshabalala & Dries Wolmarans

du Toit Grobler & André Hoffmann

Pat Naidoo & Viv Crone

Past Presidents sharing a laugh with TC

WATTSUP

SAIEE host Urania Village Heritage Day

With all the National Heritage Day celebrations, which took place the weekend of the 24th of September, the SAIEE played host to the Urania Village community. It was a day in which all were encouraged to celebrate their cultural traditions in the wider context of the great diversity of cultures, beliefs, and traditions that make up the beautiful nation of South Africa.

SAIEE's Historical Museum was open to the public for the first time. The Chairman of the Historical Section, Mr Max Clarke said: *"A special word of thanks to all who were able to assist with the Heritage Day program. I have no idea how many visitors we had, but it was a steady stream through the rooms for almost the whole period (11-00 to 15-00), and it wouldn't surprise me if it was well in excess of 100... maybe even 200 people"*.

The Southern African Veteran and Vintage Association, who had some of their members' vintage cars on display, also entertained the visitors. Stallion Security provided a jumping castle to entertain the youngsters, while mom and dad went on a tour through the site, from the museum through to the Observatory Telescope itself.

For refreshments, we catered for a variety of taste buds - from Indian cuisine through to cupcakes and delectable brownies.

The MC for the day, Lukholo Mkhasakhasa from Hillbrow online radio, left us gasping at his entertaining jaunts, introducing the various singers and poets alike.

Mrs Janine Meyer-Hoffmann, who organised this event at very short notice, did an amazing job. She said: *"I would like to thank the following groups of people and individuals who so willingly took part in this Heritage Day Celebration to make this a very special day, showcasing the rich history, culture and diversity we have here in the East of Johannesburg: The SAIEE (South African Institute of Electrical Engineers), SAASTA (The Johannesburg Telescope), The Southern African Veteran and Vintage Association, Urania Village Committee, Kensington Heritage Foundation, Black Tie Sound & Technical, ER24 Medical Assistance, Stallion Security, Lukholo Mkhasakhasa and all the amazing performers, singers and poets alike."*

From left: Minx Avrabos (SAIEE), Councillor Carlos da Rocha (DA, Ward 66) & Janine Meyer-Hoffmann (Africa Event Xcellence)

From left: Lukholo Mkhasakhasa (Hillbrow online radio), Minx Avrabos (SAIEE), Zani Challe (Performer) & Janine Meyer-Hoffmann (Africa Event Xcellence)

WATTSUP

iX Engineers – an Enterprise Development success story

From left: Ashley September – iX Director, Lebo Leshabane – iX Managing Director, Denver Dreyer – CEO – WorleyParsons RSA and Hans Karemaker – iX Director.

An active participant in the transformation of South Africa, project delivery and engineering consultancy WorleyParsons RSA has demonstrated that Enterprise Development can be successful, as attested to by the creation of iX Engineers (Pty) Ltd, a 53% black-owned consulting engineering company focusing on the public infrastructure sector.

iX Engineers has been established following the incorporation of WorleyParsons' Public Infrastructure (PI) business with Black Jills Engineers, who was among the first participating companies in WorleyParsons' Enterprise Development programme.

Effective from 1 October 2016, iX Engineers will provide professional services for the design, development and through-life-support of public infrastructure, including roads, dams, water supply, water treatment, wastewater, power transmission and distribution infrastructure. Current Managing Director of Black Jills Engineers, Lebo Leshabane will take up the role of CEO of iX Engineers with 53% equity held by black employees of which 35% of these shares are black women owned. The balance is held by senior management from WorleyParsons' existing PI business who will be moving over to iX Engineers.

"WorleyParsons takes Enterprise Development seriously and we are committed to building sustainable businesses. We saw an opportunity to grow Black Jills Engineers and simultaneously transform our PI business into a majority black-owned independent organisation," says Denver Dreyer, CEO of WorleyParsons RSA.

He adds that all of WorleyParsons' PI projects will be transferred to iX Engineers, ensuring that the company starts with a full order book. *"Where projects are not ceded to iX, we will continue to stand behind our customers and will subcontract to iX as they build their own project pipeline going forward."*

Standby power systems: Reliability ground-breaking local technology

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

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

Powermode MD Jack Ward notes that the PMP is a 'first' for the SA standby power market, being based on the now universally-accepted principal of the Internet of Things (IoT). *"The IoT is defined as a system in which the Internet is linked to the physical world through any number of sensors which have the ability – and the power - to radically change the way people manage their lives and businesses, generally through resource optimisation,"* he notes.

Focusing on the PMP, Ward says empirical data is continuously streamed in real-time to Powermode's 24x7 Operations Centre in Johannesburg where technicians will react to an alarm signalling a disparity in standby power quality from accepted benchmarks by immediately notifying the company concerned. If authorised, a service crew will be dispatched to any location country-wide.

Powermode boasts a nation-wide support infrastructure, complemented by telephonic response for technical queries and priority on-site response for emergency call-outs. Services are provided by trained and skilled technicians. *"With the frequency of power outages and the critical nature of South Africa's power grid, it is important*

Actum Electronics has the defence sector in its sights

As a niche importer and distributor of quality components and instrumentation products, Actum Electronics has built up a solid reputation. *"We have supplied the defence sector since the Group's inception, and continue to focus our product offering here,"* director Greg Barron notes.

The latest trends in the defence sector are space optimisation, weight reduction, temperature resistance and robustness. *"This equates to a high degree of reliability, as military applications demand superior performance under the most demanding conditions,"* Barron comments.

International products distributed by Actum Electronics include Erni Electronics GmbH, a leading manufacturer of connectors. Laird Technology is a preferred supplier of EMI shielding and custom absorbers for military applications from jets to fleets.

Instrument Plastics specialises in the manufacture and supply of optical grade contrast enhancement filters for electronic displays. These filters are designed to improve display readability by enhancing contrast and reducing reflections, while also providing protection and improving the overall appearance.

Actum Electronics is also the exclusive local distributor of the Schroff and Calmark range of rugged-yet-lightweight modular solutions with high shock and vibration resistance, all designed for EMI/RFI interference. KVG Quartz Crystal Technology GmbH offers a wide range of crystals, oscillators, filters and specific quartz crystal products.

"A great benefit of KVG is that it has a standard range in addition to customer-specific solutions. Actum Electronics has had great success in specifying the KVG products into military as well as avionics projects in South Africa," Barron reveals.

The Actum Group comprises Actum Electronics, which focuses on electronic components, and Actum Industrial, which encompasses industrial components, instrumentation, pneumatics and professional tooling. The two main divisions represents leading international brands in their respective markets.

Greg Barron | Actum Director

that standby power plants, particularly in large enterprises, are safeguarded from threats that could disable them when they are needed most. In such instances critical computer systems may be forcibly shut down and cash tills will become inoperable," stresses Ward

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

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

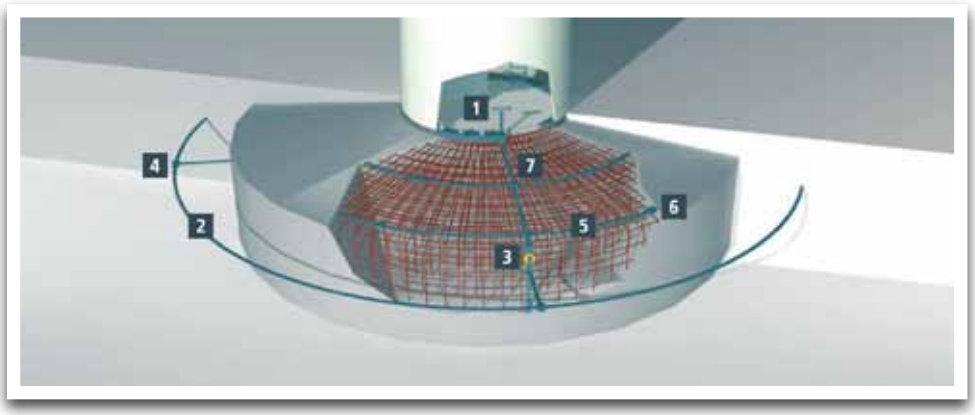
Ward highlights the operational reports from a successful, six-month pilot project involving the roll-out of the PMP at a large South African chain of 118 retail stores. They reveal that 44 stores were subjected to 195 potentially costly power outages during this period. More than 280 trading hours and 250 non-trading hours were affected.

He says the results underline the importance and value of having deep insights into an organisation's power infrastructure.

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

WATTSUP

The essential role of earth-termination systems for wind turbines



Increasing hub heights have resulted in a high number of wind turbines now being equipped with concrete or hybrid towers. These towers are comprised of a concrete base and a tubular steel tower on the top. When it comes to lightning protection, DEHN Africa advises that it is essential to implement a single, common earth-termination system for all wind turbine purposes, as lightning current must be dispersed in order to prevent the wind turbine from being destroyed in the event of a lightning strike.

The earth-termination system should discharge high lightning currents to the ground, distributing them without exposing humans and animals to electric shock, whilst averting dangerous thermal or electrodynamic effects.

The main functions of earth-termination systems for wind turbines include:

- Protective earthing with the task of connecting electrical equipment to the ground and protecting persons and material assets in the event of electrical fault;
- Functional earthing, to ensure safe and hassle-free operation of electrical and electronic equipment; and
- Lightning protection earthing to safely conduct the lightning current from the down conductors to the ground.

The design of earth-termination systems according to IEC 61936-1 should fulfil the following four requirements:

- Mechanical strength and corrosion resistance.
- The handling of calculated maximum fault current from a thermal point of view, especially when the transformer is located in the nacelle.
- Avoid damage to objects and equipment.
- Protection of people from voltage and earth-termination systems occurring in the case of maximum earth fault current and lightning strikes.

Tubular steel towers fulfil these requirements due to their cross-section and completely metallic body (Faraday cage). However, should the reinforced concrete towers be made of pre-fabricated concrete elements, they must consist of an integrated earth-termination system.

Furthermore, foundations made with reinforced concrete are used as earth electrodes as they have a low earth resistance and provide an excellent basis for equipotential bonding and foundation. Earth electrodes make both technical and economical sense, hence they should be designed and installed as per DIN 18014.

Karma, Much More than a Drone

GoPro's founder and CEO, Nicholas Woodman, introduced a new line of HERO5 cameras, cloud-based software, and drone, Karma, to international press at the base of Squaw Valley, CA, near Lake Tahoe.

"With these new products, we're delivering on our promise to make it easy to capture and share engaging stories," said Woodman. *"HERO5's ability to auto-upload photos and videos to a GoPro Plus account dramatically simplifies mobile, on-the-go editing, sharing and enjoyment. This is a game-changing experience that we will continue to build upon."*

Woodman adds, *"We're stoked to launch Karma and show how much more it is than a drone. Karma packs Hollywood-caliber aerial, handheld and gear-mounted image stabilization into a backpack. It's so easy to use, a beginner can have fun straight away."*

EHL Consulting Engineers hosts PR Breakfast

Fred Knoetze (MD – EHL), Jaco Swartz (MD – Legislative Compliance Specialists), Ilan Keet (Organiser – EHL), Tony McDonald (Chairman – ECB)

EHL Consulting Engineers (Pty) Ltd held their annual breakfast for professionals at the end of September 2016. The event is characterised by an informal and open forum in an intimate setting, whereby ECSA professionally registered staff, as well as those registered as candidates, are given the opportunity to mingle with like-minded professionals from industry. Various topics are covered and provide the platform to allow aspiring professionals the opportunity to interact and gain knowledge and experience from qualified professionals.

EHL recognises the value of the professional and the role the professional plays in its business strategy- and to the country as a whole. The event attracts top speakers and captains of industry, and creates an atmosphere of learning through a bidirectional exchange of knowledge and experience, in which all participants play an active role. This year's event hosted two external speakers- Tony McDonald from the Electrical Conformance Board and Jaco Swartz from Legislative Compliance Specialists. The talks were both informative and stimulated much discussion and debate amongst the delegates.

EHL is a specialist electrical, control and instrumentation consulting engineering firm operating in various manufacturing sectors. Being one of the largest and most experienced electrical engineering companies in South Africa, EHL is able to draw on the best and brightest professional, technical and project management staff.

The risks & costs of an ageing system

Communications systems are the lifeline of a business as this is where your clients turn to when they need to reach you or, you need to reach them. With technology advancing at a rapid rate, conventional communications systems are no longer adequate enough to bridge the gap between you & your customer and are often the most overlooked piece of technology within a business.

Due to rapid advancements in technology, outdated systems pose risks if they are not updated when necessary. A few of these risks include increased security threats, the inability to support new business requirements and system failures.

Your communications systems and security may seem like two completely different entities, but they go hand-in-hand. Outdated security policies means that businesses with feudal communications systems have a higher chance of falling victim to toll fraud, an illegal activity similar to computer hacking only with mobile phones, calling cards, and pay phones.

"Toll fraud is responsible for huge revenue loss every year and thus, ensuring your communications systems remain up to date with the latest technology greatly mitigates the risk of your business falling victim to toll fraud," explains Ravin Naidu, Regional Director South Africa, ALE, marketed under the brand Alcatel-Lucent Enterprise, leading providers of enterprise communications solutions and services.

Another risk associated with outdated communications systems is the restrictions it places on you, your clients and your business. *"Although your systems may be working well for you and meeting your business's requirements, the constraints it places on future interactions with your customers will become imminent. Business models need to change as readily as technology to ensure that you are continuously accommodating new standards, new features and new users,"* Naidu adds.

System failure is the most damaging risk of all to a business. Data loss due to outdated systems can result in system downtime and, as is the case with many system failures that occur with older models, spare replacement parts are hard to come by as they are outdated and no longer in demand. The time required to repair older systems increases with age which means that investing in a newer, more technologically advanced infrastructure greatly reduces the risk of downtime should a system failure occur.

Although newer systems may come at a higher price, it is a long term investment for any business. *"It is in every business owner's interest to adapt to market changes and understand the latest that technology has to offer. By identifying the risks associated with ageing systems, you can eliminate potential downtime while boosting the longevity of your business,"* concludes Naidu.

WATTSUP

Experts meet to exchange innovative ideas in electrical engineering

From left: TC Madikane (SAIEE President), Du Toit Grobler (ECSA Representative and SAIEE Past President), Dr Ben Kotze (SAIEE Central Centre Chair and Senior Lecturer, CUT), Dr Kanzumba Kusakana (HOD Department of Electrical, Electronic and Computer Engineering), Frans de Jager (ESKOM), Dr Frik Grobler (Co-organizer, ESKOM Conference) and Prof Herman Vermaak (RGEMS Research Unit Leader).

During September 2016, the Department Electrical Electronic and Computer Engineering in collaboration with the South African Institute of Electrical Engineers (SAIEE), and Eskom hosted the 2nd Bi-Annual Engineering Conference themed 'engineering for a better future'. The purpose of the conference is to bring together technicians, technologists, engineers and researchers in the field of Electrical Engineering to exchange ideas on research, latest trends on innovations and development in the field.

Prof. Alfred Ngowi, Dean of Faculty of Engineering and Information Technology, Central University of Technology (CUT) spoke about the fourth-industrial revolution and what engineers should know about it. *"The fourth industrial revolution has distinct features compared to the previous industrial revolutions, it has speed, impact and wider scope to do things. To be successful in the fourth industrial revolution there is a need to work collaboratively in all sectors and ensure that appropriate skills are imparted to future engineers."*

SAIEE President, Mr. Thembinkosi Madikane, commended CUT's engineering lecturers for taking an active lead in the electrical engineering fraternity. Mr Madikane mentioned that SAIEE, as a voluntary professional association, strives to be a leading, respected and reputable entity in the society of Electrical Engineers, promoting electrical science and its applications for the benefit of its members in Southern African and keeping close contact with appropriate national and international organizations.

"I'm proud to say that our members are professionally engaged in a full range of engineering activities including academic research, manufacturing, electronics, telecommunications, measurement and control, mining, and power infra-structural services and they make meaningful contributions to the steady advancement of technology as well as the quality of life of communities out there."

Dr. Kanzumba Kusakana, Head of Department, Electrical Engineering, presented a paper on the Performance, Operation, Equipment, and Technology efficiency (POET) approach on energy efficiency. He defined energy efficiency as the ratio of energy input and output. Based on the worldwide increase on energy demand, he focused on strategies that can be implemented for utilizing energy efficiently.

The organizing committee would like to thank the contributors as well as the sponsors ESKOM, SAIEE, CUT, Surgetek, Imperial GM Bloemfontein and Montello for their input in a well hosted and successful conference.

Tectra Automation teams up with NMMU to produce WeldCore®

Tectra Automation was contracted to supply Bosch Rexroth motors and control systems, which are essential in the production of the WeldCore® technology, a result of a 15-year research relationship between Nelson Mandela Metropolitan University (NMMU) and Eskom. WeldCore® is able to determine the lifespan, predict the maintenance requirements and hence prevent the failure of high-temperature steam pipes in refineries and power stations.

Ideal for older processing plants, WeldCore® utilises a specialised sampling technique to provide information on whether a pipeline or other high value component needs replacement. WeldCore® can defer downtime for unnecessary maintenance, predict end-of-life dates and can play a crucial role in the prevention of premature failure by identifying problems.

From left: Prof Danie Hattingh (eNtsa Director - NMMU), Mr Phillip Doubell (Eskom Chief Researcher / Inventor), Dr Ian Wedderburn (eNtsa Deputy Director / Inventer) and Dr Phil Mjwara (Director General - Department of Science and Technology) at the TMS Showcase event.

High Risk Inland Mini Substations Mitigate against Vandalism & Copper Theft

Electrical substations pose a number of unique challenges including vandalism and the theft of copper. This is especially true for mini substations, which are often located in residential areas and in remote rural areas, and applies to those owned by power utilities as well as private owners.

While larger substations are often protected using surveillance equipment, this is not always feasible with mini substations and apart from the unnecessary disruption of electrical services, the damage done to these installations could have potentially lethal consequences for maintenance personnel.

Working in collaboration with Eskom, WEG Transformers Africa (WTA), part of the Zest WEG Group, developed a vandal proof mini substation which is now approved by the power utility.

Andre Mans, Chief Operating Officer of WTA, says that this approval is very important as it confirms the functionality as well as reliability of the vandal proof mini substation. *"This level of approval not only underpins that the mini substation meets all the criteria but also gives absolute assurance to the marketplace,"* Mans says. Notably, the mini substations are targeted at both power utilities and private end users.

The WTA vandal proof mini substations are ideal for installation in high risk areas. The entire enclosure, including doors and lock protection facilities, are constructed from 6 mm steel with the doors being specially reinforced. The four way locking mechanism is complemented by heavy duty door hinges. The transformer unit is sealed, further protecting the installation. A major advantage is that the mini substation is constructed as a complete unit and is offloaded on site with its roof in position. This is advantageous to contractors as installation does not necessitate assembly of the unit.

The mini substations are manufactured at WTA's Wadeville facility which underwent a complete modernisation programme over the last two years and this included streamlining of processes and upgrading of equipment. This modern operation now boasts best-in-class production and manufacturing capabilities.

WATTSUP

Solar cars cross the finish line as records tumble

The V&A Waterfront in Cape Town was the scene of celebration as 11 teams from all over the world crossed the finish line after successfully driving just over 27,000 kilometres collectively on public roads on solar power alone.

Dutch team Nuon won the Challenger class after completing 4,716 km, breaking the four-year old record of 4,630 kilometres and beating Japanese team Tokai by 172 kilometres.

"We're really excited – we already started celebrating in traffic as we came into Cape Town when we suddenly realised that we'd won. The team that is here has been working on the car for years, so they were very emotional," said Sarah Bennink Bolt from the Nuon team.

The Dutch team had to have a perfect day today to stay ahead of strong competitor Tokai, who set the record in 2012 and won the World Solar Challenge on numerous occasions in the past.

"Tokai was really good last year in Australia at the World Solar Challenge, and while a lot of people thought we were a shoe-in for the Sasol Solar Challenge in South Africa, it wasn't obvious to us," continued Bennink Bolt. *"We had to work incredibly hard to beat them – they came out strong this year."*

With new regulations set for the global competition, all the teams will use the South African event to build completely new vehicles for the 2017 challenge in Australia, which is shorter than the Sasol Solar Challenge.

In South Africa, five teams held their own against the tough international competition. North-West University came in fourth position with 3,524 kilometres under their belt, and high school team Maragon Olympus managed to beat the University of Johannesburg by just 40 kilometres.

"We are very proud of the fact that Sirius x25, the NWU solar car, travelled through the whole of South Africa without ever once being put on a trailer," said Jimmy Pressly from the NWU team. *"The competition was great, and representing South Africa like this was a privilege. We plan on keeping the flag flying high by competing in the Bridgestone World Solar Challenge in 2017 with a brand new, better car."*

North-West University had to work hard to come back from an accident during track testing just before the Challenge began. But the 28-member team worked long hours, beating two international and four South African teams on the event.

For the Sasol Solar Challenge, a new record has been set, and teams are already planning their return in 2018 to improve on today's achievement.

"We try to break the record in South Africa every year," said Nuon's Bennink Bolt. *"The World Challenge is only 3,000 kilometres, so this is a tough challenge for us. It takes long hours, early mornings, hard work and a car that is always at its best. We'll be looking to break it again in 2018!"*

The Sasol Solar Challenge director, Winstone Jordaan, said that this has been the most competitive event to date.

"The calibre of competition at this year's Challenge has been awe inspiring to watch. We also had a very safe event with no major incidents – which is always our biggest point of pride when moving more than 350 people through the country on public roads."

The 2016 Sasol Solar Challenge is sponsored by Sasol as a vehicle of inspiration to young South Africans to become the country's future engineers and scientists.

SAIEE CGC hosts CV and and Job Interview Workshop at Wits

Members of the Central Gauteng Centre

Inline with paying it forward by investing in South African Youth, the SAIEE Central Gauteng Centre (CGC) hosted a CV and Job Interview Workshop at the University of Witwatersrand in September. In attendance were final year Electrical and Information Engineering students. The aim of the workshop was to close the gap graduates face in applying for employment. These include lack of skills in compiling their CVs, to displaying their competencies, and their underperformance in job interviews.

The aim of the workshop was to equip graduate students with the skills to enter the job market. For example, there was a presentation about how to compile curriculum vitaes (CVs), and presentation skills for job interviews.

In the spirit of collaboration, co-founders Lushia Van Buuren and Lizelle Hamann of Luelle Consulting™, a recruitment consulting agency, and Anker van Tonder, an HR Manager at a large corporate, participated as facilitators and job interview panel HR representatives. They shared useful industry experience and insights with the students, SAIEE CGC thanked them for their contribution.

To reach many more students, the event was streamed live via the SAIEE CGC Facebook Event Page. The students of Wits University, who attended the event, expressed their gratitude to the SAIEE CGC for bringing industry insights and knowledge to them. The SAIEE CGC sees this initiative as a great stepping stone in establishing and growing a Student Chapter at Wits University.

SAIEE CGC would like to thank the experienced and practising professional electrical engineers whom participated in the Mock Interview panels, some of whom are SAIEE members:

- Prudence Madiba represented an Engineering manager
- Zwelandile Mbebe represented a Telecommunications Chief engineer
- Khayakazi Dioka represented a Power systems Chief engineer
- Philip Groenewald represented an Engineering manager

An extension of gratitude to the SAIEE CGC members whose contribution ensured the success of the workshop: Zwelandile Mbebe, Anthea Solomon, Phetheni Khumalo, Tshego Cornelius, Kgomotso Setlhapelo, Lehlohonolo Mashego, Cuthbert Nyamupangedengu and Michelle Govender To access the videos from the event, navigate to the SAIEE Central Gauteng Centre Facebook CV Workshop Event Page. The videos are posted on the discussion thread.

Enhancing Power Quality at Wayne Plastics

Impact Power Innovations were contracted by Wayne's Plastics, a division of BBF Safety Group (Pty) Ltd to investigate opportunities to enhance the quality of power within their world class manufacturing facility.

Wayne's Plastics are South Africa's leading injection moulded PVC and PU gumboot manufacturer catering for the most diverse working environments.

The Innovative and Systematic Approach to enhancing Power Quality Establishing a Power Quality consequence and cost fingerprint for any site is the key step in driving reliability and engineering value back into power networks. Impact Power Innovations provide the transition from establishing Power Quality consequence and cost baselines into real financial value through leading edge Elspec Power Quality Measurement and Solutions Technologies.

Different industries have varying perceptions of how Power Quality affects the reliability of the operation. It is vitally important when conducting Power Quality Impact Assessments to look beyond theoretical and technical impacts of poor power quality. Every effort as far practical should be made to draw correlation and congruity between perceived customer operation implications and power quality data. The Technical Loss considerations, Power Cost (kVA/kVAR) reductions and any form of quantified operational loss analysis serve as a sound basis for investment into Power Quality Solutions.

IN TERMS OF BYLAW 3.2 ANNUAL MEMBERSHIP FEES ARE DUE ON 1ST JANUARY 2017

2017 Membership Fees

The Council meeting of 2 September 2016 approved annual membership and registration fees for 2017. The 2017 fees, effective from 01 January 2017 is indicated below. The SAIEE Council agreed to a discount for fees paid before 28 February 2017. Members are therefore encouraged to pay promptly to minimize the increase.

Grade of Membership	Annual Subscriptions paid before 28 February 2017		Annual Subscriptions paid after 28 February 2017		New Members FEES * see Notes 1 & 4 below	
	RSA incl VAT (R)	Outside RSA excl VAT (R)	RSA incl VAT (R)	Outside RSA excl VAT (R)	RSA incl VAT (R)	Outside RSA excl VAT (R)
Student	152	107	195	138	195	138
After 6 yrs study	976	684	1,254	878	1,254	878
Associate	976	684	1,254	878	1,254	878
Member	1,079	755	1,386	970	1,386	970
after 6 years	1,261	883	1,620	1,134	1,620	1,134
after 10 years	1,309	924	1,695	1,187	1,695	1,187
Senior Member	1,320	924	1,695	1,187	1,695	1,187
after 6 yrs/age 40	1,430	1,001	1,837	1,286	1,837	1,286
Fellow	1,430	1,001	1,837	1,286	1,837	1,286
Retired Member (By-law B3.7.1)	606	424	771	545	n/a	n/a
Retired Member (By-law B3.7.3)	nil	nil	nil	nil	n/a	n/a

1. The fee for all new applications is R2570 which includes an entrance fee of R920. On election to the applicable grade of membership, the new member's account will be adjusted accordingly and refunds made on request. Entrance fee for Students is free and new Student applicants require payment of R189.
2. Transfer fee to a higher grade is R500.00 for all grades of membership (except Student within 3 months of qualifying).
3. Members are encouraged to transfer to a higher grade when they qualify. It will be noted that the fees of Member and Senior Member grades after 10 and 6 years respectively are equal to the fees at the next higher grade.
4. Members elected after June 2017 pay a reduced subscription fee.

By-law B3.7.1: Where a member in the age group of 55 to 70 years has retired from substantive employment in the engineering profession, such member may make written application to Council for recognition as a retired person and a reduced membership fee.

By-law B3.7.3: Any member complying with the conditions of B3.7.1, but who has been a member of the Institute for not less than 25 consecutive years, shall be exempt from the payment of further subscriptions. Members who comply with the requirements of By-Law B3.7.3 may make written application to Council for exemption from paying subscriptions.

By-law B3.9: Any member in good standing who has been a member for fifty (50) consecutive years shall be exempt from the payment of further subscriptions.

Members not in good standing by failing to pay their memberhip fees by end of June of each year, are subject to Council decree to be struck-off the SAIEE membership role.

Members in good standing, and no longer in substantive employment, and do not receive payment or salary for work done, may apply to Council for a reduction in their annual subscriptions.

Why become a SAIEE Member?

what's in it for me?

2017

SAIEE OFFERS:

- Save up to R1,110 ECSA discount on ECSA annual membership fees
- Receive 11 issues of the **watt**now magazine
- Access to the peer-reviewed Africa Research Journal
- Membership grade recognise Prestige and Status
- Access to Monthly Lectures
- Generous discounts on CPD Training Courses
- Access to monthly CPD accredited Site Visits
- Be part of a SAIEE Centre in your area
- Networking Opportunities
- Assist in Recruitment
- A Mentorship Programme
- Members are able to serve on Organising Committees
- Access to the Electrical Engineering Library at SAIEE House
- 2nd Year & onwards Engineering Students welcome
- Claim 1 (category 3) CPD credit for being a SAIEE Member
- Have an attractive certificate of Membership to hang in your office

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Earn CPD Credits

"Wind Trees" to power homes?

Picture a steady breeze blowing through the leaves of a tree. Now imagine these leaves could do more than simply churn in the current of air—what if they could capture the wind and transform it into renewable energy?

COMPILED BY | MINX AVRABOS

Energy from wind is the fastest-growing source of electricity in the world, according to the Union of Concerned Scientists, an environmental and social research institution.

The development of wind power has mostly taken place on a large scale, usually by utility companies providing power to a grid of millions of customers. That's because wind energy is most efficient when it's capturing very strong winds, more common in remote areas and at heights of greater than 15 metres off the ground.

Those turbines need to be as tall as a five-story building, and they take up a lot of horizontal room, too - several hundred metres per turbine, due to their mechanical components. They require more maintenance than solar panels.

All of these factors make it challenging to develop small scale wind generators for domestic use. But that hasn't stopped companies from experimenting in the hopes of one day allowing individual homeowners to capture energy in their own backyards or balconies, and reduce their reliance on fossil fuels. Last December, two "wind trees"- or arbres à vent - quietly churned in a plaza in Paris, as world leaders met for the historic climate talks at the Le Bourget Conference Center nearby. Developed by a French company called New Wind, the "trees" had plastic "leaves" painted green, with curves that held dozens of tiny blades soundlessly harnessing the wind no matter which way it blew.

Unlike larger industrial turbines, which need winds of over 35 kilometres per hour to function, the leaves captured energy from wind speeds of less than 8 km/h.

THE ANSWER, MY FRIEND…

New Wind was founded by former film and television writer Jérôme Michaud-Larivière in 2011, and created its first prototype in 2013.

After working through several possible iterations, the company settled on a "seemingly chaotic" arrangement of leaf-turbines on each branch.

The latest design is just under 10 metres tall and 7 metres wide, sporting a total of 54 leaf-turbines that can capture up to 5.4 kilowatts of energy at a time and produce around 2,400 kWh annually, said New Wind spokesperson Marine Bieliaeff. The startup estimates this would meet half of the average French household's annual energy needs; run a small, low-consumption office for 12 months; or charge an electric car for 16,000 kms each year. That's the equivalent of about 600 litres of fuel.

In January, New Wind installed its first tree for a private company, the Swiss bank Piguet Galland. They also have contracts to provide more trees to companies in France, Germany, Switzerland and Luxembourg in the year ahead, with plans to expand beyond Europe next year. *"A lot of companies are looking for renewable energy,"* Bieliaeff said.

CEO Olivier Calloud called the Piguet Galland tree *"as much a piece of art as an innovation in the domain of sustainable development."* And indeed, the trees in their current iteration are not a long-term or scalable solution, because they are not designed for household use - they weigh several tons and take up a good bit of room.

Then there's the price, a single wind tree costs about R750 000 (about €50,000) to deliver and install. That's not even close to cost-competitive with solar power. Photovoltaic solar panels producing the same amount of energy (5.4 kW) cost between R225,000 - R300,000 (€15,000-20,000) in Europe, according to the country's environment and energy agency ADEME.

Wind Trees to power homes?

continues from page 23

Wind Tree

New York Rooftop Turbine

TURBINES ON NYC ROOFTOPS

As developers look for new ways to incorporate sustainable measures into their buildings, wind often remains an untapped resource. An American-based energy manufacturer has completed several high-profile wind installations in New York City, demonstrating the great potential for vertical-axis wind turbines and building buzz as they make their debut on city rooftops.

NEW YORKERS ARE BLOWN AWAY

In Long Island City, Queens, three turbines we installed on top of a newly-built apartment building in Pearson Square Court. Producing 9.6 kilowatts, the turbines produce power that offsets the common areas in the building, including the lobby, hallways, gym, and roof lounge.

Atop a 590-foot apartment complex in downtown Brooklyn, a turbine can be seen spinning on the building, visible from the Long Island Expressway and surrounding streets. Before these installations were set in motion, a site analysis was conducted to determine which renewable energy solutions would generate the optimal amount of electricity. The evaluation measured the site's surroundings and how solar and wind resources would impact energy generation. The helical structure of the turbines are well suited to extract energy from winds in urban settings, which tend to come from many directions, and both the Pearson and 388 Bridge Street sites have unobstructed locations for the turbines to gain maximum winds.

The market for renewable energy is exponentially growing in the US and around the world. The systems are getting smarter, more cost competitive, and the demand for clean energy in urban areas is rising. Turbines are changing the face of renewable energy in cities, stirring up conversations about wind power that may not be happening otherwise.

POWER FLOWERS TO DOMESTICATE WIND TURBINES

While most of us will offer strong vocal backing for the construction of wind farms, that can soon change if someone suggests building one nearby. As a result, the tri-blade towers get exiled to the middle of nowhere – or even further away. Instead of having a few high performance giants scattered throughout the land, an architect proposed a structure that would bring a few less efficient

turbines together and place them closer to the users of the power they generate.

Embarking on a 12 turbine Power Flowers installation, the designers asked themselves if it was possible to turn windmills into objects of desire. Bringing a few turbines together on a tree-like structure seemed the way to go, offering not-too-unpleasant aesthetics and power generation in one package. Using the familiar three-bladed turbine for such a creation would lead to similar issues as those currently faced by wind farm builders, so the team opted for the less efficient but not so unwieldy vertical-axis turbine instead.

The design team has based its creation on an existing turbine created by Urban Green Energy called Eddy. The makers say that Eddy can be assembled in less than an hour, is safe to use in winds up to 193 kph (120 mph) and will last for at least 20 years. The Power Flowers structure would feature a hollow steel column with branches at the top. These branches would be home to either three or 12 Eddy-like turbines and could be deployed closer to, or even within, urban environments such as parks, streets or roadways. Although vertical-axis turbines are considered less efficient than their tri-bladed bigger brothers; the Power Flowers design would allow for more of them to be packed into locations otherwise unavailable. Using figures provided by Eddy's manufacturer, the team reckons that a three-turbine Power Flowers structure would generate over 13,000 kWh of power every year at an average wind speed of 5 metres per second and generate as little as 42.8db of noise at 12 metres per second. Each 12-turbine structure's annual power output for the same average wind speed is calculated at 55,000 kWh.

Power Flowers on Rooftop

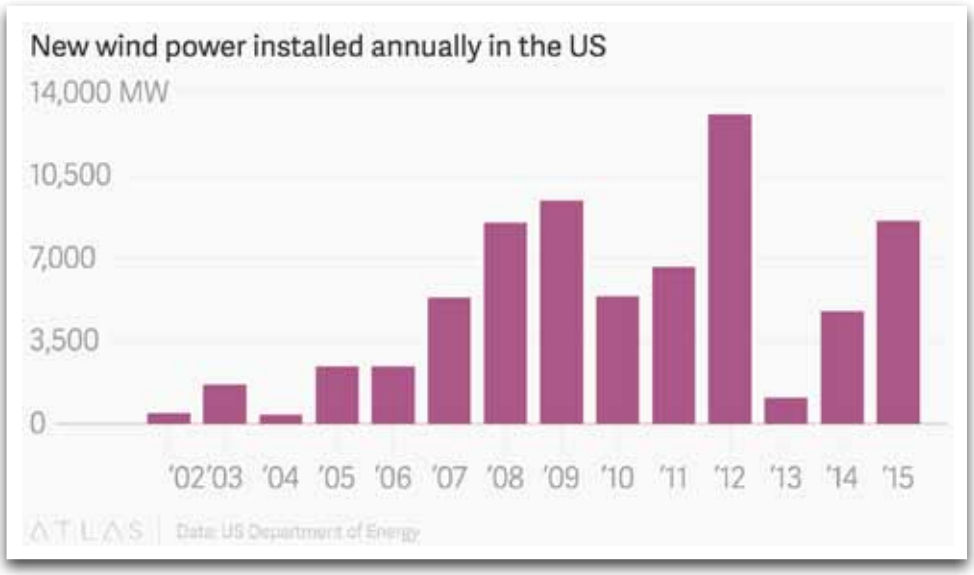

Table 1

There are of course unresolved practical and engineering issues to overcome, which would make it very interesting to see if such a structure could actually jump from design software into the real world.

We'd be watching closely for what sort of statistics would actually be produced and how such a thing would be received by the public at large.

Putting all that aside for a moment, would you object to one of these creations appearing outside your bedroom window or in the middle of your local park? wn

Earn CPD Credits

The Development of Solar Photovoltaic Plants at Eskom

Eskom is committed to diversifying its generation asset base and reducing its carbon footprint. Solar Photovoltaic (PV) is one of the renewable technologies being implemented with current installed capacity of 2.73 MWp and growing.

BY | DR. MARUBINI MANYAGE | MSAIEE

Eskom uses various technologies to generate electricity. The current generation plant mix includes coal, nuclear, hydro, gas, wind and Photovoltaic (PV), with a total installed capacity of 45 GW. The utility is constantly investigating other forms of energy sources to diversify its current plant mix and to reduce its carbon footprint.

Eskom Renewables Business Unit (RBU) is tasked with introducing alternative energy sources in a form of renewable energy technologies, to reduce carbon footprint, and also to pursue low carbon growth opportunities, in line with Eskom's strategic imperatives. Some of the current renewable technologies under development are small hydro, Concentrated Solar Power (CSP), PV and Wind, with the completion of the 100MW Sere Wind Farm, Western Cape, as the Eskom renewable flagship.

South Africa has favourable solar resources for implementing solar PV plants. The PV development in South Africa has grown significantly, especially after the Department of Energy (DoE) announcement in 2011 of the Renewable Energy Independent Power Procurement Program (REIPPP).

Besides that, the PV projects are known to have the shortest construction time, the Levelized Cost of Energy (LCoE) for PV has been declining and is becoming competitive with other technologies.

This in turn has increased market interest for deployment and integration in South Africa.

This article provides a summary of the Eskom solar PV program and PV plants, both ground-mount and rooftops, installed since initiation in 2011 to date. It also highlights projects under development, and concludes with some requirements for consideration when implementing solar PV projects.

In 2011, Eskom embarked on the development and execution of two solar PV plants with total capacity of 1 MW, to showcase government's commitment to low carbon energy for the United Nation Framework Convention on Climate Change (UNFCC), 17th Conference of the Parties (COP17). The projects were executed within 3 months, and the key dates were met within budget. The plants were then successfully demonstrated to government and media, after which an announcement was made that PV plants would be installed in all Eskom facilities.

This initiative demonstrated Eskom's commitment to renewables and ensured rapid launch of the Renewables Business Unit. Furthermore, there is an increase in expertise within Eskom for developing PV projects. RBU then initiated a program called iLanga PV to develop further projects. The strategy was to start with the development of small-scale (<1MVA) projects and then move to utility-scale projects.

One of the constraints experienced in the beginning was that the iLanga PV program did not have financial allocation in the DoE Integrated Resource Plan (IRP) 2010-2030 with 8400 MW of Solar PV. The only Eskom allocations in the IRP were for CSP 100 MW and Sere Wind 100 MW. It was decided that the PV plants would then be designed for self-consumption purposes on Eskom's owned facilities. As net-consumers, the PV plants will not be categorized as generating

Solar Photovoltaic Plants in SA

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plants and therefore, a generating license would not be required. However, the National Energy Regulator of South Africa (NERSA) would be formally informed of each project size, location and commission date for their records. Furthermore, Eskom will follow the respective municipalities or Eskom Grid Access Unit (GAU) process for network connection applications and requirements.

The utility has successfully commissioned 8 small-scale solar PV plants as shown in table below. The total capacity installed at Eskom so far is 2.73 MWp. The installed plants have a first year energy yield estimate of 4.6 GWh/year, with subsequent CO_2 savings estimate of 4.6 kilotons/year based on 1:1 ratio. The plants are operational and monitored weekly by the RBU maintenance team.

The site photos on the next page show all the small-scale plants installed at Eskom. The highlight of these projects is the 400 kWp Rosherville plant, which has 9 different configurations and technologies for research purpose, a first of its kind in Africa. The Eskom Research Centre produces research work which feed back to the PV projects development, and provides input to future PV plans. The site attracts academia and industry to the benefit of the country.

On the next page is a load and PV power profiles of a commercial Eskom Sunilaws building in East London with 165 kWp PV. Commercial buildings tend to have similar load profile, which increases in the morning and drop off in the evening, as people leave the building. The PV profile follows similar shape as the sunrises and sets, making it a suitable renewable technology for commercial buildings. Implementing other energy efficiency techniques can reduce the load profile even further.

PLANT LOCATION	CAPACITY (KWP)	TECHNOLOGY	YEAR OF INSTALLATION	STATUS
Small-Scale Solar PV Projects (<1MVA)				
1. Kendal PV	620	Fixed-tilt ground-mount with mono-crystalline	2011	Operational
2. Lethabo PV	576	Single axis tracking ground-mount with mono-crystalline	2011	Operational
3. MWP Carpark PV	396	East-West Fixed-tilt carpark with poly-crystalline	2011/12	Operational
4. MWP CPV	2x12.8	Dual–axis Concentrated PV	2011/12	Operational
5. MWP Block E PV	358	Fixed-tilt rooftop with poly-crystalline	2013	Operational
6. Rosherville PV	400	Combination of fixed and tracking ground mount with poly-crystalline and thin film	2014	Operational
7. Sunilaws PV	165	Fixed-tilt rooftop and carpark with poly-crystalline	2015	Operational
8. Bellville office PV	195	Fixed-tilt rooftop with poly-crystalline	2016	Operational
9. Mkondeni Park PV	326	Fixed-tilt rooftop and carpark with poly-crystalline	2016/17	Construction
Total	2735			
(MWac) Utility-Scale Solar PV Projects (>1MVA)				
1. Grootvlei PV	7	Ground-mount	TBD	Tender phase
2. Majuba PV	8	Ground-mount	TBD	Concept/EIA
3. Lethabo PV	8	Ground-mount	TBD	Concept/EIA
4. Tutuka PV	8	Ground-mount	TBD	Concept/EIA
5. Arnot PV	8	Ground-mount	TBD	Concept/EIA

Kendal PV (620kWp)

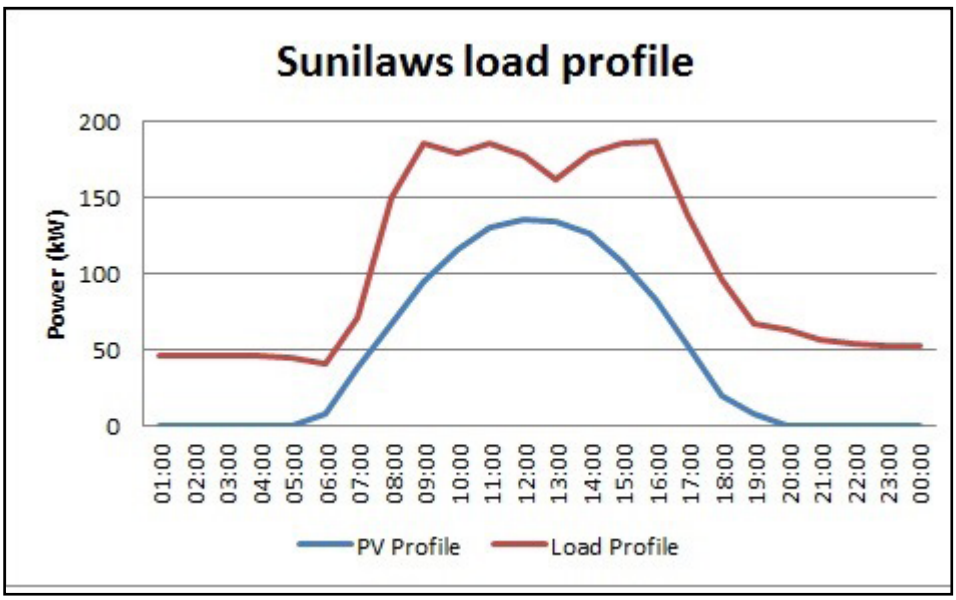
Lethabo PV (576kWp)

MWP Carpark PV (396kWp)

MWP CPV (2x12.8 kWp)

MWP PV (358kWp)

Rosherville PV (400kWp)



There are several utility-scale (>1MVA) projects under development as shown in the table. The projects are at various life cycles with engineering concept studies completed. Two Environmental Impact Assessment (EIA) authorizations have been issued for Grootvlei and Arnot PV projects. Water Use License Approval (WULA) authorization has also being issued for Grootvlei. Other projects EIAs and WULAs authorizations are in progress and expected by end of 2017. These projects are executed with consideration of LCoE and have to be competitive with industry Independent Power Producers (IPPs). This is to make sure that the market does not take advantage of Eskom as it is a state-owned entity.

Some practical advices to take into consideration when developing small-scale PV projects and optimising LCoE are:

STRUCTURAL

- A structural analysis of existing roof structures is required in order to determine whether the structures would be able to carry the loads induced by the implementation of a new PV plant.

Solar Photovoltaic Plants in SA

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Grootvlei PV Concept Site layout

The analysis should be done before construction, and signed by a relevant professional engineer.

- It is advisable to avoid structures with extensive waterproofing requirements which may also need replacement before the end of PV lifespan.
- If the building has property insurance, it should be reviewed before introducing a new PV plant.
- Any future development on the structure should be taken into account during PV design.

DESIGN

- To optimize PV cost in buildings, it is recommended to perform an energy audit and then implement energy efficiency methods before sizing a PV plant.
- For 25 years' design life, select quality PV panels and inverters from reputable manufacturers, who will be able to honor the warranties. Inverter replacement in the life of the plant should be accounted for in PV costing.
- Review the Grid Code for renewables for minimum requirements. SA's Code is currently being reviewed to ensure that there are no stringent requirements that will hinder the development of small-scale PV.
- Check the network voltage levels at Point of Connection (PoC), as high or low voltage variations may cause spurious plant trips. Switchboards with loads that have high startup currents may also cause the PV to trip during startup.
- Fault levels from the network at PoC must also be considered when sizing PV equipment downstream, although the PV itself does not generate significant fault levels.
- For additional safety in a grid-tied system, an additional anti-islanding relay can be installed for protection should the Inverter/s anti-islanding protection fails. This is done in all Eskom installations.
- For installations with standby generator, an integrated PV design with generator can be made to optimize the generator fuel.
- PV plants require monitoring to ensure that the benefit is realized and to manage maintenance activities. The use of standard control and monitoring

Copper – essential in renewable energy, solar and water systems

Copper plays an important role in renewable energy systems. Since copper is the highest rated thermal and electrical conductor among the engineering metals, power systems that utilise copper generate and transmit energy with maximum efficiency and with minimum environmental impact.

By using copper instead of other lower electrical energy-efficient metal conductors, less electricity needs to be generated to satisfy a given power demand. Currently, requirements for connecting electric generation systems – like home photovoltaic renewable energy or wind systems – to the electricity grid vary widely. But all power providers face a common set of issues in connecting small renewable energy systems to the grid, so regulations usually have to do with safety and power quality, contracts (which may require liability insurance), metering and rates. In an attempt to address safety and power quality issues of grid-connected systems, Carel Ballack of the CDAA, who is on the committee appointed by SABS is in the process of writing a new standard for grid tied solar installations (SANS 10142-3).

Copper has long been used in solar heating/hot water systems, where it is commonly used in heat exchangers. Now, it promises to become equally valuable in photovoltaic (PV) and wind systems.

COPPER IN SOLAR ENERGY SYSTEMS

- It has the best thermal conductivity of all engineering metals.
- It is highly resistant to both atmospheric and aqueous corrosion.
- It is easy to fabricate and to join by soldering or brazing.
- It has been used both for plumbing and for roofs since metals were first employed in those applications.
- Solar water heating systems using copper are more efficient.

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Solar Photovoltaic Plants in SA

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equipment that is readily available in the market reduces PV cost. The plants can be monitored and analyzed remotely. The important information can be selected and emailed daily to clients and other stakeholders for information or action.

LICENSE AND PERMITS

For grid-tied solar PV plants, consult either the municipality or Eskom for network connection requirements before construction.

Some of the requirements (depending on the network provider) are:

- application for the connection of embedded generation;
- use of approved inverters with anti-islanding capability and settings according to NRS 097-2-1;
- changing existing unidirectional meter with a bi-directional meter;
- signed PV designs and commissioning report by relevant ECSA professional engineer and provision of a copy of electrical certificate of compliance while the relevant SANS standards are being developed or updated to include PV;
- change or update existing electricity contract and applicable tariff.

Eskom GAU does not allow Low Voltage (LV) grid-tied connections to its network at present. Currently there are several sites testing what the LV requirements are considered safe and technically achievable.

The existing Eskom PV plants, both connected to the Eskom network and municipality network, are classified as Medium Voltage (MV) connections. The iLanga projects will not make LV connections to either Eskom or municipality networks so as not to contravene GAU rules, and also to provide a uniform position to the South African public. GAU is close to finalizing its requirements, as the public is keen on installing residential LV grid-tied PV systems legally.

Other municipalities (e.g. City of Cape Town) do allow LV connections, as they have established their minimum connection requirements, some of which are describe above.

- Not all municipalities have formal processes for allowing solar PV grid connection applications for residential and commercial systems. It is advisable to adopt the City of Cape Town requirements since that is at an advance stage. This will make it easier for municipalities to manage, and know the status of embedded generation in their networks, to ensure safety to the public, and also for reporting embedded generation to NERSA.
- For ground-mounted PV, choose a land space with minimum environmental impact - ie. land in or near wetlands should be avoided. EIA may be required which can trigger WULA authorization which further delays the project execution.

In conclusion, Eskom has a program for solar PV technologies with installed capacity of 2.73 MWp and growing. All existing PV plants are operational as per design and monitored remotely. The Eskom PV procurement specifications are available in the public space, and can be used as a guideline. There are several plants under development, which are further improved with the lessons learnt from existing projects. The utility has contributed into solar PV space and renewables in general, both internally and externally, and keeps searching and implementing innovative ideas to reduce its carbon footprint. wn

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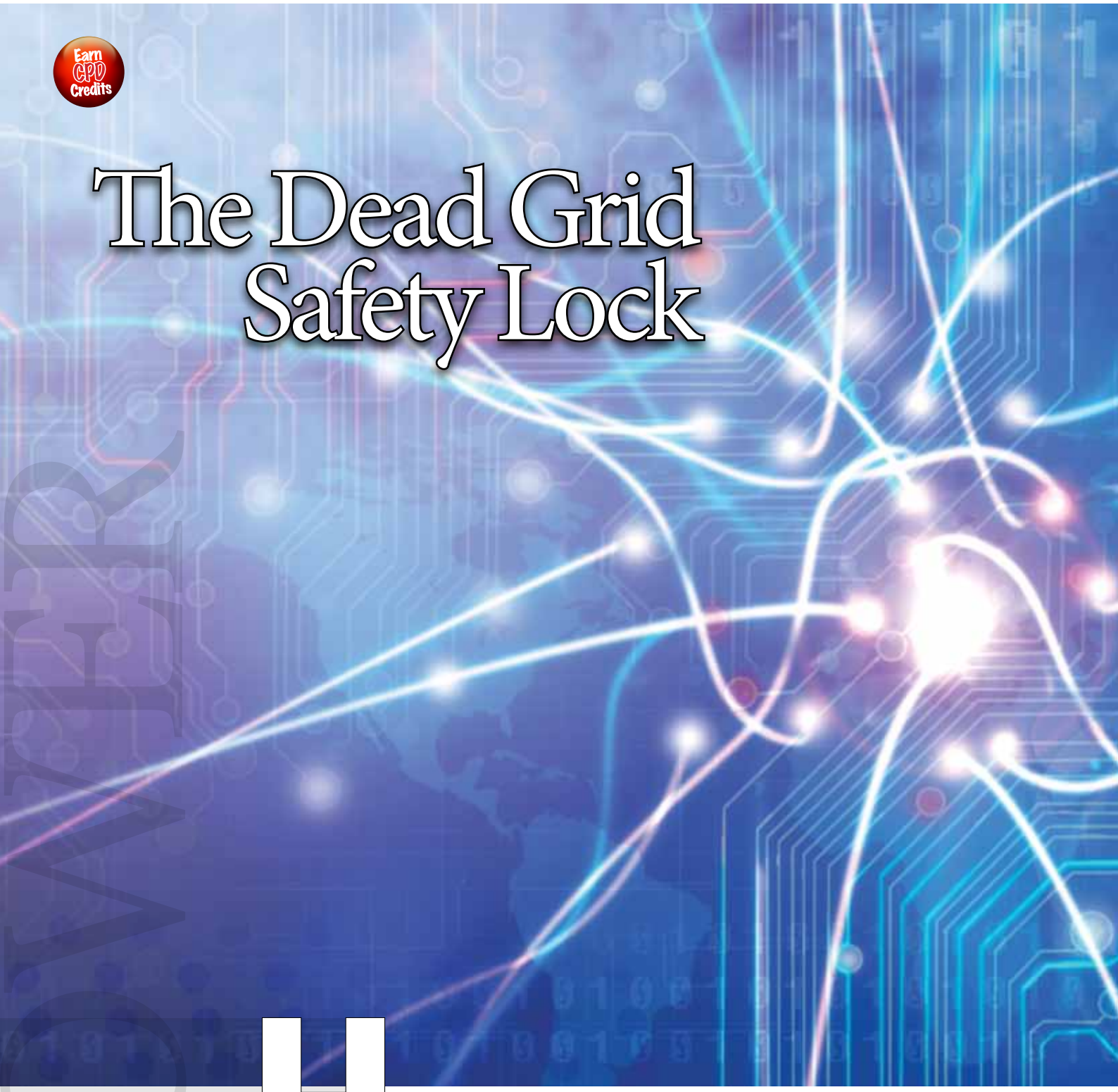
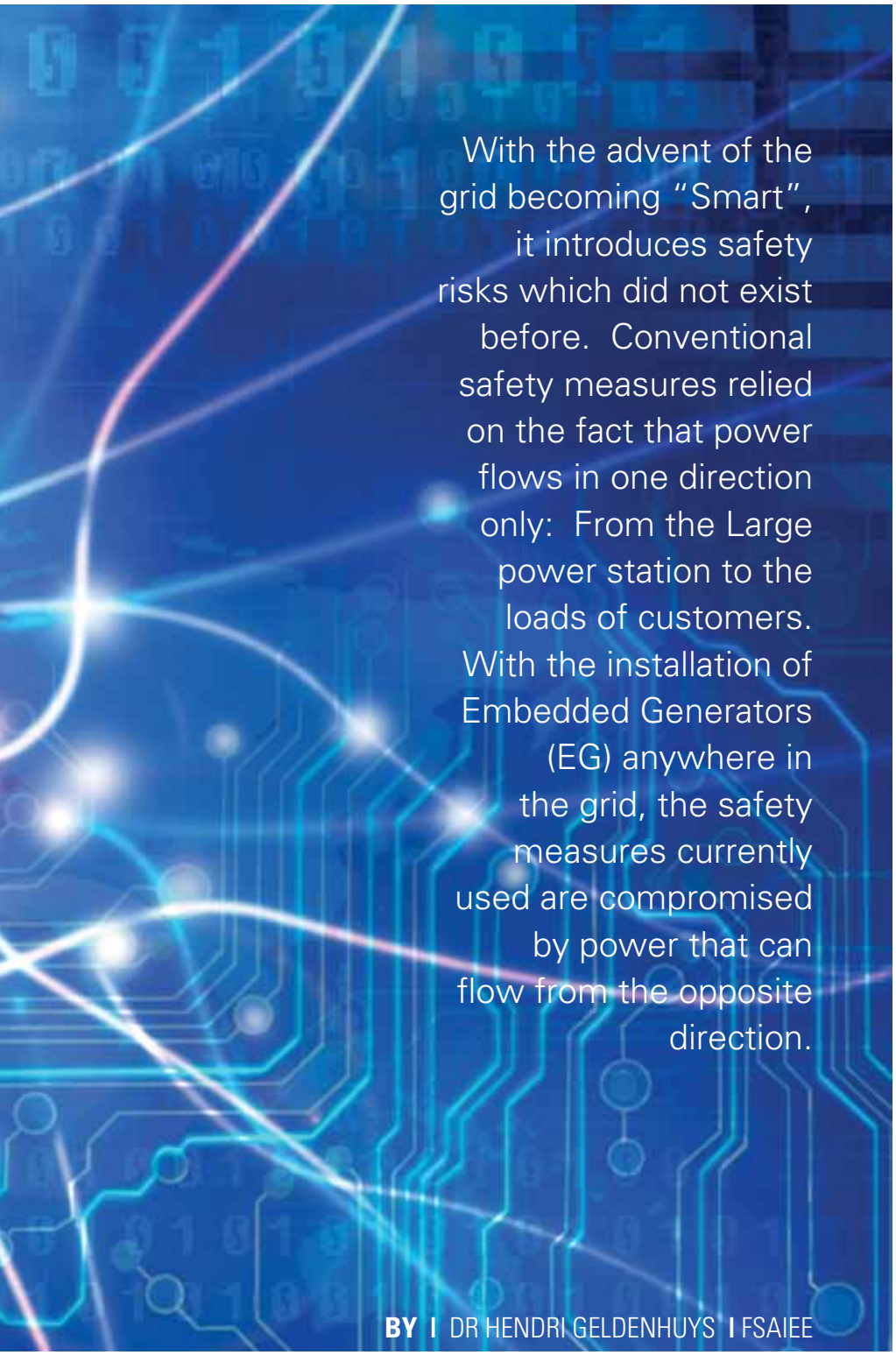
SAFETY FROM EMBEDDED GENERATORS ON LOW VOLTAGE FEEDERS



The Dead Grid Safety Lock

High Voltage (HV) systems in particular, and Medium Voltage (MV) systems to a lesser extent, have traditionally dealt with power flow in any direction. Safety measures on these systems deal with this issue adequately: this is not the case on Low Voltage (LV) systems. The main difference is that HV and MV apply elaborate safety earths and phase bonding, on both sides of a work site after the grid has been



With the advent of the grid becoming "Smart", it introduces safety risks which did not exist before. Conventional safety measures relied on the fact that power flows in one direction only: From the Large power station to the loads of customers. With the installation of Embedded Generators (EG) anywhere in the grid, the safety measures currently used are compromised by power that can flow from the opposite direction.

BY | DR HENDRI GELDENHUYS | FSAIEE

disconnected from all sources. This is most likely controlled by remote-scada switching capability. A "Faraday cage" is created around the work site, and even if it was to become live again, the earthing will protect the workers effectively and cause the source to trip on fault current.

In LV systems, earthing the work site in the same way that it is done in HV and MV systems is not possible. The complexity of LV networks and the related technologies that are used, makes it impossible to consistently do earthing on both sides of the work site. Only LV overhead bare wire feeders make earthing possible on both sides of the work site. Other LV technologies aim to cover-insulate live conductors and hardware, and make it specifically NOT possible to earth LV live conductors. This insulation strategy makes it impossible to apply working earths on both sides of the installation. The alternative is to use LV live-work techniques at all times. This is not a practical option either, live work is cumbersome, and only done by suitably skilled staff equipped with live tools.

Normal safety procedures for LV work comprise of:

- Identify circuit;
- Open, isolate, tag and lock out the circuit (It does not prescribe Earting & Bonding);
- Test at the work location for it to be dead;
- Work commences.

For customer owned Embedded Generators (EG) to be integrated into the LV network, either the same safety work procedures have to be followed, or a means has to be provided that fulfill the same task. Either way, the same equipment standards that are applicable to the above requirements must be met.

Where only one customer with an EG is connected, at LV on a transformer, it is possible to use the same operating safety procedure as for the utility source. For this to be implemented a utility accessible, lockable isolation point is required at the customer premise.

The isolation point must be clearly marked with respect to its purpose and location on the grid; it has to be registered on the utility control database. The normal utility isolating

The Dead Grid Safety Lock

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A LV connected PV Embedded Generator on a farm.

point should also carry warning notices that this feeder has got embedded generators installed and that isolation, etc. of the installation has to be done at both ends of the feeder. In the case of LV feeders, that has many customers connected to it, often behind high security walls etc., implementing such measures becomes impractical. To cater for this situation the concept of the Dead Grid Safety Lock [DGSL] has been created.

THE DGSL PRIMARY FUNCTION

The primary function of the DGSL is to work in tandem with the normal LV Safety Work Procedures mentioned above. The critical step, that links the DGSL to the safety procedure, is the final test to confirm that the network is dead and is safe to work on. Once the grid before the DGSL is proven to be dead, isolated, tagged and locked out, the DGSL ensures that the EG cannot liven up this part of the network. So, even if power from the EG is restored, the DGSL will prevent it from endangering the lines men working on this section of the system. The DGSL function relies on the EG to disconnect when the utility source is switched off. This is done by the generator anti-islanding, or alternatively out of

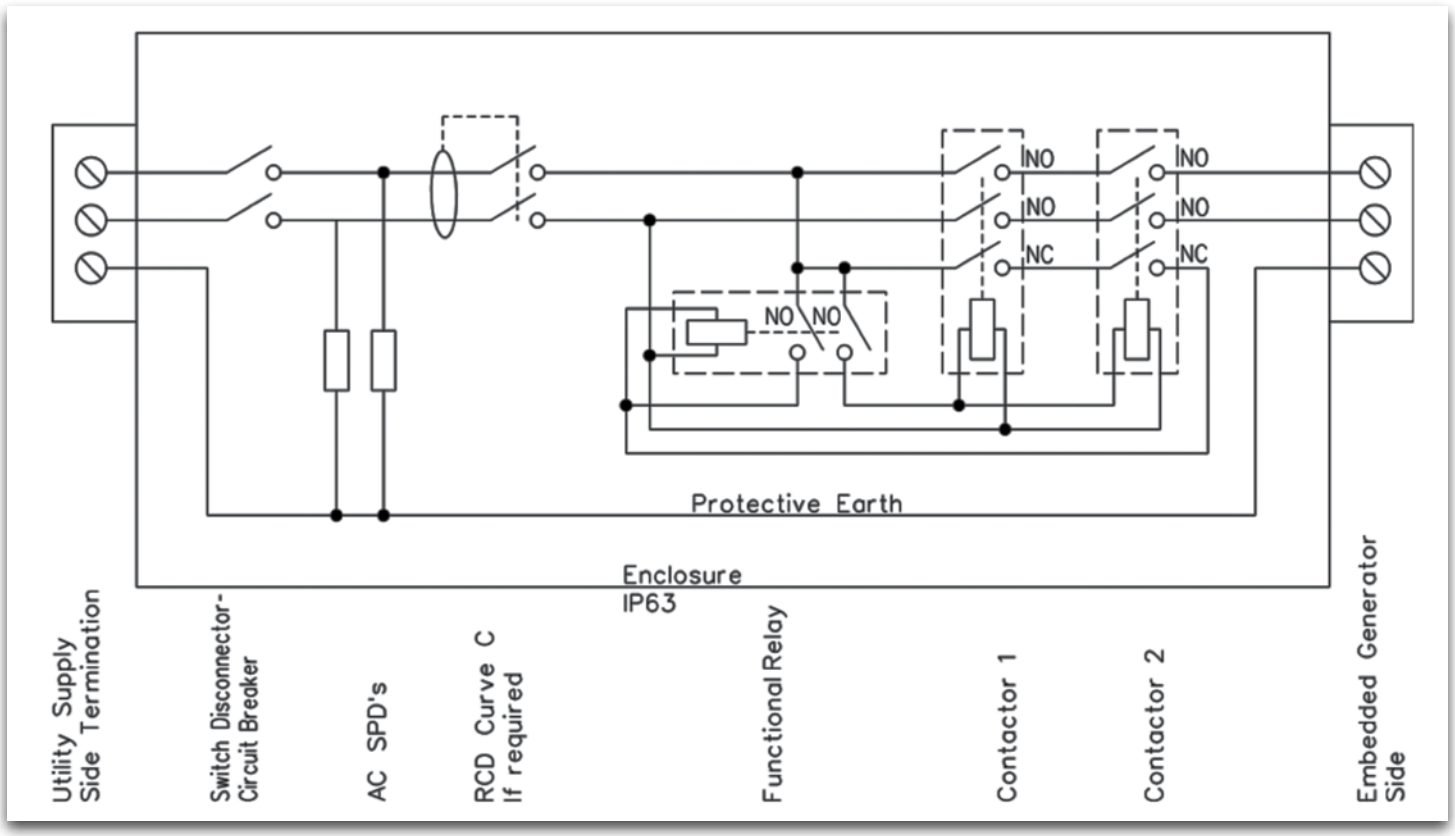

Figure 1: A schematic diagram of the DGSL.

bounds frequency or voltage functionality. Should the EG not disconnect, the testing step will alert the linesman of the abnormal operation condition.

The operation of the contactors, and the functional relay, is such that it cannot switch back, or become live from the EG's side of the network. From here the name of the device is derived; namely when the power is dead, it locks the system and can only be switched on when the power is restored by the linesman from the utility side. It therefore ensures that the network remains safe to work on.

This function can be achieved with one contactor. However, if this contactor fails (for example burned closed) the safety function is lost. By adding the functional relay and the 2nd contactor, the reliability of the system is so enhanced that the risk of failure becomes negligible as shown in table 1.

The DGSL core function comprises of two contactors being controlled by a functional relay. The contactors must have auxiliary NC contacts as shown. The functional relay must have the following capability:

FUNCTIONS:

- Two DPDT contacts;
- Start-up delay 30s or longer;
- Restart delay 30s or longer;
- Low voltage Must-Open, voltage dip-time response, as per figure 2;
- Low voltage Must-Remain-Closed, voltage-dip-time response, as per figure 2;
- Over-voltage functionality is not required in this device. However should it have such capability it should be compliant t to NRS 097-2-1;

Type of Failure	Function		Safe Outcome	Probability [/hour]
	Lock out	Disconnect Function		
One Main Contactor	Yes	Yes	Yes	1.14E-05
Auxiliary Relay	No	Yes	Yes	1.14E-05
Auxiliary Relay and one Contactor	No	Yes	Yes	1.30E-10
First the Auxiliary Relay followed by both Contactors for different reasons	No	No	Compromised	1.49E-15
Both Main Contactors for the same cause of failure*	No	No	Compromised	?

The table is assumes the normal failure rate of both the relay and the contactors as 1 per 10 years.

***Possible "same cause" could be fault current behind the ADD or lighting current through it. However the probability of this, is not the average failure rate.**

Table 1. Failure analysis of different components of the DGSL.

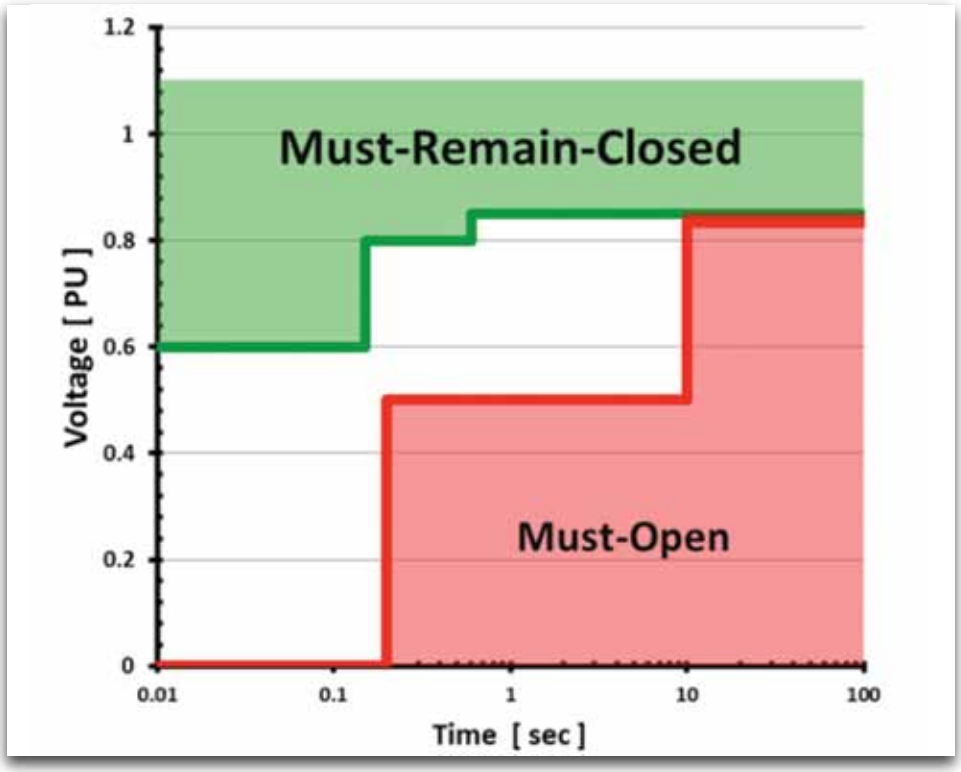

Figure 2. The requirements of the grid connection code for renewable power

The Dead Grid Safety Lock

continues from page 37

- Over-and-under-frequency response is not required in this device. However it is permitted to have it and should be compliant to NRS 097-2-1 limits;
- PLANTS for the EG to have to remain connected and have to be disconnected.

FUNCTIONAL RELAY SOURCING

It may not be possible to find relays that are certified in accordance with the DGSL specification.

It is proposed to allow a concession in this regard for an interim period, that relays which are certified in accordance with VDE 126-1-1 can be considered as an interim solution. (Although it might not be 100% compliant, however, it would fulfill most of the critical safety features.)

It is anticipated that companies (in SA) will see the opportunity created by the requirement, and will develop relays for the market that are compliant to local and foreign specifications.

It is anticipated that such a device could be made at a fraction of the cost of the current devices.

Secondary and other components integrated into the DGSL include:

1. A set of surge arrestors. These are included as the nature of EG's location exposes the installation to significantly more lightning activity.

2. Residual current breaker curve C (as in Fig 1) (if this function is not covered by the inverter of certain types of inverters).

3. Switched isolator and over-current protection, as required by SANS 10142-1.

4. Protective earth conductor that links the EG installation earthing and bonding to that of the power system.

5. An IP 63 rated enclosure to protect the safety-critical-equipment for a lifetime designed for in excess of 20 years.

ENSURING THE QUALITY AND LONGEVITY OF THE DGSL

It is clear that the reliability of the DGSL is of primary importance to the safety of the utility and other workers on the network. It is therefore a primary consideration that no errors are allowed to be made in the design, assembly or the installation of the DGSL.

By ensuring that all the components comply with the DGSL specifications, the normal SANS 10142-1 will be exceeded. This compliance will allow for a better controlled environment.

Similarly, the SANS 1973-1/3 standard for switchgear assembly is a well proven and ideal vehicle for this type of equipment.

The DGSL specifications call for stringent routine testing. The result is that the quality and design of DGSL are ensured in a well-controlled environment.

The role of an electrician, or master electrician, in the context of SANS 10142-1 would therefore be to integrate the DGSL and to certify the balance of the installation.

It is foreseen that companies will see the opportunity to bring of bringing a range of DGSL's to the market. Typical standard ratings would be 10A – 2.3 kVA and 20A - 4.6 kVA single phase, 10A - 20A – 13.6 kVA three phase and so on, dependent on standard ratings of contactors most likely.

SUMMARY

The DGSL provides a secure way in which utility staff can work confidently while their safety is not compromised by Embedded Generators. Certification of the DGSL through SANS 1973 allows existing South African industry-instruments and organizations to implement the concept very quickly, and with the least effort.

NRS 097-2-1 AND SANS 10142-3

This work is spearheaded by the NRS utility co-ordination committee for LV EG grid integration standards.

The NRS committee includes representatives of companies that work in this field. Members of SANS 10142-3 (which considers "the installation" aspects of EG) are utility experts.

The contribution of all of these persons is recognized. This cooperation is critical for the successful completion of this work. wn

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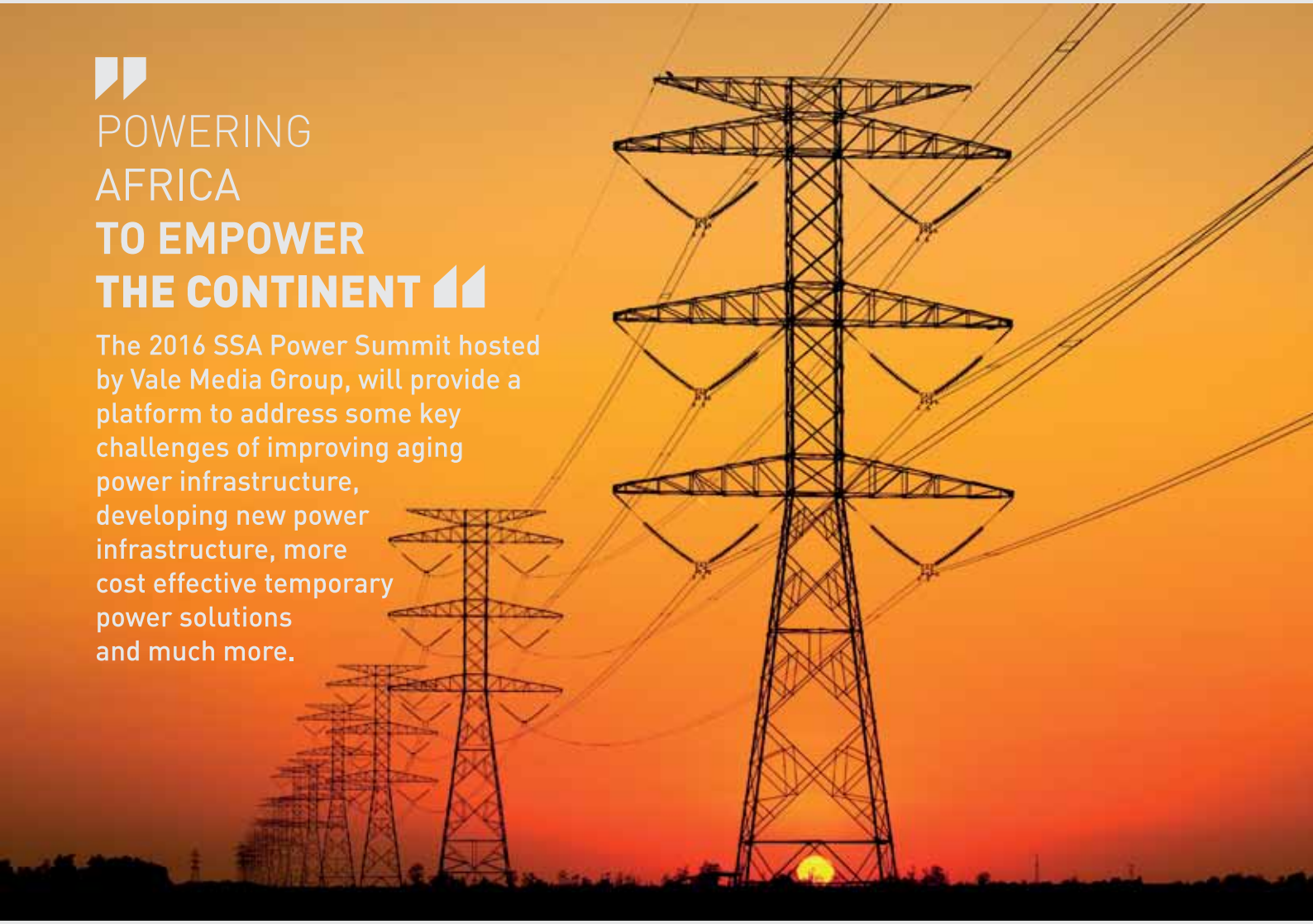

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Software cost estimation

The discipline of project management predominantly involves balancing project scope, project time and project cost [15]. Changing one of the three invariably affects the other two, resulting in consequences for the project. For example, increasing the project scope would increase the time it would take to complete the project as well as the overall project cost.

BY | GINO BOUGAARDT | PR. ENG. | MSAIEE

A project cost estimate is produced at the start of a project. It provides a cost approximation of resources required and the management thereof for completing the project.

An accurate cost estimate is important to successfully deliver on all aspects of a project. Project cost estimation is more challenging in Information Technology (IT) and software development projects as opposed to other types of projects. Some of the reasons being:

IT projects are being developed in an environment that is constantly and rapidly changing with the evolution of technology, from hardware to the new generation of programming languages, tools, processes, frameworks and methodologies. For example, waterfall method, prototyping, iterative and incremental development, spiral development, rapid application development, agile unified process and many more. [5], [16].

A lack of historical software management data on completed software projects that contain a wealth of information about a project's evolution. This information not only includes past estimates and their actual performance, but also about the tools, techniques, packages and methodologies used.

Inadequate appreciation for the effort required completing tasks from, for example, software developers.

Pressure to produce estimates before clear specifications of the project requirements have been produced.

Project scope creep that affects estimates if clear, complete and reliable specifications are not formulated at the start of the project.

Deliberately reducing the estimate, in some measure, to make the bid more acceptable during the tender process.

The influence of cost drivers such as the project software size, software complexity, required quality, experience of the development team, user interaction/ participation etc. are difficult to determine [2], [5], [7].

The cost drivers are one of the research areas of The Standish Group. The Standish Group is an organization that conducts global research in IT environments and software projects across a range of companies. Their CHAOS report showed that the average project cost overrun in 1994 was 189% over the original cost estimate [17]. Furthermore, the average project cost overrun in the 2000 study was 45%, in 2004 it was 56% and in 2006 it was 47%. Further studies report a continuation of this alarming trend where in 2008 the average project cost overrun was 54%, in 2010 it was 46% and in 2012 it was 59% [17], [18], [19].

These research findings show that cost overruns are a cause for concern, as it can have significant financial implications, considering these projects can run from the tens of millions into the hundreds of millions of US dollars. For example, a New York City Automated Payroll (NYCAP) System project, which started in 1999, was originally estimated at US $66 million. However, when it was completed in 2011 the total cost was a huge US $360+ million. This was more than 5 times the original estimate [19]. It is evident that project cost estimation is an essential skill for a project manager, to hopefully avoid such massive cost overruns.

PROJECT COST ESTIMATION

In most software development projects cost estimates are determined based on the effort estimate, usually expressed in person-months, man-months, staff hours, staff days or staff weeks. Effort is the number of labour units that are required to complete a project task. It should not be confused with duration [1], [16].

Details of the project tasks can normally be found in the Work Breakdown Structure (WBS) of the project [1], [15]. The effort is mostly a function of the size of the project (a cost driver), which is measured in lines of code (LOC) or function points (FP). Lines of code is a software metric determined by counting the number of lines of source code in the text of a software program, while a function point is a metric that expresses the amount of software functionality that has to be delivered [4], [12]. Depending on the

Software Cost Estimation

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cost estimation tool being used, the form of the effort function can be different by the inclusion of other cost drivers as follows:

Effort=$f(x_1,x_2,\ldots,x_n)$

Where: $x_1,x_2,\ldots,x_n$ represent the cost drivers

The cost estimate is calculated by multiplying the effort estimate by the average salary per unit time of the staff involved in performing the task. The effort estimate is best determined by the people who will perform the task, since they understand the complexity of the task [16].

The purpose of this article is to present, discuss and analyse the more popular project cost estimation tools and techniques for use in the software development environment. It is good practice to compare project cost estimates prepared from various tools and techniques as their shortcomings can lead to inaccurate estimates.

The strengths and weaknesses of the more popular tools and techniques will be discussed in order to assist project managers to make informed decisions. This article is not an exhaustive discussion of all the cost estimation tools and techniques in the software development industry, but rather an introduction to the topic. This article begins with a discussion of non-algorithmic cost estimation techniques followed by a discussion of algorithmic cost estimation tools. Finally, conclusions are drawn.

SIMPLICITY OF NON-ALGORITHMIC COST ESTIMATION TECHNIQUES

The simplicity of non-algorithmic techniques relies on human decision making to determine the project cost estimate. Non-algorithmic techniques include analogy based costing, expert judgment, bottom-up and top-down.

ANALOGY BASED COSTING

Analogy based costing uses the actual costs of similar completed historical projects in order to estimate the new project and hence derives the cost estimate through reasoning by analogy [1], [5], [15], [16]. A weakness of analogy based costing is that the historical data of the similar, previous projects may not be accurate, or even exist [20]. Analogy based costing can be used to cost the total project or to cost the project at various sublevels.

The total project cost approach has the advantage that all components of the project are included in the cost, therefore, it is not time consuming and hence less costly to produce. The sublevel costing approach provides more detail, and thus similarities and differences between the projects can be analysed [9].

However, this costing requires good expert judgment to determine the attribute differences between projects [1], [9], [15].

EXPERT JUDGMENT COST ESTIMATION

Expert judgment cost estimation is a method of consulting experts that provide cost estimates using their own methods and experience. The Delphi technique is used to resolve the inconsistencies in the estimates.

It is a process of constant interaction between a coordinator and a number of experts while producing the estimate. There is no interaction between the experts themselves; however, a meeting is held by the coordinator after each round of estimations to discuss widely varying estimates. The advantage of expert judgment cost estimation is that it is fast and an expert with the relevant experience can provide a good estimate. The disadvantage is that the estimate depends on the expert and the expert may be biased [9]. Experts may use the analogy based costing approach, the top-down or the bottom-up approach if the project is small in size and complexity [15].

BOTTOM-UP COST ESTIMATION APPROACH

The bottom-up cost estimation approach focuses on estimating the cost of each individual component, work package, activity or work item that makes up the total project which is normally found in the WBS. The total project cost estimate is calculated by summing up the individual costs of each work package.

The bottom-up approach therefore requires a well-defined scope and a detailed and complete WBS [1], [5], [9], [10], [15], [16]. Using smaller work packages increases the accuracy of the cost estimate because the people involved with the work packages are providing the cost estimates, rather than people who are unfamiliar with the project [1].

The bottom-up approach is the most accurate cost estimate, however, it is the most time intensive to produce [16]. On the other hand, the bottom-up estimation approach is viewed risky by senior management who tend not to trust their subordinates.

They fear that excessive resource requirements will be estimated for the work packages in an attempt to ensure success and hence exert control over the budget. True bottom-up cost estimation is rare while top-down cost estimation is more common [10].

TOP-DOWN COST ESTIMATION APPROACH

The top-down cost estimation approach is the opposite of the bottom-up cost estimation approach and the total project cost estimate is produced from the global characteristics of the product. The total cost is then split up among the various components of the project. This approach is faster and easier than the bottom-up approach and minimal project detail is required at the start.

However, it is less accurate than other methods, including the bottom-up estimate approach [5], [9]. There is a debate concerning the cost estimation accuracy, or lack thereof, resulting from limited human decision making which forms a large part of the process in the execution of the non-algorithmic techniques. Non-algorithmic techniques do not use sophisticated mathematical formulas/models to calculate the project cost estimate.

COMPLEXITY OF ALGORITHMIC COST ESTIMATION TOOLS

Complex algorithmic tools make use of sophisticated mathematical formulas/models to determine the project cost estimate. The effort or cost estimate is a function of a number of variables. The variables are the major cost factors or drivers that would contribute to the cost estimate [9].

The following algorithmic cost estimation tools consider multiple cost drivers and include software cost estimation packages, machine learning and hybrid tools.

SOFTWARE COST ESTIMATION PACKAGES

Software cost estimation packages covered here include Software Lifecycle Management, Software Productivity, Quality and Reliability and the Constructive Cost Model.

SOFTWARE LIFECYCLE MANAGEMENT

Software Lifecycle Management (SLIM) is a suite of tools developed by L. Putnam that is based on the Putnam model. Putnam is one of the earliest models developed. The software equation is [14]:

$$\text{Size} = C \times \text{Productivity} \times (\text{Effort})^{1/3} \times (\text{Time})^{4/3}$$

Where:

- Size is the product or system size measured in LOC.
- C is a constant. It is a measure of the state of technology applied to the project. Applying better technology can increase the constant.
- Productivity parameter reflects the system characteristics (e.g. number of files, number of reports, number of programs and subprograms the system has). It can be determined using historical data collected from past projects.
- Effort is the person-months or person-years needed.
- Time refers to the project duration (development time) in months or years.

This software equation is very sensitive to time. Decreasing the project time in order to complete the project faster greatly increases the project effort required, assuming other project attributes remain the same. An increased effort leads to an increase in the project cost, as additional people are required, hence trading time for effort is costly [14]. Moreover, the estimated cost is dependent on the estimated project size. Estimating the project code size, measured in lines of code (LOC) before it is completed, is extremely difficult. Although the LOC metric does not count blank lines and comment lines, a disadvantage is that it is dependent on the programming language being used. A higher-level programming language requires fewer LOC in comparison to a lower-level programming language that requires more LOC.

The expressive power of the programming language being used is not taken into account in the LOC metric. Hence, it is difficult comparing projects using different languages [8]. Furthermore, the LOC is not always delivered to the user/client. An alternative measuring method to lines of code is function points.

These points provide a means for both the software developers and users to measure the functional requirements of the software project. Function point metrics are independent of the programming language [4].

SOFTWARE PRODUCTIVITY, QUALITY AND RELIABILITY

Software Productivity, Quality and Reliability (SPQR) developed by C. Jones, is a software tool that utilises function points to size and cost a software project. Functions are related to the type of data (i.e. system types) that the software project uses or generates. The system types of the software project are identified in the system requirements specification documents of the project. The function point analysis (FPA) technique estimates the number of each of five system types, according to FPA rules, in the software project.

The five system types are internal logical files, external interface files, external inquiries, external inputs and external

Software Cost Estimation

continues from page 43

outputs [4], [20]. A drawback of FPA is that this technique cannot easily be automated. FPA is time consuming, as trained professionals need to manually extract the estimates from the requirements documentation, hereby introducing their own expert judgment and bias [11]. FPA is effective in business environments; however, it is not successful in embedded systems, scientific, technical or in heavily computational applications due to the function point counts. FPA is used in four versions of the SPQR model: SPQR 10, 20, 50 and 100. The numbers 10, 20, 50 and 100 relate to the number of questions the user has to answer as input to the model for refinement purposes [5]. The COnstructive COst MOdel (COCOMO) tool also has a family of models just like SPQR that starts with a basic model and ends with a detailed model that incorporates many variables to determine the effort and cost estimate.

CONSTRUCTIVE COST MODEL

B. Boehm developed the COCOMO and COCOMO II family of models. COCOMO II is an extension of the original model. The basic COCOMO II model is simple and provides a rough effort estimate (in person-months) based solely on the program size in thousand LOC (KLOC) or converted from function points or object points. The intermediate and detailed COCOMO II models consider five scale factors and seventeen cost factors (see table 3.1) in estimating the effort [3], [9], [12], [15].

Each individual factor (e.g. RELY, DATA, PREC, FLEX etc.) in table 3.1 is rated between very low to extra high, dictated by rating guidelines. The estimator rates each individual factor according to their software project. This is a weakness as the measurement is not precise because it is measured qualitatively by selecting a fixed rating from a rating scale (i.e. very low to extra high – only six ratings). The scale factors provide exponential effort variation while the cost factors provide linear effort variation as per the effort equation [6]:

$$Effort = A \times (Size)^{(B+0.01\times \sum_{i=1}^{5} SF_i)} \times \prod_{i=1}^{17} EM_i$$

Where:

- A and B are calibration constants
- Size is the software size measured in thousands of source lines of code (KLOC)
- SF represents the 5 scale factors
- EM is the effort multiplier for the 17 cost factors.

SCALE FACTORS	DESCRIPTION
PREC	Precedentedness
FLEX	Development flexibility
RESL	Risk resolution
TEAM	Team cohesion
PMAT	Process maturity
COST FACTORS	**DESCRIPTION**
	Product factors
RELY	Required software reliability
DATA	Database size
CPLX	Product complexity
RUSE	Reusability
DOCU	Documentation
	Platform factors
TIME	Execution time constraint
STOR	Main storage constraint
PVOL	Platform volatility
	Personnel factors
ACAP	Analyst capability
APEX	Application experience
PCAP	Programmer capability
PLEX	Platform experience
LTEX	Language & tool experience
PCON	Personnel continuity
	Project factors
SITE	Multisite development
TOOL	Software tools
SCED	Required schedule

Table 3.1 COCOMO II Scale Factors and Cost Factors

The detailed COCOMO II model is ideal for large systems. It has the advantage in that it can work on each non-homogenous subsystem separately. Although, the COCOMO II tool is easy to use it requires an estimator with expert knowledge of software development. Moreover, COCOMO II requires a lot of input data (scale and cost factors) to determine the effort and cost estimate [3]. There are complex non-linear relationships between the scale factors, cost factors, effort estimate and the cost estimate. Machine learning tools and various combinations of them (hybrid tools) use historical software project data in an attempt to model the non-linearity in the

data with the purpose to produce accurate cost estimates.

MACHINE LEARNING AND HYBRID TOOLS

Machine learning tools include the use of variations of artificial neural networks (ANN) to estimate the project effort and cost [13]. One of the hybrid tools uses neuro-fuzzy to improve the standard COCOMO II model [6].

ARTIFICIAL NEURAL NETWORKS

An artificial neural network (ANN) typically consists of a layer of input nodes, one or more layers of hidden nodes and a layer of output nodes (figure 3.2). The ANN tool is designed to model or capture the causal relationship between the input (independent variables) and the output (dependent variable) in a given data set through training. The data set in this context is historical software development project data that consists of both the input data and the output data. The input variables could be the actual known cost factors data (e.g. the size of the software, RELY, CPLX, ACAP, etc.) and the output variable could be the actual known effort data of historical projects [13].

The ANN is trained with a historical data set using a training algorithm in order to set the weights. The trained ANN model can then be used to estimate the effort of new software development projects by providing the required input data to the ANN model.

ANN models can be accurate in prediction; however, large data sets are needed to accurately train neural networks.

A shortcoming of ANN is that it is not easy to understand nor is it easy to explain the decision and training process. The training process is much like a black box. On the other hand, the neuro-fuzzy approach utilises fuzzy logic in its decisions making process.

NEURO-FUZZY COCOMO II MODEL

The Neuro-fuzzy COCOMO II model combines three different tools namely neural networks, fuzzy logic and the standard COCOMO II model [6].

Fuzzy logic dictates that a variable can take on any value between 0 and 1, which is in contrast to Boolean logic where a variable may only be 0 or 1.

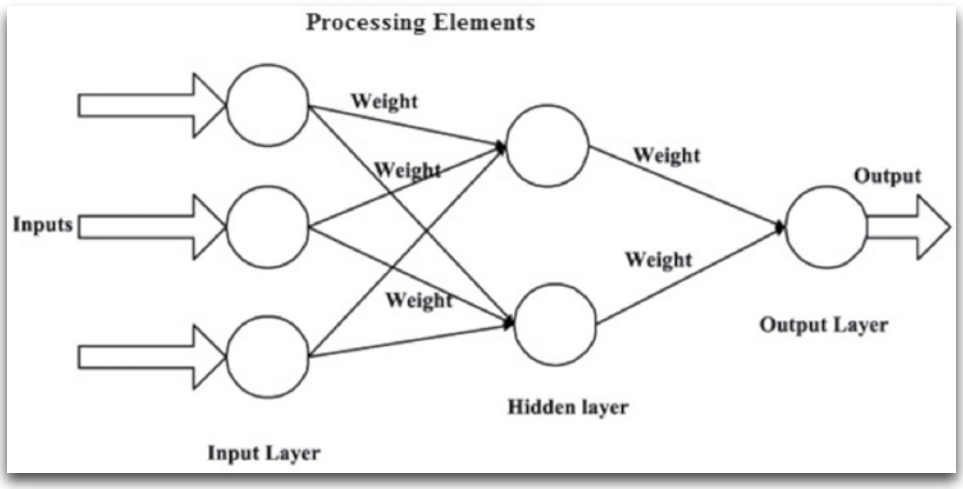

Figure 3.2 Architecture of Artificial Neural Network

Properties of the fuzzy logic approach are precision and accuracy since variables can take on truth-values and are not limited to only 0 or 1. The neuro-fuzzy logic approach enhances the standard COCOMO II model by converting the qualitative ratings of a scale or cost factor into a quantitative multiplier.

The six qualitative ratings of the COCOMO II model are very low, low, nominal, high, very high and extra high. The conversion is done via a neural network using a fuzzy set made up of fuzzy numbers, fuzzy rules and fuzzy member functions.

The quantitative multiplier for each scale and cost factor is the input into the COCOMO II model [6]. As mentioned earlier, the six fixed discrete qualitative ratings in the standard COCOMO II model can lead to inaccurate estimates.

This constraint is solved in the neuro-fuzzy logic approach that allows for a continuous selection of rating values as input into the COCOMO II model, which can lead to more accurate estimates.

CONCLUSION

Effort and cost estimation in software development projects has remained a challenge because of the complexity involved. Accurate cost estimation is a vital part of project management, as it will ensure better resource management. Project managers and practitioners have to be knowledgeable and skilled in the application of the various tools and techniques to accurately estimate the effort and cost of a software project.

Non-algorithmic cost estimation techniques involve, to a large extent, the

Software Cost Estimation

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use of human decision making which introduces bias whether it is analogy based costing, expert judgment, bottom-up or the top-down approach.

The expertise of the individuals making the decisions is vital despite the strengths and weaknesses of the non-algorithmic cost estimation techniques. On the other hand, algorithmic cost estimation tools use sophisticated mathematical formulas and processes to estimate costs.

Most of the intelligence is built into the tools therefore limiting the need for human decision making, however, it is still important. The algorithmic cost estimation tools are not perfect and are only as good as the data that is provided to them, especially in the case of machine learning tools.

No technique or tool is a best fit for any software development project since each technique or tool has strengths and weaknesses and it thus becomes imperative that the project manager utilises a variety of techniques and tools as a best practice.

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calendar

OCTOBER | NOVEMBER | DECEMBER

OCTOBER 2016

5 - 6	New Engineering & Construction Course	Johannesburg	roberto@saiee.org.za
12 - 13	Fundamentals of Practical Lighting Design	Johannesburg	roberto@saiee.org.za
17 - 18	MS Project Professionals	Johannesburg	roberto@saiee.org.za
19 - 20	Core Financial Management for Engineers	Johannesburg	roberto@saiee.org.za
21	SAIEE Banquet	Johannesburg	geyerg@saiee.org.za
26 - 27	Optical Fibres, Cables & Systems Fundamentals	Johannesburg	roberto@saiee.org.za
26-28	Sub Sharan African Power Summit	Cape Town	www.ssapower.com

NOVEMBER 2016

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9 - 10	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za
16	Power Transformer Unit Protection & Testing	Johannesburg	roberto@saiee.org.za
17	Power Transformer Power & Maintenance	Johannesburg	roberto@saiee.org.za
23 - 24	Leadership & Management Principles in Engineering	Johannesburg	roberto@saiee.org.za
23 - 24	Fixed Broadband Access Technologies	Johannesburg	roberto@saiee.org.za
24	National Student's Project Competition	Kwa-Zulu Natal	geyerg@saiee.org.za
30-1 Dec	Design of Economical Earthing Systems	Johannesburg	roberto@saiee.org.za

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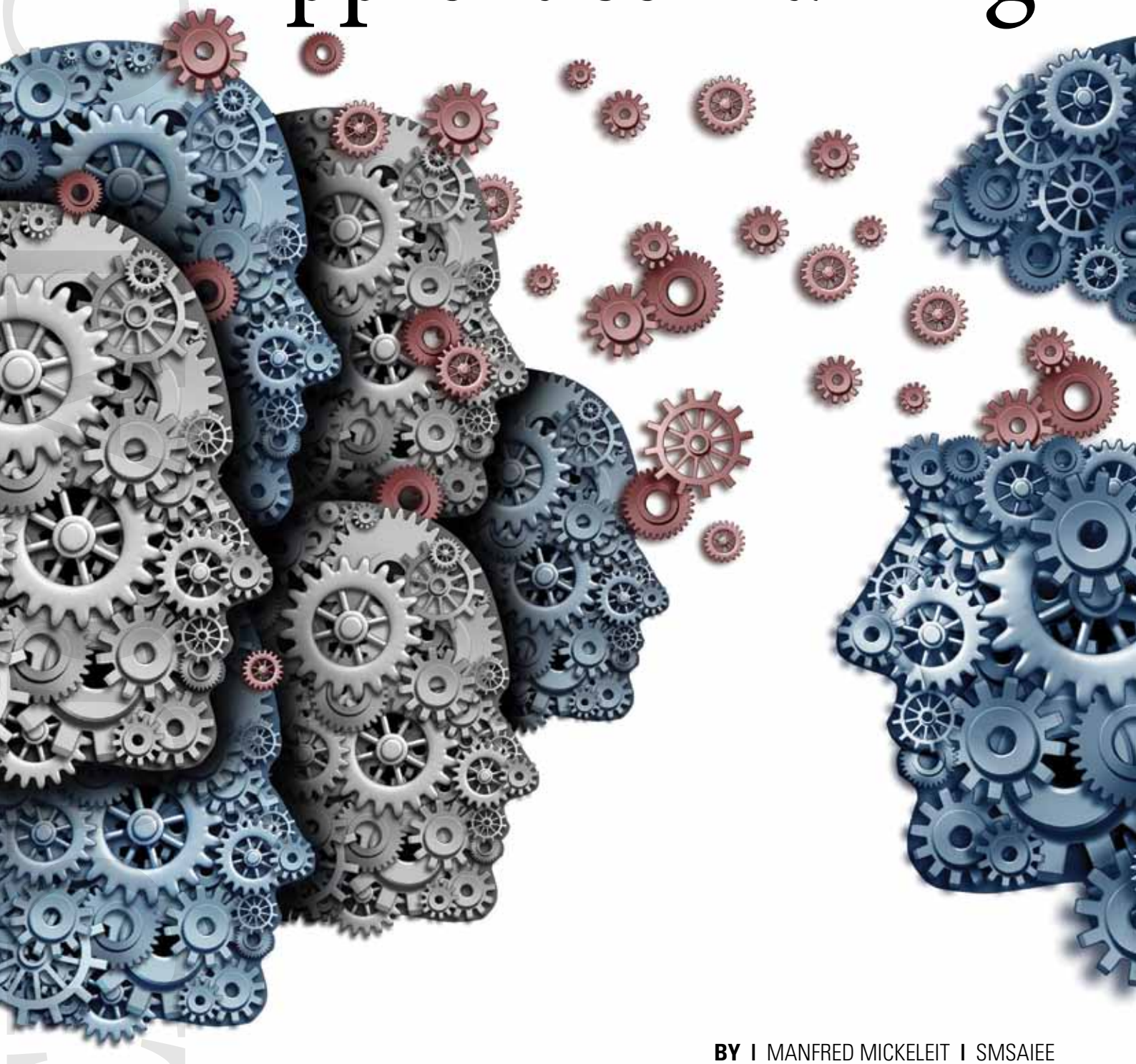
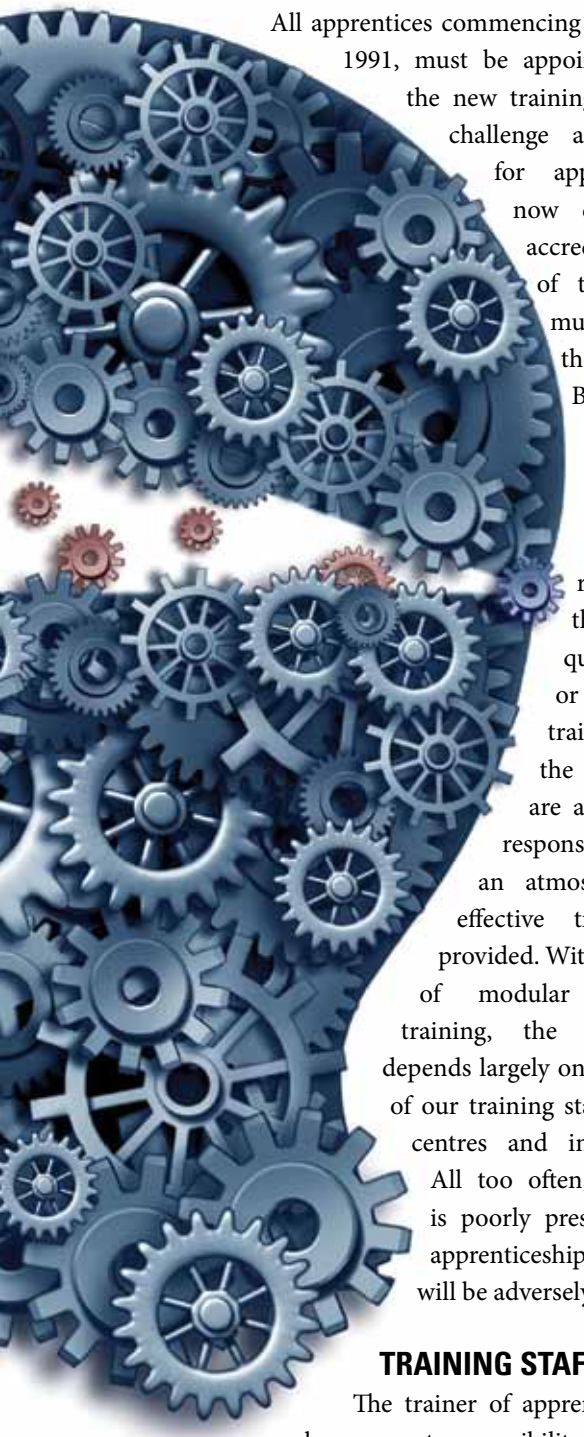
The Challenge of Apprentice Training



BY | MANFRED MICKELEIT | SMSAIEE

The Apprentice Training Board for Local Authorities has been fully accredited since 22 July 1991 (see Government Notice No. 121631). Responsibility for the accreditation of all apprentice training by Local Authorities vests in the Government Training Board under the Minister of Manpower.



All apprentices commencing duty after 22 July 1991, must be appointed in terms of the new training conditions. The challenge and responsibility for apprentice training now depends on the accredited centres of the various large municipalities and the "Training Board". It has often been said that the quality of the people involved is a primary requirement for the provision of quality service or training. The training officers in the training centres are accordingly largely responsible for creating an atmosphere in which effective training can be provided. With the introduction of modular institutionalised training, the system's success depends largely on the quality factor of our training staff in the training centres and in the workplace. All too often, when a subject is poorly presented, the whole apprenticeship period of study will be adversely affected.

TRAINING STAFF

The trainer of apprentices accordingly bears a great responsibility. Such task requires strength of character, maturity, professional knowledge, educational expertise and a sound understanding of young people. One needs to realise that such task is not limited to simply to imparting technical knowledge. One must be aware of, and also further the good qualities and abilities of all apprentices, in an attempt to mould their character and morality. This is necessary so that, apart from performing professional tasks, the apprentices will also happily fulfil their duty towards the country and the state. Clearly this will only be possible by setting a good example.

A good trainer also needs to know that the majority of mechanical apprentices tend to commence their training with an expectation that, as mechanics, they will simply be expected to assemble racing cars, motor cycles, machines and/or various appliances. Apprentices are often disappointed when they discover that, more often than not, they are expected to perform the same rather monotonous tasks over and over. This is particularly true when they do not fully understand the purpose or importance of specific tasks. The danger of such disappointment which can effectively smother or dampen enthusiasm about the trade, can effectively be countered if the trainer succeeds in explaining the underlying relationship between the various tasks, with the emphasis placed on the task that is being performed by the apprentice.

The trainer always needs to be forthright and fair in dealing with apprentices, thereby gaining their respect. Trainers need to avoid agitated reprimands, outbursts of temper, scolding or repeated disapproval; continuous fault-finding rather than affording praise when it is due, as these actions lessen apprentices' enjoyment in their work. The trainer should also avoid mass admonition and needs to treat apprentices individually according to their specific personality or nature. Apprentices need to feel that the trainer has time for each of them and that they are important as individuals. Depending on the circumstances, trainers need to be strict but fair with one individual but gentle and kind towards another. Above all, the trainer needs to foster enthusiasm in the work environment, punctuality, orderliness and truthfulness, leaving no doubt as to the importance of these qualities.

Apprenticeship

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The trainer needs have an understanding of the numerous questions which apprentices may raise. All such questions need to be answered realistically and to the point. By evading answers, apprentices might form an impression that the trainer does not fully understand the subject. Trainers accordingly need to possess a measure of innate instructional ability and be interested in the development of the apprentices placed in their care.

Training of apprentices does not only consist of purely technical training but it also embraces the following:

- Character building and personal development.
- Physical training.
- Training with regard to participation in the community.

It is important that all of these tasks should be shared jointly by the parental or communal home and by the training environment.

CHARACTER BUILDING AND PERSONAL DEVELOPMENT

Character building and personal development needs to be carefully considered in the relationship between training staff and young apprentices. Apprentices require moral support in the workplace, should they experience personal problems. The fundamentals of order and discipline should always be adhered to. Punctuality and respectful behaviour towards their tutors are very important.

Young apprentices should furthermore be continually reminded of the importance of cleanliness in their personal appearance, tidiness of the workplace and the cleanliness of machines and equipment. A motto to follow might be: Show me your working place and I will tell you what kind of worker you are". Great value should also be attached to frankness and honesty. A will to perform and a willingness to work should be encouraged and cultivated in all young apprentices during their apprenticeship. It is also important to train apprentices to work accurately and productively, in order to prepare them effectively for senior positions which may later be available.

PHYSICAL TRAINING

A healthy, strong and fit body is a prerequisite for professional work performance and the fulfilling of obligations towards the state and the community. Keeping healthy and fit during the training period is important and regular exercise in a gym or swimming pool are excellent ways to achieve this.

PARTICIPATION IN THE COMMUNITY

Young apprentices should from the very beginning feel like fully-fledged members of the enterprise as a whole. They should be taught about the value of comradeship and feel proud about being part of and belonging to the enterprise. All of this can be promoted by informing them about the background and role of the enterprise, as well as their own future prospects in the enterprise. Their parental home, their work and their training environment should jointly contribute to providing them with the necessary recognition.

Parents need to be made aware of the performance and achievements of apprentices by being provided with half-yearly Technical College reports. The Department should also encourage parents to visit the training environment, not only to see the working environment, machines, equipment, etc., but also to interact with the training staff and other young apprentices.

The question is often asked, who appoints the afore-mentioned training personnel? How are they trained? If they are trained, who trains them? At present the Apprentice Training Board for Local Authorities bears this burden. The Board is responsible for the selection and training of training officers so that our apprentices are taught by competent professional trainers, who have a thorough up-to-date knowledge of the subject matter. This is necessary in order to prepare apprentices to carry out their duties efficiently, to improve the image of apprenticeship programmes by giving the training concept value i.e. they must assist the Board in creating a vibrant, dynamic image of the apprenticeship period in the outside world.

Personally, I think teaching staff should have widespread industrial experience, and should be given a comprehensive test in teaching practice before final certification. In this regard, the Board should investigate and support a variety of research activities for the training programme and the following types of research should be carried out:

- Method of instruction.
- Supervision of instruction.
- Measuring effectiveness of instruction.
- Selection and training of teachers.
- Methods of coordinating training with industrial needs.

TRAINING PROBLEMS

In the new modular training system, a considerable period of the apprentice's practical training is provided in the workshop. Unfortunately, many workshops tend towards specialisation, with the result that apprentices do not learn many

important aspects of the trade completely, even though the employer has their best interest at heart. The modular training system should rectify this problem, but we should be aware of the natural human desire among employers to make a profit, which tends to keep apprentices doing the kind of work for which they have shown a special aptitude. This also militates against the broad training which is so necessary in modern industry.

The second problem with training on the job, is that there is no assurance of getting proper training from a well-trained artisan force. Not all artisans are good teachers. If young apprentices are lucky enough to fall under good artisans, they will receive good training. If they are unlucky and fall under poor artisans or foremen, they will receive poor training. Therefore, in future, close supervision is essential in order to ensure that apprentices receive balanced training on the job and in the training centre. It is to be hoped that with the modular competency training system, the injection of better qualified craftsmen or artisans who have received special instruction in the training of apprentices, will alleviate the above-mentioned problems. Well-trained artisans will, I hope, in future take pride in their craft and possess the necessary ambition to progress as far as possible; their future depends on such progress.

CONCLUSION

This article has been compiled for those concerned with apprenticeship training. Management has a great influence on the future quality of apprentice training in South Africa.

Future training officers of institutionalised training centres should be tested for mental alertness, manual coordination, vocational interest, personal characteristics, emotional receptiveness and ambition.

This is necessary because they become key players in the training environment, in realising the full potential of apprentices.

Upcoming Megascience

Science and Engineering usually represent two sides of the same thing: 'How it works' and 'How to do it', with a liberal sprinkling of sometimes mind boggling mathematics.

BY | DUDLEY BASSON

Let us take a look at some astonishing projects, which are set to make significant advances in physics and cosmology, which will test science and engineering to their limits:

- The neutrino research at the South Pole Ice Cube station is soon to be augmented by a European collaboration, pioneering the deployment of a five cubic kilometre array of neutrino detectors, deep underwater off the Mediterranean coast.
- Breakthrough Initiatives comprises projects Breakthrough Listen, Breakthrough Message and Breakthrough Starshot. These highly innovative and extremely ambitious projects focus on extra-terrestrial intelligence.

The following major scientific/engineering enterprises represent an unprecedented surge of innovation and endeavour of science and engineering:

- The 305 metre radio telescope dish, at Arecibo, Puerto Rico, has remained the West's largest single dish telescope since its construction in 1963. Russia's RATAN-600, a 576 m ring radio telescope was constructed in 1974. China's construction of a 500 metre radio dish instrument was completed on 3 July 2016 and is planned to be operational by September. This instrument will be well suited to searching for extra-terrestrial intelligence.
- The James Webb space telescope, due for launch in October 2018, is the much

larger successor of the hugely successful Hubble space telescope. Its 6,5 metre segmented gold coated beryllium mirror will be deployed when the instrument is in solar orbit, at the Earth's L2 Lagrangian point.

- The remarkable success by CERN's Large Hadron Collider in detecting the Higgs boson, and the subsequent upgrade doubling the beam energy, have set the scene for further fundamental research. China has also embarked on high energy particle physics research, with plans to build a much larger and more powerful instrument.
- The vast interferometric array of the Event Horizon Telescope is expected to be ready by 2017 to take on its ultimate target – the Black Hole at the centre of the Milky Way galaxy.
- ALMA and the SKA will provide radio astronomy with phenomenal opportunities for exploring and understanding the non-visible universe.
- The spectacular successes of the LIGO gravitational observatories, have set the scene for the new science of gravitational astronomy.
- Helium-3 mining on the Moon. This controversial issue may well have a major impact on power generation on planet Earth.
- China launched a new space race on 17 August 2016 by placing the world's first quantum prototype communication satellite in orbit. China is taking a world lead in quantum computing and communications. China's Tiangong-e Spacelab is ready for launch which may become the primary space station when the current International Space Station is decommissioned. Following the success of the 2013 Chang'e moon landing and deployment of the Yutu (Jade rabbit) rover, further moon missions are being planned.
- China's new supercomputer, the Sunway TaihuLight, launched June 2016, is indeed a monster: theoretical peak performance of 125 petaflops ($1,25 \times 10^{17}$ floating point operations per second) 10,649,600 cores, and 1,31 petabytes of primary memory, outperforming the previous world record of the Tianhe-2 supercomputer with 33,86 petaflops processing. The SKA radio telescope enterprise may well require supercomputer processing in the exaflops range at its computer centres in Cape Town and Perth, when it becomes operational.

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- The Global Energy Network Institute (GENI) was founded in 1986 by Peter Meisen to investigate the idea of Dr. R. Buckminster Fuller, proposing a global electric renewable energy grid. GENI's mission is to accelerate the attainment of optimal, sustainable energy solutions in the shortest possible time for the peace, health and prosperity of all. China has taken a lead in the pursuit of an international smart power grid.

NEUTRINO OBSERVATORIES

Neutrinos are extremely small particles, almost without mass, and which travel at almost the speed of light. They are able to pass through the Earth practically unhindered – only an extremely small portion colliding with other matter. The flux of neurinos pasing through the Earth is immense – about 65 billion particles per square centimetre per second. The majority of neutrinos passing through the Earth are created by nuclear reactions within the Sun.

Neutrinos were first postulated by Wolfgang Pauli in 1930 to explain the extremely small loss of energy when a neutron decays into a proton and an electron (beta decay). This was proven by Americans Clyde Cowan and Frederick Reines, using a nuclear reactor as a source of subatomic particles. It was postulated that nuclear reactions in stars should produce natural neutrinos, as well as other particles.

There are three types (commonly referred to as 'flavours') of neutrino: electron neutrinos, muon neutrinos and tau neutrinos. Each neutrino also has a corresponding antiparticle called an antineutrino. The combined mass of the three neutrinos is less than one millionth of that of an electron. (Neutrino mass is estimated at 1,78 x 10^{-37} kg) Curiously, neutrinos can change from one type to another whilst in flight.

Due to their small size, and lack of an electric charge, neutrinos are extremely difficult to detect. When they do interact with an atomic nucleus, they can be detected from the resulting scintillation, which may produce a brief flash of blue Cherenkov light. When light passes through a clear liquid, it will travel at a lower speed than in a vacuum. If a particle travels faster than the slowed down light, it will produce Cherenkov light, which can be detected by photomultiplier tubes.

The ideal neutrino detector would require a large target, and an extremely thick shield to exclude other radiation. Neutrino observatories were built in deep mines in the US, India and South Africa. Neutrinos created in the atmosphere by cosmic rays were discovered in 1965. The first discovery was led by Frederick Reines of Case Western University in Cleveland in collaboration with a Wits University group led by Friedel Sellschop (1930-2002). Sellschop was a Namibian born physicist and protégé of the famous South African scientist Sir Basil Schonland.

He had a brilliant academic career: BSc from Pretoria, a MSc from Stellenbosch and a PhD from Cambridge, after which he returned to South Africa on the advice of Schonland. He was the founding Director of the Nuclear Physics Research Unit at the University of Witwatersrand in 1956. This laboratory was later renamed the Schonland Centre for Nuclear Sciences. In 2005, the Schonland Centre was donated to the state to be run as a National Facility by iThemba Labs. Sellschop received the Max Planck medal for his work in both neutrino and diamond physics. His research in the physics of diamonds was very broad. As a member of the CERN NA43 and NA59 collaborations, he contributed with experiments that used the perfect and very rigid diamond lattice to produce and study the highest energy near monochromatic photons ever produced in a laboratory.

The Case Western-Wits team operated a liquid scintillator at a depth of 3 km in the East Rand Propriety Gold Mine (ERPM). A large number of oil filled scintillator tanks, fitted with photomultiplier tubes, were installed in a specially prepared tunnel branching from a mining tunnel. This was put into operation in September 1964, and the first plausible neutrino interaction was detected on 25 february 1965.

There are more than thirty neutrino observatories currently in operation around the world, several others have been closed and more are being planned. The deep ice AMANDA observatory at the South Pole was superseded by Ice Cube in 2005. Ice Cube has been briefly described in the June 2015 issue of Wattnow.

Another prominent neutrino observatory is Japan's Super-Kamiokande. The detector is a 50 000 ton tank of water located 1 km underground. The water acts as both a target for neutrinos, and the detecting medium for the by-products of neutrino interactions. The inner surface is lined with 11 146 photomultiplier tubes of 50 cm diameter. When the tank is empty the interior spectacle is awesome.

Japan's T2K (Tokai to Kamiokande) experiments are underway to detect differences in the behaviour of neutrinos and their corresponding antineutrinos which might explain why matter persists over antimatter without having obliterated each other shortly after the Big Bang.

The J-PARC laboratory, at Tokai village, fires beams of neutrinos to the Super-Kamiokande detector 295 km away. The beam travels underground and also beneath a mountain due to the curvature of the Earth.

The K2K neutrino experiment directed a beam of muon neutrinos underground from the 12 GeV proton synchrotron at the KEK, Tsukuba to the Kamioka observatory 250 km away. This experiment, conducted from 1999 to 2004, researched the oscillation between muon neutrinos and electron neutrinos. The K2K collaboration consisted of approximately 130 physicists from 27 universities and research institutes. The experiment confirmed results obtained at the Super-Kamiokande.

The KM3NeT Optical Module

The U.S. Department of Energy's Fermi National Accelerator Laboratory near Chicago, the NOvA experiment, produces the world's most powerful beam of neutrinos. This is sent from Fermilab in Batavia, Illinois, deep underground to northern Minnesota 800 km away.

The world's largest neutrino observatory is being planned for the sea bed, off the Mediterranean coast. The KM3NeT (Cubic Kilometre Neutrino Telescope) collaboration has developed, what it believes is a cost-effective plan for building this research infrastructure at the bottom of the sea. The phased rolled-out will consist of three building blocks, where each building block comprises 115 strings of 18 optical modules (glass spheres containing 31 outward-facing photomultiplier tubes). The three sites which will be near Toulon (France), Portopalo di Capo Passero (Sicily) and Pylos (Greece) will occupy a total of five cubic kilometres of sea water. The strings will be anchored on the sea bed, and kept vertical by the buoyancy of the modules, and an additional buoy at the top. The long strings of modules will allow reconstruction of the direction of the neutrinos, providing information of their origin in space. The whole sky can then be monitored by linking to Ice Cube at the South Pole and Russia's Lake Baikal Gigaton detector. The research infrastructure will also house instrumentation for other sciences, such as marine biology, oceanography and geophysics.

In December 2015, the KM3NeT collaboration successfully tested the deployment of a string of its latest optical modules. It has already raised €31 million to begin phase one of the project.

The new deep water, multi-megaton Dubna neutrino telescope was put into operation at the bottom of Lake Baikal by scientists from the Institute for Nuclear Research of

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the Russian Academy of Sciences (RAS), the Joint Institute for Nuclear Research and a number of other research institutions.

Dubna is a town in Moscow Oblast, Russia. It has a status of Naukograd, being home to the Joint Institute for Nuclear Research, an international nuclear physics research centre, and one of the largest scientific foundations in the country.

The telescope forms the first cluster of the future neutrino telescope named Baikal-GVD (Gigaton Volume Detector).

BREAKTHROUGH INITIATIVES

This represents the largest, and most ambitious SETI (Search for Extra-terrestrial intelligence) project ever envisaged. This 10-year, multi-disciplinary search effort will use the world's largest telescopes to mine data from the nearest million stars in our own, and 100 other galaxies.

On 20 July 2015 Yuri Milner was joined at the Royal Society by Stephen Hawking, Martin Rees, Frank Drake, Geoff Marcy, Pete Worden and Ann Druyan to announce the unprecedented $100 million global Breakthrough Initiatives to reinvigorate the search for life in the cosmos.

Other board members include Facebook CEO Mark Zuckerberg.

Breakthrough Listen will be the most comprehensive and intensive search ever undertaken for signs of intelligent life beyond the Earth.

It proposed that the 100 metre diametre Green Bank telescope in West Virginia, and the 64 metre diametre Parkes telescope in New South Wales in Australia, be used for scanning the cosmos. This will be 50 times more sensitive, have 10 times more sky coverage, and 5 times more spectrum than previous SETI research, and will be 100 times faster. It is also proposed that the Lick telescope in California be used for the deepest search of optical laser transmissions. It should be possible to detect signals with the power of aircraft radar from the nearest 1000 stars. Breakthrough Listen should also be able to detect a 100 W laser signal from a star at the centre of the Milky Way.

Breakthrough Message will fund an international competition in order to generate messages representing humanity and planet Earth. These might one day be sent to the extra-terrestrials.

The aim is to encourage debate about how, and what to, communicate with possible intelligent beings beyond the Earth. Some scientists have expressed concern about making ourselves known to possibly hostile extra-terrestrials. When extra-terrestrial civilization is detected this could present a tricky political problem. What organisation will be empowered to handle the communications, and how and by whom will it be authorised to represent planet Earth?

An early attempt to communicate with the extra-terrestrials was made in 1972 by NASA'a spacecraft Pioneer 10. This was the first spacecraft to pass through the asteroid belt and the first to take close up images of Jupiter. After the flyby it continued in the direction of constellation Taurus, leaving the Solar System in 1983. It will take the craft two million years to reach Aldebaran in Taurus. Pioneer 11 was launched in 1973. It returned pictures of Jupiter's Red Spot as it took a gravity assist to reach Saturn where it took close up pictures of the planet and its rings. Pioneer missions 10 and 11 each carry gold anodized aluminium plaques, designed by Drake and Sagan, with graphic messages to any extra-terrestrials who may be able to intercept the spacecraft. The plaques included nude male and female human figures with a slight concession to modesty being made in the case of the female. It seems astonishing that anyone could think that the extra-terrestrials might be offended by a lack of modesty in the figures. If ET does manage to capture one of the craft he will be left wondering how Earth people manage to reproduce.

Some scientists have suggested that the extra-terrestrials might be using communications so advanced that we may have no way of detecting or understanding them.

Breakthrough Starshot is an extreme venture, announced on 12 April 2016, to send a swarm of 1000 very small craft to investigate planets orbiting Alpha-Centauri 4,37 light years away. A proof of concept will be developed for sending small craft named StarChip at speeds of from 15% to 20% of the speed of light, initially propelled by laser beams of up to 100 GW impacting on light sails, which would also serve as antennae. The craft could take from 20 to 30 years to reach Alpha-Centauri, and 4 years to send a message home.

If the dream of quantum-entanglement communications becomes reality it may well be possible to have live communications with spacecraft at Alpha-Centauri. The craft would initially be launched aboard a mother-ship, and then be deployed in space. The craft could be accelerated up to target speed in 10 minutes, each requiring

about one terajoule of laser energy focused on its sail. The mission could cost up to $10 billion, and possibly be launched within 20 years. Starshot is unlikely to interest investors with a low risk quick return investment in mind.

On 24 August 2016 ESO (European Southern Observatory) announced clear evidence of an Earth-like planet orbiting Proxima Centauri. This is the closest star to Earth, only 4,25 light years away and slightly closer that Alpha Centauri. It has an 11,2 day orbit around its red-dwarf parent star. Evidence indicates that it is a rocky world with temperature and presence of water conducive to life.

The planet is close to its star and in tidal lock with one side permanently in full sunlight. This planet will not have seasons but the boundary between light and dark sides might provide opportunities for life. During the first half of 2016 Proxima Centauri was regularly observed using the HARPS (High Accuracy Radial velocity Planet Searcher) spectrograph on the ESO 3,6 metre telescope at La Silla in Chile, and simultaneously monitored by other telescopes around the world.

On 16 August 2016 China launched the world's first quantum communications satellite named Micius after an ancient Chinese philosopher and engineer, who, more than 2400 years ago, proposed that light always travelled in straight lines and that the physical world was made up of particles.

This will test ultra-secure uncrackable encryption keys sent from space to ground and test quantum entanglement up to distances of 1200 km. This implies the instantaneous teleportation of data. The implications are mind-boggling. Einstein did not like the idea of quantum entanglement calling it "Spukhafte fernwirkung" - spooky action at a distance - but spooky or not, it is here to stay.

A swarming project similar to Starshot was proposed by NASA, with a possible time frame of 2020-2025. This is the ANTS (Autonomous Nano Technology Swarm) mission. This is specifically intended for data gathering, where a single spacecraft would be ineffectual. A sub-mission would be the Prospecting Asteroid Mission (PAM). A transport ship from Earth (ant habitat) would stop at a Lagrangian point, and then deploy up to 1000 nano-class spacecraft which would use thrust from solar sails for mobility. Up to 80% of the craft would be workers, each carrying a specialised instrument.

The coordinator ants will decide which asteroids are worth investigating, and organise the workers accordingly. The key feature of this mission is its autonomy – it would be impossible to control the ants from Earth due to time delay. The primary objective of this mission is the exploration of the asteroid belt in search of mineral resources, and material with astrobiologically relevant origins and signatures. Although proposed some years ago, this project does not seem to have proceeded beyond the concept stage.

NASA has launched its OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer) spacecraft on 8 September 2016 on a two year trip to take a sample from near-Earth asteroid Bennu. It is hoped to obtain a sample from the dawn of the solar system to understand the process that may have led to the origin of life and the habitability of our planet. This highly complex and innovative space mission will run for seven years. Principal investigator is Dante Lauretta, Professor of Planetary Science and Cosmochemistry at the University of Arizona's Lunar and Planetary Laboratory.

In November 1974 a message to the extra-terrestrials was sent from the Arecibo telescope at 2380 MHz and 1000 W power. This was a 1679 binary digit array portraying life and chemistry on Earth. The array was the product of the two prime numbers 73 and 23 so that there would be only two ways of arranging the data into a rectangle. The message was aimed at the M13 globular cluster 25000 light years away so there was no serious expectation of receiving a reply. The Arecibo telescope is also used for astronomical RADAR being able to transmit pulses in the terawatt range.

On 29 August 2016 an international team of astronomers announced the detection of signals coming from the direction of a planet system in the Hercules constellation 94 light years away. This was detected on 15 May using the Russian RATAN-600 radio ring telescope. This was seen by some as a possible candidate for extra-terrestrial communications justifying further monitoring, but was later identified as a signal from a Russian satellite.

Recently the ALMA observatory recorded radio frequency energy from the cosmos which was then transposed to musical frequency sound waves to provide a human feeling of space. This can be found at www.almasounds.org This is reminiscent of an occasion when

Megascience

continues from page 57

NASA OSIRIS-REx ready for launch

Tiangong-2 Spacelab ready or launch.

Beethoven was contemplating the night sky and entertained the idea of "the music of the spheres". According to Czerny, this has been expressed in the second of the "Razumovsky" string quartets.

At the Jupiter flyby of NASA's Juno spacecraft on 27 August 2016, the craft's Radio/Plasma wave instrument recorded emissions emanating from above the planet. These were signature emissions of energetic particles producing the aurora. Rendered audible, these produced ghostly sounds.

The frequencies of gravitational waves from inspiralling and colliding neutron stars are sometimes in the audible sound range which can be rendered as sound waves and actually listened to. The final inspiral may sound like a rapid glissando from bass to treble.

Major scientific projects are being proposed at an accelerating pace, so that we can expect both planned and unexpected scientific discoveries and breakthroughs in the near future. wn

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IN MY OPINION : ELAINE PORTER

Finding the sweet spot in Africa's power development

The East African Power Industry Forum (EAPIC) in Nairobi, Kenya this week highlights not only of the value power offers as an enabler to grow and transform economies, but also of the burgeoning investment and business growth opportunities in Africa's power sectors – if you know how to navigate the markets.

BY | ELAINE PORTER

The prevailing power supply issues in Africa are well documented. Aging electricity infrastructure has become unreliable and more than 30 African countries are experiencing power shortages. These either force them to resort to expensive short-term fixes, or face power blackouts. Research shows that the economic cost of such power shortages can amount to more than two percent of the country's GDP.

In recognising that this is not sustainable and to bring about change, Government-led initiatives in a number of fast growing and emerging economies across sub-Saharan Africa - in particular - have identified increasing their power capacity as a top priority objective of their national visions.

According to Paul Grota, Director, Power, WSP Parsons Brinckerhoff, Africa: *"In reality, many African countries are faced with the very real challenge of trying to balance their fiscal spending between providing basic services, including electricity – often in very underdeveloped and remote areas – while struggling to keep up with demand for electricity from industries and rapidly growing populations. This demand is expected to increase by more than two-thirds by 2040."*

"That said, the power sectors in a number of African countries have undergone significant transformation over the last decade to unbundle bottlenecks, create more open and competitive markets and attract investments for bankable projects," adds Grota.

It's been estimated that USD450 billion (ZAR6.9 trillion) will be needed to build new power generation capacity on the continent over the next 25 years. Africa's ideal energy mix, however, is not a straightforward answer. Jay Urban, Director of Power Generation at WSP | Parsons Brinckerhoff,

Africa, explains that: *"While many African countries are making a concerted push into the sphere of renewable energy, coal and other fossil fuels will continue to be an important part of the mix, at least for base-load power and for the foreseeable future."*

A recent story published by Bloomberg stated that despite low oil, coal and Natural Gas prices, 2015 saw more global investment into the development of renewable energy (USD134 billion) than fossil fired power plants (USD80 billion) for the first time.

"This is certainly a significant development, especially in emerging markets. However, in Africa the shortage of base-load power needs to be addressed urgently," Urban says.

"Solar energy, for example, currently can't compete with base-load solutions because, while a solar energy plant can feed into the grid during off-peak times (during the day), due to storage capacity challenges these solutions often don't prove efficient for peak time. Although this is slowly changing with new technology developments for improved Concentrated Solar Power storage, alternatives need to be included in the overall energy mix," he adds.

Grota adds that because the power situation of every African country is different, pin-pointing an ideal energy mix that could be applied across the board is not so cut and dry. *"The natural reserves of each country differs - one country may be sitting on a wealth of coal, another may have deep oil or natural gas reserves, while other more arid countries lend themselves more towards solar or wind energy power plants.*

While hydro power has played a significant role in providing a base-load alternative to fossil fuels over the years, drought in much of sub-Saharan Africa has seen these power stations struggle to meet demand as well.

"Given the geography of the continent, rural and remote Africa also presents further opportunities for power producers who have an appetite for owner-managed micro-grids in decentralised market models."

There is undoubtedly a burgeoning of opportunities in Africa's power sectors. However, successful investments will require more certainty around state-led resource programmes, prioritisation of these programmes and having an inherent understanding of local market issues and operating environments.

"We are in a prime position to assist both investors and developers in navigating the power sectors in Africa and can share insight, expertise and experience based on our working knowledge so that they make informed and responsible decisions," says Grota.

"As Africa's power sector transitions through various planning and roll-out phases, the pressure of growing demand is on. We want to be a part of the process of identifying and implementing the right solutions, as these are very exciting prospective projects for us – and the continent." concludes Grota. wn

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!

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

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

QUESTION ONE

Is solar technology suitable for remote power requirements?

ANSWER ONE

Supplying electrical power to remote locations remains one of the larger challenges faced by the agricultural sector. This is predominantly because of the expense of installing overhead lines and laying cables over long distances.

In instances where the power requirement is large going the conventional reticulation route is unavoidable, however for smaller power applications, generally where 15 kW or less is required, it is certainly possible to use solar energy.

One must, however, bear in mind that solar energy has its own challenges in terms of being relatively expensive and it is obviously sensitive to changes in weather. That being said, there are very large parts of the country, such as the Northern Cape, where the high prevalence of sunshine makes solar energy a practical alternative.

QUESTION TWO

Can Variable Speed Drives (VSDs) be used in conjunction with photovoltaic cells to provide power in remote locations?

ANSWER TWO

Access to solar technology will allows agricultural operations to use this power source for remote electrical applications, such as pumps. A typical system would comprise photovoltaic cells, a modified AC VSD, or inverter, batteries and the associated switchgear.

In this application, instead of the VSD receiving normal Eskom three phase power it receives DC power from the solar system. A normal solar inverter would not be suitable in this application as its software and output is not configured for motor control. A normal VSD would also not be suitable because its input is configured for three phase power and not for DC power.

The easiest solution is to modify a normal industrial three phase VSD to accept DC input from the solar system and, in conjunction with this, to have software in the VSD that changes its normal behaviour to be suitable for the solar use.

The VSD would convert the DC input to a variable AC output which would then drive a motor coupled to a pump, for example. An installation configured in this manner will operate the same as if connected to the main power utility during peak sunlight.

As the sunlight fades the VSD can compensate for this reduction in solar rays by running the motor slower thereby drawing less power and extending the service time of the solar installation. By operating the solar system in this manner

WATT?

it is possible to optimise the hours of good sunlight and achieving a service time of more than 8 hours per day is possible.

In many remote pumping applications, this type of solar installation may be sufficient to fill up a local water tank, trough or small reservoir for watering animals.

Such a system could then be placed remotely and operated autonomously without the need for expensive power lines or cables being run over long distances.

In critical applications that have to operate continuously solar power is not a feasible technology because there is never a 100% availability of sunlight. However, as detailed above, it can be used for many other applications where a full 24/7 service is not essential, and not only is it simpler to implement and operate, it is also cheaper.

In addition to this, there can be a number of variations in the configuration of this system. One option is to operate purely off solar power without batteries. This system would stop working immediately there is insufficient sunlight, and this renders this option unsuitable for critical or demanding applications.

Another option would be to configure the system using solar power and batteries operating together. A third option would be a hybrid system that automatically switches between the direct solar power and the batteries, as and when required This third method is obviously the most expensive but would be the most effective solar power option.

With this method the system would run the pump, for example, and charge the batteries when there is sufficient sunlight. As the sunlight fades the batteries would begin supplying the load. Using this type of combination would give an extended number of hours per day, and the only limit on the number of hours would be the amount that the end user is willing to spend on batteries.

It should also be stressed that an off-the-shelf AC VSD is not suitable. It will have to be modified to be used in such an application.

Considering the relative reduction in cost of photovoltaic systems during the last few years and also the freely available sunlight in much of South Africa, this is considered a very useful technology for the agricultural sector, farmers and perhaps even for remote communities. WN

Information provided by Zest WEG Group

October

Movers, shakers and history-makers

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

1 OCTOBER

1908 The first Ford Model T (colloquially known as the Tin Lizzie, T-Model Ford, Model T, T, Leaping Lena, or flivver) was rolled off Ford Motor Company's production line.

2 OCTOBER

1902 Beatrix Potter's "The Tale of Peter Rabbit" was published by Frederick Warne & Co. in London.

3 OCTOBER

1950 The US Patent Office issued a patent to John Bardeen, Walter Brattain, and William Shockley for the transistor, which started a revolution in computer engineerings.

4 OCTOBER

1966 Lesotho (Basutoland) gained independence from Britain.

5 OCTOBER

1895 The first individual time trial for racing cyclists was held on a 50-mile course north of London, England. The event was organised by Frederick Thomas Bidlake, an English racing cyclist of the late 19th century.

6 OCTOBER

1948 Paleoanthropologist Mary Leakey found the first partial fossil skull of Proconsul africanus, an ancestor of apes and humans in Kenya.

7 OCTOBER

1919 The oldest existing airline, KLM, Royal Dutch Airlines, was established.

8 OCTOBER

1993 The United Nations lifted economic sanctions against South Africa.

9 OCTOBER

1936 In the United States, the Hoover Dam began converting the power of the mighty Colorado River into electricity, sending the much needed power over hundreds of miles of treacherous terrain to power-hungry Los Angeles.

10 OCTOBER

1957 A fire at the Windscale nuclear plant in Cumbria, UK became the world's first major nuclear accident.

11 OCTOBER

1902 The first ever Test Cricket match between South Africa & Australia began.

12 OCTOBER

1988 Steve Jobs unveils the NeXT, the computer he conceived after moving on from Apple Computer Inc. Although the NeXT ultimately failed in the marketplace, it introduced several features new to personal computers.

13 OCTOBER

1893 The melody for "Happy Birthday To You" was copyrighted. It was originally published as "Good Morning To All" in a book called "Song Stories for the Kindergarten" written by Mildred and Patty Hill.

14 OCTOBER

1899 The UK's Morning Post reporter, Winston Churchill, departs to South Africa

15 OCTOBER

1956 The first FORTRAN reference manual is six months before the first compiler's release. Only 60 pages long, with large print and wide margins, that first programming language was miniscule by today's standard.

16 OCTOBER

1984 Desmond Tutu, South African Anglican Archbishop, was awarded the Nobel Peace Prize

17 OCTOBER

1979 Mother Teresa of India was awarded the Nobel Peace Prize

18 OCTOBER

2012 Newsweek announced that after nearly 8 decades in print, they are going online only.

19 OCTOBER

1932 Henry Ford gave his first radio speech during which he appealed to the American public to re-election of President Herbert Hoover.

20 OCTOBER

1908 King Leopold II sells Congo to Belgium, up until then King Leopold II effectively owned the region.

21 OCTOBER

1949 An Wang filed for a patent for his "pulse transfer controlling devices." Computer designers had been looking for a way to record and read magnetically stored information.

22 OCTOBER

1878 The first rugby match under floodlights took place in UK, between Broughton and Swinton.

23 OCTOBER

2001 Apple ventured into the handheld and music entertainment markets by introducing the iPod.

24 OCTOBER

1926 Harry Houdini had his last performance at the Garrick Theatre in Detroit, USA.

25 OCTOBER

2001 Windows XP, the family of 32-bit and 64-bit operating systems produced by Microsoft, was launched. The name "XP" stands for "Experience."

26 OCTOBER

1863 The Football Association, also known simply as The FA, was formed. It is the oldest football association in the world.

27 OCTOBER

1980 The ARPANET, predecessor of the modern Internet, set up by the USA's Department of Defence Advanced Research Projects Agency (DARPA), crashed.

28 OCTOBER

1924 M.de Bruin, a quarry man and miner, discovers an infant fossil skull in a lime quarry in Taung, South Africa (now popularly known as the Taung child).

29 OCTOBER

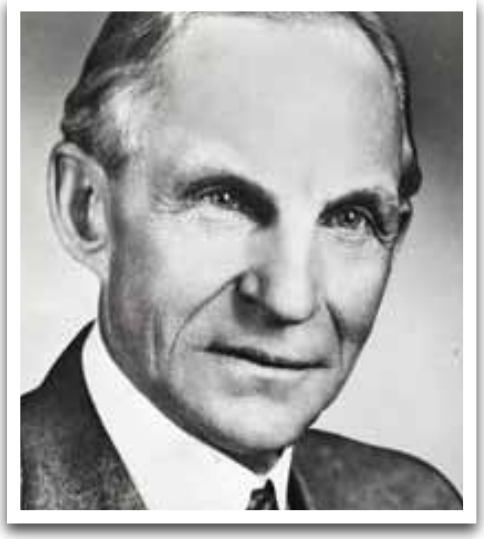
1929 The Wall Street stock market crashed, signalled the beginning of the 10-year Great Depression that affected all Western industrialized countries.

30 OCTOBER

1899 British Post reporter Winston Churchill reached Cape Town.

31 OCTOBER

1945 The First Conference on Digital Computer Technique was held at MIT. wn



I received this letter from Mr Jimmy Taylor, whom I invited to attend the Past President's luncheon in September, in order for us to honour him being a member for 69 years. Unfortunately he couldn't attend, but he sent me this anecdote instead - Ed

Thank you for the kind invitation to the SAIEE PAST PRESIDENTS' LUNCHEON on 16 September, 2016. Unfortunately my wife and I will be unable to attend. For some reason the occasion has brought back so many memories, some of which I would like to share with you.

In February, 1945 youngsters from almost every part of South Africa were thrown together in Johannesburg as apprentice Telephone and Telegraph Electricians. Our training school was located in New Mines House on the corner of Fox and Sauer Streets.

The same block also housed the City Telephone Exchange, Marshall Street Post Office and office accommodation for the area faults men. The Johannesburg Stock Exchange was across the street. In later years the block was redeveloped and housed the headquarters of the Witwatersrand Region Engineering Division.

Although most of the apprentices were Afrikaans speaking, all lectures and study notes were in English. Many of us were country boys; the biggest town I had ever seen was Pietermaritzburg. I have a vivid memory of a tall, blond well built Afrikaner Izak Mentz from Clocolan wearing a cowboy hat, khaki shorts, and shod in velskoens striding across Market Street near the library.

For most of us Jo'burg was really the City of Gold with Manners Mansions, Ansteys and Escom House towering over narrow streets. The central area boasted many cinemas and tearoom bioscopes, and at night there were pie carts with shiny copper boilers on street corners, where you could buy a hotdog with, or without mustard. When funds permitted (our pay was 2 shillings per day with an additional 2 shillings away-from-home allowance) a visit to His Majesty's or the Coliseum with its beautiful mock night sky was a special treat.

VE day (Victory in Europe Day - 8 May 1945) dawned while our class were undergoing field training on cable jointing. I happened to be in a manhole in von Brandis Street. The risk of people falling into the manhole resulted in us getting the day off. That night the streets and pavements of central Jo'burg were filled with people celebrating the end of the war. Whether drunk or sober, people shook hands or embraced one another without reserve.

So began a dream career of a lifetime in the South African Post Office, my student membership of the SAIEE, and my friendship with Roy Patrick which has endured to this day. Wednesdays were days spent at the Witwatersrand Technical College. Dr A.W.Rowe was the principal, but A.T.Aspinall was the man who persuaded us to join the SAIEE. He was our lecturer on Technical Electricity he told us that joining the SAIEE was the 'right and proper thing to do'. He added that he would pick up the completed forms at the next class. Who could have refused?

Over the years I attended a number of talks at Kelvin House. Attendance of at least two per year were almost mandatory: the inauguration of Jack Hewitson, and later Alan Bennett, as presidents of the SAIEE.

Looking back at the sale of ISCOR, and the creation of corporate entities out of ESCOM, SAR & H and the SAPT I wonder whether the economic advantage outweighed the loss of their annual output of thousands of qualified artisans and highly skilled technicians?

Thank you for a bright and interesting **watt**now, which inspite of being a technical journal, still retains a human touch.

With kindest regard,
Yours sincerely,
Jimmy Taylor

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