wattnow

EMBRACING MEMBER INITIATIVES & COLLABORATION - #MAKEITHAPPEN

RSA | R30.00 incl. VAT

POWER

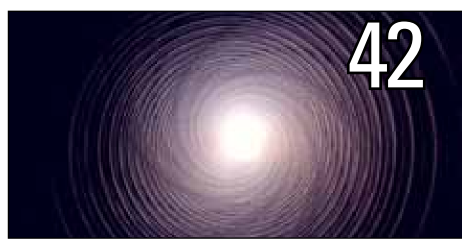
SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | APRIL 2017

contents

FEATURES

GENERAL

REGULARS



SAIEE @saiee

wattnow

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

TECHNICAL EDITORS
Derek Woodburn
Jane-Anne Buisson-Street

CONTRIBUTORS
J Alberts
J de Kock
T Blom
M Cary
D Basson
J Buisson-Street

EVENTS
Gerda Geyer I geyerg@saiee.org.za

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

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

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

PUBLISHER
South African Institute of Electrical Engineers

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

ISSN: 1991-0452

April is here, the days are becoming shorter and the nights longer, which means our power consumption, will in all probability increase. Eskom has really come to the party for the consumer and hopefully there will be no loadshedding - which seems to be something of the ill-forgotten past.

This issue of **watt**now features Power. Our first feature article is "When utilities have no knowledge of connected embedded generators" (pg20), in which Prof Jan de Kock and Jaco Alberts explain what happens when free-loaders plug into the grid.

Self-generated electricity is generally cheaper and provides a high degree of independence from the grid. However, these systems are exposed to all weather conditions and are vulnerable to lightning. Read more on page 36.

Jacob Machinjike has recently been inaugurated as the SAIEE's 2017 President. The May issue of **watt**now will feature his presidential address and everything about the SAIEE you did not know. The May issue will also be available at the African Utility Week, taking place from 16 - 18 May in Cape Town. Come visit our stand and meet us.

The 2017 SAIEE Smart Grid Conference will be taking place on 19 - 21 September. Registration is now open and we have an awesome line-up of speakers; visit www.saiee-smartgrid.co.za to register and qualify for a very nice early bird discount. Seats are limited, so book now to avoid disappointment! Early bird discounts close 30 April 2017.

Herewith the April issue. Enjoy the read!

Minx

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

ELSPEC Pure BlackBox

THE ULTIMATE HAND-HELD POWER QUALITY ANALYSER

available from Impact Power Innovations

This device is an advanced Class A power quality analyser embedded with innovative PQZIP technology.

It is an **easy-to-use plug and play device** that continuously records all power quality parameters with no threshold and recording configuration needed. The device is available in two versions: Single Phase and 3-Phase.

PQZIP

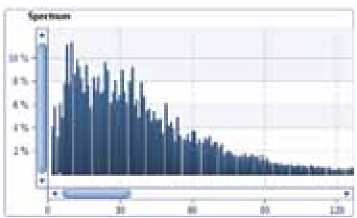
The PQZIP continuous recording enables it to easily predict, prevent and troubleshoot issues without the need to set up triggers or thresholds in order to capture a specific event. With PQZIP the installation is straight forward!

Conforms to IEC 61000-4-30 ED.3

The BlackBox

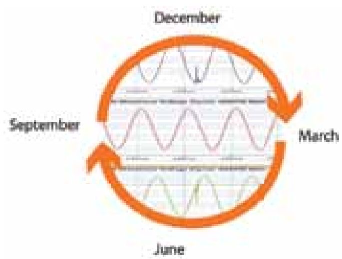
Power Quality Analyser Series

Outstanding Features:



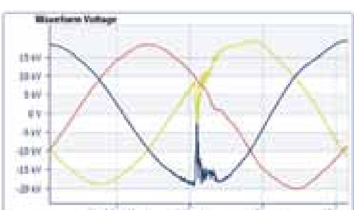
Extended Harmonics Recording

The Pure BlackBox records and stores 128 harmonics components at 50Hz resolution and 512 inter-harmonic components at 5Hz resolution for both voltage and current.



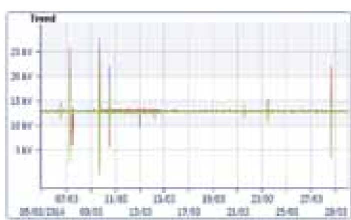
Continuous Waveform Recordings

The Pure BlackBox is the only hand held analyzer able to record and store all electrical parameters, at any given time for more than a year with no gaps in the data. It provides a clear and comprehensive view of network conditions at all times, offering the most advanced power quality analysis capabilities.



Get the most accurate information

The Pure BlackBox records voltage and current waveform sampled at a rate of 256 Sample/Cycle at 50/60Hz, which provides information at a very high resolution, enabling it to detect and analyse the slightest change.



Supreme Trend Resolution

More than 5,000 power quality parameters such as RMS, THD, power, power factor, unbalance and harmonic are logged continuously for more than a year at ½ Cycle, 10/12 Cycles, 150/180 Cycles, and 2 hour resolution.

Impact Power Innovations

Energy Efficiency through power quality

Contact our professional team of Power Quality Specialists for all your enquiries.

www.impactpower.co.za, 0861 357732 (0861-ELSPEC) or email info@impactpower.co.za

Proudly Bidvest

ELSPEC When Power Meets Quality

TC MADIKANE
2016 SAIEE PRESIDENT

It gives me pleasure to present the SAIEE Annual Report and Financial Statement for 2016. On the 5th of April 2016, I was given the honour of taking up the prestigious position as the President of the South African Institute of Electrical Engineers. The SAIEE is a learned institute with more than 7000 members globally.

It is recognised by the Engineering Council of South Africa (ECSA) as a Voluntary Association in terms of Section 25(3) of the act. My theme for 2016 was #ploughback and #makeithappen.

Keeping in line with that theme, I attended 66 functions/events in my capacity as the SAIEE President. I made sure that I networked with other stakeholders to make SAIEE visible. My greatest memories of the year were the interactions that I had with all the Centres and Student Chapters. I also believe that the good relationship SAIEE has with ECSA to date is worth noting. No wonder that the new ECSA Council is so well represented by Electrical Practitioners, in six out of eight High Impact Committees we have at least one Electrical Practitioner representative.

It is said that a photo speaks a thousand words and I have attached photos of some of the events that I attended.

FINANCES

Our Association is not for gain, but to ensure that we serve and provide value our members. I am pleased that we have increased the number of bursaries this year, resulting in a total of 16 Bursaries holders. It is my desire that we continue with that positive trend, as I believe there is no finer way to contribute to a better future to our country. As the SAIEE, it is important, that we ensure that we continue to produce future Electrical Engineers, and really #makeithappen.

I am also happy to report that our revenue for the last financial year, for both for membership and CPD increased by 18% and 39% respectively, compared to 2015. Well done to the CEO and his team, especially considering the continuing tough economic conditions under which we operate. Of course, the beneficiaries of the CPD courses are our members and I am glad that all regions are able to share in the CPD courses. Unfortunately, the publication revenue indicates a downward trend compared to 2015. I am well aware though, that the Publication team is working hard to come up with innovative ways of dealing with Wattnow and ARJ

I want to extend my appreciation to Viv Crone, Honorary Treasurer and Stan Bridgens, CEO, for their dedicated management of the financial affairs of

the SAIEE. The Institute is in a very sound financial position, and the details will be covered under the report of the Honorary Treasurer.

MEMBERSHIP

Those who attended my inauguration will remember that one of my ambitious goals was to increase SAIEE membership by 20%. I am proud to report that our figures indicate an increase of just over 8%. The increase in numbers was achieved through various strategies, including visibility on social media, posting activities on the day of the event in our website and facebook – always keeping members informed of SAIEE happenings. We worked very closely with ECSA to access those registered Electrical Practitioners who are not yet members of SAIEE. I believe that the fruits of that exercise will be further realised in future.

T/he interest Group in East London has been revived and currently has approximately 80 members. East London has electrical practitioners in the automotive industry (i.e. Mercedes Benz Nissan, Volkswagen, Ford and General Motors), Eskom, Buffalo City Municipality, Walter Sisulu University and Consulting Engineers amongst others.

Our future members are the youth, and therefore need to be nutured more innovatively and sometimes even using unconventional approaches. In 2016, we launched the Student Chapter in Mangosuthu University of Technology (MUT). I intend to continue to be active in KwaZulu-Natal (KZN) Centre, especially in ensuring that Student Chapters in that province are active in growing membership.

EVENTS

There were number of events that took place in 2016/17. Thank you to the collective effort of the various sub-committees of Council, who organised these events. I would like to single out three prestigious events.

The Presidential Invitation Lecture took place in May 2016, at the University of Johannesburg, and the Guest Speaker was Professor Thokozani Majozi. He is a full professor in the School of Chemical and Metallurgical Engineering at Wits University, where he also holds the NRF/DST Chair in Sustainable Process Engineering. His topic was "A Process Systems Engineering Approach To Synthesis And Design Of Sustainable Processes". He meticulously managed to link his topic with the day-to-day events of Electrical Engineering Practitioners.

Our Guest Speaker at the 65th Bernard Price Memorial Lecture was Professor Tshilidzi Marwala, Deputy Vice Chancellor: Research, Internationalization and the Library of the University of Johannesburg. This event was attended by more than 150 guests in Johannesburg and they were thrilled by his topic, "Fourth Industrial Revolution; Artificial Intelligence and Society".

The Banquet is one of the highlights of any President, and I was pleased to present awards to a crop of well deserving individuals. We had such a good quality of nominations, and the Panel had the mammoth task of selecting from this large pool. We had two recipients of the President's Awards for 2016. They are both individuals who are well respected in the industry, Dr Rob Steven, President of Cigre and Mr Sicelo Xulu, Managing Director of City Power.

STRATEGIC OBJECTIVE

It is good governance to review the strategy of any organization or entity. EXCO took a decision to have a strategic session


SAIEE
wattnow


SAIEE
wattnow


SAIEE


SAIEE
wattnow

during 2016. In that meeting we agreed on five key strategic objectives namely; relevance, growth, governance, benefits and marketing. I am pleased to report that the Champions responsible of these objectives have worked hard on these objectives and I am sure by end of 2017 we will witness the results.

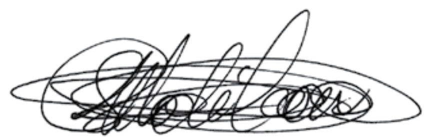
ACKNOWLEDGEMENTS

My gratitude goes to the Office Bearers, EXCO and Council, who supported and guided me during my term of office! They all collectively shared their knowledge and experience, which not only assisted me during my term of office, but will be useful for my future.

My special thank you also goes to our CEO, Stan Bridgens, and the SAIEE staff for their support and cooperation. And to Gerda Geyer - you are a star!. She did a sterling job managing all my travel arrangements to all the 66 events, which had to be juggled with my business schedules.

Finally my special thanks to my wife, Mahle, for her unwavering support. I would never have managed to complete this assignment without her help. And I cannot neglect to thank my company, Igoda Projects, for affording me such a memorable opportunity to #ploughback.

It is my pleasure to congratulate Mr Jacob Machinjike on his appointment as the next President, and to give him assurance of my continuing support during his tenure. As I now hand over the baton to him, I am certain he will take our Institute to a higher level.



TC Madikane | SAIEE President 2016/17
Pr. Eng | FSAIEE | FSAAE

SAIEE 2017 ANNUAL GENERAL MEETING

2017 SAIEE President Jacob Machinjike and his wife, Gladys.

Jacob Machinjike, General Manager: Grids in Eskom Transmission, has been appointed as the 2017 President of the South African Institute of Electrical Engineers (SAIEE) at the recent Annual General meeting (AGM) held at the Military Museum in Johannesburg at the end of March.

Jacob started serving in SAIEE leadership as an Office Bearer in 2014 when he served as the SAIEE Junior Vice President.

Jacob Machinjike has 30 years' experience in the engineering industry and a sound understanding of the operation and maintenance of the entire value chain of the electricity supply industry. He is no stranger to receiving accolades for his leadership role including being named Transmission Executive of the year 2011 and 2015. In 2015 Jacob was also proceeded to be named the runner-up for the more prestigious Eskom Executive of the Year award.

He holds a Bachelor of Science in Electrical Engineering (Honours) and a Master of Business Leadership (MBL). He is a Fellow of the SAIEE and is registered with the Engineering Council of South Africa (ECSA) as a Professional Engineer.

He joined the SAIEE in 1996 as a Senior Member. He became a fellow in 2002. He served as a Council member from 2001 to 2006 and then again from 2011 to the present. Jacob has served on various council committees, including Membership, Professional Development, Finance, Restructuring and Policies and the SAIEE's Executive Committee.

In 1998, Jacob was the recipient of the SAIEE's Young Achiever's Award. Besides being General Manager at Eskom responsible for Transmission Grid assets, he also represents Eskom on the Governing Board of the GO15 (an international organisation of very large power grid operators). He is a former director of a number of Eskom subsidiary companies, which include Trans Africa Projects (TAP), PN Energy Services, Pebble Bed Modular Reactor (PBMR), Umeme of Uganda, Motraco and Elgas of Mozambique.

"The objective of the 2017 SAIEE presidential term of office is to continue building on the focus areas of the past few years, namely developing and nurturing skills to ensure the professionalisation of engineers, technologists and technicians," explains Jacob. He sees the role of the Engineering Professional in today's complex decision-making as requiring *"enthusiasm in growing membership among students and practicing engineers, increasing their ability to serve customers and to help in resolving South Africa's and society's challenges. Some of the opportunities require making use of new and emerging technologies, industry models, smart technologies, innovative solutions to attract investments, members' access to international institutions and global business,"* says Jacob.

Sy Gourrah was elected Junior Vice President. She will serve the next 4 years on the Executive Committee, when she will be inaugurated as the 2020 SAIEE President.

Sy's is currently a Fellow of the SAIEE and she was the President of the AMEU (Association of Municipal Electricity Utilities). Sy have been a member of two committees, the Professional Development Committee and the Education & Training Committee at the SAIEE. Her vast experience in the industry makes her a valuable asset for the SAIEE.

From left: Refilwe Buthelezi, Kgomotso Sthlapelo and Tshego Cornelius.

From left: Mahle Madikane and TC Madikane (Immediate Past President).

SAIEE Past Presidents
From left: Prof Pat Naidoo, André Hoffmann & Andries Tshabalala.

From left: Sipho Madonsela (ECSA CEO), Jacob & Gladys Machinjike.

From left: Zwele Mbebe with a friend and Prof Thomas Afullo.

From left: George Debbo (SAIEE Senior Vice President) and Sharon Stobbia.

From left: TC Madikane (SAIEE Immediate Past President), Revona Botha and Jones Moloisane.

From left: Thavi Govender and Stan Bridgens (SAIEE CEO).

Prof Pat and Maureen Naidoo.

From left: Dawie & Sy Gourrah (Junior Vice President).

The Eskom Team:
From left: Prince Moyo, Mphiliseni Mthimkhulu, Thomas Tshikalange, Elsie Pule, Jacob Machinjike (2017 SAIEE President), Nozuko April, Victor Shikoana and Boitumelo Gcwabaza.

Providing the right battery to meet industry's solar needs

Effectively harnessing South Africa's abundant solar energy in a business environment offers both environmental and cost-saving benefits. However, when introducing a solar solution, many companies find themselves facing unexpected challenges due to incorrect set-up and battery usage. The winning formula is to clearly understand the company's precise energy needs upfront to implement a solution that correctly addresses requirements, both in terms of equipment set-up and choice of solar battery. This is according to Ingo Eichner from Probe, South Africa's leading importer and distributor of batteries and solar solutions.

Eichner says that solar is not necessarily an either-or scenario. *"Obviously it is desirable to be completely off-grid. But solar can still reap great energy saving benefits working in conjunction with the grid, providing crucial power during daylight hours, storing essential energy and converting it for later use, and only pulling in grid power when necessary."*

"Large industrial applications would typically run off a 3-phase application in order to power heavy-duty or specialist equipment," says Eichner. *"A healthcare facility or large corporate environment where any dips or surges in power could be catastrophic, would require a large bank of solar batteries to support the crucial UPS backup power.*

At the other end of the spectrum, petrol filling stations could also successfully incorporate solar into their energy plan. Eichner says, *"During the day, solar energy would run the petrol pumps, with a smaller bank of batteries storing energy. Then at night the solar battery bank would kick in with energy provision. This is ultimately a cost-effective way to run a small or medium-sized business, especially in remote locations."* Here, Probe's gel battery would be used in the solar solution, given that it charges at a slower pace and is ideal for standby power.

The AGM/Gel type batteries are ideal in a grid-tied system from a cost benefit point of view, where batteries are only used in a power outage. There other types of batteries however these are typically mostly costly from an initial investment point of view, however Eichner believes that the customer should obtain possible alternatives to determine the life time cost of the installation and not just look at the initial cost of the battery investment.

At times companies find that their solar systems are not operating at optimal levels. The blame is often laid at the door of specific components, such as the solar battery. But generally, Eichner says, investigation will reveal that the industrial or business requirements have simply been underestimated. He cites the example of an 800 metre-long factory development that is powered with solar energy to run heavy machinery and a sophisticated 24-hour security system. The battery bank kept draining and upon inspection and testing, it was found that an insufficient amount of solar panels had been installed on site. Solar energy consumption was sky-rocketing, leaving insufficient energy remaining for recharging the battery bank.

Eichner says, *"The client was simply not harnessing enough solar energy, which meant that the batteries were being pulled into the system to continually power the site. Due to the lack of solar panels, the batteries were continually used without being sufficiently charged. To ensure an optimal system, it was necessary for the client to install a further 10 solar panels, and even a back-up generator to assist with overflow consumption."*

High Voltage, High Power DC Contactors from Denver Technologies

GIGAGVAC, have released a new family of HX contactors, with current carrying capability up to 600A, 1500V. Robust High Voltage/High Power load break bi-directional DC contactor. Designed for high voltage Power conversion equipment OEM's: Photovoltaic/Battery inverters, battery pack designers, DC combiner boxes and other HVDC industrial drive systems.

Excellent isolation performance: 10kV withstand between open contacts for critical safety applications. Mechanically linked SPDT auxiliary contacts for critical safety applications. Reliable indication of the main contacts in the closed position. Hermetically Sealed - Exceeds IP67-69 specifications. No exposed arcing to open air environments. Designed to meet UL1604 for hazardous locations.

Clean Energy Revolution for Japan: Governor of Fukushima inaugurates Asia's first E3 Power Plant

Seen at the opening of the first E3 power plant

ENTRADE CEO, Julien Uhlig congratulates Governor Masao Uchibori for opening this venture.

Significant progress for the clean energy revolution: Six years after the natural disaster and the reactor catastrophe in the Fukushima prefecture, Governor Masao Uchibori inaugurated the first E3 power plant by pressing the button that starts the operations. The clean energy power plant by ENTRADE, located at the small health resort Nishigo, uses biomass which is available in the region – for instance pellets derived from waste wood and saw dust – to provide a hotel and a spa resort with electricity and heat. After the successful start-up of the pilot plant further E3 power plants will be set up during the following weeks.

"By using biomass from the region we protect the environment together with ENTRADE and in addition create jobs" says Mitsuo Fujita, Managing Director of the building company Fujita Construction and operator of the hotel and spa resort Abukuma, beautifully situated in the woodland. *"In the future we plan to derive a third of the energy which is required here around the clock from E3 power plants (25 electrical, 55 kW thermal)."*

The first power plant, which was installed by ENTRADE, supplies enough heat to bring the water for the healing treatments to a pleasant temperature and to heat the rooms of the hotel. This means going easy on the resources, saving costs and besides that strengthening the regional economy.

"Besides delivering clean energy to large industrial estates in Great Britain, we now demonstrate a further application of our innovative power plants here in Japan: in the energy-intensive hotel and tourism industry" says Julien Uhlig, CEO at ENTRADE. *"As of today we start to reduce the load on the Japanese power grids together with our partners and still make even more renewable energy available.*

Our special thanks go to the Governor Masao Uchibori, Entrepreneur Mitsuo Fujita but also to the government of North-Rhine Westphalia, which has been cultivating a close cooperation with the Fukushima prefecture."

CDH grows Technology and Sourcing practice

New Director, Vania Munro, has experience in Information Technology agreements and procurement, including software development, licensing, cloud infrastructure and storage, websites, maintenance and support, professional services/ consulting.

She also has a wealth of experience insofar as retail banking payment systems and products are concerned. *"CDH has a strong presence in the Technology and Sourcing practice area and Vania adds much-needed capacity and expertise to enhance our service delivery and service offering,"* says Christoff Pienaar, Director Technology and Sourcing, Cape Town.

We are thrilled to welcome Vania to our dynamic team and we are confident that her knowledge and breadth of experience will enhance our Technology and Sourcing offering.

WATTSUP

Vertiv Identifies Data Centre Infrastructure Trends for 2017

Vertiv, formerly Emerson Network Power, today released six data centre infrastructure trends to watch in 2017. This year's trends follow the 2016 data centre trends published by Emerson Network Power last year.

"In 2016, global macro trends significantly impacted the industry, with new cloud innovations and social responsibility taking the spotlight," said Giordano Albertazzi, president, Europe, Middle East and Africa for Vertiv. *"As cloud computing has integrated even further into IT operations, the focus will move to improving underlying critical infrastructure as businesses look to manage new data volumes. We believe that 2017 will be the year that IT professionals will invest in future-proofing their data centre facilities to ensure that they remain nimble and flexible in the years to come."*

Below are six infrastructure trends shaping the data centre ecosystem in 2017:

1. Infrastructure races to keep up with connectivity at the edge
   Distributed IT and the industrial Internet of Things (IIoT) are pushing IT resources closer to users and industrial processes. While the data centre remains core to delivering applications and services, such as point of sale and inventory management, network closets and micro data centres are growing in number and importance as internet-connected sensors and devices proliferate and remote users demand faster access to information.

2. Thermal management expands to sustainability
   Data centre cooling has changed more in the last five years than any other data centre system. Fuelled by the desire to drive down energy costs, traditional approaches that focused on delivering "maximum cooling" have been displaced by more sophisticated approaches focused on removing heat as efficiently as possible. Increased use of advanced economiser technologies and the continued evolution of intelligent thermal controls have enabled highly resilient thermal management strategies that support PUEs below 1.2.

3. Security responsibilities extend to data centre management
   While data breaches continue to garner the majority of security-related headlines, security has become a data centre availability issue as well. The 2016 Ponemon Institute Cost of Data Center Outages study revealed that cyber attacks accounted for 22 percent of the data centre outages studied.

4. DCIM proves its value
   DCIM is continuing to expand its value, both in the issues it can address and its ability to manage the increasingly complex data centre ecosystem. Forward-thinking operators are using DCIM to address data centre challenges, such as regulatory compliance, Information Technology Infrastructure Library (ITIL), and managing hybrid environments. Finally, co-location providers are finding DCIM a valuable tool in analysing their costs by customer and in providing their customers with remote visibility into their assets.

5. Alternatives to lead-acid batteries become viable
   New solutions are emerging to the weak link in data centre power systems as operators seek to reduce the footprint, weight and total costs of traditional valve-regulated lead-acid (VRLA) batteries. The most promising of these is lithium-ion batteries. With prices decreasing and chemistries and construction continuing to advance, lithium-ion batteries are becoming a viable option for the data centre and are being scaled to handle row- and room-level requirements. While this battery technology has been available previously, the improving economics have spurred increased commercialisation efforts in the data centre industry.

6. Data centre design and deployment become more integrated
   Technology integration has been increasing in the data centre space for the last several years as operators seek modular, integrated solutions that can be deployed quickly, scaled easily and operated efficiently. Now, this same philosophy is being applied to data centre development. Speed-to-market is one of the key drivers of the companies developing the bulk of data centre capacity today, and they've found the traditional silos between the engineering and construction phases cumbersome and unproductive. As a result, they are embracing a turnkey approach to data centre design and deployment that leverages integrated, modular designs, off-site construction and disciplined project management. Vendors that bring together infrastructure expertise, design and engineering capabilities and sophisticated project management to deliver a turnkey capability can build better data centres faster.

Engineers speak out on recent cabinet reshuffle

Consulting Engineers South Africa (CESA), the industry association for consulting engineers, representing a member base of over 500 companies which employ over 23 000 people in various capacities is dismayed by the current cabinet reshuffle. As an industry we pride ourselves on excellence in the delivery of infrastructure projects.

The current cabinet reshuffle, which we accept as being the prerogative of the President, regrettably not only runs the risk of exacerbating the already troubled economic situation in which we find ourselves, but also sends out a disturbing message on rewarding mediocrity, and punishing excellence. The latter is counter-intuitive to the culture we seek to establish among young engineering professionals. These will be responsible for ensuring the wellbeing of our infrastructure for generations to come.

CESA further reiterates that the country cannot afford this questionable reshuffle based, according to the President, on the need for more "effectiveness and efficiency" according to the President, when this flies in the face of dispensing the very performance needed to achieve this objective. As engineers we believe that a better approach would have been to dispose of the non-performers, and bring on board better performers.

The industry is already experiencing difficulty amidst corruption, appointment of consulting engineering firms that have little or no track record of delivery, and even mafia-style criminal activity halting construction activity. The latter not only puts lives at risk, but also affects job security in a sector where limited employment opportunities exist currently due to the already low levels of capital investment in infrastructure.

The junk status downgrade investment rating by Standard & Poor's, a leading global credit rating agency, emanated primarily from the political uncertainty confirmed by this ill-timed reshuffle. This further limits investor confidence. It will not only hamper economic growth, but will further limit our ability to create more jobs. Skilled engineering practitioners from various technical disciplines are currently being retrenched at a time when this has been identified as at least six out of the ten most scarce skills in the country.

The jury, of course, is always out on whether new appointees will be future star performers. Also whether some Ministers would have learnt from their past shortcomings.

As an industry we are committed to the success and well-being of our country, in support of initiatives towards constructive and sustainable economic transformation. We offer our support to partner with those ministries entrusted with infrastructure delivery.

We, like all other citizens, are committed to a South Africa that benefits all, in the present and for generations to come.

Fluke Breakfast Presentation

SAIEE Corporate Partner, Fluke, recently hosted a breakfast at the SAIEE Head Office. Pradeep Ravi, Technical Sales Manager for Middle East, Africa & Turkey for Fluke Corporation did a presentation on "Detecting Electrical Energy Losses with Thermal Imaging cameras". The presentation involved getting results with infrared cameras. In order to detect electrical energy losses as a manifestation of thermal energy, they go beyond and use complementary solutions like Power Quality and Vibration, to get to the root cause of the problem and do corrective actions.

From the left: Sibel Canli, Fluke Marketing Manager Middle East, Africa and Turkey; Francesco Pagin, Fluke Regional Sales Manager Sub Saharan Africa; Pradeep Ravi, Fluke Technical Sales Manager Middle East, Africa and Turkey; Patrick O' Halloran, City Power; Gerrit Barnard, Comtest and Erick Wessels, Fluke Area Sales Manager Sub Saharan Africa.

WATTSUP

Team effort pays off on CONCO Sebenza project

As CONCO heads into the third and final year of the key City Power Sebenza project, all stakeholders involved have agreed that team effort has been a significant contributor to the success of the project thus far. At the end of last year, CONCO hosted a function on site with representatives from City Power, PSW/Nyeleti Consulting Engineers, and subcontractors, marking two successful years into the project.

City Power commended and thanked CONCO and consulting engineers PSW/Nyeleti, for the way in which they have run the project. *"As one of the biggest projects undertaken,"* said City Power's Patrick O'Halloran, Chief Engineer for plant condition monitoring, *"it's critical to our network that the project is delivered on time or before time and it's really what we come to expect from CONCO nowadays. It's been such a great team effort and not just one person making it happen."*

CONCO Special Projects Director, Mario Prasti said that although the project was earmarked for completion within 45 months, the aim is to complete it in 32 months. *"We basically broke up the project into three years. The first year saw commencement of the civil work of which 90% was civils and on the backend, the procurement. The bulk of the Installation and commissioning was undertaken in the second year and the third year will see the installation of the three 315 MVA 275kV/88 kV/22 kV autotransformers built locally by Actom, and the connection phase."*

City Power's Acting General Manager Infrastructure Planning, Tony Whittaker expressed that when this project (Sebenza) has been completed, it will go a long way to satisfy the ever-increasing demand for capacity in Johannesburg and it can be used as the template to roll out other major projects like Quattro. He also thanked CONCO and the team of consultants working on the project for their excellent work and stated that CONCO had *"thrown down the gauntlet"* for others to follow in the future.

CONCO Senior Project Manager Thamie Nyembe said that good planning and management is vital for a project of this magnitude. *"The Sebenza team has been absolutely fantastic from the point of view that we've had to overcome some serious challenges. It was encouraging to hear City Power comment as to how the team goes the extra mile when challenges arise, coming up with better solutions. In regard to safety, almost 600 000 man hours have been clocked with no incidents. Considering we have had a complement of about 140 people on site at any one time, this is quite an achievement."*

Hein Schuld, founder of PSW Consulting Engineers, echoed the team's efforts and gave insight into how projects of this nature begin and evolve: *"I always ask young engineers what they think consulting engineers do and they are always surprised if I tell them that we are really dream-builders. The customer has a dream of what he wants to do and you have to sit down with him and make sure that you understand it. That's what Riaan and I have been doing with regard to Sebenza, since 2007, which is when this project started. We pushed the ball backwards and forwards until we had a clear picture of the dream. Then we put this dream on a piece of paper and sent it out to price. That's when it comes together, and the wonderful thing is that this entire team bought into that dream building project. We are now two-thirds of the way, so congratulations. We, as an entire team, feel drawn in. It's not you against us, everybody is involved from the tea girls right through to the senior people (junior to senior). Everybody is working to get this project up and running and everyone is putting in an extra bit of effort which I've not seen on many other projects; every single body without exception."*

Mervyn Naidoo appointed Group CEO of ACTOM

Mervyn Naidoo
Group CEO | Actom

Mervyn Naidoo has been appointed Group CEO of ACTOM with effect from March 1, 2017.

Naidoo, formerly Divisional CEO of ACTOM's LH Marthinusen division, succeeds Mark Wilson, who has held the Group CEO post since 1996.

Wilson, who has been Chairman of ACTOM since 2008, retains the Chairman position.

In announcing Naidoo's appointment as Group CEO, Wilson also announced the appointment of Andries Tshabalala as Deputy Chairman with effect from March 1, 2017. Tshabalala previously held the post of Group Executive Director.

"The Board and I would like to take this opportunity to wish Mervyn and Andries well with their new responsibilities and look forward to working together in growing and developing the ACTOM Group in the upcoming years," Wilson commented.

Tshabalala's main responsibilities as Deputy Chairman will be to assist both Naidoo and himself with strategy, customer liaison and empowerment, Wilson added.

Naidoo was appointed Divisional CEO of LH Marthinusen (LHM) in mid-2014. He was previously Divisional CEO of Reid & Mitchell (R&M), which he was appointed to in 2012, following ACTOM's acquisition in early-2012 of the former Savcio Group, to which LHM, R&M and a number of other leading businesses operating in the electrical rotating machines and transformers repair markets belonged.

At the time of the acquisition Naidoo was an Executive Director of Savcio Holdings and the group's Business Development Executive. An electrical engineer by profession, he has also held senior management posts in several other local electrical rotating machine repair companies during his 25-year career.

ACTOM (Pty) Ltd is the largest manufacturer, solution provider, repairer and distributor of electro-mechanical equipment in Africa, offering a winning and balanced combination of manufacturing, service, repairs, maintenance, projects and distribution through its 40 outlets throughout Southern Africa.

ACTOM is also a major local supplier of electrical equipment, services and balance of plant to the renewable energy projects.

It also holds numerous technology, distribution and value added reseller agreements with various partners, both locally and internationally.

Farms Raise Safety and Productivity through Asset Tracking

With workers and machines occupying the same working area in busy farming operations, proximity detection systems (PDS) are becoming vital tools to promote safety and productivity.

The PDS is a sensing device that detects the presence of an object, an interface that provides an audible and/or visual alarm to the equipment operator, and wiring between the two.

Linking the proximity detection hardware products and the monitoring devices is Booyco's Electronics Asset Management System (BEAMS) – a web-based application used on a robust database. BEAMS is essentially a central information hub, and provides a reliable single source of information that can be leveraged for greater insight into all aspects of the operation.

"BEAMS provides an effective asset management solution that will allow farming operations to feel secure in the control of their assets," Lourens explains.

WATTSUP

Aluminium offers Benefits in Transformer Windings

While copper has been assumed to be the material of choice for transformer windings, global specialist WEG Transformers has successfully manufactured thousands of transformers with aluminium windings.

An important factor behind this option is the likely future increase in the price of copper, as worldwide reserves of the metal gradually decline. While copper reserves are currently estimated at 5,6 billion tonnes; the reserves of bauxite, from which aluminium is generated, are more than 13 times greater at 75 billion tonnes.

The price of copper has fluctuated greatly in the past and has recently risen much faster than the price of aluminium, making the winding of conductors with aluminium increasingly attractive.

After years of testing, it has been established that there are no significant differences between the use of aluminium windings and copper windings in designing and manufacturing distribution transformers, as well as small to medium power transformers. Either metal gives the transformer the same quality of operation and performance. The use of aluminium in transformers began as early as the Second World War when industry experienced a shortage of copper, which was in huge demand for the arms industry. By the 1960s, when copper prices rocketed due to high demand, aluminium again became popular in windings; previous technological problems were overcome, and these transformers became more reliable.

One of the myths that has been disproved is the belief that aluminium-wound transformers have bigger losses of electricity. While the aluminium conductors are larger than copper conductors, they are lighter; the result is that the mass of the core in an aluminium transformer is 5 to 20% more, but the total transformer mass is almost the same – for the same level of electrical loss.With regard to the respective thermal properties, aluminium has a lower melting point than copper but it is still well above the real working temperatures of the windings. In normal circumstances, the 'hot-spot' temperature in the windings is between 105°C and 120°C, while aluminium only melts at 665°C.

An aluminium coil.

More importantly, the lower thermal conductivity of aluminium does not affect the performance; the temperature differences in the conductor are negligible in relation to the temperature difference between the ambient air and the windings.

Cummins demonstrates virtual reality at PEWA 2017

Cummins, a global power leader and corporation of complementary business units that design, manufacture, distribute and service diesel and natural gas engines and related technologies, demonstrated its recently launched Virtual Reality training and marketing device at Africa's highly acclaimed Power & Electricity World Africa (PEWA) Exhibition.

The Cummins exhibit showcased two sets of high-tech equipment for media and customers to experience. By wearing goggles and a headset, one is swept up in a simulated 3-D tour of a plant or data centre, complete with sound to further drive the reader's trip into the world of virtual reality. The viewer is introduced to various products in a data centre, including the recently launched QSK95 Series of high-horsepower generator sets.

The QSK95 is specifically designed and engineered for critical applications that demand a robust, reliable source of power to ensure uninterrupted operations, for applications such as hospitals, sports stadiums, office buildings, data centres and the like. Commenting at the exhibition, Kenny Gaynor, Director of Power Generation for Cummins Southern Africa said, *"This incredible innovative device has been engineered for use in training and education, providing a very new and dynamic teaching experience. Innovation is about unlocking and unleashing new ways of thinking, doing and delivering against a background of continuous improvement."* The compact and portable headgear provides endless marketing opportunities for the broad range of products.

Innovation is synonymous with Cummins; it is a value that propels the business and forms part of its pledge to customers. *"We*

All-weather voltage detectors enhance safety of electrical installations

DEHN Africa has introduced the new PHE4 series of voltage detectors to improve safety during maintenance of electrical systems and installations. The detectors provide reliable information in all weather conditions – wet and dry – and can be used both indoors and outdoors.

The voltage detector PHE4 series verifies the presence/absence of voltage on every electrical pole that has been installed from 1 kV to 420 kV.

A test function on the PHE4 series allows the required functional test to be performed before and after using the voltage detector. All the live parts are tested – from the indicator right up to the test probe. In addition, the control panel is large enough to safely and easily operate the device while using protective gloves.

After conducting the functional test, the voltage detector remains operational for four minutes. Both a visual indication and an acoustic signal indicate whether voltage is present or not. If a larger distance is required to ensure safety, or if the length is not sufficient to reach the point of contact, an extension handle can quickly and easily be attached through the plug-in coupling system by DEHN Africa.

The market leader DEHN, a globally active family-owned electrotechnical company with about 1,700 employees worldwide, offers innovative products and solutions as well as comprehensive services in the field of surge protection, lightning protection and safety equipment. DEHN focuses on the protection of system and building technology, the transportation, telecommunication and process sector, photovoltaic systems, wind turbines, etc. The company's continuous growth is based on more than 100 years of tradition as well as highest quality standards and consistent customer and market orientation throughout the world. DEHN protects.

are committed to bringing our customers more innovative, sustainable and reliable power solutions. More Dependability. It's what we call The Power of More," comments Gaynor. Remote monitoring is another example of this promise. This Cummins cloud-based, state-of-the-art technology is new in South Africa and is a key differentiator for the company.

It provides support for equipment via the cloud, relieving pressure from the local source. The technology provides real time data from a Cummins controller via a cell phone or email, alerting the customer by providing information that predicts future problems and power outages. Downtime or maintenance issues can then be prevented and scheduled accordingly. Typical applications for remote monitoring include maintenance, multi-building businesses that are controlled by one data centre, telecommunications, banking, hospitals and franchisee businesses.

Cummins enjoys 90 years of experience in power generation. Cummins Southern Africa is headquartered in Johannesburg, with branches in Longmeadow, Bloemfontein, Cape Town, Durban and Port Elizabeth; as well as Zambia, Botswana, Mozambique and Zimbabwe.

Earn CPD Credits

The Distribution Network Code [7] requires of licensed distributors, which in South Africa include Eskom and most Municipalities, to consider the applications for embedded generators to be connected to the grid.

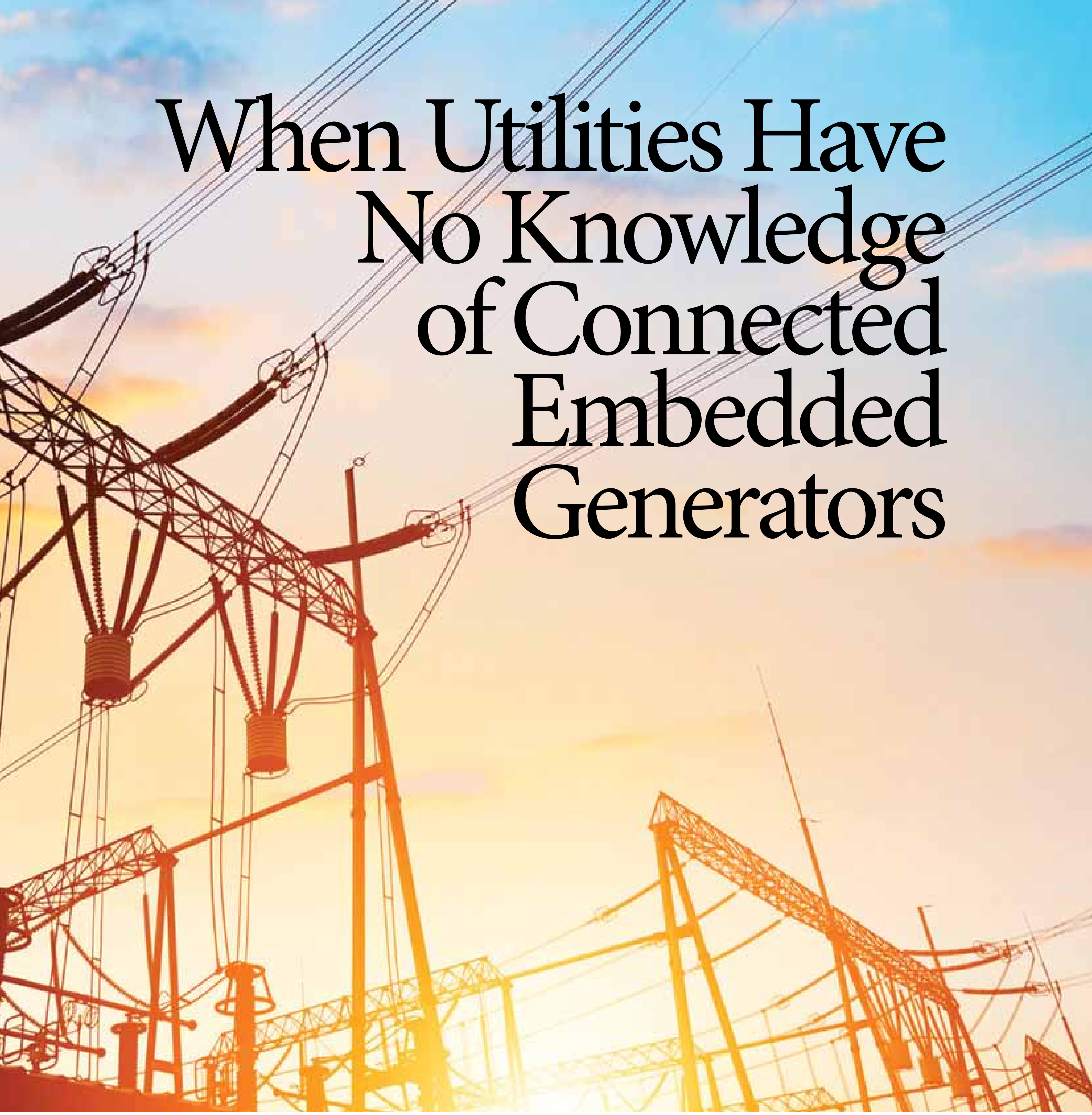
NERSA further requires licensed distributors to maintain a database of all such embedded generators. However, there is an occurring trend, fuelled by rising electricity costs, in which consumers simply do what they want – and right now that includes paying as little as possible for electricity.

This is partly achieved through the installation of small scale embedded generators – more specifically, solar photo voltaic (PV) panels.

BY I JACO A. ALBERTS I PR.ENG I M.ENG I MSAIEE I MIEEE
AND PROF. JAN A. DE KOCK I PR.ENG I FSAIEE

This results in licensed distributors operating distribution networks, with little to no knowledge of such connected generators. This paper is a summarized version of recent research, highlighting the impact of connecting embedded generators to the distribution grid. When the installation of embedded generation is well coordinated, problems and pitfalls can be avoided. When utilities are ignorant, or not aware of the imminent problems, they may soon encounter network performance issues. These problems will be even more prominent when utilities are unaware of what consumers connect to their grids, whether legally or otherwise.

In order to investigate the impact of unauthorized and uncontrolled addition of embedded generators to the distribution network, it is necessary to first understand conventional LV feeder design principles. A test feeder system will be used to compare the addition of a single



When Utilities Have No Knowledge of Connected Embedded Generators

embedded generator to an LV feeder to a baseline network, without any generators connected. Although solar PV generation takes place when day-time demand is generally low, the impact of embedded generation during high demand periods will also be considered. The impact of increased size and penetration of embedded generators will also be considered. The hypothesis is, that a high penetration of embedded generation removes the diversity between loads used to size cables or conductors, when distributions feeders were initially designed.

LV FEEDER PLANNING CRITERIA

A properly designed LV feeder aims to supply load to each consumer along the LV feeder, at a voltage within regulation limits (nominal voltage ±10%), using an overhead line or an underground cable, that can carry the current within the thermal limits of such a conductor or cable, from a transformer that is not overloaded. The LV feeder design must further ensure that all equipment, conductors, or cables are protected in case a fault may occur.

FEATURE

Embedded Generators

continues from page 21

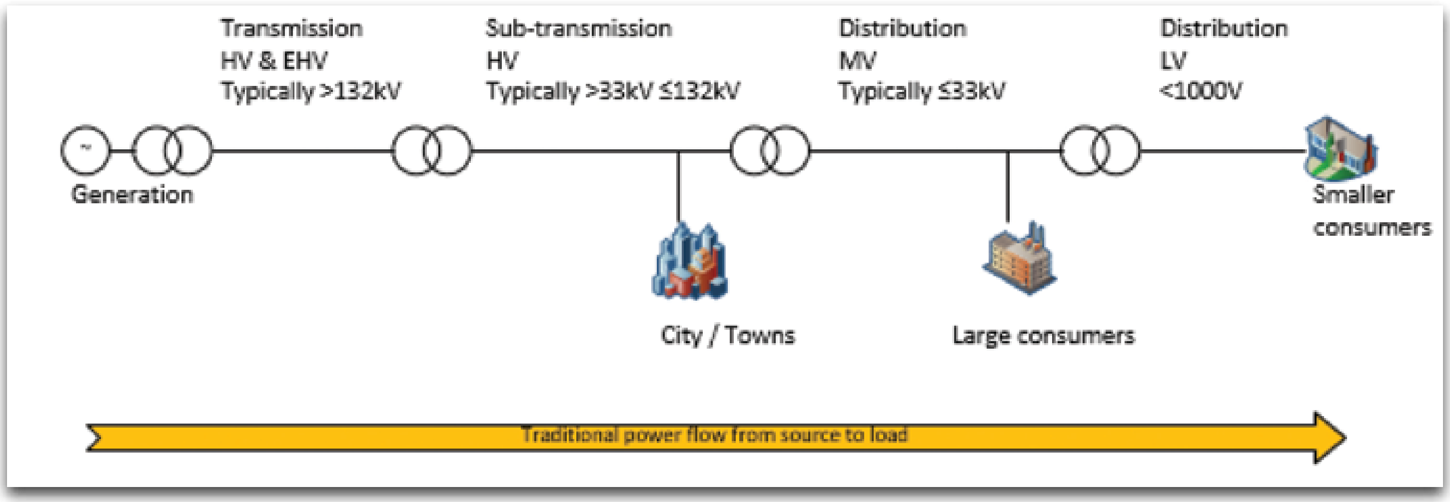


Figure 1: Traditional power flow direction from utility source to end-user loads

Historically, current has been flowing only in one direction – from utility source to the load. The voltage drops along the conductor or cable away from the utility source. Traditionally, the upper voltage limit never featured in LV feeder designs, and consequently, nobody bothered about it. Consider Figure 1.

However, as soon as an embedded generator is added, the voltage will rise, and current might flow in the reverse direction, i.e. back to the utility source, depending on whether the load requirement is downstream or upstream from the embedded generator. A generator connected to the distribution network is said to be embedded, because the System Operator has no control over dispatching the energy generated by such a generator. Sometimes it is referred to as distributed generation (DG). Figure 2 indicates this tendency.

Embedded generators are classified in three main groups by the South African Grid Code [8]:

A: Small-scale embedded generators (SSEGs) are usually connected to the LV network. Generators in this category are further divided into three groups:
A1: up to 13.8 kW;
A2: between 13.8 kW and 100 kW;
A3: between 100 kW and 1 MW;

B: between 1 MW and 20 MW, and

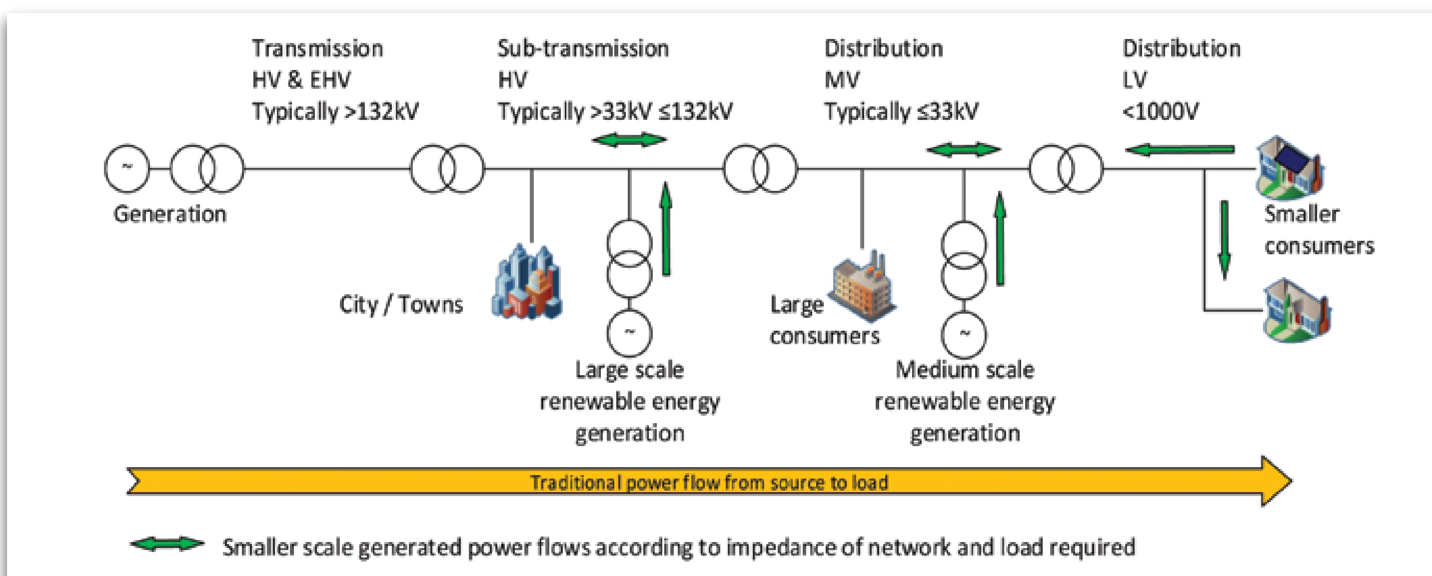
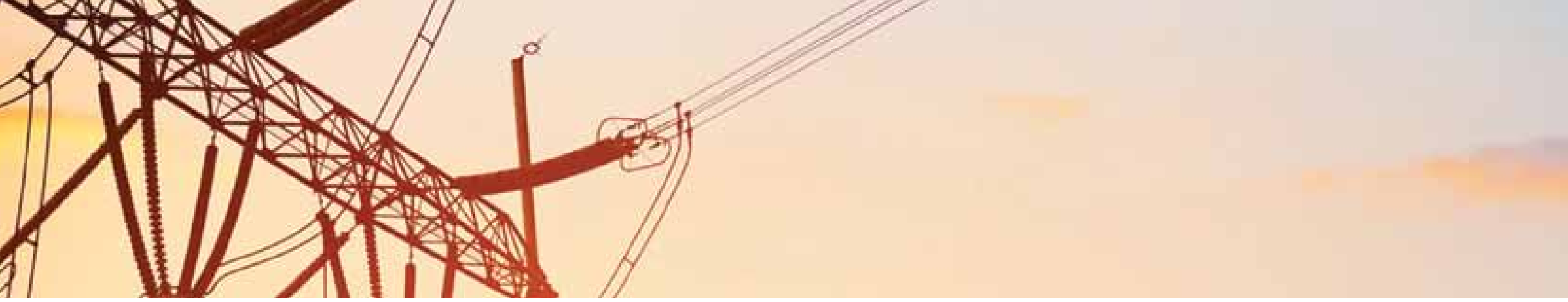


Figure 2: Power flow indicating renewable power plant connected at various parts of an electricity network. Power may flow upstream or downstream from where it is connected.



any generator connected to the MV distribution network;

C: 20 MW and larger, and any generator connected to the transmission network.

In this paper, the authors examine embedded generators connected to the LV network. LV feeders are often designed with tapered cable sizes, but there are utilities that require that the same cable or conductor size be used throughout. Both these design strategies are worth considering. In a reverse power flow scenario, a tapered conductor size approach might be restrictive towards the end of the feeder.

In a single conductor size installation, protection might be a problem as a single circuit breaker is used at the transformer until service conductor t-offs are made at distribution boxes, where the smaller conductors are again equipped with circuit breakers.

A low voltage feeder design is only possible if a representative load modelling technique is available. Coincidence between loads, or the lack thereof, plays a major role in the load modelling process. Various techniques have been developed over the years. At present, the Herman-Beta method is used to model the load through a beta distribution curve. After-Diversity Maximum Demand (ADMD) forms the basis of this calculation.

To understand how unauthorized and unverified connection of SSEGs can cause compliance issues, it is important to briefly review the core design approach: the load modelling technique and its dependency on ADMD.

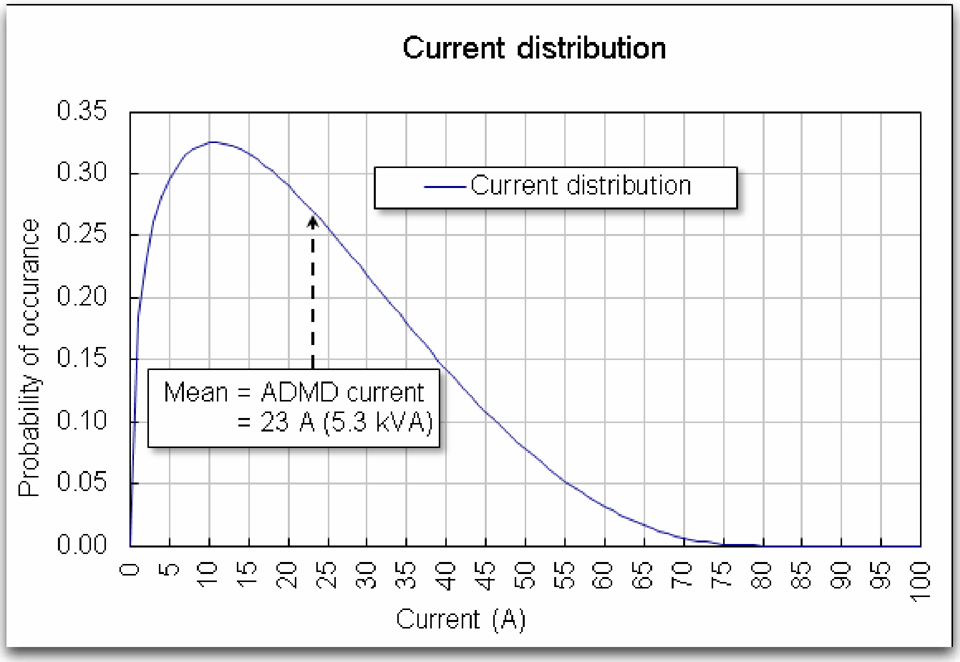


Figure 3: Beta current distribution plot for consumers with limiting circuit breakers of 80 A and an ADMD of 5.3 kVA, at the time of domestic peak load. A beta current distribution curve is described in terms of alpha and beta values, and is scaled and bound on the X-axis by the circuit breaker size (in NRS 034 denoted by the symbol "c")

VOLTAGE DROP CALCULATION

Rationalized User Specification NRS034 [9] recommends the Herman-Beta voltage drop method for LV feeder design. This method uses a statistical approach with an assumed risk factor of 10%. This method is based on the findings by Prof. Trevor Gaunt, Prof. Ron Herman et al. [1] that the current distribution at peak time resembles a beta distribution curve.

An example of a beta distribution curve at an ADMD of 5.3 kVA per household (23 A) for a household domestic circuit breaker of 80 A is illustrated in Figure 3.

The ADMD is represented by the mean of the distribution curve, and the upper limit is restricted by the domestic service cable circuit breaker. The Herman-Beta formulae are not the subject of this paper, and can be found in NRS034. Typical alpha and beta values for various ADMD values are also provided in NRS034.

When the ADMD changes, the beta current distribution curve will become more skewed towards the left for a reduction in ADMD, and move more towards the right for an increase in ADMD. It is important to realise that the underlying parameters that describe such a beta current distribution curve will also change if the ADMD changes.

ADMD CONSIDERATIONS

By definition, ADMD is the maximum demand for a group of homogenous consumers divided by the number of homogenous consumers. In essence, the calculation of ADMD is based on a future saturation demand, some 15 to 20 years

Embedded Generators

continues from page 23

into the future. In [2], Alberts & De Kock illustrates how an incorrectly calculated ADMD can lead to costly decisions.

NRS034 also provides a formula, based on the Central Limit Theorem, to relate the maximum demand to the Herman-Beta method's alpha, beta and "c" parameters.

The selection of an appropriate ADMD is often a very controversial matter. Engineers want to design a network that will not overload. A developer has a vested interest to pay as little as possible for bulk supply contributions, usually based on an amount per kVA, by desiring demand values that are as low as possible, i.e. ADMD values that are as low as possible. NRS034 lists ADMD values for different living standard measurement (LSM) values, and indicates that these values must be adjusted for different climate values. The ADMD can be determined by one of three methods according to the CSIR [3]:

- Measurement of the maximum demand;
- Using energy consumption and load factor; or
- Using an appliance model.

Although it seems that consulting engineers and utility engineers very often use a "gut-feel" or "thumb-suck" method, these two methods are not listed as appropriate methods to select an ADMD!

Direct measurement is useful only when sufficient measurement data is available to establish annual and seasonal trends. Measurement intervals are also important, as shorter metering integration periods provide more accurate values while longer integrating periods provide less accurate values. Shorter metering integration periods, such as one minute or five minutes are not often implemented, since it will result in a relative short time span of profile data stored in the meter. 30-minute integration periods are enshrined in the South African metering codes [10], but it must be understood that in such a case, the 1-minute ADMD differs by as much as 5% from the 30-minute ADMD if no load control is implemented, and as much as 15%, if load control is implemented [4].

When the energy consumption and load factor method is used, care must be taken that the correct load factor is used. When both values are mere estimates, an incorrect ADMD will most likely be determined. This method is based on what a community can afford to pay for electrical energy.

An appliance model is useful if the 24-hour appliance use and appliance mix of a community is known. Few appliance models exist and they are mostly based on assumptions. Alberts & De Kock illustrated in [2] and [4] that an appliance model can be used to model load effectively. The developed appliance based simulation model was also used to illustrate the effects that energy efficiency and SSEG interventions have on ADMD, load factor and coincidence.

Furthermore, ADMD is a factor of the coincidence of electricity demand between a group of consumers. Coincidence, by definition, is the maximum demand for a group of consumers divided by the sum of the individual maximum demands of the consumers. Diversity is the reciprocal of coincidence. If the coincidence between loads for a group of consumers changes, the ADMD will also change.

This paper will examine whether a large oversupply of electrical energy by SSEGs will result in a lack of diversity between consumers.

Before assessing how unauthorized SSEG connections impact on network design performance, it is necessary to understand the guidelines developed to help safeguard network asset investment and performance.

NRS097 REQUIREMENTS FOR THE CONNECTION OF EMBEDDED GENERATORS

NRS097-2-3 [11] sets simplified connection criteria for low voltage connected generators for households with a LSM larger than 7. These criteria attempt to limit the amount of SSEGs that a utility should allow on feeders (refer to Figure 4).

In summary, NRS097-2-3 requires that:

- Generator sizes should be limited to less than 350 kVA.
- The LV fault level of the customer must be larger than 210 A.
- The total DG that is supplied by a MV feeder should be restricted to 15% of the feeder's peak load.
- The total DG connected to a MV/LV transformer should not exceed 75% of the transformer rating.

For shared LV feeders, the requirements are:

- The individual generator size should be limited to approximately 25% of a customer's NMD.
- The maximum generator size a customer can connect to a shared LV feeder, is 20 kVA. Connections larger than 20 kVA require a dedicated LV feeder.
- Any generator larger than 4.6 kVA

Simply reliable. Simply available.

Get the most from your enclosures

Meet the Universal Enclosure range, providing the right enclosure for any application

Finding the right enclosure for your specific needs can be complicated. The Universal Enclosure range helps simplify this process by providing a complete offer of enclosures fit for both indoors and outdoors. Thanks to functionalities such as temperature and humidity control, Universal Enclosures help keep your electrical equipment in top form no matter where it's located.

Scan here to discover more information.

www.schneider-electric.co.za

Life Is On | Schneider Electric

Embedded Generators

continues from page 24

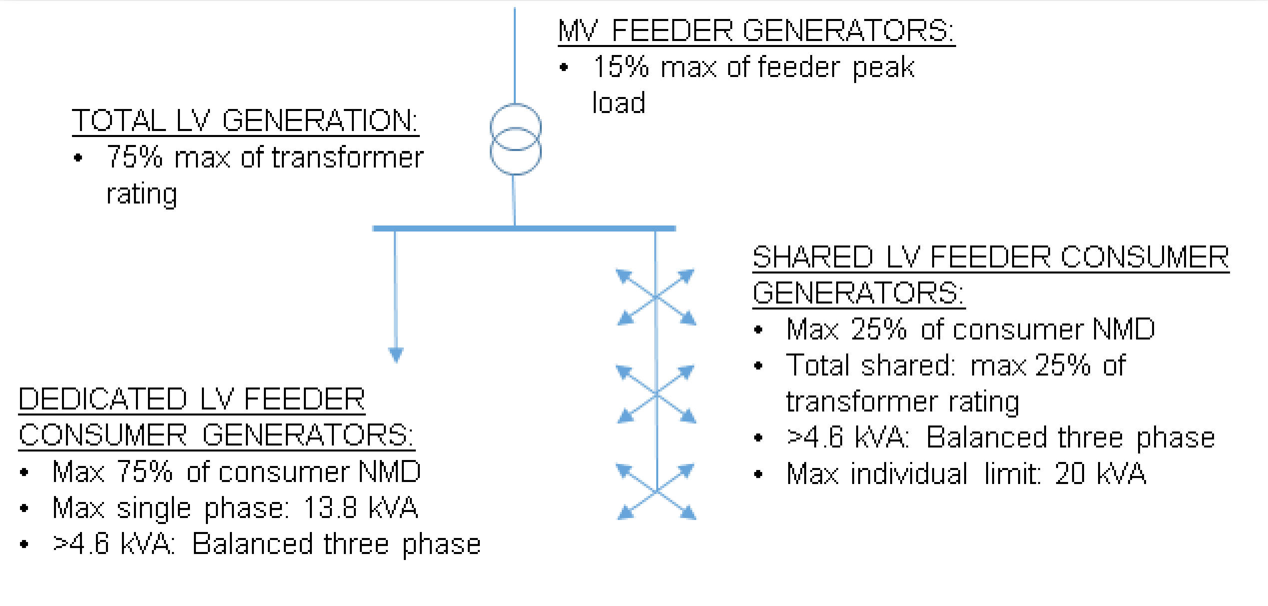


Figure 4: NRS097 proposed limits of embedded generation

must be a balanced three-phase generator.

- The total limit of SSEGs to be connected to shared LV feeders should be limited to 75%.
- Connections to SSEGs that do not supply load will be on dedicated feeders.

The requirements, as outlined above, are summarized in Table 1.

For dedicated LV feeders, the criteria are:

- SSEGs connected to dedicated LV feeders from a transformer, are limited to 75% of the transformer's capacity.
- The dedicated LV feeder size should be limited so that the voltage rise between the SSEG and the transformer LV busbars does not exceed 1%.

NRS097-2-3 also states that larger connections can be allowed, but will be subject to further studies.

PHASES	CIRCUIT BREAKER SIZE OF SERVICE CONNECTION (AMPERE)	NMD (kVA)	MAXIMUM DG SIZE THAT CAN BE CONNECTED AT UNITY POWER FACTOR (kVA)
1	20	4.6	1.2
1	60	13.8	3.68
1	80	18.4	4.6
3	60 or 80	41.4	13.8 (4.6 per phase)

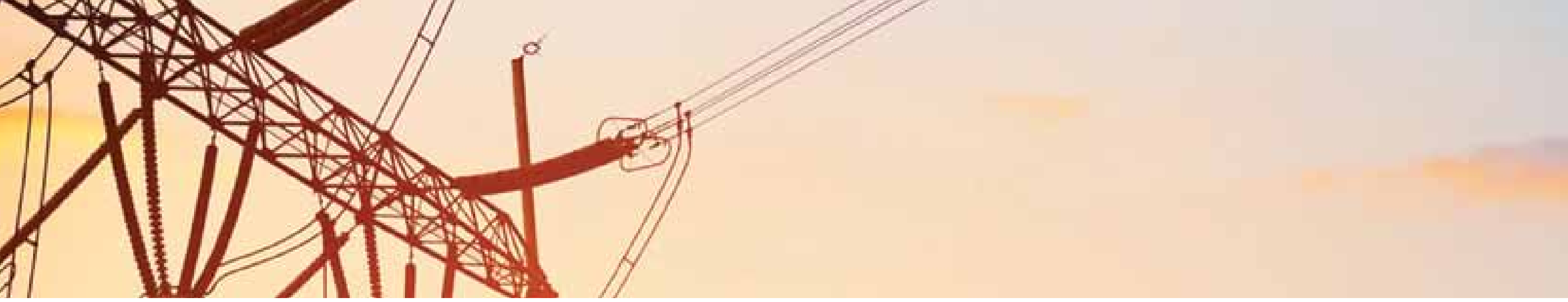
Table 1: Allowable LV DG connections (individual limits)

Considering the abovementioned limits imposed by NRS097, the 15% limit for the MV feeder will be exceeded if the limits are applied to each transformer zone on a MV feeder.

Although NERSA requires utilities to maintain a database of all embedded generators connected to the distribution network, consumers continue to install solar rooftop PV panels without consulting or informing the utilities.

Why are limits required? Solar PV generation is at maximum generation when domestic load is at a daytime low. Under such conditions, voltage rise and cable loading under reverse power-flow conditions are of concern.

MV/LV transformers do not have automatic tap changers, and a high penetration of SSEGs at MV level can even cause high voltage conditions on the secondary side of transformers further downstream.



PRACTICAL ILLUSTRATION: NETWORK PERFORMANCE WITH SSEGS CONNECTED TO THE GRID

TEST NETWORK

Everything will be in order when planning can be coordinated using the guidelines provided by NRS 097, and each generator can be considered in context of the grid's unique localized conditions. In this instance, safety precautions can be taken, metering can be addressed, protection can be reviewed, and quality of the inverter technology as well as the control functions can be reviewed.

However, what happens when SSEG installations are made and the utility is not consulted, or the utility is consulted, but proper care has not been taken to assess the generator's impact on the network?

Consider the network diagram provided in Figure 5 for two cable design scenarios: a tapered cable size scenario and a single conductor size scenario. This test network has been selected so that the design conditions are met for both scenarios.

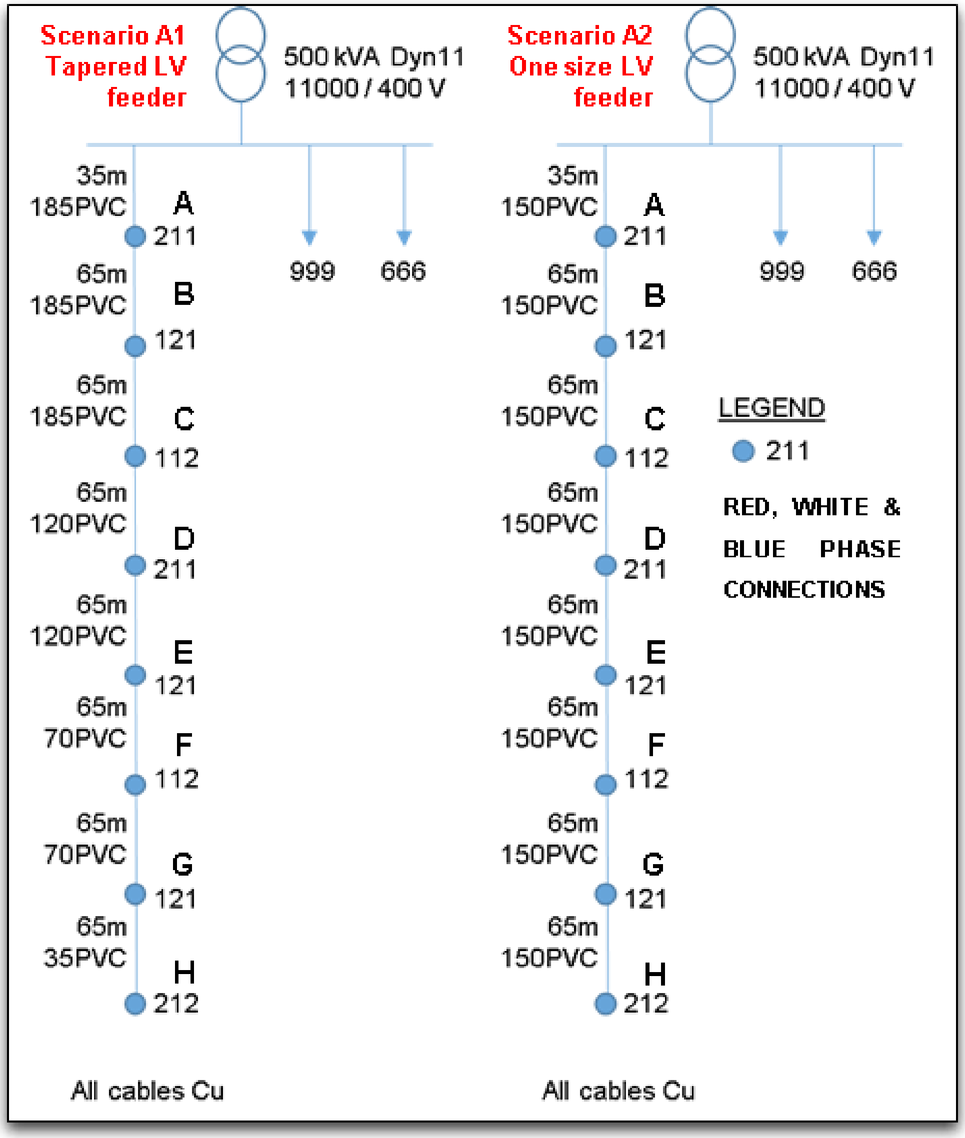


Figure 5: Test feeder system for network performance analysis

This test feeder was also used in several other publications by the authors of [2], [4], [5], [6]. In both feeder design scenarios, the LV feeder is operated near its limits, i.e. cable sizes were selected to be at its thinnest to allow the voltage drop to be just within the legal requirement (0.90 p.u.).

Service connection cables are based on an assumed position on a property connecting to the consumer's distribution board. The load distribution over a complete feeder as well as the transformer is balanced, although the load at each distribution point along the feeder is not balanced. This was chosen on purpose to ensure that unbalance exists at various points along the feeder. In reality, feeder load will hardly be balanced, even though best efforts are made towards designing for a balanced load distribution situation.

BASELINE RESULTS

Baseline results are calculated before considering any energy efficiency and SSEG interventions.

Embedded Generators

continues from page 27

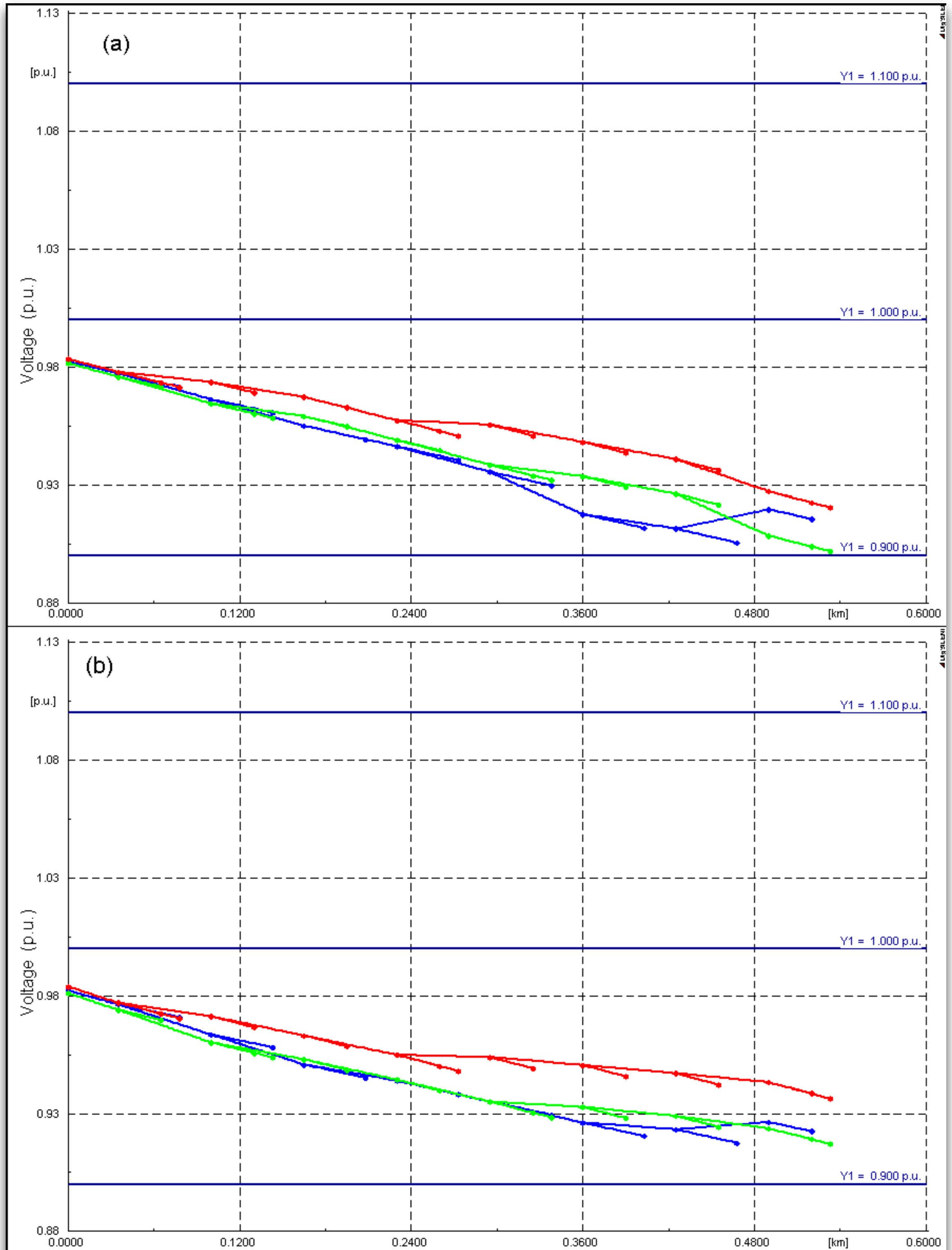
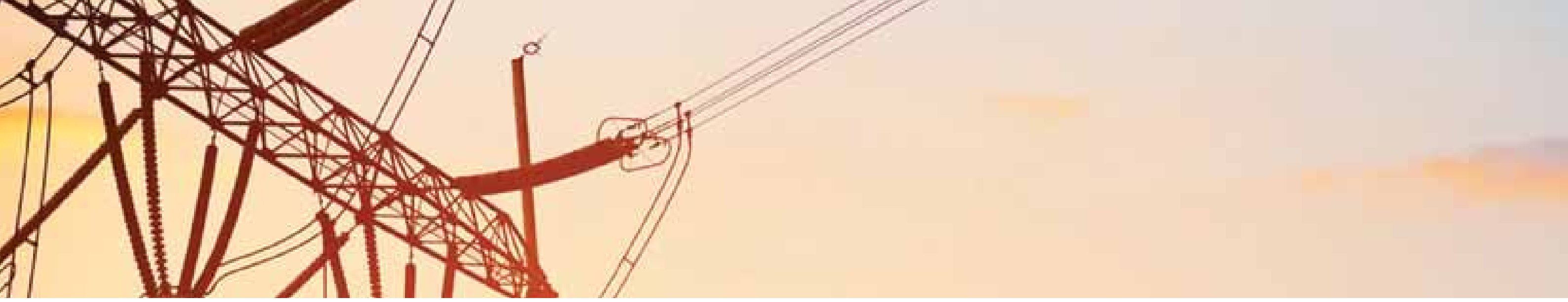


Figure 6: Baseline DigSILENT PowerFactory voltage profile along test feeder under high load conditions for a) a tapered conductor size feeder, and b) a single conductor size feeder



SCENARIO NO.	SCENARIO	HIGH LOAD TAPERED FEEDER	HIGH LOAD ONE SIZE FEEDER	LOW LOAD TAPERED FEEDER	LOW LOAD ONE SIZE FEEDER
A1 & 2	No renewables (baseline)	HL-A1	HL-A2	LL-A1	LL-A2
E1	One DG unit close to transformer – 3 kW unit	HL-E1		LL-E1	
E2	One DG unit at the end of the feeder – 3 kW unit	HL-E2		LL-E2	
E3	One DG unit midway along feeder – 3 kW unit	HL-E3		LL-E3	
C, D	100% DG penetration – 3 kW units	HL-D2,3,4,6,7	HL-C2,3,4,6,7	LL-D2,3,4,6,7	LL-C2,3,4,6,7
F, G	100% DG penetration – 9 kW units	HL9-G2,3,4,6,7	HL9-F2,3,4,6,7	LL9-G2,3,4,6,7	LL9-F2,3,4,6,7

Table 2: SSEG impact load flow scenarios

SSEG SCENARIOS

Table 2 lists the load flow scenarios evaluated.

The control algorithms 2, 3, 4, 6 and 7 for scenarios C, D, F and G in Table 2 are:

- 2: Voltage Q-droop: Reactive power is controlled proportionally to the voltage deviation from a set-point.
- 3: Voltage Iq-droop: Reactive current is controlled proportionally to the voltage deviation from a set-point.
- 4: Constant Q: The active and reactive power outputs are fixed according to user criteria specified.
- 6: Q(V) characteristic: Reactive power controller with a variable set-point. Within the set-point voltage limits, the reactive power output is maintained.
- 7: Cos phi (P) characteristic: Power factor controller.

Methods 1 and 5 in DigSILENT PowerFactory were not investigated. Method 1 is for constant voltage control, in which the voltage is controlled by varying the reactive power to maintain a set-point voltage at the busbar. Method 5 is a Q(P) characteristic in which the reactive power is varied according to the power output of the inverter.

FINDINGS

The scenarios in Table 2 were assessed under high load conditions (evening peak) as well as low load conditions (midday load, when solar PV provides maximum output). During high load conditions, typical of the evening peak, solar PV might not have any impact, but the assessment was made as if other forms of SSEGs, such as wind turbines were used.

FEEDER VOLTAGE

The results for the voltage drop are illustrated in Figure 7.

Adding a single generator to a group of consumers should be harmless, shouldn't

Embedded Generators

continues from page 29

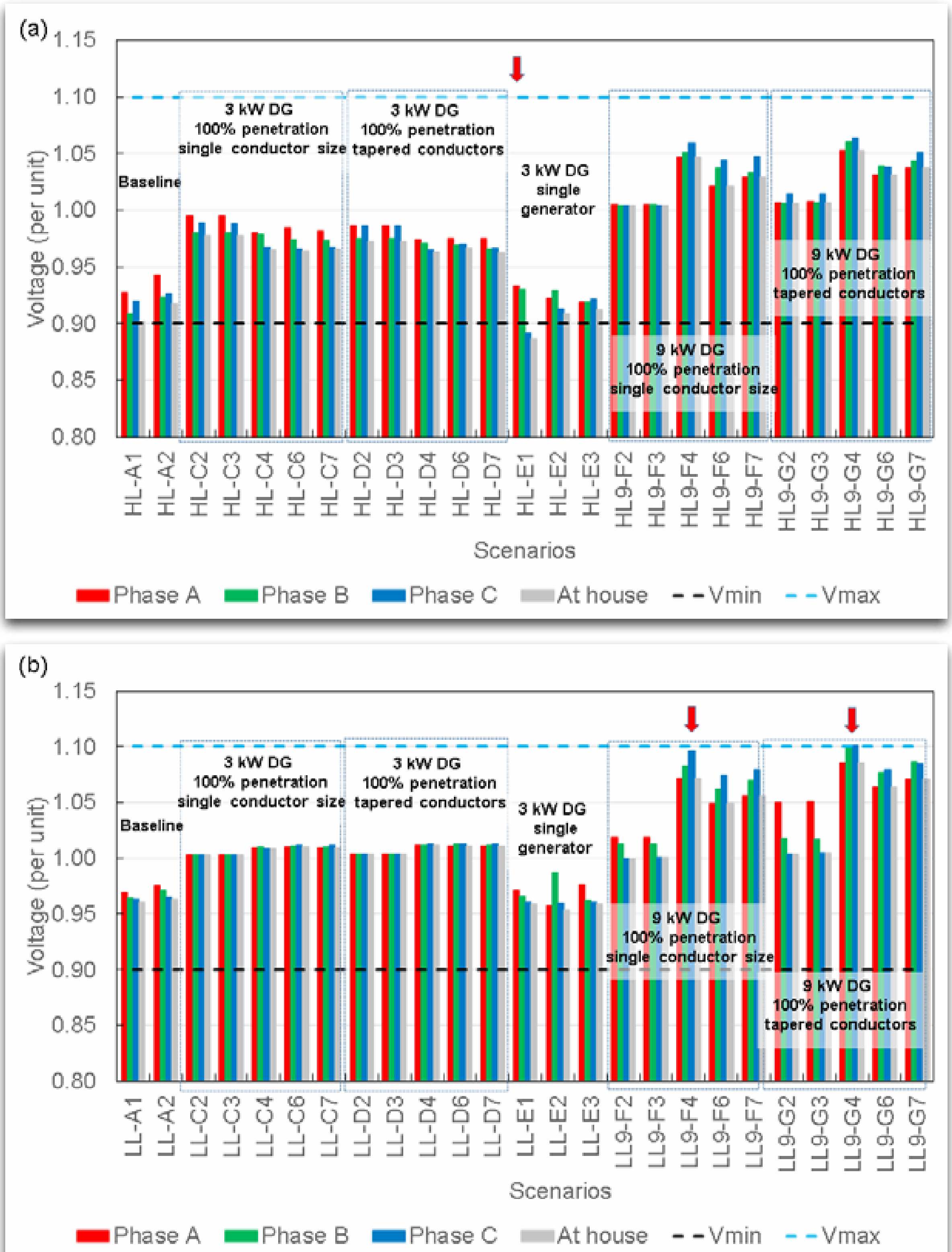


Figure 7: Comparison of the voltage at the end of the LV feeder for various inverter control methods and sizes for a) high load conditions and b) low load conditions. Violation of voltage limits are marked in red arrows.

Embedded Generators

continues from page 30

it? Solar PV generation is at its maximum when domestic load is at its daytime minimum, but what if the generation takes place at the time of the evening peak, when using a micro wind turbine? Scenarios E1, E2 and E3 indicate the addition of a single embedded generator close to the transformer, at the end of the LV feeder and mid-way along the LV feeder respectively.

In Figure 7a, Scenario E1 has a blue phase voltage at the end of the feeder less than 0.90 p.u. due to the unbalance introduced on the feeder.

The above generator is relatively small when compared to the ADMD (56%), but is sufficient to introduce enough unbalance to violate voltage regulation limits. It is interesting to note that placing the generator further away from the transformer does not result in voltage regulation outside the limits.

This simple example illustrates why it is important for a consumer to consult with the utility, even when adding a single small generator. It further illustrates that the utilities also cannot ignore their duty to assess network performance, even if a single small generator is added.

Generators connected at domestic levels should be of Grid Code category A1 type (less than 13.8 kW), generating at unity power factor according to the Grid Code, and limited to 4.6 kW according to NRS097. If for instance 3 kW generators are used, then voltage rise problems are not expected.

If, however, the generator size is increased beyond NRS097 limits, say to 9 kW, and a single-phase connection is utilized (assuming now the consumers ignored making contact with the utility, and also ignored NRS097 recommendations),

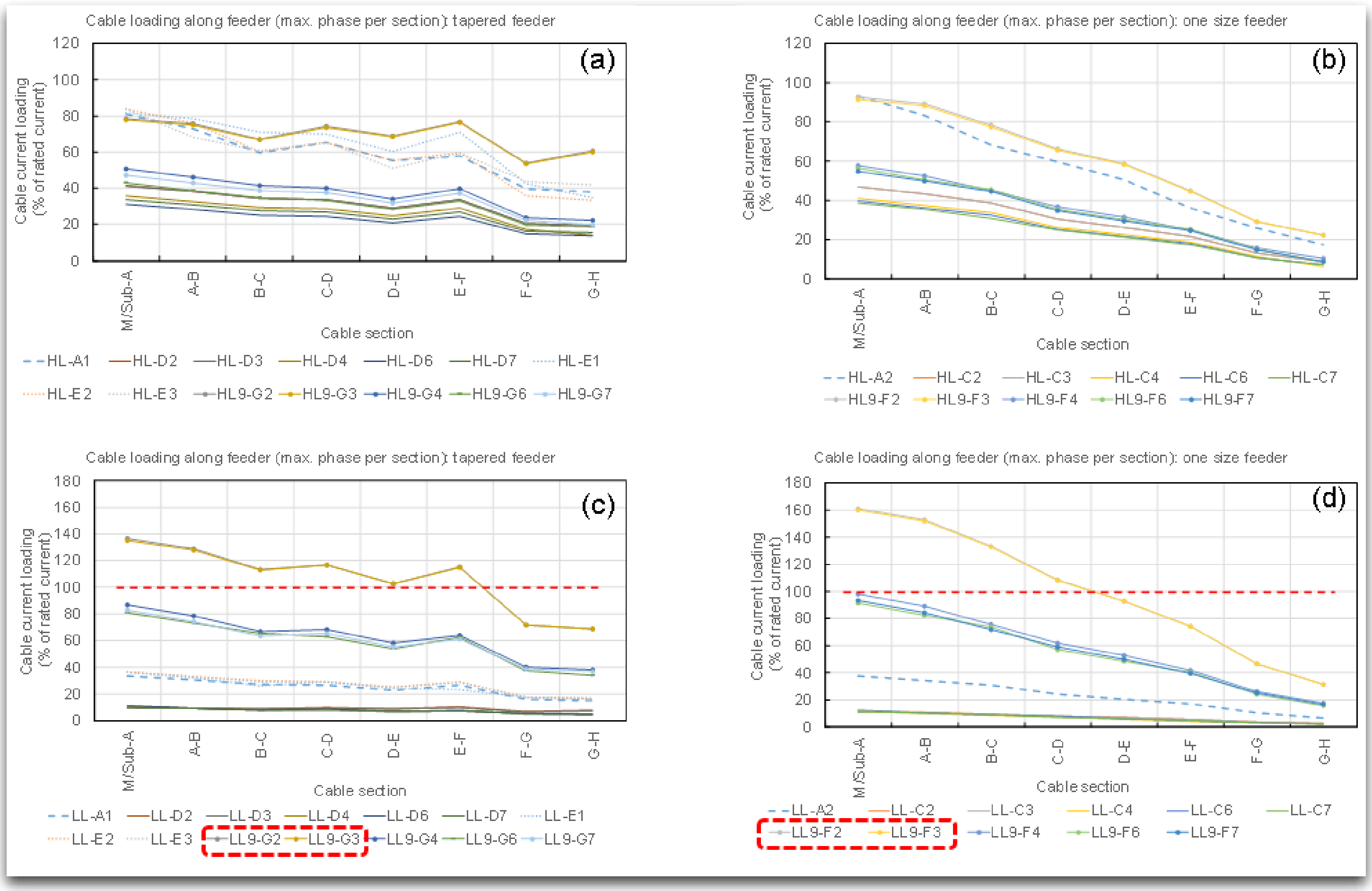
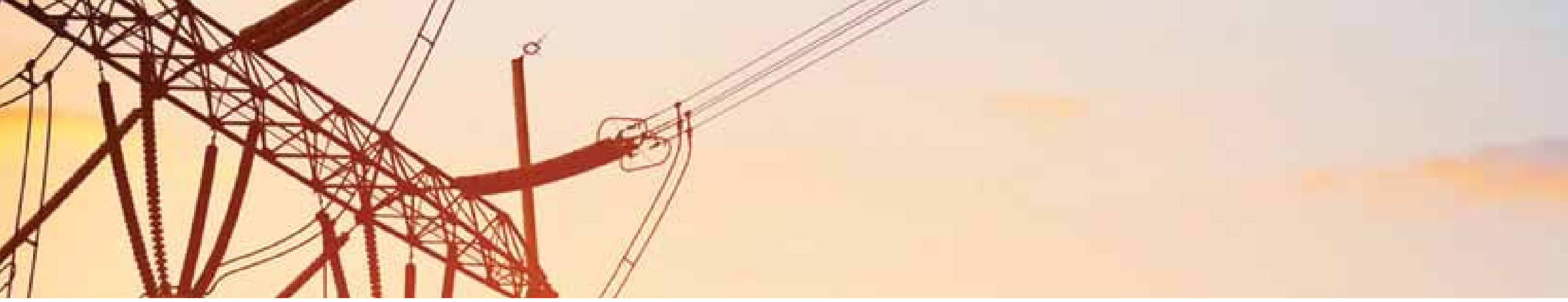


Figure 8: Comparison of cable current loading per scenario along feeders under high load (sub-figures a and c) and low load conditions (sub-figures b and d) for a tapered LV feeder and single conductor size feeder respectively. X-axis alphabet letters refer to the distribution box labels in Figure 5. Scenarios in violation of cable thermal limits are marked in a red rectangle in the legend of the sub-figures.



voltage rise problems can be experienced. For a 5.3 kVA ADMD system, a 9 kW SSEG becomes a borderline case in which voltages at the end of a feeder are at the upper voltage limit of 1.10 p.u.

CABLE CURRENT

The results for current drawn by cables are portrayed in Figure 8.

Under high load conditions, SSEGs assist in reducing cable current. However, when high levels of embedded generation are present, and surplus energy is supplied to the grid, then there is a risk that cables are overloaded due to a lack in diversity between SSEGs. This is clear in the 9 kW systems in Figure 8, but only if the generator control methods are of the Voltage Q-droop or Iq-droop type.

Increasing the sizes even further will result in other control methods also exceeding cable thermal limits. Tapered conductor size feeder systems will be more prone to conductor overloading.

REVERSE POWER FLOW THROUGH TRANSFORMERS

The results for power transfer through the transformer, based on PQ-plots, are shown in Figure 9.

Under low loading conditions, the power factor can become leading. Under high demand, it is possible that the resulting power factor reduces to 0.87 lagging. The reason for this is primarily that only real power is generated, as can be easily illustrated by Figure 10.

It is theoretically possible to leave the utility with 0 kWh to sell, and only kVarh to provide. In a domestic network,

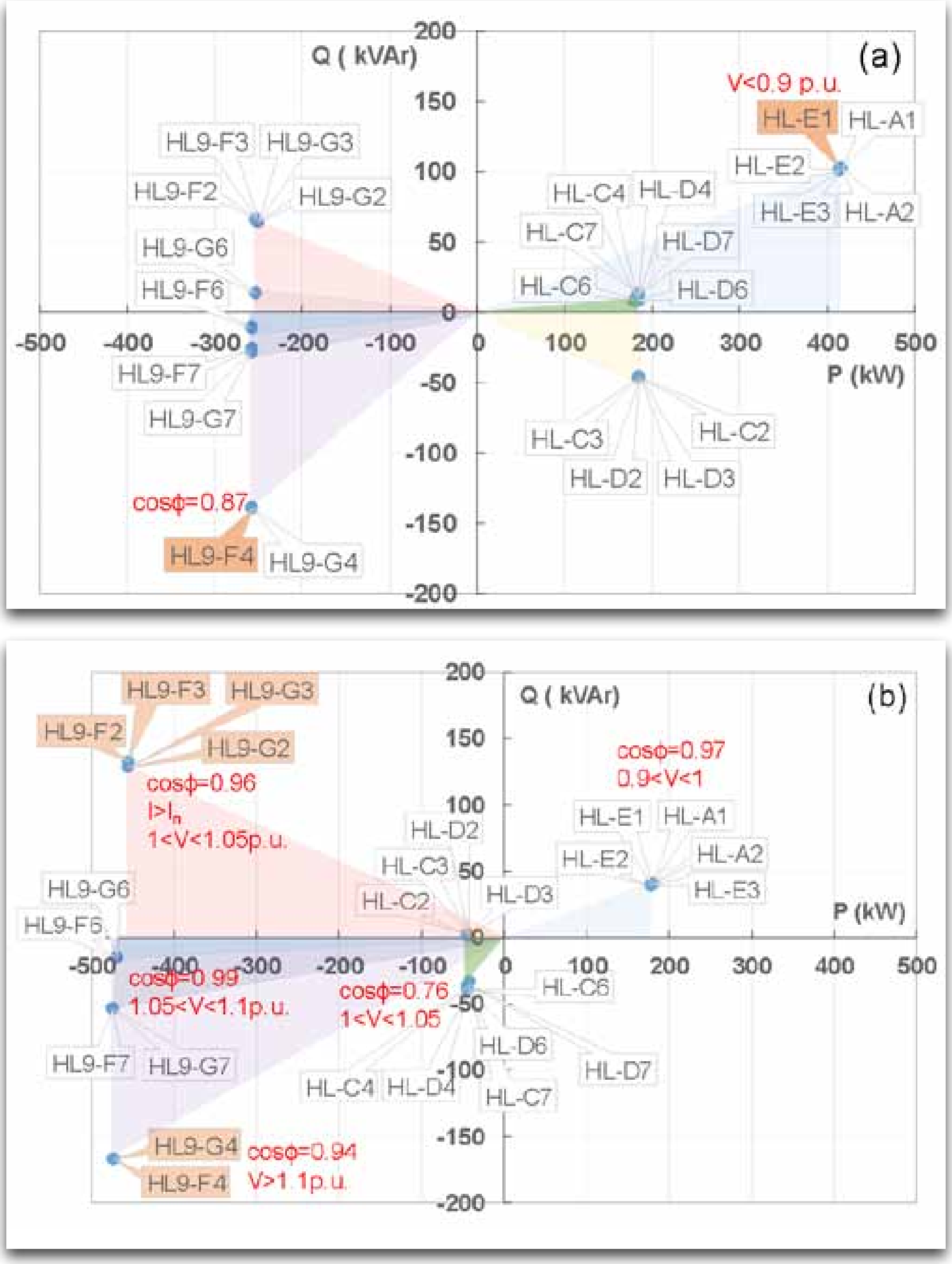


Figure 9: Power transfer through transformer for a) high loading and b) low loading conditions respectively. The power factor is leading where P and Q have opposite signs. Highlighted scenarios are those scenarios with corresponding voltage or cable loading problems.

FEATURE

Embedded Generators

continues from page 33

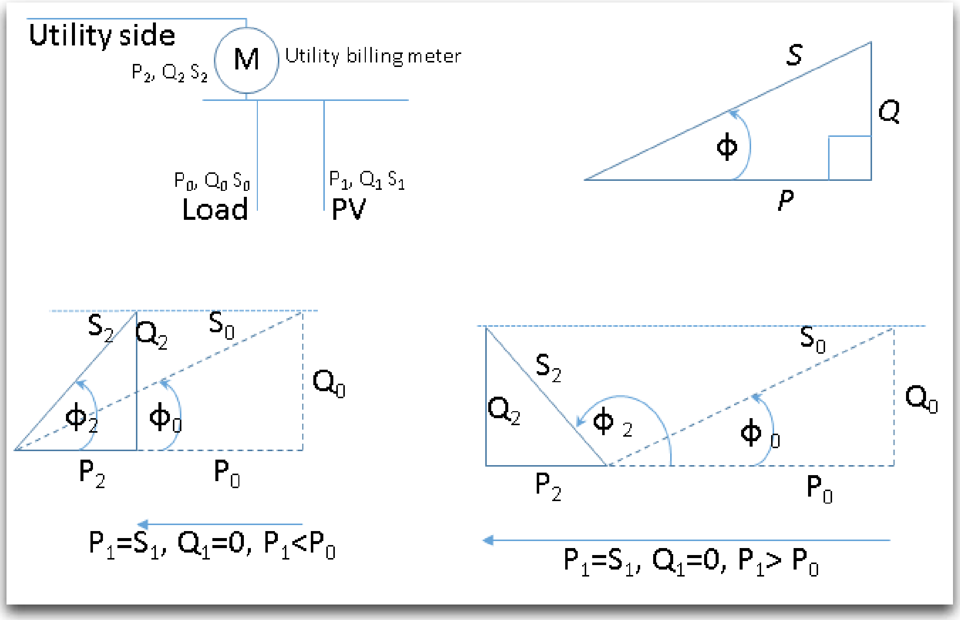


Figure 10: Unity power factor generation impact due to SSEG addition. Top left: sample single line diagram; top right: power triangle; bottom left: generating less energy than consuming; bottom right: generating more energy than consuming.

reactive energy is not recovered. This raises another question: how will utilities recover reactive power provided from domestic and small consumers? Should billing not change to kVA/h instead of kWh or should meters capable of recording reactive power also be used? This will of course create new challenges in the conventional and prepaid meter markets. Smart meters inherently should be capable of recording the active and reactive power generated and absorbed.

CONCLUSION

In general, at low penetration levels of SSEGs, and for small generator sizes, utilities should not experience too many problems. However, when networks are designed near limits, then a risk exists that a single generator located close to the transformer, along an LV feeder, is sufficient to cause regulation problems. Utilities will simply have to find a way to involve their consumers. The risks of network problems cannot be avoided, but can be managed if both the utility and the consumers talk to one another.

The intent of this paper is not to provide utilities with answers to their problems, but simply to create an awareness of the imminent problems that may arise.

Enforcement of standards are required by utilities to ensure that they can operate their networks safe, reliable, and to the mutual benefit of the consumers and the utility.

Referring to Figure 11, generally, the networks will generally perform satisfactorily if the following condition is met (assuming that the networks were complying under normal circumstances before SSEGs were introduced):

$$ADMD_{original} > ADMD_{reverse} \quad ...(1)$$

The ADMD in the reverse power flow direction is a function of the SSEG size and the demand at the time of generation. Assuming a solar PV application, Equation 1 then can be rewritten as:

$$ADMD_{orignial} > \left(\frac{PV\ size}{power\ factor} - Demand_{Solar\ max}\right) \quad ... (2)$$

Demand$_{solar\ max}$ is the demand of the network prior to any SSEG being added at the time when a PV system produces maximum output. PV size is the AC output of a PV array (in kW).

Solar PV is only one case of an added SSEG in which residential systems experience a minimum load requirement during DG maximum output. Equation 2 may be generalized further for any form of DG at any time during the day:

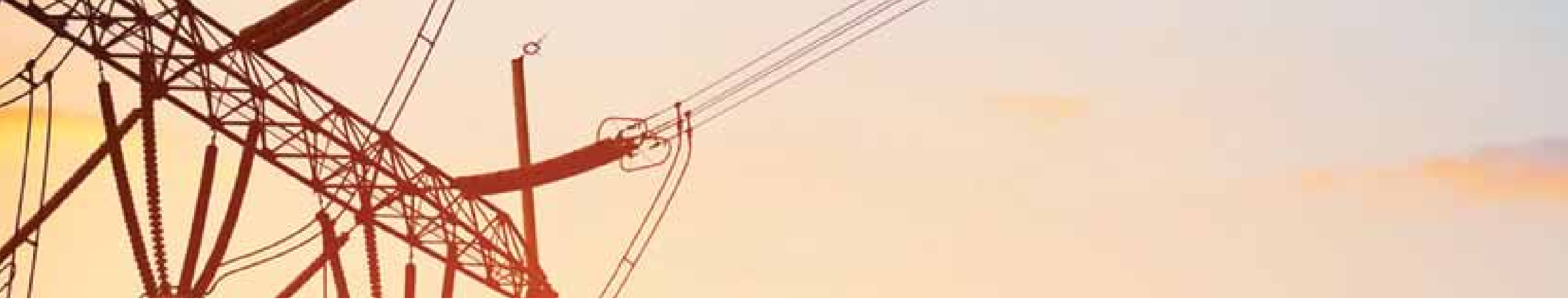
$$ADMD_{normal} > \left(\frac{SSEG_{output(t)}}{power\ factor} - Demand_{t}\right) \quad ... (3)$$

Demand$_t$ is the average demand recorded at time *t* in *kVA* (total demand at time *t* divided by number of consumers), prior to any SSEG connected, and *SSEG* $_{output\ (t)}$ is the SSEG system output at time *t*, in kW.

When examining whether the addition of SSEGs will affect a designed network negatively, Equations 1, 2 and 3, must yield a logical true result. wn

REFERENCES

[1] C. T. Gaunt, R. Herman, M. Dekenah, R. L. Sellick, and S. W. Heunis, "Data collection, load modelling and probabilistic analysis for LV domestic electrification," *15th International Conference on Electricity Distribution, 1999*



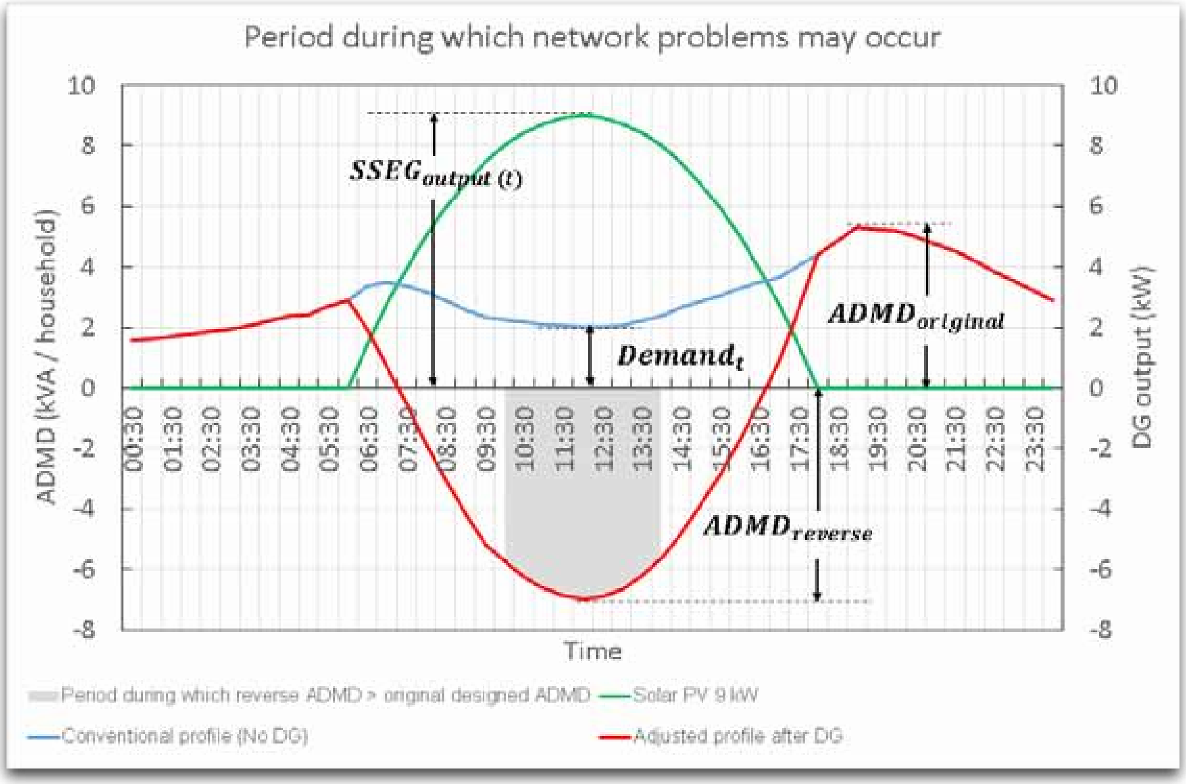


Figure 11: 24-hour load profile with reverse power flow as a result of a 7.5 kW SSEG. In this example, the reverse ADMD (6.99 kVA) is larger than the original designed ADMD (5.3 kVA) in the shaded area.

[2] J. A. Alberts and J. A. de Kock, "Evaluation of Design and Planning Parameter Impact by Energy Efficient Measures through Appliance-Based Modelling", 2017 Domestic Use of Energy Conference, Cape Town, *Unpublished at the time of writing this article.*

[3] CSIR, *Guidelines for human settlement planning and design,* vol. 2. Pretoria: CSIR, Building and Construction Technology, 2005.

[4] J. A. Alberts, "Impact of energy efficiency and renewable energy on electricity master planning and design parameters," M.Eng. dissertation, School of Electrical, Electronic and Computer Engineering, North-West University, Potchefstroom, South Africa, 2016.

[5] J. A. Alberts and J. A. de Kock, "Impact on power factor by small scale renewable energy generation", 2017 Domestic Use of Energy Conference, Cape Town, *Unpublished at the time of writing this article.*

[6] J. A. Alberts and J. A. de Kock, "The impact of small scale embedded generation on existing networks," in Proceedings of the *64th AMEU Convention*, 2014, pp. 56–60.

[7] NERSA, "South African distribution code: network code," Pretoria: NERSA, 2014.

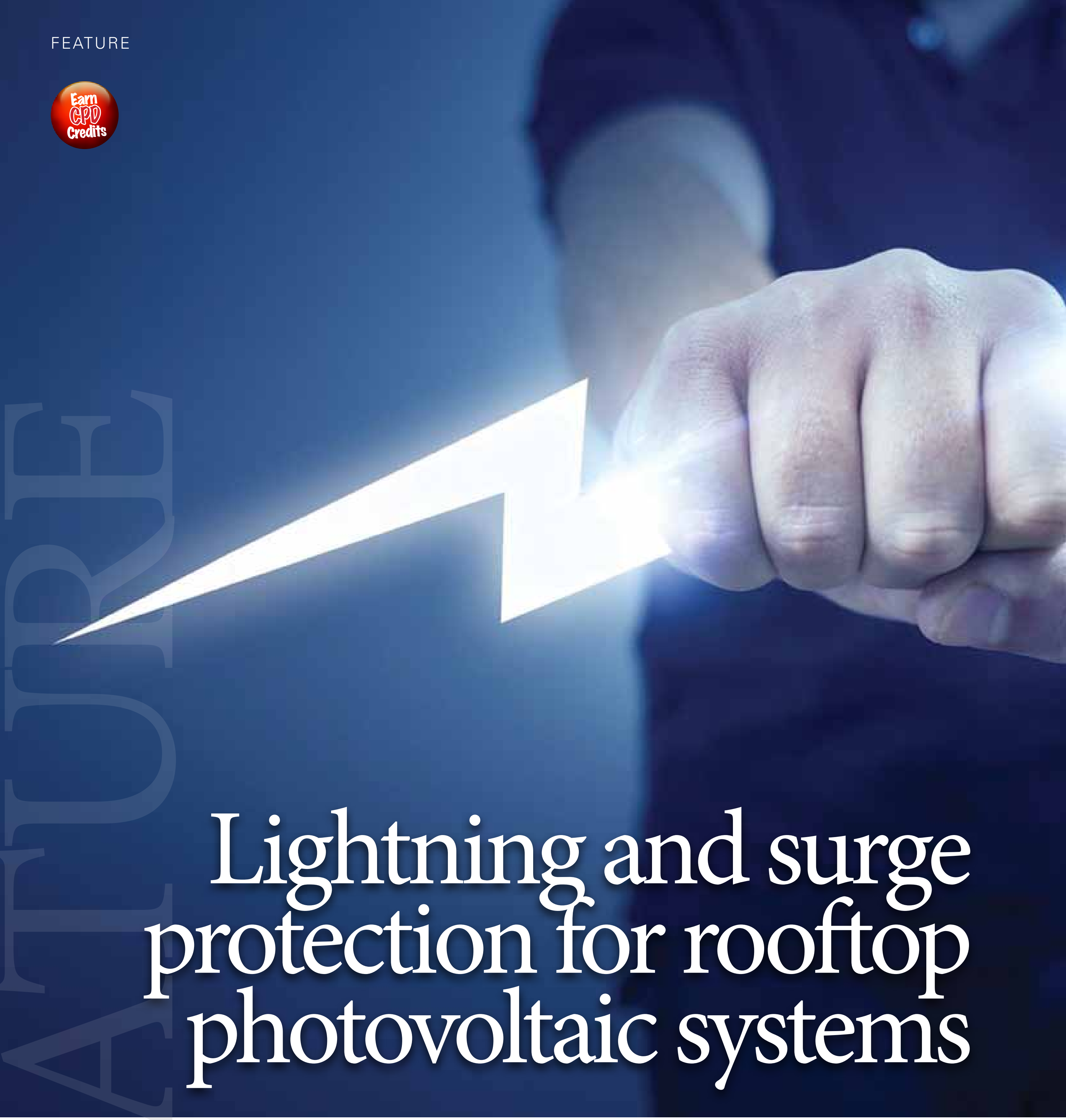
[8] NERSA, "Grid connection code for renewable power plants (RPPs) connected to the electricity transmission system (TS) or the distribution system (DS) in South Africa," Pretoria: NERSA, 2014.

[9] SANS (South African National Standards), "Electricity distribution — Guidelines for the provision of electricity distribution networks in residential areas, Part 1 : Planning and design of distribution networks," Pretoria: SABS, Standards Division, NRS 034-1 (SANS 507-1), 2007.

[10] NERSA, "South African distribution code: metering code," Pretoria: NERSA, 2014.

[11] SANS (South African National Standards), "Grid interconnection of embedded generation, Part 2: Small-scale embedded generation, Section 3: Simplified utility connection criteria for low-voltage connected generators," Pretoria: SABS, Standards Division, NRS 097-2-3, 2014.

Earn CPD Credits



Lightning and surge protection for rooftop photovoltaic systems

At present, about one million PV systems are installed in Germany. Based on the fact that self-generated electricity is generally cheaper and provides a high degree of electrical independence from the grid, PV systems will become an integral part of electrical installations in the future. However, these systems are exposed to all weather conditions and must withstand them over decades.

The cables of PV systems frequently enter the building and extend over long distances until they reach the grid connection point. Lightning discharges cause field-based and conducted electrical interference. This effect increases in relation with increasing cable lengths or conductor loops. Surges do not only damage the PV modules, inverters and their monitoring electronics, but also devices in the building installation. More importantly, production facilities of industrial buildings may also easily be damaged and production may come to a halt.

If surges are injected into systems that are far from the power grid, which are also referred to as stand-alone PV systems, the operation of equipment powered by solar electricity (e.g. medical equipment, water supply) may be disrupted.

NECESSITY OF A ROOFTOP LIGHTNING PROTECTION SYSTEM

The energy released by a lightning discharge is one of the most frequent causes of fire. Therefore, personal and fire protection is of paramount importance in case of a direct lightning strike to the building.

At the design stage of a PV system, it is evident whether a lightning protection system is installed on a building. Some countries' building regulations require that public buildings (e.g. places of public assembly, schools and hospitals) be equipped with a lightning protection system. In case of industrial or private buildings it depends on their location, type of construction and utilisation whether a lightning protection system must be installed. To this end, it must be determined whether lightning strikes are to be expected or could have severe

Lightning & surge protection

continues from page 37

consequences. Structures in need of protection must be provided with permanently effective lightning protection systems.

According to the state of scientific and technical knowledge, the installation of PV modules does not increase the risk of a lightning strike. Therefore, the request for lightning protection measures cannot be derived directly from the mere existence of a PV system. However, substantial lightning interference may be injected into the building through these systems. Therefore, it is necessary to determine the risk resulting from a lightning strike as per IEC 62305-2 (EN 62305-2) and to take the results from this risk analysis into account when installing the PV system.

A risk analysis performed by means of this software provides a result which is understood by all parties involved. The software compares the risk with the technical expenditure and provides economically optimised protection measures.

Section 4.5 (Risk Management) of Supplement 5 of the German DIN EN 62305-3 standard describes that a lightning protection system designed for class of LPS III (LPL III) meets the usual requirements for PV systems. In addition, adequate lightning protection measures are listed in the German VdS 2010 guideline (Risk-oriented lightning and surge protection) published by the German Insurance Association.

This guideline also requires that LPL III and thus a lightning protection system according to class of LPS III be installed for rooftop PV systems (> 10 kWp) and that surge protection measures be taken. As a general rule, rooftop photovoltaic systems must not interfere with the existing lightning protection measures.

NECESSITY OF SURGE PROTECTION FOR PV SYSTEMS

In case of a lightning discharge, surges are induced on electrical conductors. Surge Protective Devices (SPDs) which must be installed upstream of the devices to be protected on the alternate current (ac), direct current (dc) and data side have proven very effective in protecting electrical systems from these destructive voltage peaks.

Section 9.1 of the CENELEC CLC/TS 50539-12 standard (Selection and application principles – SPDs connected to photovoltaic installations) calls for the installation of surge protective devices unless a risk analysis demonstrates that SPDs are not required.

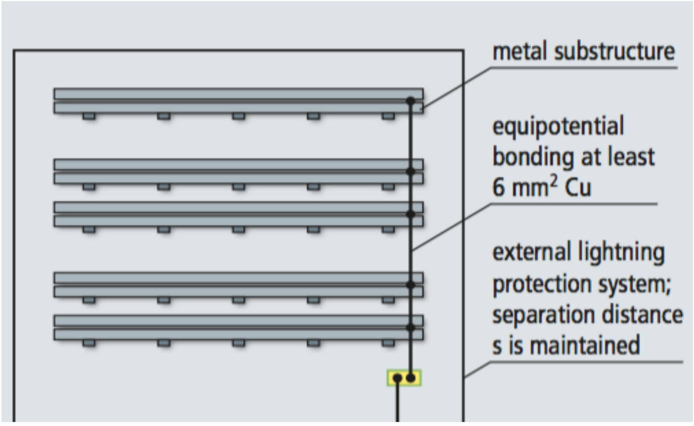


Figure 1 - Functional earthing of the mounting systems if no external lightning protection system is installed or the separation distance is maintained.

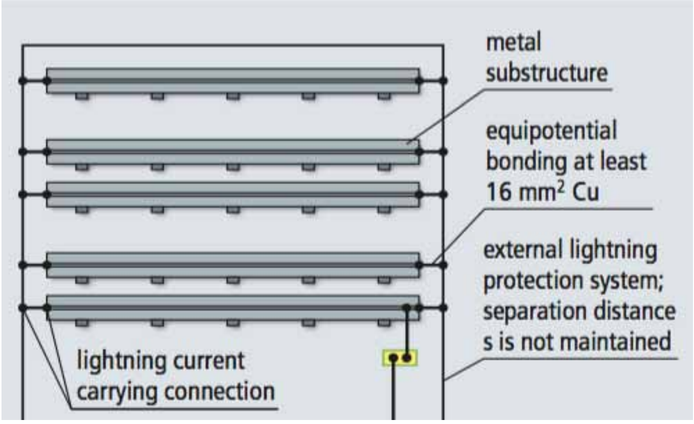


Figure 2 - Lightning equipotential bonding for the mounting systems if the separation distance is not maintained.

Figure 3 - UNI earthing clamp: A stainless steel intermediate element prevents contact corrosion, thus establishing reliable longterm connections between different conductor materials.

According to the IEC 60364-4-44 (HD 60364-4-44) standard, surge protective devices must also be installed for buildings without external lightning protection system such as commercial and industrial build- ings, e.g. agricultural facilities.

CABLE ROUTING OF PV SYSTEMS

Cables must be routed in such a way that large conductor loops are avoided. This must be observed when combining the dc circuits to form a string and when interconnecting several strings.

Moreover, data or sensor lines must not be routed over several strings and form large conductor loops with the string lines.

This must also be observed when connecting the inverter to the grid connection.

For this reason, the power (dc and ac) and data lines (e.g. radiation sensor, yield monitoring) must be routed together with the equipotential bonding conductors along their entire route.

EARTHING OF PV SYSTEMS

PV modules are typically fixed on metal mounting systems. The live PV components on the dc side feature double or reinforced insulation (comparable to the previous protective insulation) as required in the IEC 60364-4-41 standard. The combination of numerous technologies on the module and inverter side (e.g. with or without galvanic isolation) results in different earthing requirements. Moreover, the insulation monitoring system integrated in the inverters is only permanently effective if the mounting system is connected to earth.

The metal substructure is functionally earthed if the PV system is located in the protected volume of the air-termination systems and the separation distance is maintained. Section 7 of Supplement 5 requires copper conductors with a cross-section of at least 6 mm^2 or equivalent for functional earthing (Figure 1).

The mounting rails also have to be permanently interconnected by means of conductors of this cross-section. If the mounting system is directly connected to the external lightning protection system due to the fact that the separation distance s cannot be maintained, these conductors become part of the lightning equipotential bonding system.

Consequently, these elements must be capable of carrying lightning currents. The minimum requirement for a lightning protection system designed for class of LPS III is a copper conductor with a cross-section of 16 mm^2 or equivalent.

Also in this case, the mounting rails must be permanently interconnected by means of conductors of this cross-section (Figure 2). The functional earthing / lightning equipotential bonding conductor should be routed in parallel and as close as possible to the dc and ac cables / lines.

UNI earthing clamps (Figure 3) can be fixed on all common mounting systems. They connect, for example, copper conductors with a cross-section of 6 or 16 mm^2 and bare round wires with a diameter from

Lightning & surge protection

continues from page 39

8 to 10 mm to the mounting system in such a way that they can carry lightning currents.

The integrated stainless steel (V4A) contact plate ensures corrosion protection for the aluminium mounting systems.

SEPARATION DISTANCE S AS PER IEC 62305-3

A certain separation distance s must be maintained between a lightning protection system and a PV system. It defines the distance required to avoid uncontrolled flashover to adjacent metal parts resulting from a lightning strike to the external lightning protection system. In the worst case, such an uncontrolled flashover can set a building on fire. In this case, damage to the PV system becomes irrelevant.

CORE SHADOWS ON SOLAR CELLS

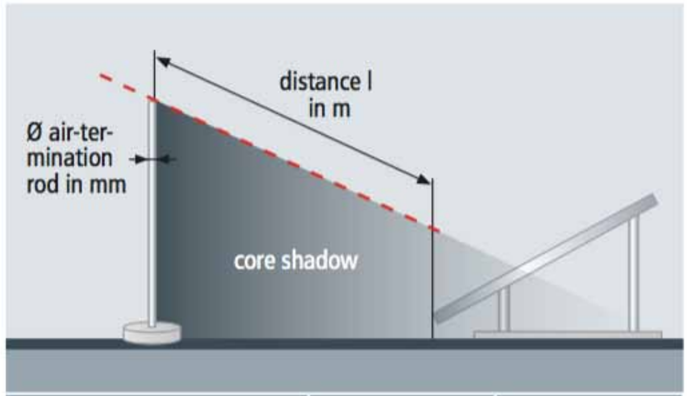
The distance between the solar generator and the external lightning protection system is absolutely essential to prevent excessive shading. Diffuse shadows cast by, for example overhead lines, do not signficantly affect the PV system and the yield. However, in case of core shadows, a dark clearly outlined shadow is cast on the surface behind an object, changing the current flowing through the PV modules.

For this reason, solar cells and the associated bypass diodes must not be influenced by core shadows. This can be achieved by maintaining a sufficient distance. For example, if an air-termination rod with a diameter of 10 mm shades a module, the core shadow is steadily reduced as the distance from the module increases. After 1.08 m only a diffuse shadow is cast on the module (Figure 4).

SPECIAL SURGE PROTECTIVE DEVICES FOR THE DC SIDE OF PHOTOVOLTAIC SYSTEMS

The U/I characteristics of photovoltaic current sources are very different from that of conventional dc sources: They have a non-linear characteristic (Figure 5) and cause long-term persistence of ignited arcs. This unique nature of PV current sources does not only require larger PV switches and PV fuses, but also a disconnector for the surge protective device which is adapted to this unique nature and capable of coping with PV currents.

To facilitate the selection of type 1 SPDs, Tables 1 and 2 shown the required lightning impulse current carrying capability I_{imp} depending on the class of LPS, number of down conductors of the external



Ø air-termination rod	x factor	= distance l
10 mm	108	1.08 m
16 mm	108	1.76 m

Figure 4 - Distance between the module and the air-termination rod required to prevent core shadows.

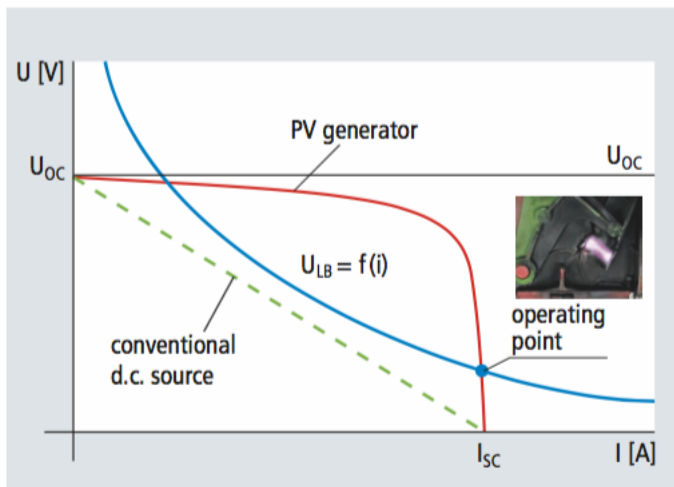


Figure 5 - Source characteristic of a conventional d.c. source versus the source characteristic of a PV generator. When switching PV sources, the source characteristic of the PV generator crosses the arc voltage range.

lightning protection systems as well as the SPD type (voltage-limiting varistor-based arrester or voltage-switching spark-gap-based arrester).

TYPE 1 DC ARRESTER FOR USE IN PV SYSTEMS

The dc switching device consists of a combined disconnection and short-circuiting device with Thermo Dynamic Control and a fuse in the bypass path. This circuit safely disconnects the arrester from the generator voltage in case of an overload and reliably extinguishes dc arcs.

Voltage-switching spark-gap-based type 1 SPDs are another powerful technology that allows to discharge partial lightning currents in case of dc PV systems. Thanks to its spark gap technology and a dc extinction circuit which allow to efficiently protect downstream electronic systems, this arrester series has an extremely high lightning current discharge capacity I_{total} of 50 kA (10/350 µs) which is unique on the market.

TYPE 2 DC ARRESTER FOR USE IN PV SYSTEMS

Reliable operation of SPDs in dc PV circuits is also indispensable when using type 2 surge protective devices. To this end, the DEHNguard surge arresters also feature a fault-resistant Y protective circuit and the SCI technology and are also connected to PV generators up to 1000 A without additional backup fuse.

The numerous technologies combined in these arresters prevent damage to the surge protective device due to insulation faults in the PV circuit, the risk of fire of an overloaded arrester and puts the arrester in a safe electrical state without disrupting the operation of the PV system. Thanks to the protective circuit, the voltage-limiting characteristic of varistors can be fully used even in the dc circuits of PV systems. In addition, the permanently active surge protective device minimises numerous small voltage peaks. Thus, the SCI technology increases the service life of the entire dc-side PV system.

SELECTION OF SPDS ACCORDING TO THE VOLTAGE PROTECTION LEVEL U_P

The operating voltage on the dc side of PV systems differs from system to system. At present, values up to 1500 V dc are possible. Consequently, the dielectric strength of terminal equipment also differs. To ensure that the PV system is reliably protected, the voltage protection level U_p of the SPD must be lower than the dielectric strength of the PV system it is supposed to protect. The CENELEC CLC/TS 50539-12 standard requires that U_p is at least 20% lower than the dielectric strength of the PV system. Type 1 or type 2 SPDs must be energy-coordinated with the input of terminal equipment. If SPDs are already integrated in terminal equipment, coordination between the type 2 SPD and the input circuit of terminal equipment is ensured by the manufacturer. wn

Amid the recent irrational conduct by a president who believes he is entitled to remove competent ministers from office in South Africa, we also see the conduct of leadership within State-Owned Entities (SOEs) who appear to act with equal irrationality and conduct that exposes Eskom's unsustainability.

BY | TED BLOM | PORTFOLIO DIRECTOR | ENERGY *

Eskom's refusal to sign off on more renewable deals has featured in the headlines for several months now. Many do not understand Eskom's behaviour and serious slurs were aired at Eskom Management's reluctance to give effect to DOE agreements.

In order to better understand where the problem of "surplus power" started, one needs to cast one's mind back to the state of affairs reigning prior to 2010. Eskom had just recovered from the 2008 rolling blackouts and ruling party politicians promised the nation there would be no more blackouts "in our lifetime".

During the 2010 World Cup Soccer tournament, the electricity balance was again an issue, and might have resurfaced if the projected 500,000-plus *"soccer visitors"* had materialised.

Vast additional temporary generation capacity was installed at all the stadiums and hotels. Bold calculations estimated that peak demand could increase by up to 5 GW. The low turnout of soccer tourists may have reduced the pressure on the grid, but sadly it would never compensate for the over-expenditure on stadiums and additional infrastructure rolled out at great cost.

** The views of the author of this article are not necessarily the view of the SAIEE.*

Eskom's electricity surplus and self-inflicted death spiral

At about the same time the Department of Energy was being hounded by politicians and Renewable Energy (RE) lobbyists alike, that Eskom was behind the curve in its rollout of RE. It was time for the department to get involved.

Unfortunately, at that time the department of Energy was operating off an outdated IEP (Integrated Energy Plan), which dated back to 2002. Thus, true to form with unsystematic planning, a rushed 2010 IRP (Integrated Resource Plan) was cobbled together, lacking partially in the scientific scrutiny and input required of a process of this nature.

This took place against the backdrop of the failed Areva nuclear energy bid that Eskom had ditched late in 2008, claiming the proposal was unaffordable.

It now appears that political meddling might have driven the decision to drop the nuclear tender, as has been highlighted by a recent enquiry in the French and Canadian parliaments. This has exposed that in the run-up to the Areva tender, some $3.5-billion changed hands, disguised as sale and purchase of reserves that everyone knew had no commercial value close to that number.

Nevertheless, the DoE decided to lead the way with its Renewable Energy Independent Power Producer (REIPP) bid process, and for obscure reasons did not follow a normal tender procedure, but instead, requested bids at different prices.

As it turns out, these prices were multiple times more expensive than the then prevailing energy prices from Eskom (i.e. R3.25/kWh vs Eskom's cost of electricity at below R0.50/kWh). The DoE somehow managed to garner the political support to proceed with this programme and the first renewables were connected to the grid in 2013. With guaranteed revenue included in

Eskom's Death Spiral

continues from page 43

the DoE offering, the massive oversupply of proposals was anticipated.

It is at this point around mid-2016 when Eskom's Brian Molefe awakened to the fact that if the DoE were to continue along this tangent, Eskom itself would eventually be priced out of the market. This was probably more of an inspiration for him to jump the Eskom ship, as opposed to the heat generated from the "leaked" Dentons report and the Public Protector's expose of his frequent Gupta home visits.

And all the while time was moving on, the DoE was asleep and no one bothered to keep the IEP and IRP data up to date. If they had, they might have seen the growing electricity surplus climbing with every additional Renewable Energy (RE) bid window being adjudicated.

Accordingly, the national electricity capacity grew from 42GW (Eskom based) to 46.6GW currently (including REIPP rolled out to date), and when Medupi and Kusile are completed (eventually), South Africa will have an installed electricity generation capacity of around 55GW by 2022.

This needs to be contrasted to a shrinking peak demand which has effectively fallen from 34GW to around 27GW. This in itself is a significant problem for any energy reseller. However, in the case of Eskom, the situation is exacerbated as it is forced to purchase all the renewable power as contracted on its behalf by the DoE.

While such an arrangement might be tenable in a fast growing energy scenario, it becomes suicidal in a shrinking demand situation, such as the one we have been in for a while now.

Placing oneself in Eskom leadership's shoes, one can see why the resistance to these RE contracts is so real for them. They have a financial nightmare looming which is made worse under President Jacob Zuma's "zero growth radical policies". And with the new energy efficiencies and rooftop solar becoming a big entry into small and medium scale development build programmes, Eskom's own generated sales could reduce to less than 23GW by 2022.

On top of this, Eskom will have to service own installed capacity of around 49GW (including some of the most expensive generating capacity in the world at Medupi and Kusile) with sales demand for its own electricity at a mere 23GW.

Their only way out of this hole will be to increase tariffs, but by doing so, they dig their over-supply hole deeper. Enter the self-fulfilling death spiral, exacerbated by poor leadership decisions of recent times which gave rise to their mounting debt pile and declining productivity. Oh dear, South Africa, get ready for the mother of all bail-outs.

The above scenario is an optimistic one, as somehow Eskom and the DoE have neglected to factor in possible household generation (self supply) that could grow to a further 8GW over the next decade or so.

Add to this the self generation and local grid connection talk of larger commercial developments and even towns and cities – as spoken of by progressive DA-led councils – and Eskom's headaches will only get worse.

It doesn't take a rocket scientist to see that demand for Eskom power (and thus their sales) will continue to go south, meaning that their generation capacity will be more than double that which they will be able to sell. This explains why acting CEO Matshela Koko may be talking about closing down the older coal-fired power stations, and seizing the opportunity to blame RE commitments to deflect the dilemma away from whence his reality is at.

The bigger dilemma for him, though, is that by closing down old coal generation units, while addressing some of his emission issues, he will be removing some of his cheapest electricity production units.

NO NEED FOR NUCLEAR

There is certainly no need or room for new nuclear energy, so whatever is behind the nuclear talk is clearly irrational political pressure at play, probably with some "pay back the Russian money" pressure being thrown into the mix. Caught between a rock and a hard place doesn't begin to describe the situation.

But whatever route Eskom takes, their financial model is doomed. Don't be alarmed if Eskom stands before Nersa at the next round of Multi-Year Price Determination later this year and asks for, wait for it.... an increase in electricity tariffs of between 25% and 35%.

Madness is the only explanation for this situation and clearly any further increases granted to Eskom cannot be a long-term solution. Conversely, it adds to their demise as it will only incentivise self-generation via solar and other means for future large scale commercial and residential developments.

The DoE and Eskom's leadership need to thrust themselves into a serious reality

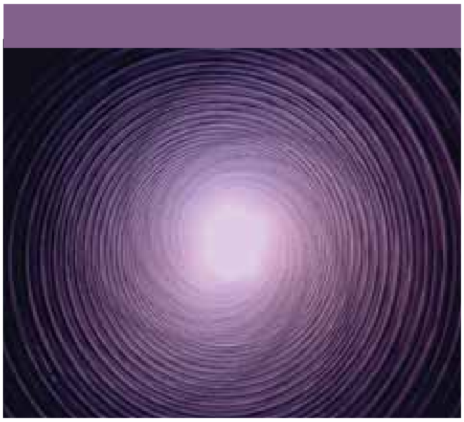
check. They should bring to a close the endless wasteful spending at Medupi, Kusile and other plants (mothball Kusile is the call).

Cut out the hundreds of unnecessary headcounts, address the coal contracts and remove the corrupt overpriced ones, bring back extreme efficiency processes, maintain and clean up existing plants for extended life and essentially become again the lean energy production entity that it was in the late 80's/early '90s. And they should never be allowed to build another power plant of any kind, given their putrid track record in this regard.

Unfortunately (for South Africa and all who live therein), while the current guard are ensconsed and under the fiddle of the master #1 piper, this dream will not become a reality.

For the big stakes capital expenditure projects lie here and in other State-Owned Entities, where the easiest of plundering takes place, hidden behind scope creep, poor audits and other nonsensical explanations.

As the classical saying goes, *"you can't leave those who created the problem in charge of finding the solution"*. So until there is a change of guard at the helm, the looting lieutenants will continue to party while concerned South Africans will watch the waste, maladministration and corruption roll on.



Eskom announces their Intention to mothball five Power Stations

Mid–March Eskom announces their intention to mothball five of their coal-fired power stations in the Mpumalanga province. These power stations are Hendrina, Kriel, Komati, Grootvlei and Camden. The Eskom spokesman, Khuli Phasiwe said *"Working within a context of surplus electricity supply, low economic growth, and the need to add new renewable energy projects, Eskom has had to create space for the renewables by proposing to close some of the coal-fired stations".*

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

In this article, I will analyse the generation capacity and conclude on the reason for the closure. The table below contains information from the Eskom Integrated report:

POINTS TO NOTE FROM THIS TABLE

In 1995 a Government White Paper recommended that Eskom build new generation capacity. The then Minister of Public Enterprises did not approve this. He stated that this should be done by black businesses. However, the return on investment on old assets by Eskom was way below the bank rate, and any new asset would have a return of less than one percent. Indeed, the total asset value of Eskom was about thirty billion rand in the early 1990's.

Compare this with Medupi which alone will have a cost price in excess of one hundred and fifty billion rand when it is complete. In 2004 when a new Minister of Public Enterprises was appointed, it was recognised that the country was about to run out of generation capacity, and a new build programme was introduced.

The green-field projects that were approved were Ankerlig and Gourikwa (Open Cycle Gas Turbine [OCGT]), Medupi and Kusile (New coal), Ingula (pumped storage), and Sere (wind). Medupi and Kusile have rescheduled completion dates ending 2025 – in five years time – the scheduled completion of the mothballing of five stations now proposed. The other projects are all commissioned.

In addition, the return to service of the three stations, Komati, Camden, and Grootvlei which were previously mothballed in 1966, 1972, and 1974 was approved in 2004. At the time of mothballing, there was also "surplus electricity supply". In addition Komati and Camden were already old and expensive to run. Grootvlei's colliery had run out of coal, which then had to be trucked in at a high cost.

It is interesting to note that Komati only added 904 MW when it was re-commissioned (compare this to one unit at Medupi). This was done at a cost per megawatt which exceeded the global average cost of new generation. However, at that time, every additional megawatt on the system was required to minimise load shedding. It is also interesting to note that the intention of the return to service project was to commission units to run for a further fifteen years. In five years time, these units would have run for between 11 and 16 years.

Eskom Power Stations **(Information from Eskom Integrated report 31 March 2016)**

	Power Station	Shut down	Start date	End date	Years old		Installed MW	Nominal MW
Total Coal	(With only one machine at Medupi and Kusile commissioned)						51,118	36,441
	To be shut down:							8,148
Total Coal after shut down in 5 years (and including Medupi and Kusile)								36,213
Base load stations - coal and nuclear								
Coal	Arnot		1971	1975	44		2,352	2,232
	Camden		1967	1972	48		1,600	1,481
	Camden (RTS)	1	2005	2008	11		1,561	1,481
	Duhva		1980	1984	35		3,600	3,450
	Grootvlei		1969	1974	46		1,200	1,120
	Grootvlei (RTS)	1	2008	2011	8		1,180	1,120
	Hendrina	1	1970	1976	44		1,893	1,793
	Kendal		1988	1992	27		4,116	3,840
	Komati		1965	1966	52		1,000	904
	Komati (RTS)	1	2009	2013	6		990	904
	Kriel	1	1976	1979	40		3,000	2,850
	Lethabo		1985	1990	30		3,708	3,558
	Majuba		1996	2001	19		4,110	3,843
	Matimba		1987	1991	28		3,990	3,690
	Matla		1979	1983	36		3,600	3,450
	Tutuka		1985	1990	30		3,654	3,510
	Kusile						4,800	
	Medupi		2015				4,764	720
Nuclear	Koeberg		1984	1985	33		1,940	1,860
Total base load March 2022								38,073
Peaking stations								
Gas	Acasia		1976	1976	41		171	171
	Ankerlig		2007	2009	9		1,338	1,327
	Gourikwa		2007	2008	10		746	740
	Port Rex		1976	1976	41		171	171
Pumped	Drakensberg		1981	1982	36		1,000	1,000
storage	Palmiet		1988	1988	29		400	400
	Ingula		2015	2016	2		1,332	1,332
Hydro	Gariep		1971	1976	44		360	360
	Vanderkloof		1977	1977	40		240	240
Import	Cahorra Bassa						2,060	1,800
Wind	Sere		2015	2015	2		100	100
Total peaking								7,641
Total generation at March 2022								43,854
Peak integrated system Demand March 2016								34,481
Forecast Peak integrated system Demand March 2022								39,244
Reserve capacity March 2022								0

There is only the 100 megawatt Sere Wind Farm included in the Eskom report. To obtain a more complete picture into the future, the Independent Power Producers (IPP's) should be added in. I have already included Cahorra Bassa under hydro.

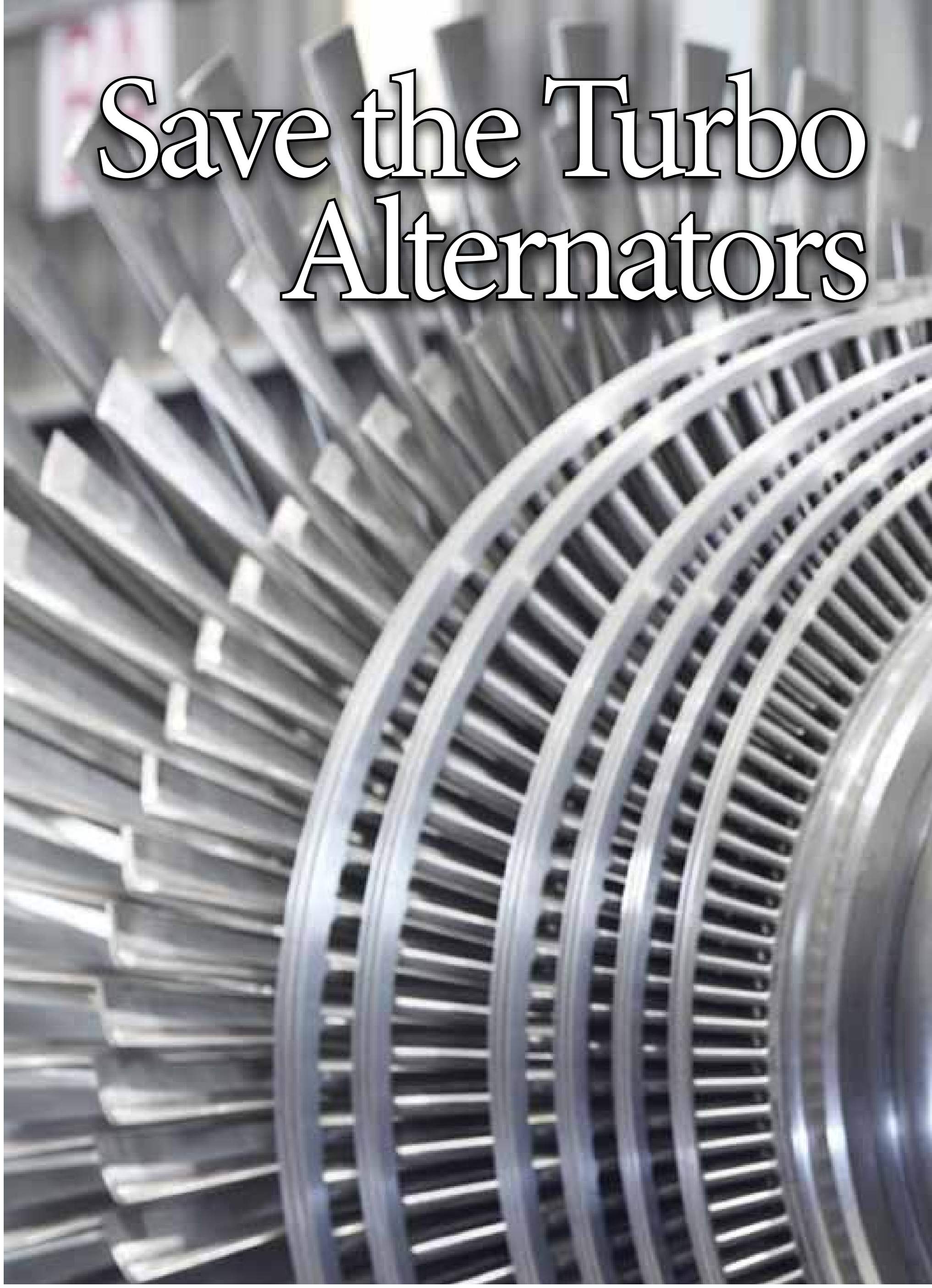
I was not able to source the current staffing levels at the power stations. However, assuming all power stations have staff complements of 600 (Koeberg and Lethabo have more), all the proposed mothball stations have a capacity of 3 MW or less per employee, with the exception of Kriel at 4,8 MW per employee. It follows that the higher this figure is, the lower the operating cost is.

Taking the above into account, my conclusion is that the reason for the proposed mothballing is mainly economic. Any renewable energy IPP's would require storage, quick start alternative generation, or spinning reserve when the wind stops blowing and/or the sun does not shine.

However, renewable energy would contribute to the reserve margin, and would contribute the reduction of greenhouse gas emissions in the longer term. wn

Earn CPD Credits

Save the Turbo Alternators



South Africa, as with other countries, is in the throes of a huge change of power supply from coal to renewables as well as with a reduction of CO_2 emission.

POWER

BY | DUDLEY BASSON

This comes accompanied by the problem of providing continuous base load from power sources which are dependent on wind or sunlight, which are intermittent and sometimes unavailable for days on end.

An effective solution to maintaining the base load supply can be found in supplying heat from concentrated solar power, to reduce the coal usage of existing coal fired power stations.

Onshore wind power turbines are a viable option at the Cape West Coast but solar power is by far the most cost effective source of renewable energy countrywide. PV (Photovoltaic) dominates the scene as improvement in efficiency, and reduction of cost, have made this the most viable option. However this generates electrical power which must be supplied to the grid and used directly, or stored elsewhere. PV is also convenient in that the panels for small scale use can be installed on rooftops, or other places where they will not occupy useful space.

CSP (Concentrated Solar Power) is more efficient at energy capture as it accepts

CONCENTRATING SOLAR PLANTS IN SOUTH AFRICA				
SITE	**MW**	**STORAGE**	**CONFIGURATION**	**PRODUCTION**
KaXu Solar One, Pofadder	100	Salt 2,5 h	Trough & tower	2015
Bokpoort, Groblershoop	50	Salt 9,3 h	Trough	2016
Khi Solar One, Upington	50	Sat. steam 2,0 h	200 m tower	2016
Xina Solar One, Pofadder	100	Salt 5 h	Trough	2017
Ilanga 1, Upington	100	Salt 4,5 h	Trough	(2017)
Kathu Solar Park	100	Salt 4,5 h	Trough	(2018)
Redstone, Postmasburg	100	Salt 12 h	Trough	(2018)
Eskom CSP, Upington	100	Salt 8 h	Tower	

Save the Turbo Alternators

continues from page 49

solar radiation of all wavelengths, but this is not particularly significant as there is little difference in the land area required by PV or CSP. CSP comes with a small unavoidable loss due to infrared radiation from the heat collector pipe. The significant feature of CSP is that it produces heat, not electricity. There are several methods of large scale heat storage available, one of which uses molten salt. A low melting point is obtained by using a eutectic mixture of two or three different nitrate salts.

Spain's Andasol CSP plant has an output of 150 MW, and the molten salt storage has a capacity of 1,01 GWh. This plant uses a salt mixture of 60% sodium nitrate and 40% potassium nitrate. Spain is currently the world leader in the use of solar power. CSP parabolic trough mirrors require single axis solar tracking to keep the mirrors focused on the heat collecting pipe. The thermal oil can typically be heated to 400°C. Dish mirrors and the mirrors of solar towers require two axis solar tracking, and can achieve extremely high temperatures. At times of shutdown, solar tower beams must be directed away from the tower but not be given a common focal point as this can be hazardous to bird life.

China is contemplating a CSP project on a mind boggling scale. On 26 September 2016, CSP company BrightSource, Inc., announced that its technology will be deployed under China's 1,35 GW commercial CSP demonstration pilot program. This will have more than three times the output of the largest CSP plant currently in operation.

David Ramm, CEO and Chairman for BrightSource Energy declared: *"This pilot program is of unprecedented scale and will drive cost reductions throughout the CSP supply chain, increasing solar thermal's competitiveness around the world."*

A highly ambitious CSP project is underway in Morocco, known as the Noor Power Station, with an ultimate planned output of 580 MW. The plant uses molten salt heat storage in order to continue with power supply well into the night. Dry cooling will be used due to the scarcity of water.

The first phase, known as Noor 1, has an output capacity of 160 MW and was connected to the Moroccan grid on 2 February 2016. The salt storage provides 3 hours of after dark power. This phase uses parabolic trough heat gathering.

Noor 2 is expected to be completed by the end of 2017. This will have an output of 200 MW and also uses parabolic troughs. It will have 7 hours of heat storage. Noor 3 will use a solar tower delivering 150 MW, and have 8 hours of heat storage.

Noor 4 will be an 80 MW PV power station.

Generating electrical power from the heat, either directly, or from heat storage, will require steam plant, turbine, alternator, condenser and grid connection, as well as cooling towers or dry cooling. This costly plant can be provided by an existing coal fuelled power station. This can greatly reduce the power station's coal use, or even revitalise one that might otherwise be decommissioned.

This is known as SAPG (Solar Aided Power Generation). The heat can be introduced to the Rankine cycle by pre-heating the boiler feedwater, which will reduce the coal requirement. This is very similar to the function of the economiser, which utilises heat from the flue gases to preheat the boiler feedwater. Hot bleedwater from the turbines is returned to the cycle as feedwater. The purified and oxygen free feedwater is maintained in a closed cycle. The condensate from the condenser is returned to the boiler as feedwater and is the lowest temperature part of the cycle.

CSP can provide heating at up to supercritical temperature. SAPG can be introduced gradually, so there need be no drastic change of operation at the power station, or in the supply of coal. SAPG will only be practicable at power stations where there is sufficient land available for the installation of the parabolic trough collectors. Coal consumption can be reduced as the area of CSP collectors is increased.

The coal fired boilers will provide a useful backup at times when there is cloud cover,

THE FIVE LARGEST CSP PLANTS OPERATING IN THE USA	
Ivanpah Solar Power Facility, San Bernadino	392 MW Solar tower
Solar Energy Generating Systems, Mojave Desert	359 MW Parabolic trough
Mojave Solar Project, Barstow	280 MW Parabolic trough
Solana Generating Station Gila Bend, Arizona	280 MW Parabolic trough
Genesis Solar Energy Project, Blythe, California	250 MW Parabolic trough

and possibly rain, for weeks on end. When the CSP output is able to supply the entire demand from the power station, it will only be necessary for the boiler plant to remain on hot standby, but ready to take over when the CSP output drops. It may also be useful to have heat storage available to buffer surplus CSP energy.

Academic research has been done, which showed that SAPG is more cost effective than a self-contained CSP power plant.

Replacing coal fired power stations with renewables will require huge tracts of land. The largest solar farms in South Africa have outputs of 100 MW. It will require an area of ten of these to produce the output of a 1 GW power station. Similarly, it will require 200 wind turbines of 5 MW output to achieve the same result. This will not have the same energy output. Only a fraction of the energy of the power station will be produced due to non-continuous availability of sun and wind.

When the grid comes under load stress, gas turbine power generation can be deployed, but this is neither budget nor carbon friendly and can only be seen as an emergency measure.

As nation-wide coal consumption is reduced, energy storage will become increasingly important. The most efficient large storage plant available is a hydroelectric pumped storage power station. These can however only be built in mountainous places where it is possible to use a large high level dam.

Typically, a 400 metre elevation difference is required between the low level and high level dams. The new Ingula station has four Francis turbine sets with a total capacity of 1,33 GW. This power station operates with a 480 metre head of water.

The Francis turbine is ideally suited to this purpose as it operates efficiently as either a pump or turbine. The Drakensberg

Save the Turbo Alternators

continues from page 51

Pumped Storage Scheme with these turbines, completed in 1981, has a capacity of 1 GW.

Battery storage is at the moment a fast moving scene. Lithium-ion batteries have improved tremendously in performance, capacity and cost reduction. Lithium-ion batteries have become hugely important for new technology, such as that being produced by Tesla Motors. Over the past year Elon Musk has begun the mass production of these batteries in the $5 billion gigafactory which his company constructed.

We have now reached the stage where electric vehicles have started to outsell petrol and diesel cars in the up-market bracket. There is even talk of banning internal combustion engines in Europe by 2030. There is a detailed account of the electric car scene in the November 2016 issue of **watt**now.

With the introduction of smart grids, homeowners will be able to sell electrical energy back to the grid from their home and car batteries, at a better price than was paid for it. They will also be able to sell surplus energy from the home solar panels easing the burden on the grid. When a large number of end users are able to store and re-sell energy from their batteries, this will represent a huge reserve of off line energy storage.

Redox flow batteries hold much promise for large scale electrical energy storage. Several different chemical designs are being researched, in particular at Aarhus University in Denmark. Much success has been had with the vanadium redox flow battery. Flow batteries have the advantage in that the output is determined only by the design of the electrodes and membrane (flow battery stack), and the storage capacity depends only on the capacity of the positive and negative electrolyte tanks. In operation, the electrolytes must be circulated through the stack by means of pumps.

The batteries are not damaged by being left in a discharged state. Flow batteries with an output of 2 MW and storage of 8 MWh have already been built and can be supplied installed in shipping containers. Recently, Zurich researchers have built a tiny redox flow battery on a chip by means of 3D printing.

A vanadium flow battery planned for China will be the world's largest battery with an output of 200 MW, and a storage capacity of 800 MWh.

Research is underway in the development of a lithium based flow battery using lithium iron phosphate and titanium dioxide, which could have a very much higher energy density than vanadium, but the charge-discharge rate and membrane design remain problematic.

Research is being conducted into the re-charging of redox batteries directly from sunlight. If this can be realised it can possibly reduce the need for PV and CSP. Solar charging of chemical species requires either a photoanode or a photocathode, which are semiconductors that facilitate electron transport to and from the solution of redox couples upon solar radiation.

If the right combination of energy levels in these semiconductors and the energy levels of the redox couples are made, so-called photocurrents can be observed, meaning that the solar energy has been captured and stored.

Self-contained CSP power units are being marketed by two Swedish manufacturers as well as in the US. These units with ten metre dishes can typically provide 30 kW of three phase power. This can be used for all purposes, including light farm machinery and pumps, with or without variable speed drives.

The units have built in heat storage to provide several hours of after dark power. These units require no batteries or water and give no emissions. Hybrid units can accept heat from liquid, gas and biomass fuels to provide power when sun availability is inadequate. This should suit farmers who have combustible waste material available.

The parabolic dishes are provided with two-axis solar tracking for optimal heat capture. The working fluid typically operates at well over 500°C to drive a hydrogen filled Stirling engine and an alternator. Using a Stirling engine removes the need for steam raising plant and turbine. These units provide an attractive alternative for small scale power in remote locations, despite the falling cost of PV.

We can expect to see smart grids and renewable energy grow together towards the elimination of fossil fuel usage, availability of unpolluted air and the ultimate reversal of global warming. wn

SAIEE PRESS RELEASE

Integrated Resource Plan

BASE CASE RESULTS AND OBSERVATIONS

In response to the Department of Energy, Republic of South Africa, Integrated Resource Plan (IRP) Update, Assumptions Base Case Results and Observations, Revision 1 of November 2016 draft document for consultation, this document has been prepared by the South African Institute of Electrical Engineers (SAIEE) with the purpose of hopefully significantly improving the Final IRP update and provide a framework to ensure that future updates are more regular and provide a clear and comprehensive guide as to how the objectives can be achieved.

COMMENTS BY | SAIEE | MARCH 2017

The IRP 2016 Update Documents are important in that they impact Government Policy, Application of Legislation by Regulators, State Owned Enterprises, Independent Power Producers, National Treasury and Electricity, the Economy and Electricity Customers in South Africa.

Various objectives are noted in the document, namely affordable electricity, carbon mitigation, reduced water consumption, localization, regional development and diversified electricity generation sources. These objectives will be discussed in this document as well as further objectives of reliability, economy, health, safety and environment.

Achieving all of the objectives is a complex task. Various topics are discussed that are considered important in working towards achieving the objectives, including accuracy of data, communication, research, training, mentoring and planning.

OBJECTIVES

AFFORDABILITY

Affordability is a relative term and will vary from one customer to another dependent on their financial priorities, the amount of electricity that they consume and when they use electricity. Some customers may not be able to afford or choose to use electricity during peak demand periods when electricity rates are higher or in the case of stepped tariffs above a certain number of units (kWh) purchased per month.

Electricity can become more or less affordable depending on various factors including technology used to generate the electricity, mix of generation sources, rate of construction of new generation plant, etc. Diesel fuel, for example, is at present a relatively expensive fuel for generating electricity and excessive use of diesel as a fuel source should be limited. Diesel generators are however used to improve reliability of supply for some customers that can afford to pay the additional costs of purchasing and operating diesel generators.

The energy mix can increase the cost of electricity. For example, a high level of non-dispatchable renewable energy sources, such as wind and solar photovoltaics with battery backup for storage during periods when the wind is not blowing and the sun is not shining, will at present increase the cost and lower the affordability of electricity.

Certain technologies, especially energy efficiency and demand side management, can have a significant impact in reducing the cost of electricity and increasing the affordability of electricity.

LEVELISED COST OF ELECTRICITY

Installing new generation plant at a rate that is higher than the rate of growth of electricity consumption will increase the cost of electricity as a result of lower overall utilisation of generators (referred to as load factor in the IRP update document).

The levelised cost of electricity (LCOE) for any technology is not a fixed rate and is influenced by the other generators in the energy mix. Simply adding generators into the mix that have a lower levelised cost of electricity will not necessarily lower the overall cost of electricity generation and could increase the overall cost of electricity due to existing generators now running at a lower load factor.

Careful planning needs to be undertaken to ensure that base-load generators can continue in the future to be utilised at high load factors to keep the overall LCOE down.

CARBON MITIGATION

Carbon mitigation is generally achieved by reducing the use of electricity generators that generate the highest amount of carbon dioxide, e.g. diesel and coal and replacing them with lower carbon generators such as natural gas, nuclear and renewables.

Carbon mitigation is also achieved through carbon capture and storage.

South Africa currently has relatively high carbon emissions due to most of the electricity being generated by coal fired power stations. Carbon mitigation will require shutting down some of the existing coal fired power stations or installing expensive carbon capture and storage solutions. This will have an impact on the overall cost of electricity as these power stations are generally operating at a relatively low marginal cost, especially those power stations where the coal is mined using less expensive mining techniques and transported relatively short distances to the power station.

Carbon mitigation will have to be closely co-ordinated and planned with Eskom who are the owners and operators of the majority of coal fired power stations in South Africa. Clarity needs to be obtained on the future planning for Camden, Grootvlei, Hendrina and Kriel coal-fired power stations. The logistics of closing power stations needs to be carefully planned and associated costs budgeted for as this will have a major impact on communities and people living nearby or who are directly or indirectly employed by the power stations.

A further option of carbon mitigation that should be considered is off-setting carbon dioxide or greenhouse gas generation through carbon trading.

PARIS AGREEMENT

South Africa is a signatory party to the United Nations Framework Convention on Climate Change, Paris Agreement:

"This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

(a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and

(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development. This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances."

As a signatory to the Paris Agreement, the Department of Energy in the IRP update should reference the agreement and any specific details that would affect the mix of electricity generation in the future in the country.

REDUCED WATER CONSUMPTION

The highest consumer of water for electricity generation at present in South Africa is coal fired generation. Reducing water consumption would entail shutting down or reducing the use of coal fired

IRP - Results & Observations

continues from page 55

generators and/or converting water-cooled generators to air cooled.

Alternative options are to increase available water via pumped storage systems that are also used to transfer water from one basin to another and desalination using waste heat from generators located at the coast.

LOCALISATION

The objective of localisation is seen in two contexts, firstly building electricity generators in South Africa and close to the point of use of electricity and secondly building electricity generators using components manufactured locally in South Africa, e.g. wind turbine towers, solar PV panels, nuclear component manufacturing and fuel fabrication, etc.

REGIONAL DEVELOPMENT

Regional development is critical for South Africa and the neighbouring countries to benefit from mutual co-operation and development.

Growth rates in the Southern African countries vary and must be taken into account in planning. South Africa has considerably higher electricity usage than the neighbouring countries. A negative growth rate in electricity consumption in South Africa has been experienced for several years partly due to conversion to more efficient technologies and switching to alternative fuels. On the other hand it is expected that the countries neighbouring South Africa will have relatively higher growth rates of electricity consumption due to the low starting base.

Mozambique has vast natural gas reserves that could either be used in Mozambique to generate electricity and transmitted to South Africa via electricity transmission lines. Alternatively, additional gas pipelines can be installed to transfer gas to South Africa or the gas can be liquefied and shipped to South African ports.

The other neighbouring countries have various fuel sources including solar, wind, nuclear, hydro and coal.

Neighbouring countries, such as Zimbabwe, could benefit from excess generation that is available in South Africa when the Kariba Dam level is low and hydro-generation is limited.

DIVERSIFIED ELECTRICITY GENERATION SOURCES

The benefit of a diverse electricity generation mix is a move towards cleaner alternative electricity generation sources. One of the challenges in a diverse electricity generation mix is balancing the supply and demand both during the hours of the week and spatially across the country.

RELIABILITY

Reliability of supply is not mentioned in the IRP Update.

Reliability goals should be clearly stated in the IRP Update, e.g. 99.99% of the time electricity should be available on average to electricity customers. Statistical scenarios can then be planned for a particular energy mix based on historical wind and solar data, water available in dams for hydro generators and allowing for unplanned events/ breakdowns on coal fired power stations, etc.

LOAD SHEDDING

The cost of unserved electricity due to load shedding is mentioned and is considerably higher than all of the costs of generating electricity. Load shedding in the future can be avoided through careful planning.

CROSS BORDER FLOWS OF ELECTRICITY

Trade of electricity in Southern African needs to be planned for. Cross-border flows of electricity in Europe enable excess renewable generation in Germany to be sold to neighbouring countries and when renewable energy is not available Germany imports electricity. Cross-border flow of electricity can improve the reliability of supply of electricity.

DEMAND SIDE MANAGEMENT

Demand side management plays an important component in the reliability of electricity supply. Switching geysers off using ripple control relays during peak demands times ensures that the grid is not overloaded.

Demand side management will play an increasingly important role in ensuring the reliability of the grid as renewable energy generation increases. The IRP Update should include considerably greater detail with regard to demand side management.

ECONOMY

Electricity generation and consumption can have a negative or positive effect on the future of South Africa's economy. Load shedding is disruptive and has a negative effect on production, congestion on roads due to traffic lights not working, low morale which affects efficiency and has a direct negative effect on the economy.

Reliable electricity supply on the other hand allows for increased productivity and efficiency in manufacturing and a direct improvement in the economy.

Affordable and reliable electricity allows industry to grow.

Large investments in electricity generation that is under-utilized and is unable to be repaid will have a negative effect on the country's investment grade. This devalues the currency, increases interest rates due to higher perceived risk and has a negative effect on the economy and growth.

Careful, detailed, accurate and ongoing planning is critical to ensure a positive effect on the economy.

HEALTH

COAL

Certain technologies such as coal have a higher negative health impact on people working in the industry, such as underground coal miners and in the vicinity of the coal power station.

Technologies with a lower negative health impact must be preferred and technologies with a negative health impact must either be shut-down or changed to improve the conditions.

Health costs related to a particular technology or power station are difficult to accurately assess. These must be taken into consideration when planning the future of electricity generation and determining which power stations should be closed.

SAFETY

Similarly safety varies from one technology to another and even within a particular technology type. For instance one coal mine may be safer than another. Some nuclear reactors are safer than others. The safety culture in nuclear power is relatively high due to the consequences of an accident.

ENVIRONMENT

Environmental impact studies and authorisations are a legal requirement and authorization must be achieved prior to construction of a new electricity generator.

The IRP Update must be integrated with the objectives and planning of the Department of Environmental affairs.

VISUAL IMPACTS

1 000 MW of wind farms will have a much greater visual impact than for instance a nuclear power plant of the same capacity. Transmission lines connecting power generation to the point of use, has a visual impact. The visual impact as well as the cost of transmission lines must be factored into the planning.

The locality and geographical distribution of generators must be considered in view of the visual impacts. Detailed planning at a local level will have an impact on the overall energy mix and must be considered.

Simply comparing the levelised cost of one technology with another to determine the mix will not achieve the overall objectives.

NOISE

Diesel generators create noise. Solar photovoltaic panels are silent.

FAUNA AND FLORA

The impact on fauna and flora is dependent on the location of a particular generator or technology and can either be significant or have no effect, for example a generator using waste saw-dust as a fuel at a sawmill has no negative effect on the fauna and flora as it will generally be located within the saw-mill yard.

HERITAGE

South Africa has a variety of heritage features that are taken into account in authorising a particular generator. The impact on heritage features can be minimised or avoided through proper planning and selection of suitable technologies and sites.

ACHIEVING OBJECTIVES

ACCURACY OF DATA

The accuracy of data in planning is critical. Data must be up to date (i.e. preferably not older than 6 months). Growth trends and forecasts must be based on historical data and confirmed future developments from electricity supply applications.

The data used in the current revision of the IRP Update is considered to be inaccurate and not suitable for the importance of the planning that is required. Accurate data is available from Eskom and must be used in the updated/ revised plan.

Detailed data relating to each project needs to be incorporated into the planning to compare and evaluate the impact on all of the objectives.

ENERGY EFFICIENCY

One of the items hardly mentioned in the IRP Update is the role of energy efficiency in achieving the objectives. Energy efficiency is often included in comments related to renewable energy and demand side management, but it is a complete topic on its own.

The Department of Energy's updated National Energy Efficiency Strategy and comments need to be referenced and co-ordinated with the IRP Update.

IRP - Results & Observations

continues from page 57

COMMUNICATION

Communication is a critical part of planning. Communication via documents on websites, information workshops, media, email, etc. has generally been well done during the last few months, but must continue on a regular basis. Updated plans must be communicated via the websites at least once per year in order to be accurate and relevant.

RESEARCH

Research is an ongoing activity. Research is required both to stay abreast with the latest technological developments (for instance small modular nuclear reactors) and costs of various technologies. Research also sometimes highlights the importance of simple technologies that have been around for a while, for example low flow showerheads, that are useful in achieving the overall objectives.

Research undertaken by institutions such as the Fraunhofer Institute for Solar Energy Systems is extremely useful for understanding the dynamic nature of electricity generation and consumption with increasing renewable energy in Germany and currently happening in South Africa.

This research should be referenced in the IRP Update Report as the charts, that are provided, are useful for explaining and illustrating the complexity of the challenge of having a diversified energy mix. The weekly profile charts clearly illustrate the impact of a mix of generation throughout the week and during different seasons in the year.

Research should not only be undertaken by professors and students undertaking post-graduate studies, but should be encouraged throughout society as a lifelong habit. Then everyone could make a contribution towards achieving the national and regional objectives of the IRP Update.

CHERNOBYL, THREE MILE ISLAND AND FUKUSHIMA

Research on previous accidents in the electricity generation industry is important to learn lessons on how to avoid repeating mistakes made in the past. Vast amounts of documentation are available on the internet from which lessons can be learnt.

It is considered important to mention the lessons learnt as this has an impact on the levelised cost of nuclear energy when comparing one type of nuclear reactor with another. Both the capital costs and operating costs have an impact on the levelised cost.

TRAINING AND MENTORING

Training and mentoring is part of the process of achieving the objectives mentioned in this document. Achieving all of the objectives is a complex task and requires a large number of people to be trained and mentored so that together we are able to continue meeting the goals.

PLANNING

Planning is the key to success. Planning and co-ordinating a large number of projects, both large and small, both geographically across the country and time-wise over the next thirty year is a highly complex task.

PLANNING TOOLS

Various software tools are available to plan for the future of electricity generation and connection of generators to the grid from simple Excel spreadsheets, to geographical information systems and software such as DigSILENT for assessing the impact on the grid of various technology mixes.

The internet and shared information in the "cloud" is a useful tool for collaborative planning.

The use of computers is required to forecast the various scenarios and as the mix becomes more complex and short and long term weather data is required to be incorporated into the planning, super-computers will be required to be part of the planning, operation and control of the electricity network.

The data output from the computer simulations and models is only as good as the data input. As previously stated the accuracy of the data is critical.

CO-ORDINATION WITH ESKOM

Eskom is the major supplier of electricity in South Africa and all planning must be carefully co-ordinated with them. Eskom is aware of grid connection applications from Independent Power Producers (IPPs) and as such needs to involved on an ongoing basis in the IRP Updates to provide the necessary information regarding projects that are in the pipeline.

Eskom are also involved in planning maintenance on generators and reporting on unplanned maintenance events. Long term planning needs to take into consideration seasonal maintenance plans.

SOUTHERN AFRICA

Planning for the region must be incorporated and referenced into the IRP update. New generators planned in neighbouring countries that will feed into the power pool and growth of electricity consumption by neighbouring countries will have a direct effect on the future of electricity flows in and out of South Africa.

CONCLUSION

The objectives of the IRP Update are noted but need to be expanded upon as detailed in this document to include reliability, economy, health, safety and environment.

Achieving the objectives requires a number of items as described in more detail in the report. The most important being accuracy of data used in the assumptions.

Broad planning has the risk of becoming outdated, inaccurate and even irrelevant and detailed planning needs to be incorporated into the broader planning. There is a significant amount of work required to incorporate feedback from the various interest groups/ stakeholders to finalise the IRP Update document. The IRP Update needs to be a live document and due to the importance and dynamic nature of the industry needs to be updated at least once a year in order to stay relevant and accurate.

The importance of the IRP Update document must not be underestimated as it will have a direct impact on many facets of the future of South Africa and the region and as such must be accurate and carefully thought through. wn

calendar

APRIL | MAY | JUNE | JULY 2017

APRIL 2017

19 & 20	Leadership & Management Principles & Practice	Johannesburg	roberto@saiee.org.za
20	2017 SAIEE Presidential Address	Cape Town	www.saiee.org.za

MAY 2017

3 - 4	Core Financial Management Skills for Engineers	Johannesburg	roberto@saiee.org.za
10 - 11	Effective Document Writing for Engineers	Johannesburg	roberto@saiee.org.za
10 - 11	Fundamentals Of Long Term Evolution (LTE) Mobile Communications	Johannesburg	roberto@saiee.org.za
16 - 19	Planning Strategic Feasibility Studies	Johannesburg	roberto@saiee.org.za
16-18	African Utility Week	Cape Town	www.african-utlity-week.com
17 - 18	Design of Economical Earthing Systems	Johannesburg	roberto@saiee.org.za
23 - 24	Fundamentals Of Practical Lighting Design	Cape Town	khuvutli@gmail.com
24 - 25	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za
25 - 26	Fundamentals Of Power Distribution	Cape Town	khuvutli@gmail.com
25 - 26	Arc Flash Studies	Johannesburg	roberto@saiee.org.za

JUNE 2017

7	Power Transformer Unit Protection And Testing	Johannesburg	roberto@saiee.org.za
8	Power Transformer Operating And Maintenance	Johannesburg	roberto@saiee.org.za
14 - 15	Optical Fibers, Cables & Systems Fundamentals	Johannesburg	roberto@saiee.org.za
13 - 15	ORHVS - Operating Regulations For HV/MV Systems	Johannesburg	roberto@saiee.org.za
21 - 22	Ethernet Acceptance Testing	Johannesburg	roberto@saiee.org.za
28 - 29	Fundamentals Of Practical Lighting Design	Johannesburg	roberto@saiee.org.za

JULY 2017

12 - 14	West Africa Power Summit	Senegal	www.wafpower.com
18 - 20	PowerGen Africa	Johannesburg	www.powergenafrica.com

■ = CPD Courses

SAIEE

www.robotscience.co.za
www.youtube.com/electronicsafrica

Afrika 2017 BOT

The world's most affordable robotics competition

DATE
22 October 2017
10:00-16:00

PLACE
Zwartkops Raceway, Quagga Road, Centurion, Gauteng

ENQUIRIES
michaele@uj.ac.za

Proudly hosted by the School of Electrical Engineering, University of Johannesburg

RETHINK. REINVENT.

UNIVERSITY OF JOHANNESBURG

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

What is IE3 and why does it save you money? With leading edge WEG IE3 compliant electric motors designed to reduce operating costs in African operating environments, Zest WEG Group Africa was recently the first equipment supplier to move from IE2 to IE3 compliant motors at no additional cost to its customers. But what is IE3 really all about?

QUESTION ONE

What does IE3 mean with respect to electric motors?

ANSWER ONE

IE3 is the international efficiency class for 'premium efficiency' electric motors, as defined by International Electrotechnical Commission (IEC) for rotating electrical machinery in its international standard IEC 60034.

In terms of this classification, motors that are IE3 compliant are more efficient than IE1 (standard efficiency) and IE2 (high efficiency) motors.

QUESTION TWO

Why is the IE3 international energy classification important?

ANSWER TWO

The most direct and immediate answer to this question is economic: better energy efficiency reduces operating costs for users of electric motors, delivering bottom line improvements in relatively short periods of time.

However, there is also a broader social and environmental benefit to measuring motor efficiency and raising the bar across industries. Globally, electric motors account for as much as 60% of industrial energy usage, with industry making up about 70% of national energy usage. Electric motors therefore consume about 40% of national energy consumption on average, while in South Africa the percentage is estimated to be much higher.

It is no surprise, then, that regulatory authorities in many parts of the world have introduced legislation to encourage the manufacture and use of higher efficiency motors, as part of national efforts to reduce energy consumption and carbon emissions. It is clear that improving energy efficiency of electric motors will have a substantial impact on reducing greenhouse gas emissions that contribute to climate change.

QUESTION THREE

Do these efficiency standards cover the full spectrum of small and large motors?

ANSWER THREE

The efficiency standards cover the range of low voltage motors from 0,12 kW to 1000 kW in size. The first reason for this is that this range accounts for about 80% of electrical motor power consumption in the global economy. Secondly, larger motors are inherently more efficient (they usually have efficiencies of over 95%), so there is less benefit to be gained by trying to improve the efficiency of large motors.

QUESTION FOUR

What is the scale of benefits to be gained by a user when 'upgrading' from one efficiency level to the next?

ANSWER FOUR

The efficiency gain depends largely on the

WATT?

capacity of the motor; generally speaking, the smaller the motor the greater the gains will be. Any comparison therefore needs to be done between motors of the same size and characteristics. For example, a standard efficiency (IE1) 7,5 kW motor has an efficiency of ≥86%, while a high efficiency (IE2) 7,5 kW motor has an efficiency of ≥88.7% and a premium efficiency (IE3) equivalent has an efficiency of ≥90.4.

When a user replaces an IE1 rated motor with an IE3 rated motor, they achieve an efficiency improvement of 4,4%.

QUESTION FIVE

Are the potential savings to be gained from more efficient motors worth the cost of the new investment for the end user?

ANSWER FIVE

With the rising cost of electricity in South Africa, users have been increasingly aware that energy costs are a growing component of every business's operating costs. By the same token, the savings on energy that can be achieved by higher efficiencies have also become more significant.

In the example above, it was shown that replacing a 7,5 kW motor rated IE1 with an IE3 rated motor of the same capacity, could deliver 4,4% better efficiency. How does this translate into Rands and cents? A calculation that assumes the motor operates for 22 hours per day for 320 days a year at 75% load will show that the IE1 motor consumes 50,363 kWh while the IE3 motor consumes 47,912 kWh The improved consumption – 2,451 kWh less over a year – means that the price difference between the units is made back in just over a year, and the savings thereafter go straight to the user's bottom line.

QUESTION SIX

How important is the purchase price of a motor when compared to its operating cost?

ANSWER SIX

In the first few weeks of continuous operation, the electrical power consumption cost surpasses the actual purchase price of the motor. Over a ten year operating life (electric motors generally have an expected lifespan of over 20 years) – assuming annual inflation in electrical costs of 5% – the purchase price of a motor accounts for less than 2% of the total cost of ownership. wn

Information provided by Zest WEG Group

April

Movers, shakers and history-makers

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

1 APRIL

1863 The Cape Town and Green Point Tramway Company began operations, with a horse-drawn service running on rails from the foot of Adderley Street and out along Somerset Road to Green Point. Both single- and double-decker horse-drawn trams were used.

2 APRIL

1952 The United States posthumously awarded SA Cheetah Squadron pilot, Lieutenant R.M. du Plooy, with the Silver Star for "gallantry in action". Du Plooy was killed the previous year in the Korean War.

3 APRIL

1702 The Merenstejin, a Dutch merchant ship that was built in Amsterdam, Holland in 1693 with a passenger capacity of 315, was wrecked off Jutten Island on the West Cape coast. It sunk with a cargo of gold and silver. Of the 200 people on board, 101 lost their lives. The wreck and part of the cargo was salvaged in 1972 and it is now a diving site.

4 APRIL

1939 Hugh Ramopolo Masekela, South African trumpeter, flugelhornist, cornetist, composer and singer, was born near Witbank.

5 APRIL

1923 Egyptologist Lord Carnarvon died of an unknown disease some months after he and British archaeologist Howard Carter discovered the tomb of Tutankamen in Egypt. Some reports state the cause of his death as a mosquito bite that caused a skin infection, which then led to septicaemia, pneumonia and his death.

6 APRIL

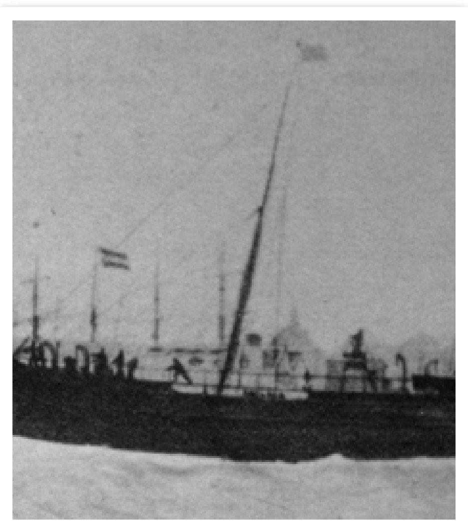
1874 Gerhardus Cornelis Oosthuizen bought the section of the farm Lang Leegte (Langlaagte), on which the main gold reef of the Witwatersrand was discovered, for £100. When the main gold reef was discovered in the Roodepoort area of Johannesburg in 1886, Langlaagte was incorporated into a group of nine farms which were declared "public gold diggings". Almost immediately people arrived at the goldfields and digger's camps had been set up. These digger's camps lead to the formation of Johannesburg.

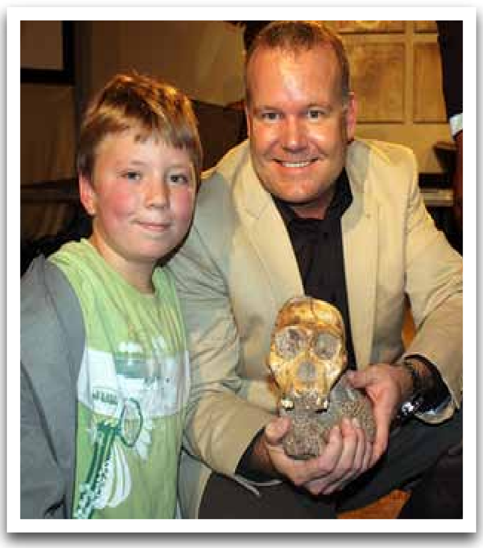
7 APRIL

1884 Charlotte Maxeke was born in Fort Beaufort. She co-founded the Bantu Women's League of South Africa, later renamed the ANC Women's League. Maxeke died on 16 October 1939.

8 APRIL

2010 It was announced that Professor Lee Berger and his son Matthew had stumbled across a new species of hominid, Australopithecus Sediba (estimated to be 2 million years) while looking for fossils at the Cradle of Humankind.





9 APRIL

1679 7 years after settlement at the Cape by Jan van Riebeeck a census showed that there were 30 white male servants, 117 children, 55 women, 87 freemen, 113 officials, 290 soldiers (70 with wives) and 191 slaves at the Cape - a total of 953 people. Indigenous inhabitants were not included in the census.

10 APRIL

837 Halley's Comet made its closest approach to Earth at a distance equal to 0.0342 AU (5.1 million kilometres).

11 APRIL

1951 The Stone of Scone, the stone upon which Scottish monarchs (and later the monarchs of England and the Kingdom of Great Britain) were traditionally crowned, was found on the site of the altar of Arbroath Abbey, Scotland. It had been taken by Scottish nationalist students from its place in Westminster Abbey, England.

12 APRIL

1969 Lucas Radebe, SA's celebrated soccer legend was born in Diepkloof, Soweto. He began playing in South Africa with Kaizer Chiefs, before transferring to Leeds United.

13 APRIL

1990 Lucas Ntuba Radebe made his debut for Kaizer Chiefs in the game versus Durban Bush Bucks. Kaizer Chiefs won 2-1.

14 APRIL

2014 Two hundred and seventy-six schoolgirls were abducted by Boko Haram in Chibok, Nigeria. To date many of these young women have not been found.

15 APRIL

1990 SA formally implemented the Montreal Protocol for the control of ozone-duplicating substances.

16 APRIL

1990 Nelson Mandela thanked the world, from Wembley Stadium, London, for support during his imprisonment.

17 APRIL

1997 President Mandela in his capacity as chief of the Temba clan, rather than Head of State, inaugurated the Council of Traditional Leaders (150 tribal leaders) were inducted into Parliament in a colourful ceremony.

18 APRIL

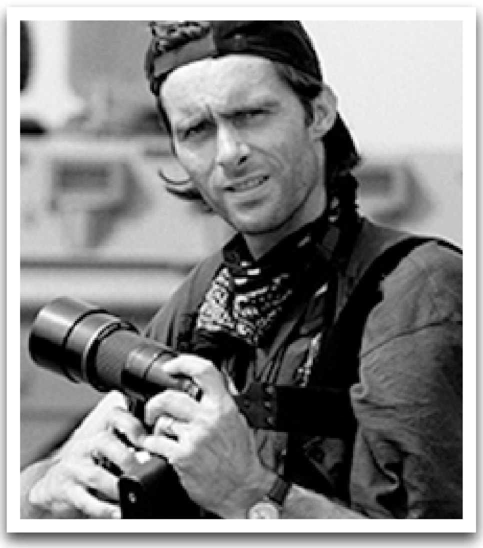
1994 Ken Oosterbroek, the Chief Photographer of The Star, was killed in bloody pre-election fighting in Thokoza township on the East Rand, just two weeks before South Africans went to the polls in South Africa's first historic democratic elections. It was a bittersweet time for those who worked at The Star during that period. Ken was a larger than life presence, an intricate personality with a wonderful talent. His untimely death in the crossfire between hostel dwellers and a South African peacekeeping force was a great tragedy.

19 APRIL

1999 Three internationally-renowned tenors, Jose Carreras, Placido Domingo and Luciano Pavarotti, perform together before an audience of some 40 000 at an open-air concert at the Union Buildings in Pretoria.

20 APRIL

1994 In terms of section 248 (1) of the Interim 1994 Constitution and acting on the advice of the Transitional Executive Council (TEC), former State President F W de Klerk issued a proclamation on 20 April 1994, providing for Die Stem van Suid-Afrika (the Call of South Africa) and Nkosi Sikelel' iAfrika (God bless Africa)



APRIL

continues from page 65

to become the combined national anthem of the country, and providing for the adoption of the new national flag.

21 APRIL

1937 South African artist Benjamin Mzimkulu Macala was born in Bloemfontein, Free State. He was largely self-taught. His subject matter of Picasso-like portraits with huge black eyes is easily identifiable in almost all his works.

22 APRIL

1970 Earth Day was celebrated for the first time.

23 APRIL

1984 The discovery of a virus that may cause Acquired Immune Deficiency Syndrome (Aids) the disease that destroys blood cells, leaving its victims open series to other diseases, was hailed as a "monumental breakthrough" in medical research.

24 APRIL

1901 A comet known only as "The Great Comet of 1901" or "Viscara" was visible to the naked eye over most of South Africa.

25 APRIL

World Malaria Day (WMD) is an international observance commemorated every year on 25 April and recognizes global efforts to control malaria.

26 APRIL

1679 Construction of The Castle of Good Hope, the oldest surviving colonial building in South Africa, was completed. The castle replaced a small clay and timber fort built by Commander Jan van Riebeeck in 1652.

27 APRIL

1960 The French-governed part of Togo land became the independent Republic of Togo, Africa's smallest independent country.

28 APRIL

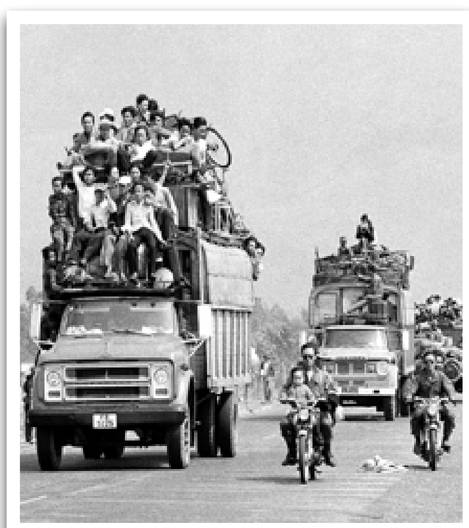
1923 The first football FA-cup final match was played in the Wembley Stadium, London, England.

29 APRIL

1829 The freedom of the press was established at the Cape through the efforts of journalist John Fairbairn, founder of The South African Commercial Advertiser. After Cape Governor Lord Charles Somerset had repeatedly censored the newspaper, Fairbairn appealed to the British government and gained the right to publish without hindrance.

30 APRIL

1975 The Vietnam War finally ended with the fall of Saigon (later renamed Ho Chi Minh City).




www.kia.co.za
FROM ONLY
R3 999
PER MONTH
KIA