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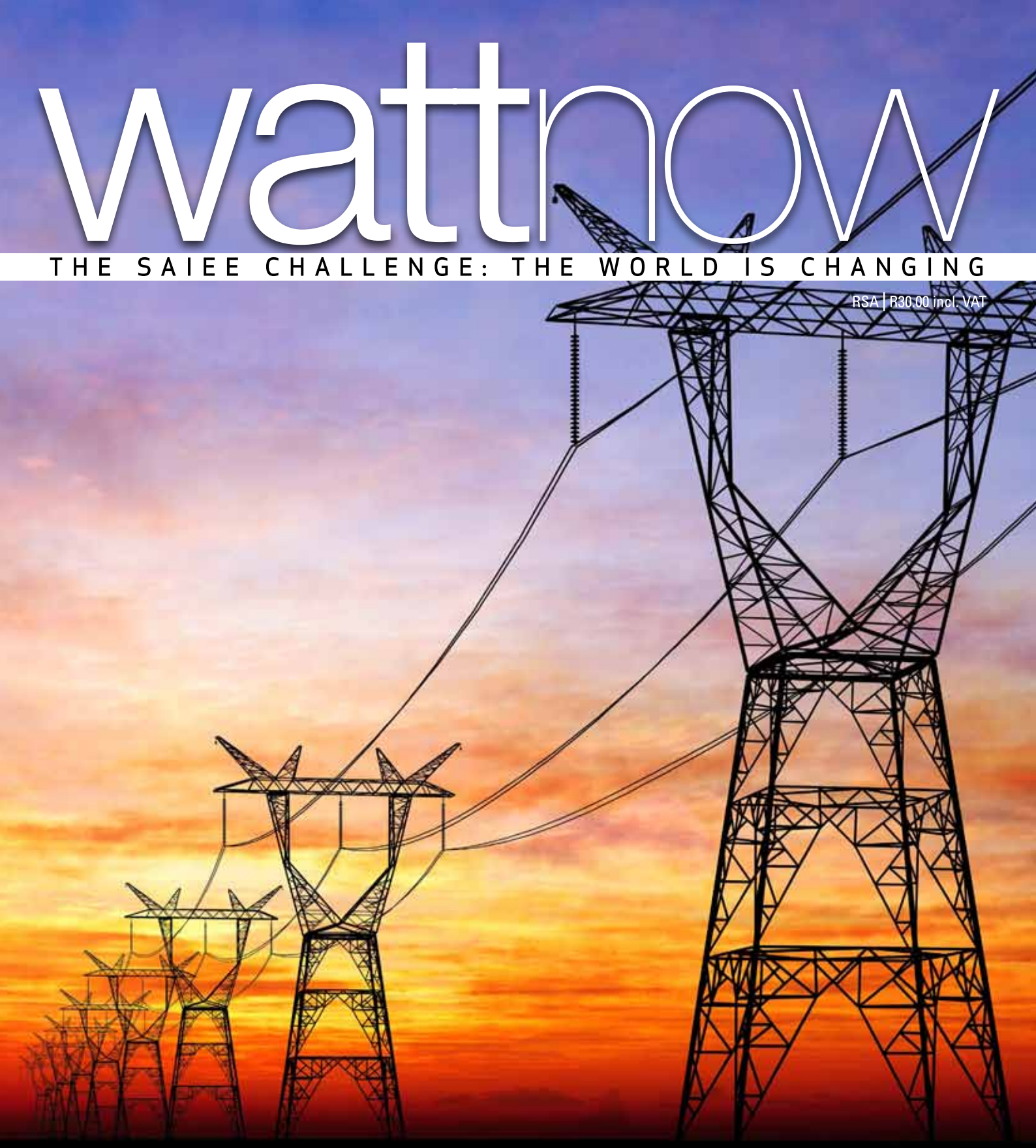

POWER

SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | JUNE 2018

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SAIEE

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ISSN: 1991-0452

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2018 Q1 - 15 527

June is in full swing, the days are shorter and nights longer. Driving to work in the mornings is no small feat as many streetlights are not working, not to even mention the traffic lights. Our Power Utility is continuously in the news, which does not bode well for the already-cash-strapped consumer.

We do not realise how reliant we are on electricity until we don't have it. During the first six months of the 2015 Load shedding debacle, South Africa lost R13.72 billion in revenue - which have never been recuperated.

Now that we have officially entered into the South African winter, the strain on our power utility company is enormous, therefore, the focus of this issue on Power.

Our first article is about Prof Rosalie Falcon who discusses the know-how on Clean Coal (on page 24).

Page 28 features an excerpt on a report on Electricity Consumption in South Africa, commisioned by Eskom in 2017, which will make your hair stand on end (and it's not due to static electricity!).

Senior SAIEE Member, Quentin Louw, wrote an article on the Illegal Electricity Connections in South Africa. Read it on page 48.

This month's "Down Memory Lane" article was aptly written by SAIEE Past President, Mike Cary, who gives us a glimpse on his career as an Earthing and Lightning Specialist.

Please share your stories with me by sending an article with AT LEAST 2000 words in a word format to my email address: minx@saiee.org.za with "Memory Lane" in the subject field.

Herewith the June issue, enjoy the read.

Minx

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

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Power Utility Business Disrupted

DR HENDRI GELDENHUYS
2018 SAIEE PRESIDENT

Power utilities world-over have developed through similar socio-economic needs but via different political systems and processes. Today the structures of the electric power business in the USA and Europe are very different from the regulated electric power suppliers in South Africa.

In South Africa, the dominant power utilities are Eskom and the Municipalities. The roots of these organisations can be found in the need of economic collaboration to build an electrical network of which the cost is far less than if each party runs his supply system. This forms the basis of the corporate monopoly- build on the same basis as public roads have done over centuries.

Disruptive technologies, such as wind and PV, are gaining traction in the network due to its cost-competitive with the traditional electric power utility energy sources. There is one major problem with these energy sources, and it is their variable nature. The extensive and competent communication and processing capability of the modern world make it possible to manage this variability and match it to network loads to an extent.

The disruption of the electric grid business would be complete when electrical energy storage at cost effective rates, becomes possible. Some analysts have extrapolated historical battery storage prices and suggest that it is just a matter of time before this happens - similar to the drop in the prices of PV modules over the last 10 years. Personally, I'm not convinced by the forecast methodologies used by some of these prophets. However, only time will tell if battery prices can get to a level where they can store electrical energy cost-effectively.

Battery-business cases are often built up by the addition of several components of attained-value added together. For example, if the battery of an electric vehicle provides not only transport but also provides grid energy storage, thereby reducing grid transmission capacity requirements. Then the sum of the value may well outweigh the cost of battery storage even at today's cost of batteries. New business models may well be the route towards this new electric business regime.

What part of the post disrupted electrical energy market would still be subject to natural monopolies? What part of this would be subject to open market competition?

For the economy to make sensible decisions in the chaos of disruption and change, it is imperative that utilities have explicit cost-reflective tariffs and that the long-term trends in these tariffs are known. Utilities can only adapt to these changes if they understand the disruptions and understand their customer needs. (Compared to ordinary business undertakings, utilities traditionally did not communicate much to their customers.) In an environment of chaos and change, the key to steady progress is extensive communication and open debate with customers and stakeholders to determine where the new space of utility operation should be.

H Geldenhuys | SAIEE President 2018
Pr. Eng | FSAIEE

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Copper Alliance

AVOID AN ELECTRICAL FIRE

Ensure that your electrical components and appliances are compliant with safety regulations

Sub-standard electrical products and services can cause fire, injury and death. The latest available statistics indicate that over 3500 fires yearly are classified as 'electrical'. Fires may be caused by using sub-standard electrical products, by employing incompetent contractors to carry out electrical installations or both.

- Be aware that there are many sub-standard products and services on offer in South Africa.
- Membership of the SAFEhouse Association is your assurance of a code of conduct that demands compliance with regulations and responsible behaviour.
- It has become clear that the need for correct copper cabling and quality components in your home is indisputable.
- Copper is the most efficient ELECTRICAL conductor available.

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Suppliers you can trust

WATTSUP

ACTOM DOES IT AGAIN...

Tegwan's Nest Primary School's Principal Mr J.S Galela (second from left) cuts the ribbon at the official opening of the new container flush-toilets, accompanied by (from left) Councillor Khanye of Dispaleseng Municipality, Mdu Ncube, Project Manager for Eskom, and Andy Abbey, John Thompson's Divisional CEO.

ACTOM group division John Thompson, carried out four major corporate social responsibility (CSI) projects during 2016/2017 to uplift previously disadvantaged communities near Grootvlei power station in Mpumalanga.

The CSI projects were undertaken as part of contract obligations linked to two contracts currently in operation at Grootvlei by John Thompson's Utility Boilers & Environmental Solutions business unit.

"The CSI projects have focussed on the development and enhancement of facilities and services in the Dipaleseng Municipality towards improving the living and working conditions of the community, including providing opportunities to small and medium contractors in the area to carry out some of the work involved in the projects," said Shad Seeth, John Thompson's Business Development Executive, who assisted in arranging and co-ordinating the projects.

John Thompson has spent a total of more than R4-million on the four projects, which were:

- Refurbishment of Tshepeha Secondary School from late-2016 to July 2017;
- Refurbishment of Tegwan's Nest Primary School between January and July 2017;
- Provision of a new library for Greylingstad's Nthoroane township community between June and August 2017; and
- Provision of flush-toilets to replace pit-toilets at Tegwan's Nest Primary School between September and December 2017.

The division commissioned a local black-owned construction company to execute most of the work involved in the refurbishment at Tshepeha school, which encompassed all classrooms, the administration block and ablution facilities, as well as paving and landscaping the grounds and repairing the main entrance gate to the property.

At Tegwan's Nest school the improvements included rebuilding the school hall and kitchen and supplying and installing two new 10 000 litre water tanks and an electrically-powered borehole pump to replace the hand-pump previously in use.

John Thompson also purchased and supplied tables, chairs, filing cabinets, a photocopying machine, maths and science kits and gardening implements.

Modified shipping containers were used to replace the library in Nthoroane township and to replace the pit-toilets at Tegwan's Nest school with flush-toilets.

Bureau Veritas South Africa (Pty) Ltd (BVSA) introduces Ithemba Trust

From left: Ms Beatrice Scharneck (HR Manager, Bureau Veritas South Africa), Mr Hennie Knight (District Legal Counsel Bureau Veritas Southern and Eastern Africa), Ms Sal Govender (VP – Southern African Region), Mr Onwell Msomi (Trustee Ithemba Trust) and Ms Yvonne Kgame (Chairperson Ithemba Trust).

Bureau Veritas South Africa (Pty) Ltd, the global leader in Testing, Inspection and Certification, today launched The Ithemba Trust, an independent body, as part of its transformation journey.

Aligned to the BVSA strong social awareness ethos, the Trust focuses on empowering females from previously disadvantaged backgrounds with a focus on education of young Black Women in the STEM disciplines of science, technology, engineering and mathematics. After graduation, the company will absorb the young ladies into the business and upskill them with soft skills on work readiness.

Enterprise development assistance will be provided to those that wish to launch their own businesses and work will be subcontracted to them to ensure they can sustain their businesses and achieve success. The Trust will focus on beneficiaries hailing from areas in which BVSA employees live and work.

District Legal Counsel for Bureau Veritas Southern and Eastern Africa, Mr Hennie Knight, said: *"Bureau Veritas has many long-established programs investing in people and skills, training, socio-economic investments and procurement; so it is a natural transition for us to partner with The Ithemba Trust.*

The beneficiaries will include young Black females who will ultimately grow and develop in the fields of science, technology, engineering and mathematics. Furthermore, we are proud to announce that our journey has culminated in us being recognised 51% Black Owned as well as 30% Black Female owned."

The independent Trustees include Messrs Yvonne Busisiwe Kgame and Zwelakhe Onwell Msomi, long-standing members of the South African business communities and highly respected and passionate about education and the transformation of women.

The Trustees have enjoyed leadership roles in local and international corporates and the education sector; bringing a powerful combined experience set to the Trust. They have also been heavily involved in non-profit organizations and charities on both local and global scales.

Commenting at the announcement, VP – Southern African Region, Ms Sal Govender said: *"BVSA is committed to the region and continues to support local legislation. We are proud to launch the Ithemba Trust today and to make a difference in our society by empowering females within the STEM disciplines through education and enterprise development. We are creating a sustainable women empowerment program that continues to create legacies and ultimately build a nation. We are poised to improve the lives of women; the backbone of society. It is our vision for South Africa to constantly exceed our client expectations through world class professionalism from a diverse and highly motivated team."*

WATTSUP

SAIEE GETS INVOLVED

On the 22 May 2018, The Glen Highschool, situated in Pretoria in the Menlyn precinct, hosted a career expo with the theme, "Science and Technology". SAIEE was invited to participate, and Monde Soni, an SAIEE Council member took it upon himself to handle the exhibit at this event.

The audience was made up of grades 8 to 12 students and a few parents. "It was quite energetic with some very interesting questions that got me thinking at times! One of the questions was, "I heard that coal is depleting, where are we going to get electricity from when it eventually runs out?"" said Soni, and added "I also got a chance to ask the students what they think the solution is – some interesting viewpoints came out! Viewpoints such as use of chemical reactions to generate electricity, to solar energy and a few more."

For those students interested in electrical engineering were told of the benefits of joining the SAIEE when they get to university. Benefits such as networking and mentorship that will be available even before they start working.

It was a very busy, and exciting day. "Besides the fact that my energy seemed to be running out faster than theirs, I had a good time with the kids," Soni concluded.

INDUSTRY STANDARD DMMS FOR ELECTRICIANS WHEN UPTIME MATTERS

COMTEST are currently promoting Fluke's 177 & 179 Digital Multimeters (DMMs), the two DMMs that are to be found on more tool belts, finding more problems, than any other comparable test tool. With their precision, reliability and ease of use, the 177 & 179 are the preferred solution for professional technicians worldwide. Each design is tested to the extreme for drop, shock, and humidity and are independently tested for safe use in CAT IV 600 V/ CAT III 1000 V environments. These DMMs give users accurate measurements; consistent, reliable performance; attention to safety; and are backed by a lifetime warranty. They measure twice as fast as other multimeters with all the features users need to troubleshoot and repair electrical and electronic system problems, in the harshest of industrial situations.

The 177 & 179 offer True-RMS voltage and current measurements, 6000-count resolution, manual and automatic ranging and provide frequency, capacitance, resistance, continuity and diode measurements. In addition, higher 0.09% basic accuracy, a digital display with analog bar graph and backlight.
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ACCESS TO ENERGY A CATALYST TOWARDS ECONOMIC GROWTH

Sandisiwe Ncemane
CDC Business Development Manager: Energy Projects.

Reflecting on Energy month, Sandisiwe Ncemane – CDC Business Development Manager: Energy Projects, highlights the direct relationship between access-to-energy and economic growth. Access to energy is among the highly transformative interventions for the African continent. This is in conjunction with an integrated African agenda, leveraging its agricultural wealth and accelerating its industrialisation capacity for an improved quality of life for the African citizen.

"This of cause is prioritised towards achieving the goal of universal access in Africa, through harnessing the aspirations to solve Africa's energy challenges, whilst establishing strategic and transformative partnerships."

As emphasized by the AfDB, this requires the mobilisation of diverse and innovative capital financing for the continent's energy sector, complemented by strengthened energy policy regulation and sector governance by the various African states.

"Access to energy in Africa can be accelerated by using existing initiatives to leverage synergies, overcome barriers, improve quality, reduce costs and increase impact."

Existing regional and international programmes as well as initiatives can be better utilised and coordinated to attract private sector involvement, improve continental energy access and thereby the prosperity through economic development prospects both on the continent and globally.

"An example of this would be the initiation of transmission inter-connection projects on the eastern and western borders of the region. This will advance the integration of the Southern African Development Community (SADC) economies," says Ncemane.

Despite the rich natural resources and advantageous natural conditions, there is a perception that African countries have yet to be adequately mobilised across all the relevant aspects in order to position the continent as an investment location of choice for the Energy sector. *"This requires critical factors and focus areas that seek to advance the realisation of maximised benefits through Energy focused frontiers."*

"Included in this, is the holistic value proposition of addressing a market need positioned at affordable levels for meaningful uptake. Plus an integrated configuration of legal, technical and environmental aspects, supported through capable networks and partnerships," adds Ncemane.

What would be the regrets, if benefits realisation for Africa were not maximised through the energy transition?

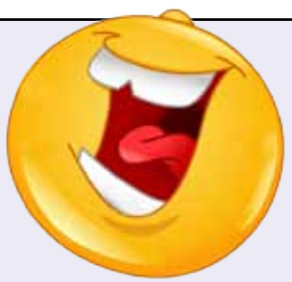
One of the perfect opportunities poised by the energy transition is for the continent to harness its capabilities. Second to this is the support to implement the strategic transformative interventions through holistic Benefits Management focused on maximising the value to the project investor, while agile to the broader developmental benefits of the country hosting the project.

For Africa, it is imperative that the objectives of regional integration, incorporate the Asian learning on Self-reliance as well as the central role of the developmental state that prioritises investment in human capacity, while realistically factoring of the position on free-market, free-trade, strategic partnerships, and enhancing the role of the private sector.

"In closing, it's important to highlight that, whilst Africa remains well endowed with possibilities and resources for a diverse energy mix, in order to be relevant to the development trajectory of Africa, access to energy must be accelerated. The continent needs to gain momentum through strategic collaborations & partnerships, as well as leverage the experience and learnings from recent mega infrastructure programmes," concludes Ncemane.

POKING FUN

A wife asks her husband, an electrical engineer...
"Could you please go shopping for me and buy one carton of milk, and if they have eggs, get 6!"
A short time later the husband comes back with 6 cartons of milk. The wife asks him, *"Why the hell did you buy 6 cartons of milk?"* He replied, *"They had eggs."*



WATTSUP

Lilian Ndhlovu, owner of Mirian and Lilian Transport PTY LTD, and her employees inside an MTO forest. Lilian is one of the students of MTO's Contractor Development Programme and her company provides silviculture services to the group.

SUCCESSFULLY BUILDING SA'S LOCALLY-OWNED BUSINESSES

MTO Forestry's contractor incubation programme has started to deliver its first alums. Meet Lilian Ndhlovu, owner of Mirian and Lilian Transport, an entrepreneur who already employs 25 people.

They say teach a man to fish and he will eat for a lifetime. But teach a woman to run a business, and she will create a vast company that employs dozens of people. This is the story of Lilian Ndhlovu, who owns and operates a forestry contractor business in Mpumalanga's White River/Nelspruit area.

Her journey started from humble beginnings, initially working alongside her husband as he offered silviculture, harvesting and transportation services to MTO Forestry in the region. This introduced her to the relevant skills and experience, not to mention a love for forestry. Soon, though, she spotted a larger opportunity:

"Looking at the lack of black women in the forestry industry, I then decided to register my own company and explore available opportunities. I approached MTO Forestry management and was awarded a short-term contract of six months on a trial basis. Based on excellent performance, relationships and my willingness to learn, the contract was then extended to a longer-term basis."

But this was just the beginning. Her diligence and professionalism helped Ndhlovu qualify for MTO's new incubation program to help develop its contractors.

The program was created in 2016 after a leadership change in the previous year. MTO Group CEO Lawrence Polkinghorne saw room to help develop the large community of businesses that work with MTO Forestry and invited forestry development veteran Parmas Chetty to help establish the MTO Contractor Development Programme.

Many of the programme's students hail as forestry workers who are active in the industry, sometimes as part of family businesses. The goal is to teach them the peripheral business skills that will help them expand and improve their companies.

For Ndhlovu, this was a unique opportunity to enhance her business skills.

KSB PUMPS FOR UNIVERSITY OF PRETORIA LABORATORY

Professor Josua Meyer, Chairman of the School of Engineering and Head of Mechanical and Aeronautical Engineering of the University of Pretoria and Dylan Mitchell KSB Sales Representative.

Danie Gouws, Technologist of the research laboratories of Mechanical and Aeronautical Engineering of the University of Pretoria.

KSB Pumps and Valves has assisted the University of Pretoria in the construction of a large controlled-temperature test unit, which will form the backbone of ongoing research into heat transfer, fluid mechanics and thermodynamics.

The impressive unit will allow students to plug directly into hot, moderate or chilled liquids to use on research projects and will shave approximately 50% off students' overall project build-up time thereby allowing more time to carry out actual research. In addition, it is expected to save considerable costs in future.

CRITICAL STUDIES

About the centralized temperature-controlled unit, the Professor explains that the system relies on temperature monitoring of flow loops where water is conditioned through the relevant heat pumps and chilling units at near boiling or lower temperatures, as well as subzero degree Glycol at -20°C.

"The user demand within each loop is controlled using a system of pumps, variable speed drives, pressure transducers and special valves to allow up to 8 experiments to plug-in simultaneously without affecting either the flow rate, working pressure or temperature of the unit. This calls for absolute reliability and requires the best possible equipment to be used to avoid downtime that may impede any of the research programs," says Danie Gouws, Technologist of the laboratory.

"In the research laboratory reliability is of the utmost importance and means that the University will not compromise on quality and will procure the best, most suitable equipment that money can buy."

ETANORM PUMPS

This meant that through its learned-team, the University specified five Etanorm 50/32/250 pump sets with 3 kW, 2.2 kW and 1.5 kW motors respectively according to flow rates, required pressure and other requirements. With their proven reliability and unwavering performance, they were selected to accomplish the main pumping requirements of the complex system.

PLC- control ensure that all parameters are checked and balanced to ensure the system delivers fluid at the right temperature set points and flow conditions 24-hours per day, regardless of the number of students using the facility. It also ensures that ongoing and larger-scale research projects can be undertaken, including some cutting-edge research that is already being done in collaboration with other international Universities.

These include valuable research concerning Concentrated Solar Power (CSP) research, nuclear safety as well as micro and power-related electronics, heat exchange tubes and clean energy studies among others being carried out by 10 staff and 30 full time students including 10 PhD students, as well as a number of Master's Degrees students.

COMMITTED TO EDUCATION

KSB Pumps and Valves external sales representative, Dylan Mitchell, says the company was initially approached by Ascend Consulting Engineers to obtain data on the pumps. The company later revealed that a project was being undertaken for the University and that sponsorships were being sought.

"In this regard we are always ready to assist educational institutions and gave the thumbs-up to the project. Wherever technical assistance was required we were happy to weigh-in with our expertise, but must commend the University, consulting engineers and the contractors who worked tirelessly to deliver a world-class installation.

"As a result, we are proud to be associated with this prestigious project which lends itself to assisting future engineers to change the face of tomorrow. This is another feather in the KSB cap."

WATTSUP

OSMOSUN®40 unit with a capacity of 40m³ per day, operating with solar energy only, without batteries.

FIRST SOLAR POWERED DESALINATION PLANT LAUNCHED IN SOUTH AFRICA

The first highly cost-effective solar powered desalination plant in South Africa will be commissioned by the end of October 2018 at Witsand, Hessequa Municipality, Western Cape.

The project was initiated by Prof. Erwin Schwella, Professor of Public Leadership at Stellenbosch and Tilburg Universities with the Municipality of Hessequa. This project is co-funded by the Western Cape Government through the drought relief fund, and by the French Treasury, through a fund dedicated to the implementation of innovative green technologies.

In this Municipality 250km east of Cape Town, several coastal villages are suffering from a structural water deficit, even outside of drought periods. A site, part of Witsand village suffering from critical water shortages, was designated for the implementation of this first solar powered desalination unit. The plant will produce 100kl of fresh water per day powered by the solar energy only, to address the normal local water requirement. The plant offers the possibility to supply drinking water besides sunlight hours through the connection to the local electricity grid.

The feature will be specifically used to address the December holiday peak period with a daily production capacity increased to 300kl.

CUMMINS ISF ENGINE RANGE IS IDEAL FOR LIGHT VEHICLES

The ISF 2.8 and 3.8 litre four-cylinder engines are the latest additions to Cummins' extensive range of dependable engines, and are ideal for use in light commercial vehicles. Customers stand to benefit from exceptional performance and low operating costs, with the reliability and durability expected from Cummins, Sales and Business Development Manager Bo Fu (Bob) states, adding that the key environmental benefits of the range includes low noise and emissions.

The ISF engine family offers exceptional performance, low weight and operating costs, and improved durability. It has been developed specifically for light commercial applications such as trucks, vans, pick-up trucks, and utility vehicles. The high torque and power availability makes them ideal for weight-sensitive and space-constrained installations below 3.5 t Gross Vehicle Weight (GVW).

EXPERTISE AND QUALITY FOCUS SEE ACTOM TURBO MACHINES EXPAND

The ACTOM Turbo Machines fitting and inspection workshop.

The drive by end-users to achieve longer lifespans from rotating equipment and to reduce their total cost of ownership has seen many customers implement component refurbishment programmes instead of simply replacing parts. This has placed ACTOM Turbo Machines in the ideal position to provide a full spectrum of specialist services across a broad range of industries.

Chris Bezuidenhout, Managing Director of ACTOM Turbo Machines, says that it has a solid reputation for its depth of experience and expertise, and can point to an extensive reference base of completed projects.

"Our services cover a wide sector of industries that use similar equipment; however, turbo machinery is used differently in the varying applications and therefore requires both technical and application related expert knowledge when it comes to maintenance, servicing, repair and most importantly, refurbishment," he says.

"For instance, a mechanical drive turbine in a petrochemical plant driving a process compressor via a gearbox will need a vastly different approach to a turbine running a generator directly in a power plant."

Recognised as the largest privately owned non-OEM mechanical rotating machinery specialist in Africa, ACTOM Turbo Machines operates a comprehensively equipped facility in Sasolburg. Bezuidenhout says that everything from engineering work for general overhauls through to specialised repair and refurbishment work including the manufacture of components is done here.

The large CNC machining capability facilitates the rapid turnaround of work while the state-of-the-art laser measuring equipment enables the accurate measurement of all components ensuring the final quality in terms of tolerances and alignment.

All work undertaken at this 2000 m^2 operation, of which 1600 m^2 is under crane, is in accordance with ISO 9001 quality standards.

Mark Gulbis, project engineer at ACTOM Turbo Machines, is quick to point out that it is all very well to have access to the correct machinery and equipment, but what really differentiates it from others is that it can count among its people the most experienced turbine technicians on the continent.

WATTSUP

CCBSA TAPS INTO SUNSHINE

Coca-Cola Beverages SA (CCBSA) is going solar by installing rooftop solar photovoltaic units at 11 of its sites, with a combined installed capacity of 10.4MWp renewable energy once completed.

Under a 25-year power purchase agreement with the Mulilo Group, the plants will produce over 18 million kWh of renewable energy for CCBSA per year and realise substantial savings in electricity drawn from the grid, while cutting carbon emissions by 14 000 tonnes a year.

Coca-Cola Beverages Africa, of which CCBSA is the South African arm, has a deep commitment to sustainability and the environment. Its manufacturing facilities in South Africa and Africa continuously strive to reduce the consumption of energy and water and minimise their operational footprint.

CCBSA used 9.642 million kWh less electricity last year and has improved electricity usage per litre of beverages produced by 9.24% over the last three years.

Globally, renewable energy and solar PV, in particular, have made massive advances and a phased shift away from fossil-based fuels is now a key part of responsible business practice.

Mulilo is the largest South African-owned Independent Power Producer and has 500MW of wind and solar plants exporting power to the Eskom grid. Romano, a partner in the consortium that was awarded the project after a 24-month bid period that started with 31 bidders, is one of the leading commercial rooftop engineering, procurement and construction companies in South Africa.

Investec, through their Power and Infrastructure Finance (PIF) division, were the lead arranger for the transaction. Investec concluded a number of similar transactions both locally and internationally and is considered the financier of choice for off-grid solar portfolios.

DEHNGUARD WITH HIGHER RATED VOLTAGES

Lightning and surge protection specialist DEHN Africa, is proud to offer DEHNguard surge protective devices, especially for use in systems with higher rated voltages 400/690V. The requisite backup fuse is also integrated. This makes effective protection against over-voltages possible for a range of applications, for example, wind power and photovoltaic plants, traction and aerial railway systems and even cranes in industrial ports. Compared to conventional solutions with external backup fuses, the DEHN arresters with an integrated backup fuse save up to 60 percent space. The new DEHNguard SE CI minimises the risk of failure caused by over-voltages. These surge protective devices are not only designed to meet high electrical demands, but also to withstand heavy mechanical loads. Besides being suitable for high voltages, these DEHN arresters are resistant to vibration and shock.

ACCESS GUARDING AT FREEZING TEMPERATURES

The Leuze MLC 500 series safety light curtain's design is robust and compact.

Access guarding in refrigerated applications can pose challenges if the sensing solution selected is not fit-for-purpose. Factors such as temperature range and ambient temperature need to be taken into account.

Countapulse Controls, the official distributor of Leuze sensing solution, offers a safety light curtain specifically engineered to cope with low temperature ranges.

The Leuze MLC 500 series safety light curtain is particularly suited for use in refrigerated areas including cold storage facilities where ambient temperatures can be as low as minus 30°C. The safety light curtains' design is robust and compact making it suitable for installation in confined areas and those where forklifts or wheeled materials handling equipment is being used.

When coupled with Leuze's Smart Process Gating technology, this safety light curtain offers a reliable system design which completely eliminates the need for signalling sensors. This makes the access guarding system simpler not only to install but also to operate, and costs associated with maintenance and servicing are also reduced. Configuration and installation of the Leuze MLC safety light curtains is easy and can be done without PC. Models are available with resolutions from 14 to 90 mm and protective field lengths from 300 mm to 3 000 mm.

Countapulse Controls is able to offer a wide range of sensing solutions for a myriad of applications not only within the food and beverage sector, but across a wide spectrum of industries.

BLACK BEARD OPENS NEW OFFICE IN DUBLIN, IRELAND, PROPELLING GLOBAL GROWTH...

Having been in business for less than two years, South African technology startup Black Beard recently opened its fourth office in Dublin, Ireland. With a presence in Johannesburg, Pretoria and Cape Town, the new Dublin office (situated nearby the famed Dublin Docks) affirms Black Beard as a truly global player within technology innovation. The startup, founded by a core team of developers, builds innovative solutions within existing markets by displacing earlier technology, solutions or business models.

FIFTY YEARS OF POWERING THE WORLD

Schneider Electric is celebrating 50 years of automation transformation, with its invention in 1968 of the first PLC (Programmable Logic Controller). Prior to the introduction of the PLC, the level of real-time measurement and control was limited to the most basic levels due to technology constraints.

"On the 50th anniversary of the invention of the first PLC, it would be hard to imagine where our industry would be today without the PLC system. It is used in transportation, manufacturing, energy management and so many other industries. I am proud to have such a legacy be part of Schneider Electric's DNA," says Schneider Electric chairman & CEO, Jean-Pascal Tricoire.

The invention initiated the effective use of digital computer technologies in industrial automation, which triggered a massive transformation to the pervasive use of digital technology to deliver industrial measurements, controls and real-time information management.

The use of digital technology introduced capability well beyond basic measurement and control to expand control system functionality by utilising the compute power of the innovative technology. Today the use of digital technology is so pervasive that new engineers find it almost impossible to imagine an industrial automation world without it. However, it is important to take a step back every occasionally, to remember the achievements that made our current capabilities possible and this is one of those times.

Throughout the fifty years following the invention of the PLC, the capability expansion delivered by automation systems appears only to be limited by human imagination.

The investment case for renewable energy

There has been a strong investment case for renewable energy worldwide for a number of years now, and this case has significantly gained momentum in the last two years. South Africa too has indicated a robust appetite for the uptake of renewable energy, not just at a macro, but also at a residential, commercial and industrial level.

BY | JUSTIN SCHMIDT | HEAD OF RENEWABLE ENERGY AFRICA
ABSA RETAIL AND BUSINESS BANKING

Much of the initial demand was driven by heightened interest following the widespread load shedding that was experienced across the country in 2008, and continues due to the sharp increases in electricity tariffs. Consumers and businesses alike began to search for ways to become more energy independent in order to mitigate the risks of being caught without electricity and initiate cost-cutting measures by hedging their electricity costs. While the actual solution, and costs thereof, may differ somewhat between households and businesses – be they small, medium or large – the underlying motivation remains the same: being the 'energy efficiency journey', an energy journey that has the additional benefit of cutting down on the environmental footprint.

Solar, in particular, has taken off as a viable and affordable way of delivering power both to households and enterprises. This is due to the abundant sunshine that Southern Africa receives: it has one of the highest solar radiation rates in the world, making investment into this form of energy a logical proposition and one that is not dependent on subsidies.

Within the solar landscape, there are a variety of options available and certain trends have emerged in the residential and commercial markets. Solar water heating is a popular option for households for its relative affordability and quick payback period, and it has seen bigger uptake than Solar PV residentially. Solar PV though is a growth area commercially, particularly for shopping centres, manufacturers, wholesalers and the agricultural industry.
There has been much interest and uptake around renewable energy from businesses in a variety of sectors. As a bank, we have approved funding for a number of dynamic deals in the past few months including pack-houses, meat wholesalers, and pig farmers.

While businesses tend to look at investment indicators such as Break Even, Internal Rate of Return and Net Present Value, they often take a view on their energy costs against the cost of loan repayments. If funding is structured correctly, customers have not only seen their Solar PV production in cost parity with the electricity they're offsetting, but also realise a cash flow neutral position by borrowing to fund this investment. This investment case is further supported by the fact that installations of less than 1 megawatt (MW) can be depreciated in one year for tax purposes.

This is only one of many examples of a Solar PV installation that is responding to energy demands and moving businesses – and individuals – from utility to own production. Growth of these renewable energy solutions will undoubtedly spur on industries across Southern Africa and the continent. The SSEG (Small Scale Embedded Generation - < 1 Megawatt installations) are now required to register their installations but do not need a license following schedule 2 of the Electricity Regulation Act being gazetted last year.

We have seen greater interest from our customers in Solar PV which is being driven by a strong investment case. As this move by household and businesses continues to ramp up in South Africa, we will see the implementation of more innovative and seamless solutions that enable households and businesses to unlock the potential of cleaner energy.

As such, banks and financial services providers across the continent ultimately need to focus on building value propositions that allow their customers to harness the prospects that renewable energy provides by making household and business operations more cost-effective and energy efficient. wn

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ELPA welcomes new National Director

South Africa's Earthing and Lightning Protection Association (ELPA) has a new national director, effective 1 June. Outgoing ELPA national director Trevor Manas has tendered his resignation after completing a three-month hand-over period with his successor, Richard Evert, an existing ELPA board member.

From left: Richard Evert ELPA National Director and Trevor Manas ELPA former National Director.

Manas was elected National Director of the ELPA board at the organisation's official launch in June 2017, while at the same time, Evert was elected to represent Eskom, one of the ELPA affiliates, on the Board. Manas' previous term was due to expire on 31 December 2017. Due to continuity needs, he agreed to have this employment period extended by four months, during which time he assisted with the transitional period of Richard Evert, at Eskom. Evert served Eskom for 28 years in the capacity of Senior Research Consulting Engineer and specialised in power system lightning performance management over the last 13 years.

Manas comments, *"I remain committed to the well-being and goals of ELPA and will continue to remain active within the association, assisting Richard where required, and also managing and adjudicating the lightning protection designer accreditation course."*

Evert adds, *"Having already been associated with ELPA as a board member since inception, I am looking forward to taking on this new role as national director. Trevor and I have established a solid working relationship and we share the same goals in moving ELPA forward as South Africa's national professional body for the lightning protection industry. Our motto – certainty through compliance – supports the overall goal of protecting lives and property from the potentially deadly effects of this awe-inspiring yet potentially deadly natural phenomenon.*

"We are acutely aware of the importance of facilitating the relationships between the industry's service providers, and service providers and end-users, as well as advancing lightning risk knowledge in communities, developing skills through our tertiary education institutions, escalating our continental support infrastructure and building weather tracking capacity.

Our recent participation in the annual ULPA/LPI conference in the United States has given us food for thought, including assessing more sustainable business models and proactive standard operating procedures to support and strengthen the industry. Lightning Protection technology and its installation is a specialised discipline, and we will endeavour to build ELPA towards a national all-encompassing body for South Africans.

"It is imperative that we do not under-estimate the damage done by lightning and the concealed nature of the transfer of electricity and charge. The danger lies in our complacency and short-term cost cutting. Insurance companies bear the brunt of the asset and property losses and families bear the brunt of human losses. It is ELPA's goal to oversee the reduction in fatalities and loss of property in South Africa. To achieve that we need the support of the entire South African community. It is my intention to mobilise all able bodies to that end."

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Renewed impetus in SA's energy renewable journey

The signing in April of 27 Power Purchase Agreements (PPAs) worth R56 billion has finally resolved the lengthy renewable energy (RE) impasse in South Africa and demonstrates renewed impetus in the country's RE journey. It is the initial step of the Department of Energy's new, clear RE roadmap, which has brought much needed certainty to national energy policy and will fast track investor confidence and boost growth in the economy.

This is according to Herman Kriel, Group Managing Director for Brand Engineering SA (Pty) Ltd, specialist electrical engineering contractor.

It is responsible for the generation of 472 MW of power for the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) projects and related RE initiatives.

"An integral element of the DoE's REIPPPP is the generation of local employment opportunities. Furthermore, it serves to promote transformation, ensure participation by Black industrialists and increase Black business ownership," says Kriel.

"The signing of the PPAs and ensuing long awaited implementation of bid windows 3.5 and 4 will create approximately 60000 new jobs over the next three years. The new, clear RE roadmap will help leverage a key objective of the National Development Plan (NDP) which is to grow an inclusive economy."

The majority of the projects are expected to reach financial closure in the coming few months, with some having closed shortly after the PPAs were signed.

Having carried out the highest number of utility scale solar RE initiatives in South Africa, Brand Engineering, together with Besamandla, is geared for the implementation of the revitalised REIPPPP projects.

The organisation has become a key construction partner for RE developers and Integrated Power Producers (IPPs), to which it offers a one stop service. It carries out balance of plant (BOP) engineering, procurement and construction (EPC) on solar fields; electrical EPC on wind farms; full EPC on grid connections as well as electrical, control and instrument (ECI) installations for Concentrated Solar Power (CSP).

Brand Engineering is also undertaking a number of battery storage initiatives. *"The use of battery storage systems to provide consistent solar power output and manage peak loads is a big game changer for RE,"* Kriel contends.
"The decreasing costs of these batteries and other RE technologies are in turn further reducing RE costs."

A battery storage project Brand Engineering recently completed is that of an off-grid battery system at the Kruger National Park, which is one of the largest energy storage systems in the southern hemisphere. It is able to store 1780kWh worth of electricity and supply 410kW worth of peak power.

"Brand Engineering is the only South African contractor with experience and exposure to all types of RE technologies for commercial and utility scale," states Kriel. *"We bring our resources and knowledge of the latest technology to improve and ultimately benefit the developer, and we guarantee specified power generation, output and carbon savings for the projects in which we are involved."*

It is fully compliant with the REIPPPP's socio-economic requirements and in fact has historically exceeded stipulated targets for local employment. *"Employing local workers, transferring and developing skills and uplifting the communities in which we work are integral to our company mission and have resulted in a track record reflecting positive labour relations, which is of benefit to all parties concerned."*

According to Energy Minister, Jeff Radebe, local community shareholding in the newly signed projects amounts to 7.1% of the total value, which amounts to an impressive R1.63 billion. wn

Clean Coal is the way to power Africa

Donald Trump can talk about "beautiful clean coal", but South Africa may be years ahead of the United States in achieving the dream.

BY I GEOFF HILL

Professor Rosemary Falcon heads the Sustainable Coal Research Group at the University of the Witwatersrand (Wits) in Johannesburg, where the late Nelson Mandela studied law in the 1950s.

Falcon leads a team of nine academics along with 20 Mastersand doctoral students who, with their own laboratory at Wits, say they have proved conclusively that clean coal is not only possible, but among the cheapest ways to generate electricity on a continent where more than 600 million Africans live without power.

"It starts by understanding that coal varies enormously," she said.

"Each region has a different recipe of minerals and fossil matter, and if you give me a lump of coal out of Kenya, the US, Europe, India or Colombia, I can probably tell you where it's from."

In North America, she said, coal was formed in hot, steamy swamps, and it burns rapidly. Ours was formed at the end of an ice age and burns for longer and at a higher temperature.

"An industrial boiler from Europe, fed with South African coal, will melt because our product burns so hot. But we also have more ash that actually absorbs heat, making the fire less efficient. So one of the first steps is to alter the coal before you light the fire. Or build a boiler designed for each coal type."

Working with Falcon is Dr Nandi Malumbazo who took her PhD in chemical engineering at Wits.

"In Africa, the use of coal is growing and that's something we have to deal with," she says. *"The challenge is to burn it more cleanly and this starts at the mine with techniques we've developed to separate poor quality coal from the better stuff that is already less toxic.*

"You then crush it and remove elements that will not contribute to a good burn. Like unleaded petrol, you're starting from a better place. Less ash, less fumes, more heat and a longer burn. From there we've done experiments and written up peer-reviewed research to show we can use it way cleaner than in most countries."

South Africa gets more than 90% of its power from coal, in Botswana it's 100%, and both Kenya and Tanzania are building new coal-fired generators.

The Wits research has drawn praise from across the continent. Dr Samson Bada of Nigeria has joined the team, along with Dr Jacob Masiala from the Democratic Republic of Congo. Both are working on ways to get the lights on in Africa and keep the air clean. There are also post-graduate staff and students from Zimbabwe, Botswana and Mozambique.

"If we mix pulverised coal with bamboo, something that grows well in Africa, we take emission levels down even further," said Masiala.

"Of course, a bamboo plantation also gives you carbon credits, and we can grow it on old mine sites to rehabilitate the ground. It's a winner on so many fronts."

West Africa has a low grade of coal, formed more recently than elsewhere though still millions of years old. But while Nigeria is Africa's largest oil producer, only half the population is on the grid.

"Air pollution is a serious problem in my country," said Bada.

"We must bring it down but we also need a lot more clean electricity. The research we are doing here can change everything."

However, for all its groundbreaking work, South Africa's clean coal is in trouble.

"Funding has been difficult," said Falcon.

"We have to scrape and beg for every cent. I'm hoping a new approach to coal in Washington will see money for work like ours, not just in the US but across the globe, and we'd be happy to share our findings with the world, and to teach and train people everywhere, especially in Africa," she said.

Falcon and her team have indeed shared their findings. She has given lectures at prestigious schools like Cambridge University in England, while Nandi Malumbazo has been to Germany, Australia and the Philippines.

Bada and Masiala have delivered papers in the US, Norway and Italy.

Clean Coal

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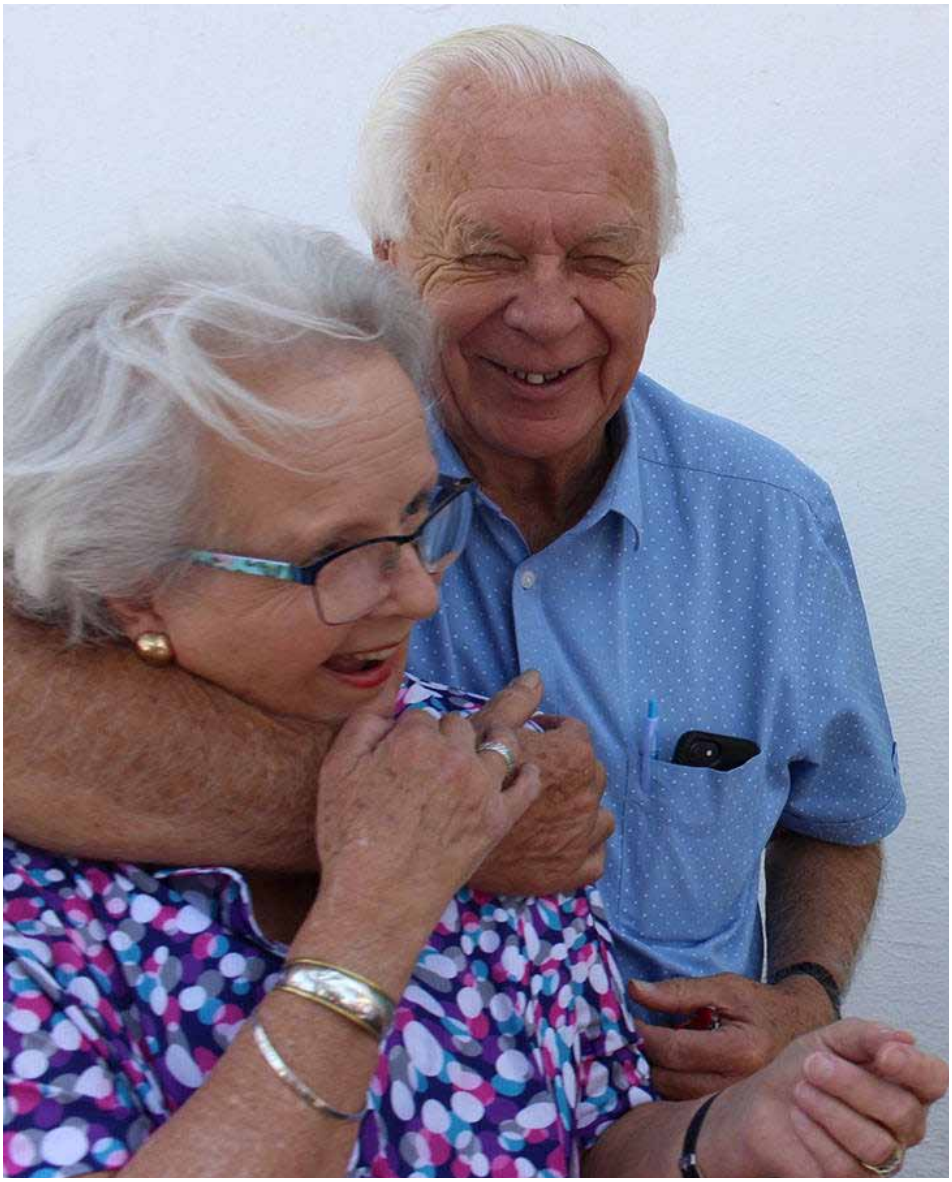

Professor Rosemary Falcon and her husband, Lionel, a retired engineer 'who helps me understand how to apply our science in the real world'. Photo: Geoff Hill

The use of coal to generate electricity in Africa is at a record high, with new plants under way in Kenya, Tanzania, Botswana, Mozambique and South Africa. Bada has little time for those who condemn this.

"I am tired of being lectured by people in rich countries who have never lived a day without electricity," he said.

"Maybe they should just go home and turn off their fridge, geyser, their laptops and lights. Then live like that for a month and tell us, who have suffered for years, not to burn coal."

Masiala agrees.

"Aid groups come to Africa and give out solar lamps the size of a pumpkin," he said.

"But no one in London or Los Angeles would be willing to make do with that. Don't tell me that China, Russia and the West should have electricity and black people in Mali or Mozambique should live in huts with light from a solar toy. We need power for cities, factories, mines and to run schools and hospitals."

The coming revolution in Africa, he said, was not about land, religion or politics, but a lack of jobs.

"Africa is urbanising faster than anywhere on the planet. And our urban youth are on the same Facebook and WhatsApp as kids in Chicago. They watch the same Big Bang Theory on TV and have the same aspirations."

Millions of school leavers, he said, can read and do algebra but have no work. And the lack of industry, he said, was linked to electricity.

Bada said he was a fan of wind and solar, but the technology was not yet there to industrialise a continent.

"Solar doesn't work at night, and turbines stand idle when the wind doesn't blow," he said.

"How do you run an operating theatre with that? How do you power a city, a school, the lift in a gold mine taking workers more than two miles underground? There has to be a baseload power supply and this can be complemented with solar. The industrial revolution and the growth of China and India has all been powered by coal. The good news is we can now burn it cleanly."

Bada said thousands of power stations around the world are still pumping out emissions from coal when it was possible to make them clean.

"What holds up the process is not a lack of knowledge, but funding and political will. And every day we live with the status quo, people are forced to breathe dirty air. That is tantamount to a crime against humanity if we have the science but do nothing."

African countries, he said, needed a massive jump in the amount of power they generate.

"Tanzania, for example, has around 70% of its people still short of electricity while it sits on four billion tons of coal. And still we hear activists from wealthy countries chanting, 'Leave it in the ground.'

"Electricity in Africa is not just an ethical issue, it's the key to security and growth. It's having no work and no hope that sees people forced into poverty, joining militia or heading for Europe," he said. *"The rich world ignores that at its peril."*

The Wits faculty wants to build an Academic Clean Coal Alliance, or ACCA, a global network of researchers.

"Whether you're an engineer, a geologist or a doctor of physics, if you share a passion for clean coal, you're welcome to join us," Falcon said.

"Our concept is for a politically neutral group to include those in countries in Africa, India and as far afield as Russia, the US, Britain, the EU and anywhere else," she said.

Falcon said she was working on sponsors and funding for the alliance which, while academic, would offer associate membership to industry, government and the media.

If there's one thing that angers everyone at the faculty, it's those who say clean coal is a myth invented by Donald Trump and his allies in business.

Falcon said they were either in denial or unaware of the truth.

"Tell me there's no such thing as unleaded petrol or painless dentistry and maybe I'll hear you out when you chant, "There's no such thing as clean coal," she said.

"In our grandparents' time all that was true, but today we have options. Fat-free yoghurt and cosmetics not tested on animals. And we have clean coal, provable, peer-reviewed and with experiments that can be replicated in any lab.

"Here in South Africa, we are long past the stage of proving clean coal. Now we're looking at how to apply it, and especially for the coal types in Africa."

The science, she said, was there.

"Clean coal is a reality. And we must start using it now to make a better world." wn

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Electricity Consumption in South Africa

COMPOSITION, KEY DRIVERS AND THE OUTLOOK

Over the past 30 years, the South African economy has gradually transitioned away from its historical dependence on relatively energy-intensive mining and manufacturing sectors towards a more diverse, and increasingly services-related range of activities. In this article, we examine the factors that influence electricity consumption in South Africa. These include - the nature and pace of economic growth, the trend in real electricity prices, the evolution and adoption of more energy-efficient process and technologies and supply-side surpluses or constraints. This article provides an overview of the historical trend in electricity consumption in South Africa, the changing composition of electricity sales by sector, critical determinants of demand, methods of decomposing demand, and a brief analysis of the medium-term energy demand outlook.

ANALYSIS OF THE STRUCTURE OF THE SA ECONOMY

The South African economy has a large and well-developed services sector which accounted for just over two thirds (67%) of GDP in 2015, while mining, manufacturing and construction contribute the bulk of the remaining third.

While the World Bank classifies South Africa as an upper middle-income country, its economic structure mirrors that of a high-income nation

which typically has a dominant services sector that accounts for more than 66% of national output.

Over the past 30 years, the South African economy has continued to transition away from its historical reliance on the relatively energy-intensive mining and manufacturing sectors towards a more diverse range of service-oriented activity. In 1975, the primary and secondary industries (mainly mining, manufacturing and construction) accounted for almost half of GDP (45%), while today they contribute just under a third of GDP (30%) (Figure 1).

Financial and business services activity expanded from 13% of GDP in 1975 to 22% of GDP in 2015 – the sector is now the single most significant contributor to national output. The contribution of transport services also increased notably

Electricity Consumption

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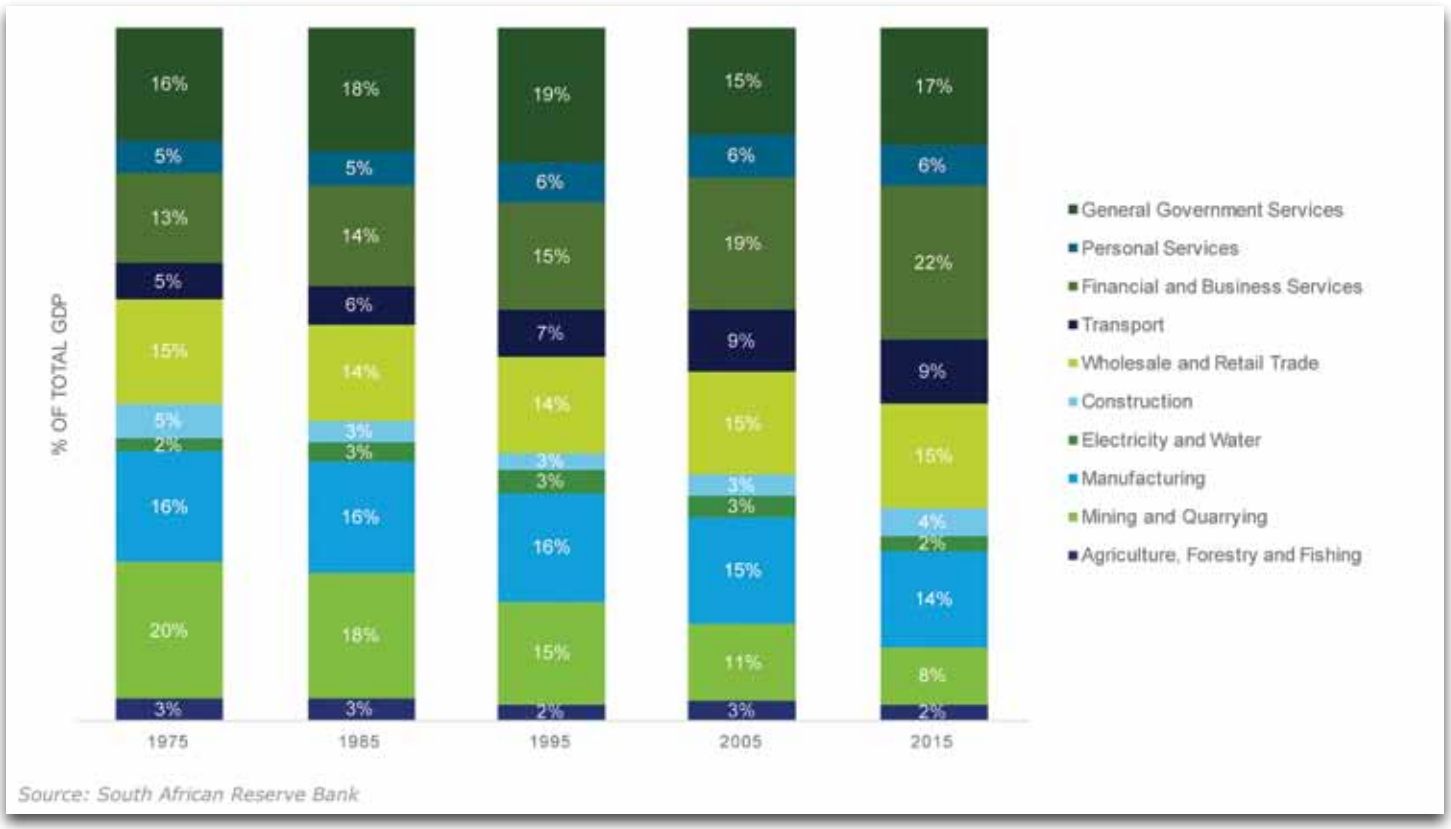

Figure 1: Evolution of the South African Economy, 1975 - 2015.

from 5% of GDP in 1975 to 9% in 2015. By contrast, the mining sector's share of GDP declined from 20% in 1975 to just 8% in 2015; the manufacturing sector fell from 16% to 14% of GDP over the same period.

NATIONAL ELECTRICITY CONSUMPTION BY SECTOR

TOTAL ELECTRICITY CONSUMPTION BY SECTOR

Data compiled by the Department of Energy (DoE) on South Africa's national energy balances shows that mining and manufacturing were responsible for just under two-thirds of South Africa's total electricity consumption (62% in 2012). The iron and steel industry alone is responsible for 10% of complete waste; non-ferrous metals industry (aluminium) consumes a further 9%, and chemical industries an additional 6%. Households in South Africa are responsible for 20% of total electricity consumption while commercial and government services in aggregate are responsible for a further 15%. This trend in electricity consumption by a relatively small group of energy-intensive manufacturing and mining industries, therefore, has a significant bearing on the overall direction in electricity demand in South Africa.

HISTORICAL TREND IN ELECTRICITY CONSUMPTION BY CUSTOMER CATEGORY

A 20-year series of electricity consumption shows that industry (both manufacturing and mining) has historically been the dominant consumer of power with its share of total national consumption varying between 52% and 63% over the period (Figure 3). The contribution of the residential or household sector to total consumption rose consistently from 16% in 1993 to 20% in 2013. The growth in household consumption is partly attributable to the DoE/Eskom household electrification programme which saw an additional 5.7 million households connected to the grid between 1994 and 2013/14. Rising average household incomes are also likely to have contributed to the consistent increase in demand from households relative to other sectors.

ELECTRICITY INTENSITY BY SECTOR

The electricity intensity of an industry can be defined as the amount of electricity consumed (e.g. in kWh) to produce a given unit of output (e.g. GDP in R). The electricity intensity of different sectors

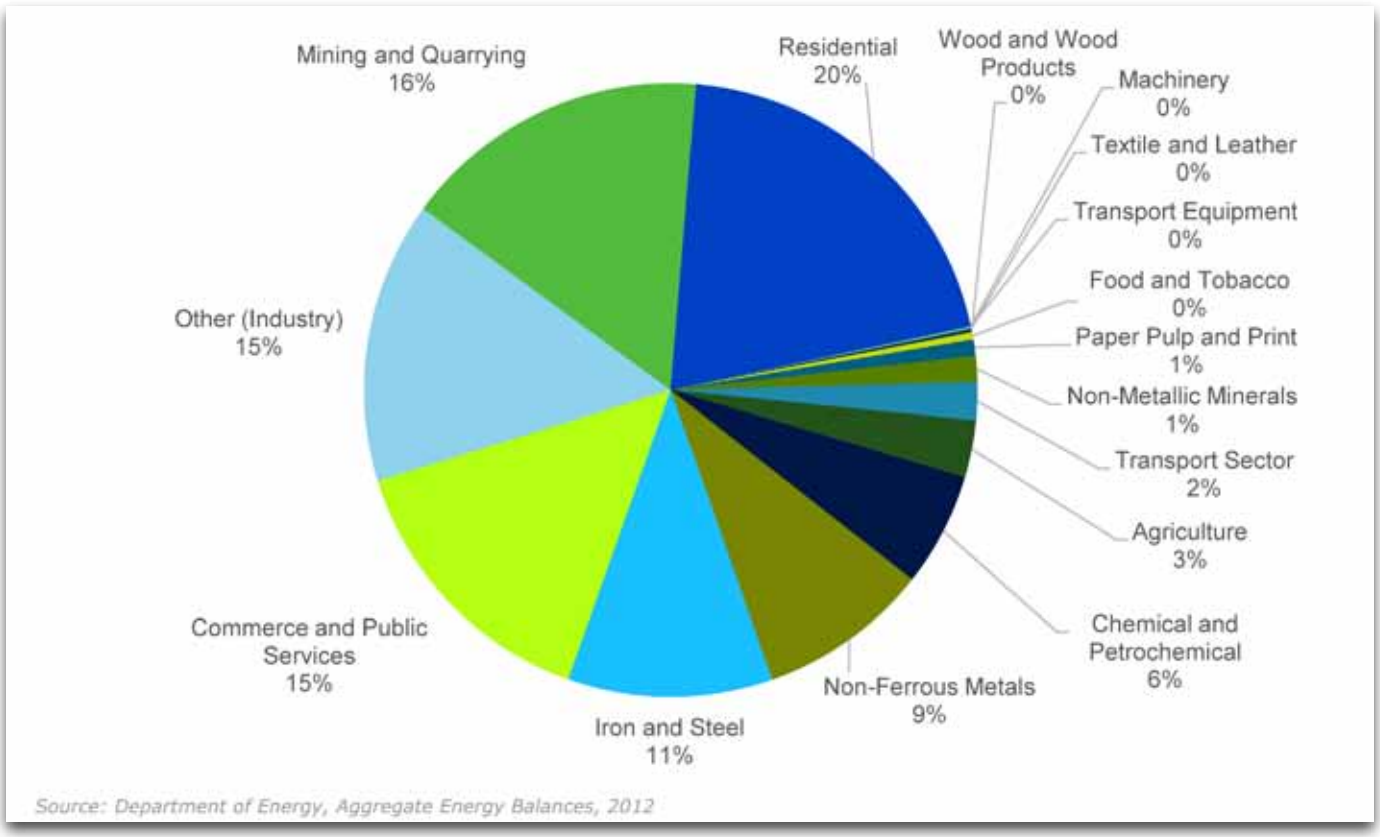

Figure 2: Electricity Consumption by Sector, 2012.

is not readily available because while the DoE reports electricity consumption by industry, these do not align with sector GDP numbers reported in the relatively aggregated national accounts.

We derived estimates of the electricity intensity of each sector by matching consumption data from DoE for 2012 to more disaggregated forecasts of industry GVA (gross value added) reported in Quantec's 2012 social accounting matrix. The results, presented in Figure 4, suggest that the non-ferrous metals industry is by far the most electricity-intensive in the South African economy - consuming 4kWh of electricity for every unit of GVA generated in 2012. Other sectors/industries that emerge as relatively power-intensive include 'other industry (other types of manufacturing activity)', iron and steel, chemicals and mining (Figure 4).

KEY DRIVERS OF ELECTRICITY DEMAND

Several factors influence the demand for electricity these include: the price of electricity, growth in the level of economic production or output, population growth, weather patterns, and technological change.

As is the case for most commodities, two of the fundamental drivers of the demand for electricity at a macroeconomic level are income and price. Rising levels of economic activity or national income are usually associated with increased demand for electricity (and energy more generally) while raising electricity prices tend to reduce consumption (by incentivising firms and households to use electricity more sparingly and more efficiently and to substitute electricity for cheaper alternative energy sources).

Other factors that have been identified in the international literature as having a significant influence on aggregate demand for electricity are the energy intensity of economic growth and the impact of technological change. Because the electricity intensity of production varies considerably from one sector to the next, changes in the structure of an economy can have a significant bearing on the longer-term trend in electricity demand.

The energy intensity and more specifically electricity intensity of an economy typically increase as a country industrialises, and

Electricity Consumption

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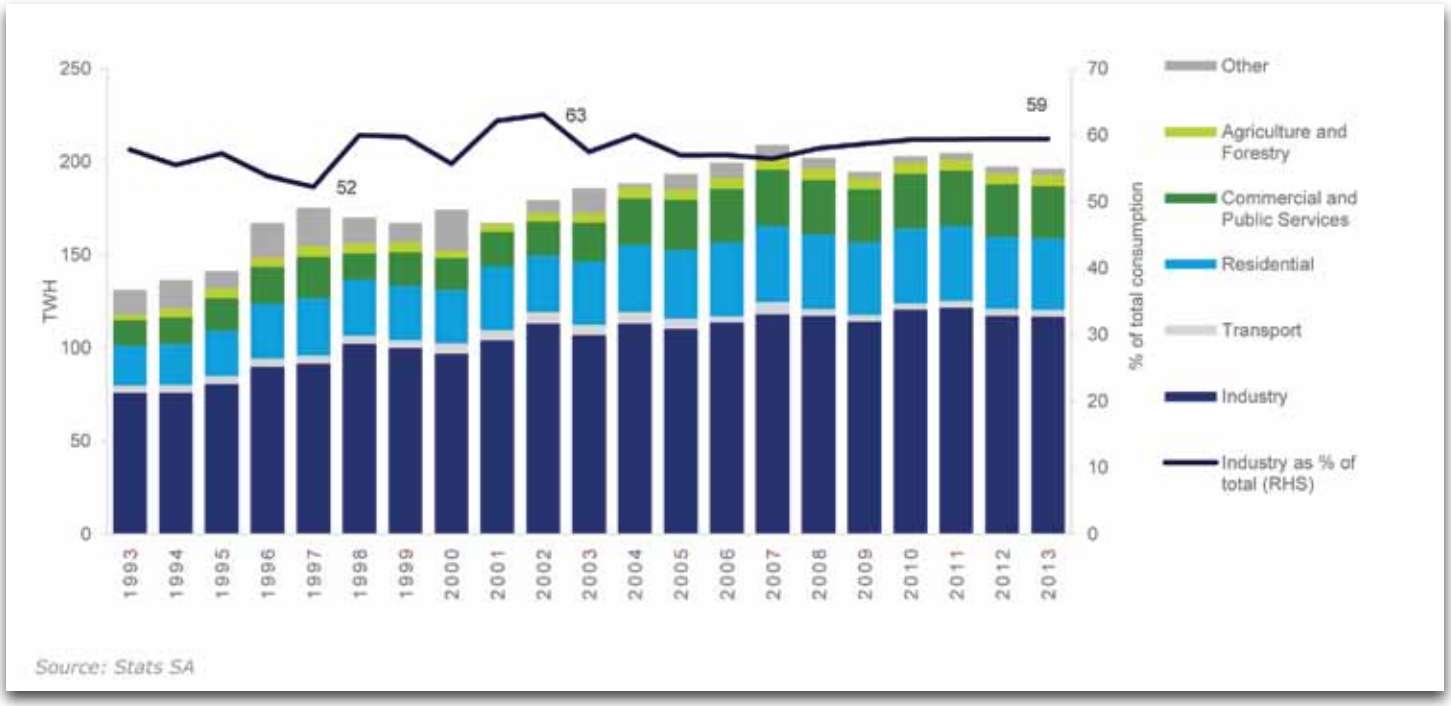

Figure 3: Trend in electricity consumption by customer category, 1993 - 2013.

the contribution of relatively electricity-intensive manufacturing activities grows. Conversely, electricity intensity declines in the post-industrial phase where economic growth is increasingly based on demand for services such as banking, education, health.

Changes in technology have also been found to have an essential influence on electricity demand, but there is some tension between technological factors that increase versus those that decrease demand.

On the one hand, technological advances, such as the advent of the electric vehicle give rise to entirely new sources of electricity demand. On the other hand, the emergence and substitution of more electricity-efficient alternatives to traditional technologies such as LED lighting vs incandescent bulbs, generate energy savings and reduces both the electricity-intensity of economic activity and aggregate demand for power.

INTERNATIONAL LITERATURE ON THE DETERMINANTS OF ELECTRICITY DEMAND

In practice, it is difficult to distinguish the influences of these key factors on electricity demand as they are interrelated - price and technological change, for example, both affect the uptake of more electricity-efficient technologies, which in turn can influence the energy-intensity of economic growth.

PRICE AND INCOME ELASTICITY OF ELECTRICITY DEMAND

In the international literature on the determinants of electricity demand, some studies focus on isolating the impact of electricity prices versus income. A survey by Deloitte (2009) on the price elasticity of electricity demand in South Africa provided a summary of price and income elasticities reported in 44 studies focusing on 12 countries. Deloitte found that there was considerable variation in the price elasticity reported across the 44 studies with estimates ranging from close to zero to -1.5. The simple average across the 44 studies however was -0.3 and most of the long-term elasticity estimates tended to be between -0.2 to -0.4. Suggesting that a 1% increase in prices would most often be associated with a 0.2 to 0.4% decrease in demand.

Most of the studies reporting that the price elasticity was elastic (greater than -1) were conducted in the 1970s and may represent factors particular to that period. The authors cautioned that the studies differed significantly concerning the methodology, the timeframe and data set used, the industry/sector examined and the country in question.

Concerning the impact of income, Deloitte (2009) noted that only 23 of the 44 studies

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Electricity Consumption

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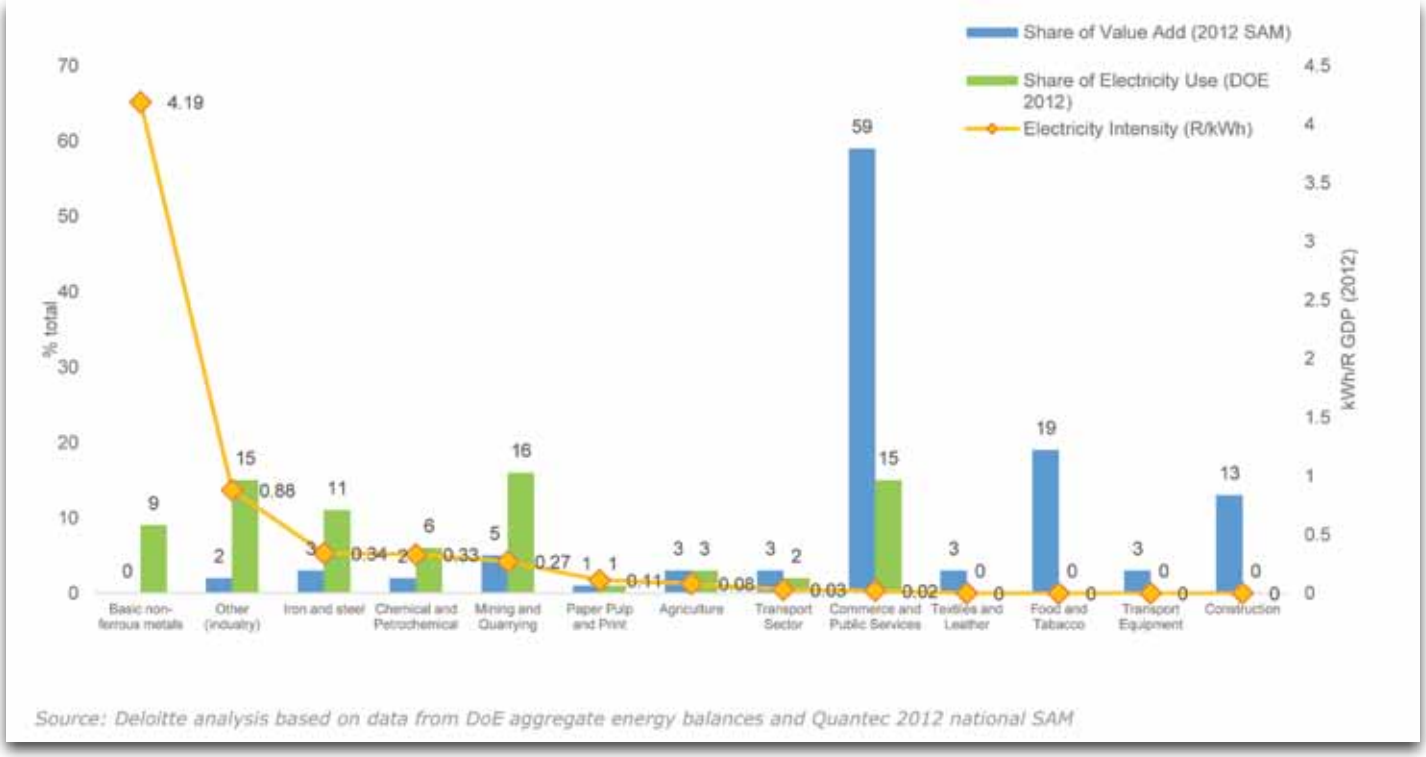

Figure 4: Estimates of the electricity intensity of selected sectors, 2012.

reported income in addition to price elasticities but that across the 23 surveys, estimates of income elasticity of electricity demand ranged from zero to 1.6, with most falling in a band of 0.8 to 1.1. Meaning that a 1% increase in income or GDP would typically be associated with a 0.8% to 1.1% increase in electricity consumption.

The results in aggregate suggest that electricity demand is generally more responsive to income than to price and that income is, therefore, the more dominant demand driver.

A more recent survey of 12 international and 10 South African studies on the price elasticity of electricity demand found once again that there was a considerable variation in estimates of price elasticities which range from statistically insignificant influence (no influence) to -1.7. The authors note that the studies employed a range of times series and panel data methodologies with some focusing on a single region and other groups of countries.

The South African studies reported various conclusions from no effect of price on consumption to profoundly negative price elasticities of around -1. The corresponding income elasticities were not reported.

Blignaut, lnglesi-Lotz and Weideman (2015) suggest that based on the literature, it can be inferred that the sensitivity of consumers to tariff changes is dynamic, that it changes over time-based on the prevailing conditions in a country's electricity market and that it also differs from region to region.

DECOMPOSING DEMAND INTO ACTIVITY, STRUCTURAL AND EFFICIENCY EFFECTS

The International Energy Agency methodology (IEA, 2013) for analysing energy or electricity end-use trends attempts to quantify the relative contributions of the following three key drivers or components of electricity demand:

(i) Activity effect: the change in demand due to the shift in economic activity– gross value-added (GVA) is the measure of economic activity for manufacturing industry and other sectors.

(ii) Structural effect: the change in demand due to a change in the mix of economic activity or areas within an economy.

(iii) Intensity or efficiency effect: the shift in demand due to change in energy use per unit of sectoral activity.

At a country level, the activity effect (equivalent to the income effect) is measured in terms of gross-value added or GVA per sector. It is calculated as the relative impact that aggregate economic activity would have had on energy use had the structure and energy intensities of the industry remained constant. The structural effect is isolated by assuming constant economic activity and energy intensity but allowing the structure to vary. The energy intensity effect, which is used as a proxy for changes in energy efficiency, separates out how changing energy intensities influence energy consumption for a sector. While this decomposition approach does not isolate the impact of electricity prices on demand, this is captured to some extent in the intensity effect as firms may respond to price by either becoming more energy-efficient or by reducing production.

The energy intensity effect is estimated by assuming the sectoral structure and economic activity in each sector remain constant while energy intensities can follow their actual development.

A study by Zhang and Wang (2013) is an example of how the IEA approach is applied to determine the influence of these three factors on electricity demand in China. Since the study focuses specifically on electricity demand (rather than total energy demand) the impact of an additional element - 'the sector electricity share in total energy demand' is also measured. In keeping with the findings of studies on the income elasticity of electricity demand, they found that economic activity was the dominant driver of electricity demand in China between 1991 and 2009; and that its impact (as a proportion of the net change in demand) varied between 64% and 250% in any given year. The other significant drivers were the sector share effect and the intensity effect. The sector electricity effect captured the positive impact on electricity demand of firms substituting away from dependence on other energy sources towards electricity.

This was responsible for 30% of the variation in demand of the period and was particularly significant from 1996 to 2001. The intensity effect was the dominant effect in decreasing electricity consumption over the period. The accumulated effect accounted for -35% of the total electricity change in absolute value. The electricity efficiencies achieved are thought to be the result of the extensive application of energy-saving technologies by firms over the period.

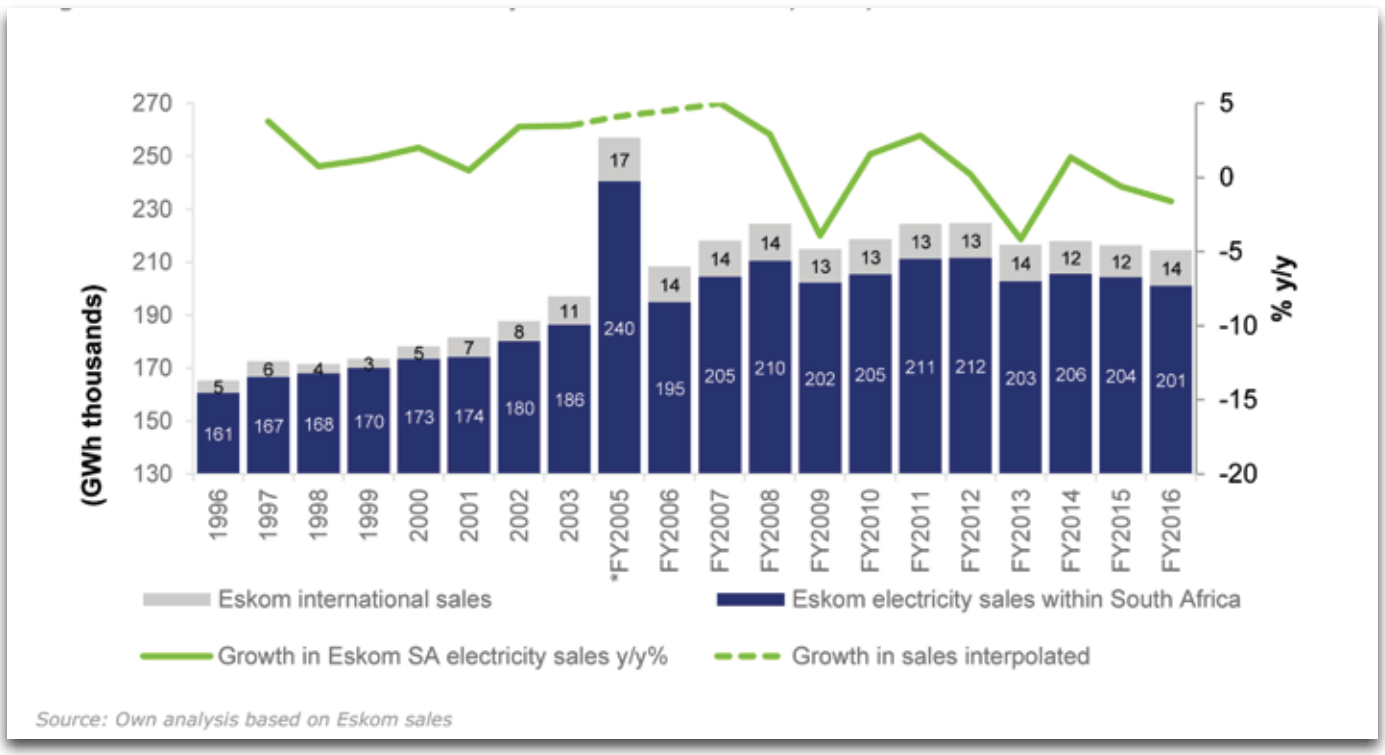

Figure 5: Historical trend in electricity sales in South Africa, GWh, 1996 to 2016.

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DRIVERS OF ELECTRICITY DEMAND IN SOUTH AFRICA

HISTORICAL TRENDS IN ELECTRICITY CONSUMPTION

Figure 5 depicts the 20-year historical trend in Eskom's annual and total sales of electricity in South Africa. Since Eskom generates roughly 95% of electricity consumed in South Africa, the trend in Eskom sales is a good proxy for the trend in national electricity sales (which are not widely available). The annual data is presented in financial years, and because of a change in Eskom's fiscal year in 2004, data for FY2005 covers 15 months (instead of 12) and must be therefore be viewed as an outlier.

Electricity sales in South Africa increased consistently from 1996 to FY2008 - growth in sales slowed to a period low of 0.5% year-on-year (y/y) in 2001 as the South African economy entered recession but gained momentum after that peaking at 5% y/y in FY2007. In early 2008, South Africa experienced a series of highly disruptive power outages as Eskom began a programme of load shedding in response to a shortage of generating capacity. About nine months later, the emerging global financial crisis reached a zenith with the collapse of Lehman Brothers and the global economy plunged into recession. Eskom sales contracted by close to 4% y/y in FY2009 as the combined impact of the global financial crisis and domestic power constraints hampered growth in local economic activity and pushed the SA economy into recession. By FY2011 Eskom's domestic electricity sales had recovered to pre-recession levels but in FY2013 electricity sales fell by ~4.2% as a sharp fall in the global demand for commodities hit production in South Africa's relatively electricity-intensive mining and manufacturing industries. Eskom's sales of power to these sectors in FY2013 contracted by between 3% y/y and 12% y/y respectively.

After recovering somewhat in FY2014, electricity sales in South Africa contracted slightly in both FY2015 (-0.6% y/y), and FY2016 (-1.6% y/y) as GDP growth slowed (to below 2% y/y) and supply constraints also put a brake on demand as Eskom re-introduced rotational load shedding. Eskom re-introduced load shedding in early 2014, and there was regular load shedding between November 2014 and September 2015.

PRICE AND INCOME ELASTICITY OF ELECTRICITY DEMAND IN SA

As discussed, a wide range of empirical studies on the determinants of electricity

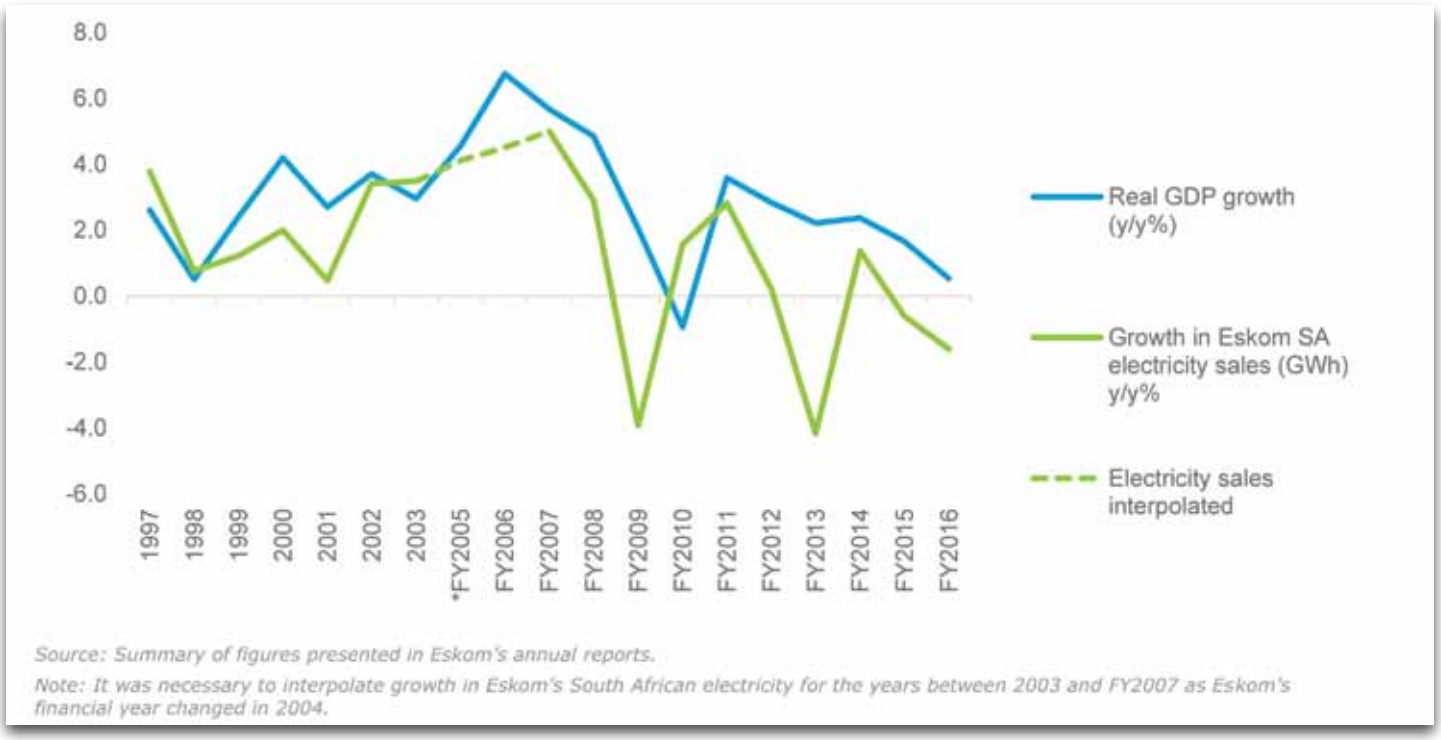

Figure 6: Relationships between growth in real GDP and electricity consumption (GWh), 1997 - 2016.

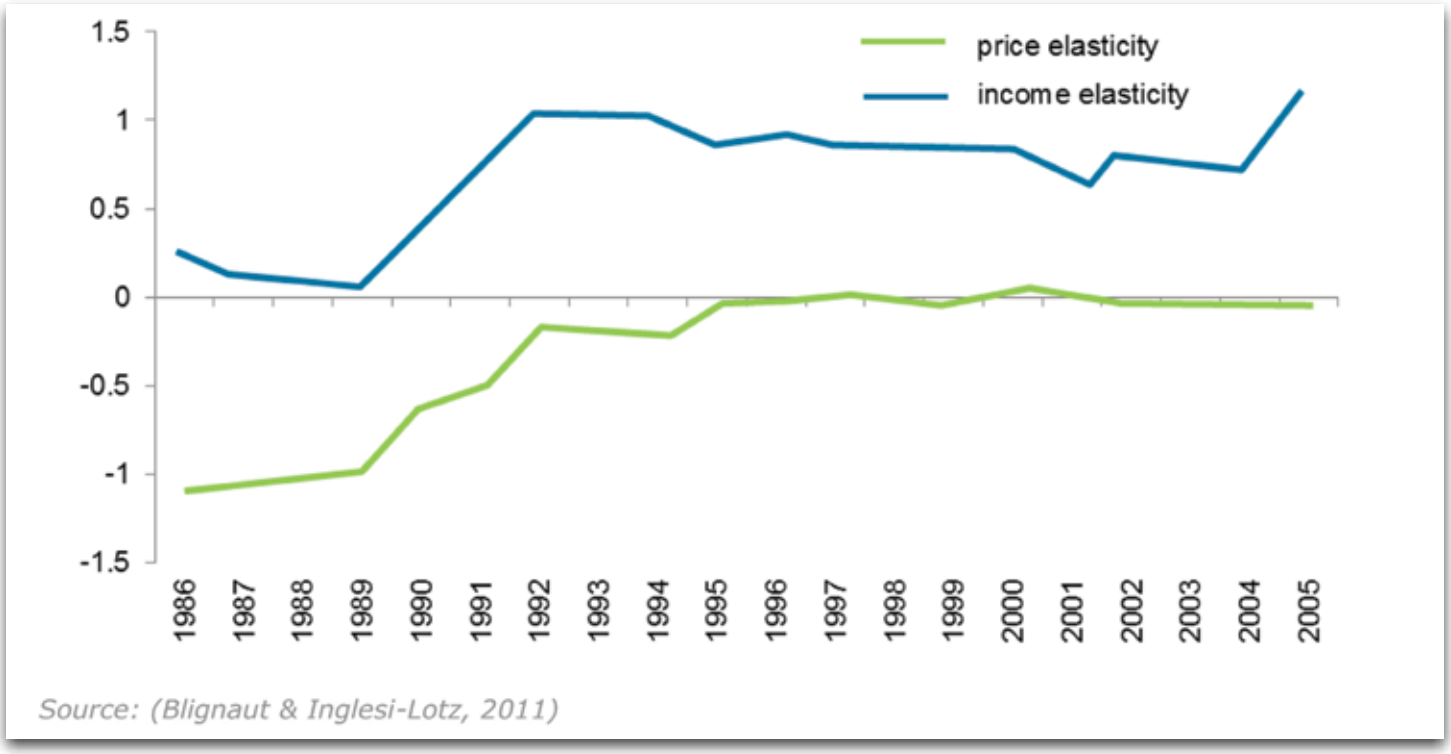

Figure 7: Price and income elasticity of electricity demand in South Africa, 1986 to 2005.

demand suggests that in the long run, economic activity (or national income) is usually the dominant driver of electricity demand and that electricity demand is generally more responsive to income than to price.

Data showing the relationship between GDP and electricity sales growth over past 20 years provides evidence of a robust positive correlation between GDP and electricity consumption in South Africa (Figure 6). The correlation coefficient between the two series over this period is 0.93.

In a study on the evolution of price elasticity of electricity demand in South Africa from 1986 to 2005, it was found that income or GDP was the dominant driver of demand over the period. The income elasticity of demand was close to 1 (unit elastic) for most of the period beyond 1990 – meaning that a 1% in GDP growth in South Africa is likely to increase electricity demand by nearly 1%. Electricity prices, by contrast, had little to no effect (Figure 7).

In recent years and particularly since FY2012, growth in Eskom's local electricity sales has been much lower than growth in GDP. While GDP expanded at an average rate of 1.9% y/y between FY2012 and FY2016, Eskom's local electricity sales were falling, averaging -0.9% y/y. In FY2013 electricity sales decreased by ~4.2% y/y as a sharp fall in the global demand for commodities hit production in South Africa's relatively electricity-intensive mining and manufacturing industries. Supply constraints also put a brake on demand as Eskom re-introduced rotational load shedding in early 2014, and there was regular load shedding between November 2014 and September 2015.

The study also showed that income and price elasticities could vary significantly over time - when real electricity prices rose sharply in the early 1980's, the price elasticity of electricity demand in South Africa was significantly negative (meaning that consumers decreased demand considerably in response to price increases). From the mid- 1980s to 2007, there was a steady decline in real electricity prices, and over this period they had increasingly little influence on consumption (Blignaut & Inglesi-Lotz, 2011).

A more recent study provides further evidence that the price elasticity of demand for electricity can vary over time and depends to some extent on the direction and magnitude of the increases. The study provides estimate price elasticity of electricity demand in South Africa by sector in the 5-year periods before and after

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the 2008 power supply crisis. In the period 2002 to 2007 electricity prices were falling slightly in real terms while in the five years after a period of load shedding in 2008 prices rose sharply - by more than 100% in real terms. We note that similar to the result of previous studies, electricity prices had little to no impact on demand over the period 2002 to 2007, and the estimated elasticities were statistically insignificant for most sectors. By contrast, for the 5-year period post-2007, the price elasticity of demand is significant and negative for 9 of the 11 industries considered and ranges from roughly -0.5 to -0.2. The results show that while the price elasticity of electricity demand is relatively inelastic, industrial sectors became more responsive to changes in the price of electricity in the five years where prices increased sharply in real terms. The implication for Eskom sales forecasters and policymakers is that when real electricity price increases are significant, consumers are likely to respond to price and reduce electricity consumption.

IMPACT OF STRUCTURAL AND EFFICIENCY EFFECTS ON THE ELECTRICITY INTENSITY OF GROWTH

While the estimation of price and income elasticities is probably the most common approach to analysing the key drivers of electricity demand, an alternative method (used by the IEA) distinguishes between the activity (or income), structural and efficiency (or intensity) effects.

The activity effect is equivalent to the income elasticity of electricity demand. The fundamental result is a long-term effect as it refers to the change in demand which is due to a change in the mix of economic activity or sectors within an economy. The efficiency effect is the change in demand due to change in energy use per unit of sectoral activity. Combined with the structural and efficiency impact influence the energy-intensity of economic growth, which in turn, is influenced by the change in real (inflation-adjusted) electricity prices.

	2002 - 2007	2008 - 2012
Agriculture	Non-significant	-0.235
Coal Mining	Non-significant	-0.291
Commercial	Non-significant	-0.291
Gold and Platinum Mining	-1.745	-0.417
Iron and Steel	Non-significant	-0.279
Liquid Fuels	Non-significant	-0.418
Non-ferrous Metals	0.821	-0.342
Rest of Chemicals	Non-significant	-0.24
Rest of Manufacturing	Non-significant	-0.251
Rest of Mining	1.068	-0.465
Transport	Non-significant	-0.346

Table 1: Price elasticities of electricity demand, 2002 - 2007 vs 2008 to 2012.

TREND IN ELECTRICITY INTENSITY OF GROWTH IN SOUTH AFRICA

Electricity intensity is defined as the amount of electricity consumed in kWh to produce a unit of GDP. Because the electricity intensity of production varies considerably from one sector to the next, changes in the structure of an economy can have a significant impact on the trend in national electricity consumption.

The electricity intensity of the SA economy was estimated using Eskom's annually reported sales within South Africa in kWh and GDP in constant 2010 prices, market values. The trend in the electricity intensity of the South African economy over more than 30 years as compared to the trend in real electricity prices is presented in Figure 8. There is a strong negative correlation between the electricity intensity of economic activity and the real (inflation-adjusted) electricity price – the correlation coefficient between the two series over the period is -0.66, meaning that changes in the electricity price could explain 66% of the change in electricity intensity.

In the early to mid-1980s, the electricity intensity of the SA economy rose sharply - this can be attributed to the significant expansion of Eskom's electricity generation capacity over this period which led to surplus capacity and consequently policies (including below-cost pricing) to stimulate demand. From 1983 to 2000, Eskom allowed the price of electricity to fall in real terms, and it was during this period that the electricity intensity of the economy reached a peak of 0.09 kWh/R GDP created.Since 1998 the electricity intensity of the SA economy has declined steadily – as the South African economy continued to transition away from its historical reliance

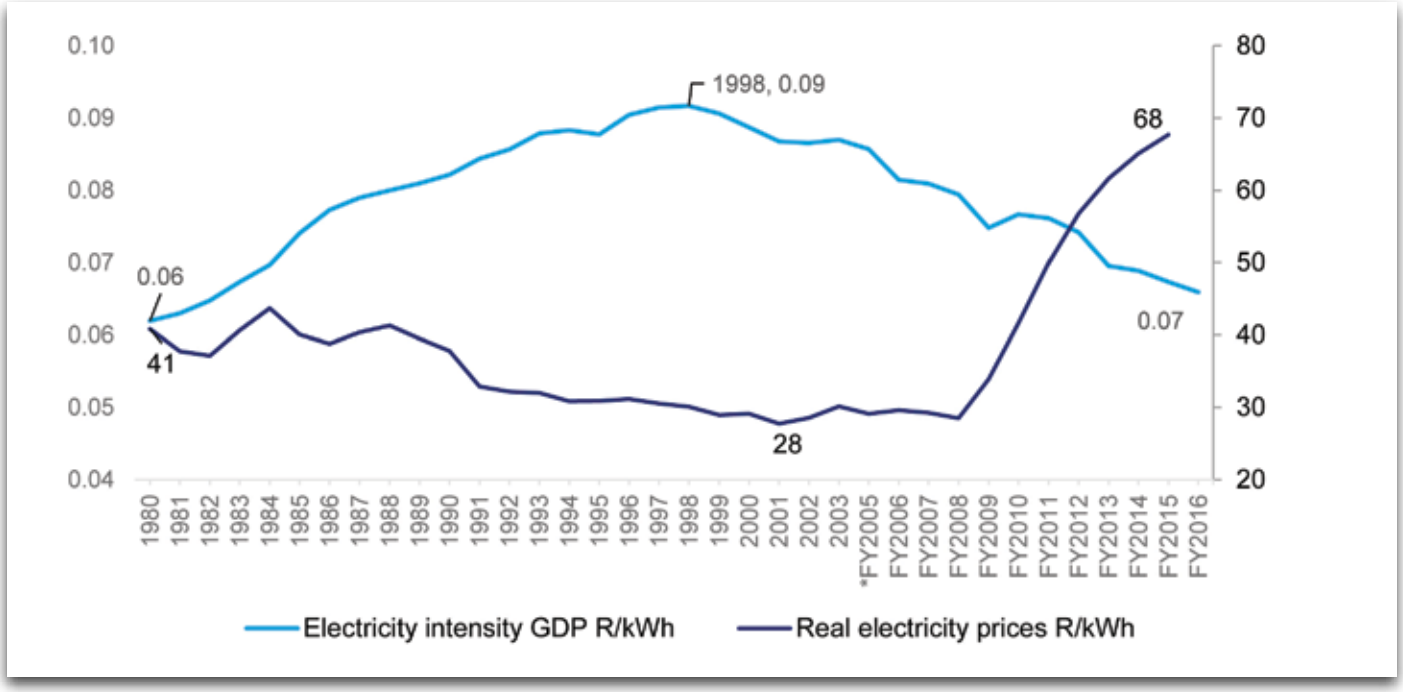

Figure 8: Trend in the electricity intensity of the SA economy vs real electricity prices, 1980 to 2016.

on the relatively energy-intensive mining and manufacturing sectors towards a more diverse range of service-oriented activity.

Electricity prices, which stabilised at low levels in 2001 and then rose sharply in real terms from 2008, have undoubtedly also incentivised and accelerated the shift to less electricity-intensive growth. Despite the steady decline in the electricity-intensity of economic activity in South Africa since 1998, data from the IEA presented in Table 2, suggest that South Africa was still relatively electricity intensive in 2010 when compared to other regions including the OECD economies, China and Russia.

Evidence of a further decline in electricity intensity of economic activity in South Africa since 2010 (as shown in Figure 8) suggests that South Africa is becoming less of an outlier.

	1971	1980	1990	2000	2010	CHANGE
OECD	0.249	0.269	0.267	0.264	0.253	1%
EU-27	n/a	n/a	0.223	0.211	0.204	-8%
Non-OECD	0.196	0.220	0.272	0.264	0.277	42%
China	0.360	0.443	0.345	0.301	0.371	3%
Russia	n/a	n/a	0.442	0.483	0.362	-18%
South Africa	0.258	0.383	0.493	0.553	0.451	75%

Table 2: Electricity intensity - South Africa and Rest of World (GWh/PPP adj. $ million) 1971-2010.

INFLUENCE OF ENERGY EFFICIENCY IMPROVEMENTS ON ELECTRICITY DEMAND

According to the World Energy Council in energy efficiency improvements refer to a reduction in the energy used for a given service (heating, lighting, etc.) or level of activity. The reduction in the energy consumption is usually associated with technological changes, but not always since it can also result from better organisation and management or improved economic conditions in the sector ('non-technical factors')."

The primary driver of the demand for uptake of energy-efficiency technology or initiatives is usually rising electricity prices but may also be supported via government policy. Improvements in energy efficiency are recognised as one of the quickest and most economical means of addressing electricity supply constraints

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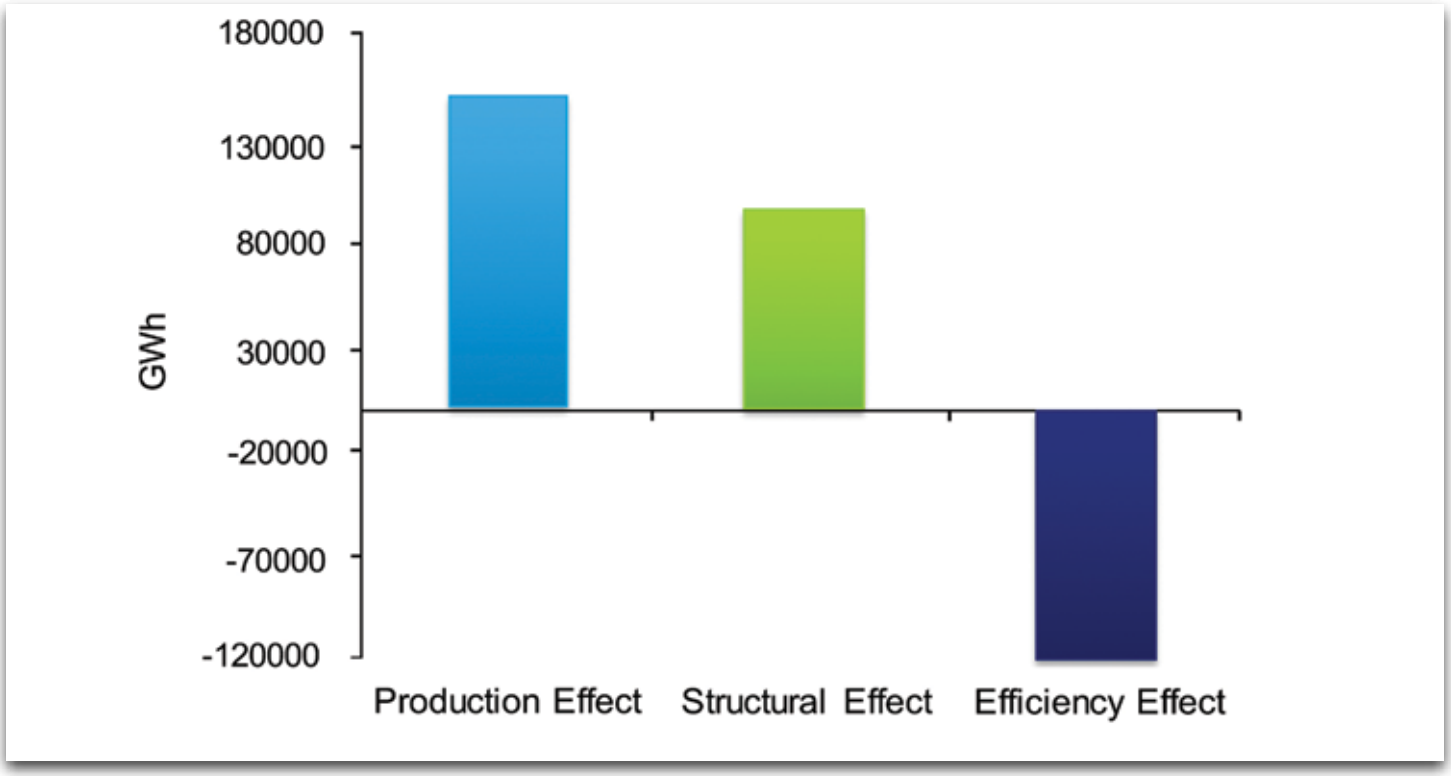

Figure 9: Contribution of output, structural changes, and efficiency to total electricity consumption (1993 to 2006).

as it takes several years to plan and build new generation capacity. The costs per kWh saved through Energy Effiiciency technologies are often lower than the marginal cost of each additional kWh generated. Energy efficiency and demand side management initiatives also mitigate against adverse environmental impacts associated with electricity generation by reducing the energy-intensity of production.

During the 3-year multi-year price determination period that ran from 2010/11 to 2012/13 (MYPD2), the DoE made a significant R5.4bn investment in integrated demand management initiatives, which were implemented by Eskom, in a bid to reduce electricity demand in the face of severe power constraints. The verified demand-side savings show that between 345MW and 590MW of evening peak demand was removed annually and a total annualised energy saving of 4859 GWh was realised over the MYPD2 period at an average cost of R1.12/kWh.

ANALYSIS OF STRUCTURAL AND EFFICIENCY EFFECTS IN SOUTH AFRICA

Following the IEA decomposition approach, Inglesi-Lotz and Blignaut (2011a) analysed the primary drivers of electricity consumption in South Africa over the period 1993 to 2006. They found that the most significant driver was output (economic growth) (Figure 9). This is not surprising, since from 1994 up until the 2008/9 recession the South African economy had to continue to expand at GDP growth rates that were above historical averages.

The analysis showed that structural effects also had a positive impact while efficiency improvements (technology/substitute) reduced demand over the period.

The fundamental shift to more electricity-intensive sectors is likely to have been promoted by a slide in real electricity prices over the period which fell consistently and stabilised at 30-year lows.

The analysis suggests, however, that significant energy-efficiency gains took place despite falling electricity prices. In the period since 2008, real electricity prices have risen by more than 100% - one would, therefore, expect to see an even more significant contribution from efficiency gains and the reversal of the structural effect – a shift to less energy-intensive sectors.

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Product Manager

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REVIEW OF ESKOM SALES FORECAST VARIANCE FOR THE MYPD3 PERIOD

NERSA currently determines electricity price adjustments in South Africa through the Multi-Year Price Determination (MYPD) methodology. The MYPD is based on rate-of-return principles and was developed for the regulation of Eskom's tariffs via 'allowable revenue'. Under the MYPD methodology, the tariff increase allowed by NERSA is a function of the revenue allowed by the regulator divided by Eskom's total anticipated sales.

As a result, forecasts of electricity sales (or demand) are the key element in tariff setting – they are used by Eskom and NERSA to determine what average tariff increase should be applied to raise the revenue that has been allowed by NERSA. The MYPD3 application was for the 5-year period between financial years 2013/14 to 2017/18.

The 5-year sales forecast that Eskom included in its MYPD3 tariff application was compiled by aggregating estimates from the six Eskom regions and a separate forecast for the Key Sales and Customer Services (KSACs) which are large industrial customers that Eskom supplies directly. In the case of MYPD3, the MYPD sales forecast was finalised on 14 September 2011. The KSACs forecast and aspects of the regional sales forecasts are produced using a bottom-up approach where information on future demand and expansions plans from each key customer is aggregated.

For other large and more disparate groups, such as commercial and residential customers, it is understood that the historical relationship between GDP growth and electricity demand (among other factors) is used to forecast increase in sales. As a result, Eskom reports that GDP growth forecasts are one of the critical sales assumptions.

Since the beginning of the MYPD3 period in 2013/14, Eskom's actual growth has been significantly lower than what was forecast in 2011 (Figure 10). Eskom predicted that sales would grow at an annual average rate of 1.8% while actual sales for the first three years of MYPD3 fell at an annual average rate of -0.3% with the variance between forecast and actual sales consequently widening every year. Sales volumes in 2015/16 were 20323 GWh lower than the MYPD3 forecast.

Much of the volume variance can be attributed to much slower than anticipated growth in economic activity. Eskom assumed in 2011 that real, annual GDP growth would accelerate from 3.3% in 2011 to 5% by 2017/18, averaging 4.5% over the period. But GDP growth has continued to disappoint relative to forecast, averaging just 1.5% in the first three financial years of the MYPD3 period. There is however still evidence of a strong positive correlation

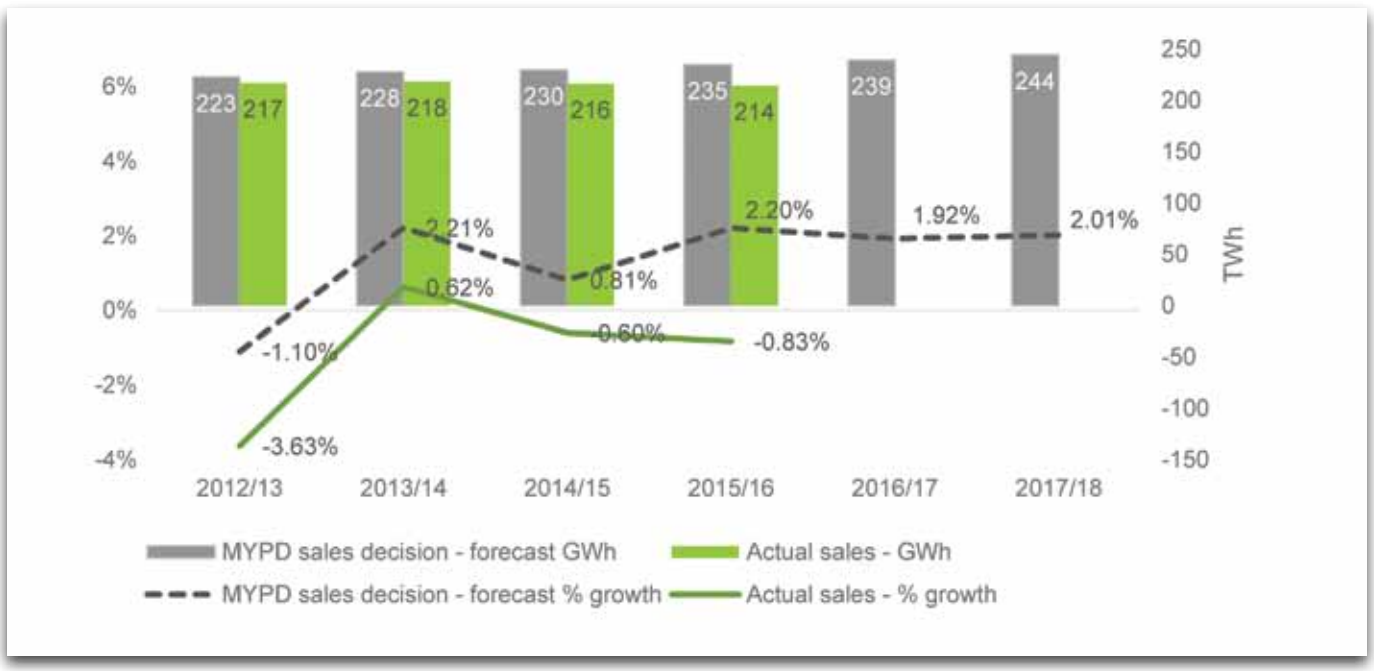

Figure 10: Eskom MYPD3 sales volume variance - forecast vs actual.

Figure 11: GDP and Eskom sales growth variance - forecast vs actual.

(0.86) between actual annual electricity sales growth and GDP growth over the first three years of MYPD3, and it is worth noting that the association would improve if international sales were excluded.

OUTLOOK FOR ELECTRICITY CONSUMPTION

As discussed above, growth in income or economic activity is consistently found in the local and international literature to be one of the dominant drivers of national electricity consumption and is widely used as a variable for forecasting purposes. While several other factors can potentially influence demand, the trend in electricity intensity and real electricity prices are also frequently used in models to forecast national electricity consumption. Electricity intensity captures the influences of changes in rate, technological and structural change but is difficult to predict with accuracy. In this section, we analyse the outlook for electricity consumption over the next five years based on expected growth in GDP, the trend in electricity intensity and real electricity prices.

THE ECONOMIC GROWTH OUTLOOK AND IMPLICATIONS FOR ELECTRICITY DEMAND

Real GDP growth slowed to 0.5% y/y in 2016 as a combination of slowing global growth and domestic factors including ongoing political and policy uncertainty continue to keep growth well below both the 20- year average of 3% per annum (and the National Development Plan (NDP) target level of 5.4% per annum). The National Treasury noted in the February 2017 Budget Review that the economy is expected to increase moderately over the next three years, with real GDP growth forecast to accelerate to 2.0% by 2018 but acknowledged that there are still significant downside risks to this forecast. Both the IMF and economist intelligence unit (EIU) forecast that South Africa's real GDP will expand at the relatively modest annual average rate of ~1.8% over the next 4 to 5 years, reaching 2.2% by 2019/2020. Using the coefficient obtained from a simple regression explaining the variation in electricity demand in terms of real GDP growth alone, we found that electricity sales would be likely to increase at an annual average rate of 0.7% over the next 5 years based on IMF forecast of SA GDP growth, significantly lower than the 2% growth Eskom forecast for the outer year of MYPD3 (2017/18).

FUTURE TREND IN THE ELECTRICITY INTENSITY OF GROWTH AND REAL ELECTRICITY PRICES

A simple extrapolation of the 30-year trend in electricity intensity using a polynomial trendline suggests that electricity intensity of economic growth in South Africa will continue to decline very gradually over the next five years from R0.07/kWh to R0.065/kWh, before beginning to increase

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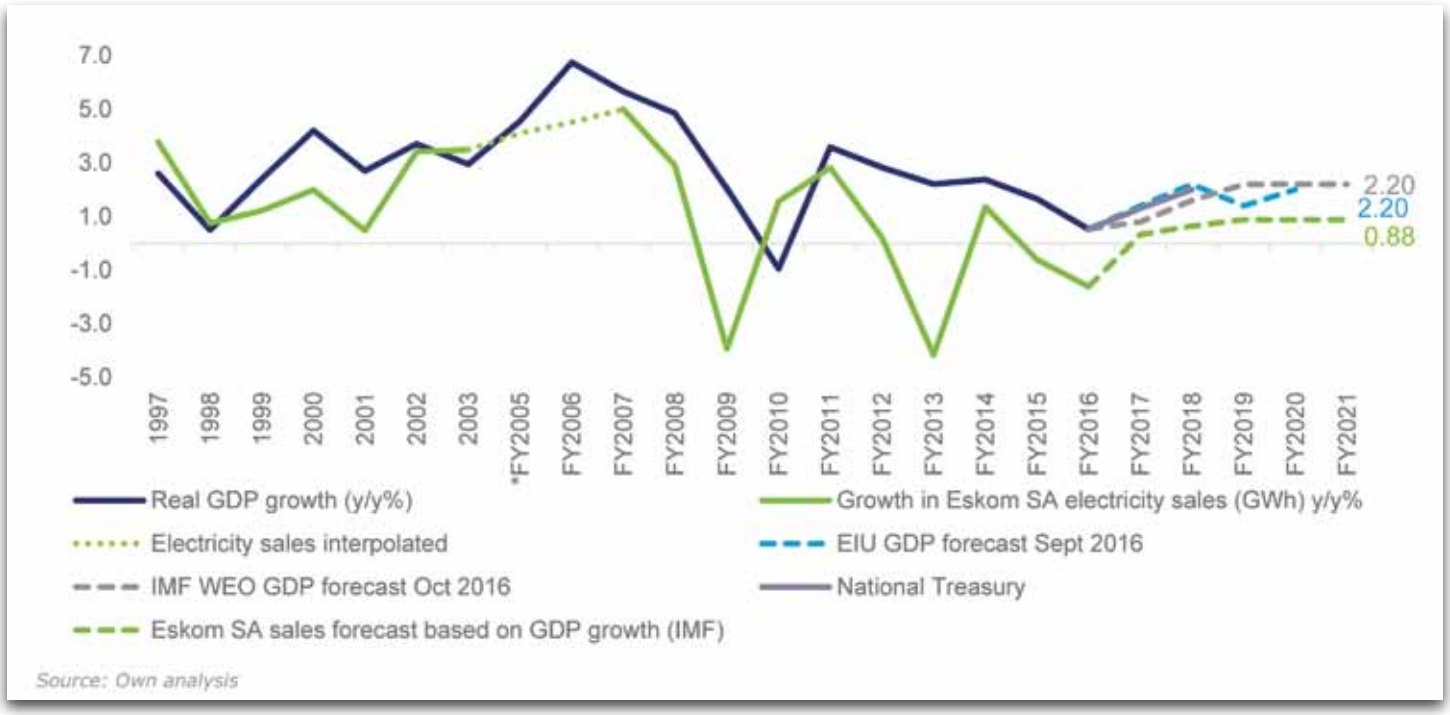

Figure 12: Real GDP and Eskom's SA electricity sales - historical and 5 year forecasts.

again. The polynomial trend is a simple technique that extrapolates the historical trend in electricity intensity to a curve that fluctuates around a long-term mean.

However, while it seems likely that electricity intensity of growth will continue to decline over the next five years, it is unlikely to return to the much higher 30-year average after that. Part of the reason for this is that Government very heavily subsidised electricity for much of the 1980s and 1990s in a bid to find a market for the surplus power generation capacity that had been created in the early 1980s.

A return to the policy of implicit electricity subsidisation that attracted electricity-intensive industries over this period would be ill-advised. Besides, South Africa is diversifying away from its traditional dependence on relatively low-cost coal-fired plants as the primary source of electricity generation. The integration of more environmentally sustainable forms electricity generation has and will continue to drive up the combined electricity generation, transmission, and distribution cost.

To produce an alternative forecast of electricity intensity we had to assume the future increase in real electricity prices. We have believed that actual electricity prices decrease by 1.8% in 2016/17 (equivalent to a 4.2% nominal increase, which is the increase required to reach MYPD3 allowed revenue off current base) and at 7% per annum after that (equivalent to a 13% nominal increase).

The forecast of the trend in electricity intensity based on a regression analysis of its historical correlation with real prices suggests that the electricity intensity of economic activity will decline faster than the polynomial trend reaching R0.05/kWh by 2021.

OVERALL OUTLOOK FOR ENERGY CONSUMPTION AND IMPLICATIONS FOR ESKOM

While multivariate regression models can be used to produce more accurate forecasts of national electricity consumption that simultaneously capture the impact of GDP, electricity intensity and real prices and other drivers on demand, this exercise was beyond the scope of this article.

It is nevertheless possible to conclude from the bivariate regression analysis provided above that, in the context of average annual real GDP growth of 1.8% increase in electricity demand is unlikely to average more than 1% per annum in the 5-year

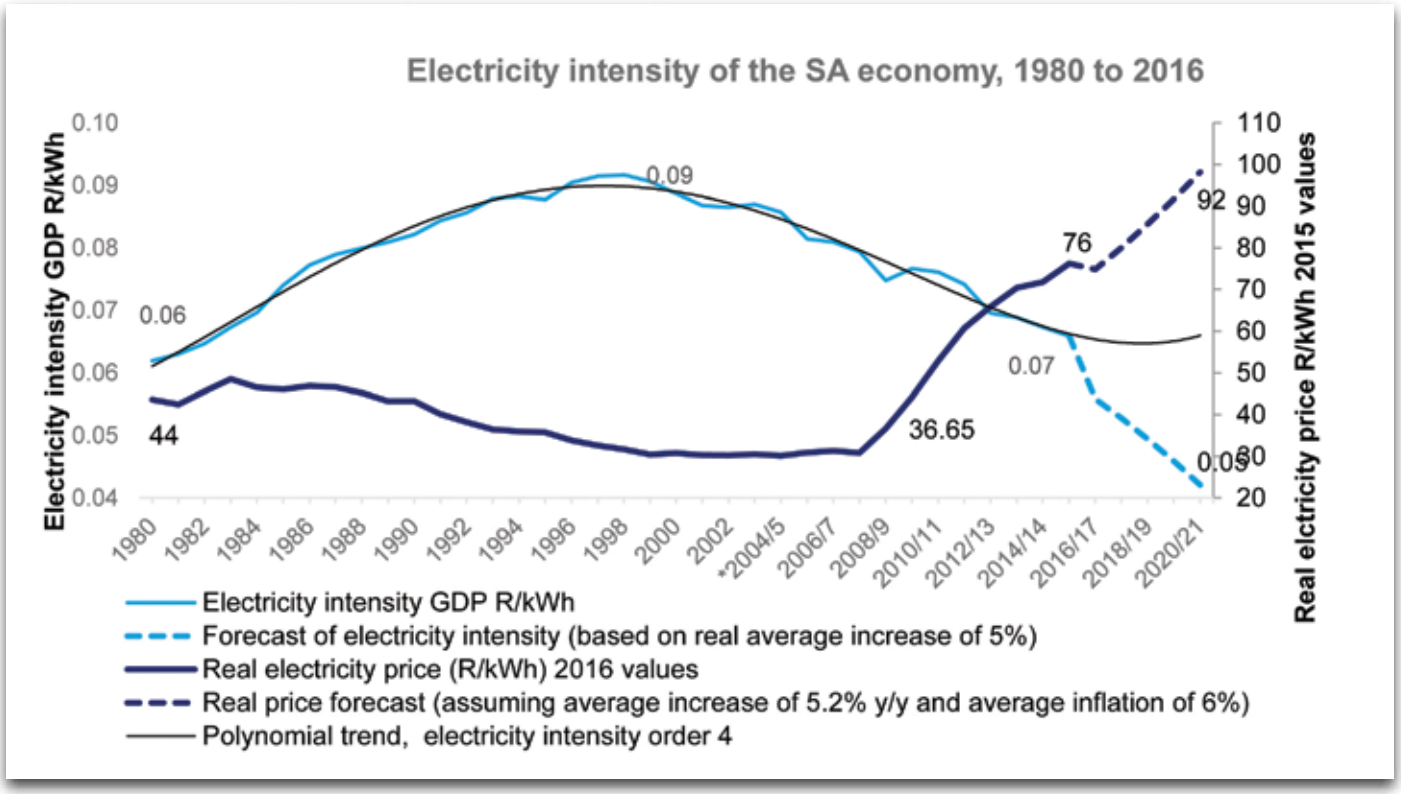

Figure 13: Electricity intensity of the SA economy, historical and forecast.

period to 2021. Evidence of a persistent trend-decline in the electricity intensity of growth suggests that there may also be further downside risk to this forecast.

We believe, based on the analysis provided above, that the 18-year trend towards less energy-intensive economic growth will persist for at least another 5 years, mainly as it is expected that real electricity prices continue to rise towards cost-reflective levels as implicit price subsidies are gradually phased out.

The implication for Eskom is that growth in electricity sales will continue to disappoint relative to the MYPD3 forecasts produced in 2011, which forecast GDP growth of 4% and annual average growth in sales volume of roughly 2%. Slower-than-expected growth in electricity sales means that Eskom will face a widening revenue shortfall in the outer years of the 5-year MYPD3 period as the approved tariff increase was calculated on the assumption of Eskom being able to realise much higher electricity sales.

CONCLUSIONS

Despite the steady decline in the combined contribution of manufacturing and mining sector to GDP (from 31% of GDP in 1995 to 22% in 2015), these sectors are still responsible roughly 60% of total national electricity consumption. As such, growth (or lack thereof) in the relatively energy-intensive mining and manufacturing industries remains an important determinant of overall domestic demand.

Available data on electricity intensity by sub-sector, further suggests that some manufacturing sub-sectors such as non-ferrous metals, and to a lesser extent 'iron and steel' are particularly energy-intensive and national demand is particularly sensitive to developments in these industries. The contribution of the residential sector to total domestic electricity consumption has increased steadily over the past two decades (from 16% in 1993 to 23% in 2013).

There are two standard approaches to identifying the key determinants of electricity demand at a national level – the first is to estimate the price and income elasticity of demand (isolating the impact of each key driver) - and the second

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is an approach used by the IEA which decomposes electricity demand into an activity, structural and efficiency effect.

An analysis of South African GDP and electricity sales growth data over the 20 years prior to 2016 provides evidence of a robust positive correlation between GDP and electricity consumption in South Africa. The correlation coefficient between the two series over this period is 0.93.

In a study on the determinants of electricity demand in South Africa from 1986 to 2005, found that the GDP was the dominant driver of demand over the period and that the income elasticity of demand was close to 1 (unit elastic) for most of the period between1990 and 2005– meaning that a 1% increase in GDP increased electricity demand by nearly 1%.

The results of a study by Blignaut, Inglesi-Lotz & Weideman (2015) noted that electricity prices had little to no impact on demand over the period 2002 to 2007 when they were stable and fell in real terms. By contrast, for the 5-year period post-2007, when actual electricity prices were rising sharply, the price elasticity of demand was significant and negative for 9 of the 11 industrial sectors considered, and ranges from roughly -0.5 to -0.2.

The implication for Eskom sales forecasters and policymakers is that when real electricity price increases are significant, consumers are likely to respond to price by reducing consumption.

Regarding electricity-intensity, we noted that over a 36-year period that there was a strong negative correlation (-0.66) between the electricity intensity of economic activity in South Africa and the real (inflation-adjusted) electricity price. The electricity-intensity of the SA economy has declined steadily since 1998 and accelerated as electricity prices, which had stabilised at low levels in 2001, rose sharply in real terms from 2008.

A review of the performance of Eskom's sales forecasts for the 5-year MYPD3 period, which runs from 2013/14 to 2017/18, shows that growth in electricity sales have been significantly lower than what was forecast for the period in 2011.

Eskom predicted that sales would grow at an annual average rate of 1.8% while actual sales, for the first three years of MYPD3, fell at an annual average rate of -0.3% with the variance between forecast and actual sales consequently widening every year. Much of the sales variance can be attributed to much slower-than-anticipated growth in GDP which averaged just 1.5% in the first three years of MYPD3 relative to 4.5% assumed by Eskom.

Regarding the outlook for electricity consumption, given expected average annual real GDP growth of 1.8% for the 5-year period to 2021, an increase in electricity demand is unlikely to average more than 1% per annum.

Evidence of a persistent declining trend in the electricity-intensity of growth suggests that there may also be further downside risk to this forecast. We believe that the 18-year trend towards less energy-intensive economic growth will persist for at least another five years, notably if NERSA (in a bid to shore-up Eskom's deteriorating financial position and reduce harm from subsidies), allows electricity tariffs to continue to rise towards cost-reflective levels during MYPD4.

The implication for Eskom is that growth in electricity sales will continue to disappoint relative to the MYPD3 forecasts produced in 2011. Further, if Eskom is not allowed to recover the revenue shortfall via the regulatory clearing account process, it will face a widening revenue shortfall in the outer years of the 5-year MYPD3 period as the previously approved tariff increases assumed that Eskom would be able to realise much higher electricity sales. wn

© This article is an excerpt from "An overview of electricity consumption and pricing in South Africa" - an analysis of the historical trends and policies, key issues and outlook in 2017 by Deloitte. A report prepared for Eskom Holdings SOC Ltd Date: 24 February 2017.

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-IS IT A PERVASIVE PROBLEM?

INTRODUCTION

Illegal connections are defined as unauthorised connections made to any power supply network. Electricity theft, due to illegal connections, is reported as significant causes of non-technical losses. These incidents are not just responsible for revenue losses but also for equipment damage, poor quality of supply and more significantly presents itself as a life hazard.

Illegal connections in South Africa

A significant source of non-technical loss contribution is directly related to electricity theft due to illegal connections. These connections are typically made to the low voltage networks found within South African supply networks. Socio-economic conditions are the main contributor of these occurrences and a common strategy which includes political, economic and engineering interaction needs to be developed to find solutions that consider all stakeholder needs and more importantly addresses the safety aspect of the population living in these communities, where these illegal connections occur.

BY | Q.E LOUW | PR TECH. ENG | SMSAIEE | MIEEE

This phenomenon is a worldwide problem. A study commissioned by "The annual Emerging Markets Smart Grid: Outlook 2015" found that the non-technical losses throughout the world contribute to approximately $90 billion in revenue losses per year, of which $60 billion in losses are due to emerging market countries such as India, Brazil and Russia of which India is deemed to be the most significant contributor of these losses.

In South Africa the problem is no different and as highlighted in Africa's Power journal (ESI Africa), the effects posted in this online publication (28th of June 2017) titled *"Eskom deploys tech to boost revenue while reducing electricity theft"* that South Africa is losing around R5.4 billion annually due to non-technical losses.

Technical losses are defined as accepted natural occurrences of power dissipation losses found within these networks. On the flip side, non-technical losses are related to external factors such as electricity theft, weak administration and non-payment of customer accounts of which the most substantial portion of these losses is due to electricity theft.

BACKGROUND

The South African problem manifests itself as presented in a further online publication by Eskom (7th of December 2016) entitled *"Taking action against electricity theft":* electricity theft is not confined to the residential sector only, but includes businesses, municipalities and some government departments.

Although the publication highlights that, in the grander scheme of things the residential sector contributes to the minority of these

Illegal Connections

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Figure 1: Typical informal settlement in Gauteng.

incidents it emphasises that it has the most severe consequences such as the loss of life as a result of contact incidents associated with illegal connections.

With this said, a more in-depth understanding needs to be considered in the residential sector to determine where the majority of these incidents occur and what the significant driving force behind these incidents are.

According to Statistics South Africa (report P0302-2017), the latest population figures account for a total population approaching 56 million people. In the Gauteng province, the smallest region out of the nine areas found within South Africa, the population accounts for 25.3% of the total country population density.

This province contributes the highest portion of the country's Gross Domestic Product (GDP) to the South African economy which is estimated to be in the region of 35% (Stats SA 2017 Q4 GDP).

There are more than 100 recorded informal settlements within the Gauteng province alone, and this is due to the perceived economic benefits and the hope of employment that this province may offer. With a current unemployment rate of almost 27% in South Africa, this province offers the possibility of becoming economically active to the economically inactive population.

In a further media release from Statistics South Africa (20 April 2016) highlights that 13.1% of all households in South Africa still account for communities living in informal settlements of which Gauteng contributes 19% of the total informal household statistic nationwide.

This perceived benefit of becoming economically active provides the conduit for the proliferation of population densities to within the Gauteng province, placing more undue social demand pressures on local government. As a result of the population densities increasing local government cannot adhere to, or keep up with the establishment of the fundamental human right to water, sanitation and electricity.

As a result of these necessary human right requirements and the associated socio-economic demand pressures not been met, the population takes matters into their own hands and connects illegally to the nearest proclaimed electrical supply network to satisfy their need for electricity.

These connections are made hazardously without any comprehension of the dangers involved. The communities purely satisfy this need by any means necessary, and from this, the assumption is made that the demand outweighs the considerable risk.

Unfortunately, this risk passes on to the supply authority with the scenario now becoming convoluted as a result of increasing difficulty to balance the legal safety requirements as per the OHS Act, the quality of supply to the paying customer, this as a result of the sensitive political demands.

The next page illustrates some illegal connections to low voltage networks typically found within the South African informal settlement environment.

Figure 2: Typical illegal connection from mini-sub.

Figure 3: Typical illegal connection from Dx Transformer.

ILLEGAL CONNECTION IMPACT

The impact as a result of these illegal connections can be divided into four key areas, they are:

SOCIAL IMPACT

The high unemployment rate in South Africa exacerbates the situation as potential employment seekers migrate to provinces, such as Gauteng, where the perceived chance of becoming economically active is not always realised. As a result of this phenomenon, population densities tend to increase in an already overstressed housing environment.

The culmination of these factors gives rise to a multitude of informal settlement households, without any necessary services such as water, sanitation and electricity. The demand to provide essential services now escalates at the local government level. Although the government, through their Integrated National Electricity Program (INEP), are offering electrification infrastructure they cannot keep up with, the sustaining demand from communities not connected to the electricity grid presents itself.

ECONOMIC IMPACT

Eskom, the largest power utility on the African continent, produces 95% of the electricity generated within South Africa. A significant portion of this generated capacity is sold off to intermediaries such as municipalities which in turn re-sell to end users.

These intermediaries are highly dependable on the revenue generated from the sale of electricity, and this revenue contributes anything from 30-40% of the total income budget for these various municipalities.

Illegal Connections

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Although the effect of non-technical losses is challenging to quantify, some parastatals such as Eskom have reported in their 2016/2017 annual financial statements that non-technical losses contributed to approximately R1.3 billion of the reported losses for the same year.

Others, such as the South African Revenue Protection Association (SARPA) have reported these losses to be in the order of R8-12 billion loss to the South African economy per year.

To emphasise the impact, the annual GDP for South Africa for 2017 was R5.316 trillion and these losses presented equates to anything from 0.15% to 0.23% of the South African GDP.

The argument then presents itself - if these non-technical losses can be contained, more budget allocation can be made to service the need for essential services within these communities which are in dire need of such services.

Figure 4: Illegal connections laying on the ground.

Figure 5: Typical illegal connection.

HEALTH AND SAFETY IMPACT

The South African Occupational Health and Safety Act (OHS act 85 of 1993)], and the Electricity regulations Act 4 of 2006 section 14 *"Conditions of License"*, requires that all authorities are to ensure that the systems supplying electricity to users are done so in compliance with the necessary health and safety requirements.

As highlighted previously the supply authorities are now faced with the real risk of contact incidents and the possible loss of life as a result of these illegal actions committed by the communities.

Figure 4 highlights the real problem as alluded to, as this particular community is filling water containers amongst live conductors which presents a real risk of the loss of life.

Other publications have highlighted the safety impact illegal connections have, and in a crime article report titled "Deadly power theft" documented in the local Lenasia Rising Sun (October 21, 2014) the following was published: *"On Tuesday, October 14, a man (35) was electrocuted to death at Lawley Station whilst connecting electricity illegally. Three men were connecting electricity illegally when one was electrocuted, and the other two men ran off. The men were connecting electrical wires from a transformer in Mecca Street to Lawley Station Informal Settlement."*

This publication further highlights the challenges supply authorities are facing in dealing with illegal connections: "Eskom disconnected all illegal connection on Friday, October 10. However, they were reconnected again within a space of ten minutes. *"The man is a supplier,"* said the Eskom personnel at the scene. *"Even if we*

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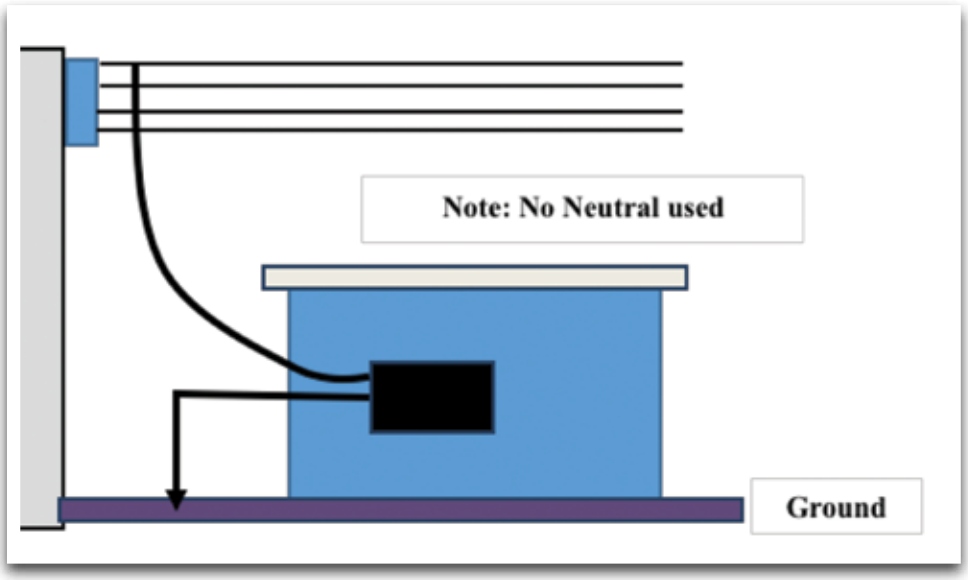

Figure 6: Bypassing the neutral.

cut the illegal connections, in ten minutes they'll be reconnected again," the Eskom personnel mentioned.

ENGINEERING IMPACT

Illegal connections are made in two fundamental ways, one directly from overhead conductors such as street lighting, and secondly, by connecting directly to the distribution source transformer with the conductors lying on the ground.

Furthermore, another form of electricity theft is achieved by circumvented the metering in the household in connecting the load between the phase and earth, thus bypassing the neutral as illustrated in figure 6.

Figure 5 presents the typical connections found where all types of conductor material are used to facilitate the illegal connection.

From the figures presented we can conclude that a consequence due to a phase to earth fault gives rise to zero-sequence currents. High impedance usually limits these currents as a result of high soil resistivity. The associated effects thereof are equipment damage and the possibility of Ground Potential Rise (GPR), which could lead to contact incidents as a result of potential step voltages.

These illegal connection conditions furthermore pose a significant challenge to the impact on the low voltage network system characteristics and quality of supply parameters to the paying customer.

HOW DO WE DEAL WITH THIS

According to the national statistics, the government have electrified approximately 90% of all households. This figure might be accurate in certain areas where electrical infrastructure was built.

Some have suggested that all informal settlements need to be electrified to rid power supply utilities of the problem of non-technical losses due to electricity theft. Although as a plausible solution, it might be argued that this would be the ideal situation in an environment which is conducive to this strategy. However, in the short term there a perceived limited degree of political will involved in this strategy and, more importantly, neither Eskom nor any municipality can electrify areas which are unproclaimed. This situation will potentially be exacerbated with the new government policy view on land appropriation without compensation. It is the belief that this will increase the demand for interim informal housing environments, which will add to the existing problem.

Furthermore, although the indigent allocation of free 50 kW/h per month seems to be an initiative to assist with the basis of free electricity where electricity infrastructure is available, one will find that when this free usage has expired, the remainder use of power will be charged and billed for accordingly. This will place the socio-economic pressure back in the hands of the user, and as a result, would foster a non-payment culture as the anticipated cost of electricity is just too expensive, especially in inactive economic communities.

Further strategies Eskom and municipalities have endorsed are the implementation of pre-paid and smart meters. This strategy works for secure proclaimed electrified areas.

The problem, however, is in the informal settlements where electricity is stolen from nearby power supplies, i.e. mini-sub, low voltage power lines or street lights, and consequently where no billing meters are installed. The significant challenges lie within this, and solutions have to be found to mitigate this specific problem.

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Illegal Connections

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FUTURE RESEARCH

Various strategies have been suggested and implemented with the great success of which one such approach is the deployment of SMART meter technology. This deployment strategy is only limited to bonafide installations and is usually at the paying customer end.

The problem that needs more significant attention is the direct illegal connections to transformers on proclaimed networks, where no billing is installed, and where the safety risk to the community is escalated.

Future research is currently underway to investigate a possible solution to mitigate these type of instances by detection and isolation of the affected source.

CONCLUSION

Illegal connections are a pervasive problem within South Africa and are deemed a direct consequence of the socio-economic conditions and circumstances communities find them in. What further elevates the problem is the safety risk to communities and especially innocent children which are unknowingly exposed to the threat.

More needs to be done to address the current unemployment situation as well as education, to stimulate economic activity. This is where the government needs to take cognisance of the fact the impact of illegal connections have on communities, and the economy has as a whole. The intended developed strategy should be seen as a joint proposal that encompasses the political, economic and engineering environments to address this problem.

Failure to address illegal connections will continue to affect the economy and society adversely, but more importantly, have a direct impact on the safety of the communities where these incidents present themselves.

By considering the quality of supply where the paying customers are connected to, the same source of supply where these illegal connections occur, as they are ultimately paying for and expecting a world-class service.

With the cost of electricity escalating, of which these non-technical loss elements contribute towards significantly, the focus should be on finding solutions to address practical implementation strategies where all stakeholder needs are addressed and satisfied. wn

ABOUT THE ARTICLE

This article is an extract from the author's dissertation titled "Zero-Sequence current-based detection of electricity theft in informal settlements", Masters Dissertation, University of Johannesburg 2017.

ABOUT THE AUTHOR

Quentin Louw is the CEO of Ntamo Technologies (Pty) Ltd, a company that designs and implements technologies to combat cable theft and infrastructure damage. He is currently studying towards a PhD at the University of Johannesburg to find solutions on how to mitigate electricity theft as a result of illegal connections. He is a registered professional with ECSA, a Senior Member of SAIEE and a member of IEEE

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Down Memory Lane

BY | MIKE CARY | PR ENG | PAST PRESIDENT SAIEE

After graduating from Witwatersrand University in 1967 with an Electrical Engineering degree, I joined Eskom as a pupil Engineer and served my pupillage from 1968 to 1969.

When I completed my pupillage, I was offered three positions, and I accepted the offer to become a research engineer in 1970. The Electrical Research Department was a new one, and I reported to Peter Randall and was the first employee of the newly formed department. I worked at Eskom House in Braamfontein, and became the Eskom Lightning and Earthing Specialist. Peter was a Past President of the the South African Institute of Electrical Engineers (SAIEE) and was instrumental in getting me to become a member in 1970.

The Research Department grew and relocated to Rosherville a couple of years after I left Eskom's employ in 1972. While working in the Research Department, I had many exciting projects/investigations. The Strategic Fuel Farm is in Ogies, and the computer that "controlled" the Farm (a disused underground colliery) continually failed due to lightning strikes.

I had to identify the spikes that damaged the computer. Using 1970 technology, I set up an oscilloscope that triggered when a "spike" was sensed. Because there were no shutter speeds fast enough, the camera was

permanently exposed to the screen. I had to travel east once a week to check the set-up. Because of the distance involved, I had to construct a portable darkroom, to develop the 35mm film while I was at the Farm, to make the necessary adjustments to the equipment.

Another project was to resolve the computer problems caused by static in the National Control Room at Simmerpan. The solution was very "domestic". The carpets were shampooed with Sta-Soft (free advertising), and hey presto – no more static.

I also undertook many earthing investigations. These are some of the highlights:

An earthing survey of the substation at the small hydropower station on the Kunene River between Angola and Namibia - the substation was built on rock, and effective earthing was achieved by tying the substation earth back to the hydro station.

A similar investigation was done for the substation serving the Gariep Hydro station, and the earthing was designed to ensure it was adequate for step and touch potentials.

The Caborra Bassa power is transmitted via an HVDC line from Mocambique to Apollo, an Eskom Distribution Station near Olifantsfontein. We chose DC, because of the line length and the voltage to ground of each pole, which was 533 kV – 1066kV between poles.

By ensuring power was available if one pole went down, the earth was used as a return pole, and up to 70% of the power could still be received. An active earth had to be found in or around Apollo.

Although Apollo was a big station, its earth was high at one-half ohm, and another option had to be explored. The Rietvlei Dam is just north of Apollo – and it is Pretoria's water supply. It was also a nature reserve and boasted amongst other game, Blesbok. I marked a 1 km square grid with survey points at 250-metre survey points.

My assistants dug 1-metre holes at each of the survey points, and we took a sample of the soil in watertight containers to Rosherville Research Laboratories to test for conductivity, moisture, etc. Electrical tests were also done at this site, to determine resistivity at various depths, which was important for DC earthing design.

Based on the results, it was decided not to use this site (I am sure that nature lovers would be forever thankful). Instead, another site was found about one kilometre away. The final earthing design was fascinating: Trenches were filled with coke (not the liquid kind), and the earthing conductor was galvanised steel.

Towards the end of the 1960s, Eskom started planning the Koeberg Nuclear Station. In 1971, I was asked to go down to Cape Town to investigate the earthing at the proposed site at Duinefontein. I was loaned a bakkie from Distribution in Brackenfell, together with two assistants. Electrical measurements were again undertaken at the site, and the earthing conditions were found to be adequate for the planned power station. The photo below shows a youthful me on the dunes during this investigation.

I must relate an amusing anecdote. We found many empty glass bottles in the dunes, and I asked the assistants to place them in the back of the bakkie so that we can dispose of it once we were back at Brackenfell. Due to the rough terrain, many bottles broke while we were traversing the dunes. The assistants threw them out. When I queried this, they replied that I could not get a deposit back on broken bottles! wn

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

We look forward to hearing from you.
- Ed

QUESTION ONE

Can one use Variable Speed Drives to control the speed on submersible pump motors?

ANSWER ONE

Yes, you can. The use of Variable Speed Drives (VSDs) to control the speed of submersible pumps in borehole applications is becoming more popular day by day. VSDs can effectively control the speed on these applications resulting in a controlled flow rate determined by the process or based on demand. Traditionally the flow would be controlled through throttling of valves, however with the use of VSDs speed control can be applied to run at optimal speed to achieve the required process flow.

Through means of speed control, we not only control the flow but there is also an opportunity to save energy through the reduction in speed which leads to reduced power consumption and ultimately an energy saving.

The VSD not only assists in saving energy and controlling the speed of the motor but it also reduces the mechanical and electrical stresses associated with starting and stopping the pump, when compared to other starting methods such as direct on line or star delta starters. Another common phenomenon referred to as water hammer will also be eliminated through the use of VSDs due to the smooth acceleration and deceleration of the pump during start-up and stopping.

QUESTION TWO

Will the VSD have any effect on the submersible pump's motor?

ANSWER TWO

Yes, VSDs due to their inherent switching pattern (Pulse Width Modulation) create increased peak voltage levels as well as increased Dv/Dt rise times. This could be harmful to motors depending on their insulation rating and their ability to withstand these peaks.

A standard 400 V induction motor insulation can typically withstand voltage peaks of up to 1 600 Volts which is not a concern if the starting method is direct on line or start delta.

VSDs, on the other hand, would typically generate peak voltages in the region of 1 250 Volts if fed from a 400 V supply. This would not have a negative impact on the motor winding insulation provided that the cable length remains relatively short (typically below 100 m).

Submersible pumps, on the other hand, are normally rated to withstand peak voltages of less than 1 000 V and this, combined with long motor cables frequently used in submersible pump applications, could result in premature winding failure when used in conjunction with a VSD.

QUESTION THREE

What should you consider before installing VSDs on submersible pumps?

ANSWER THREE

It is very important that one first consult with the Original Equipment Manufacturer of the selected pump to establish the limitations and/or recommendations with regards to the maximum allowable levels of peak voltages and acceptable Dv/Dt rise time values that the motor can withstand.

Once the above has been confirmed it is important to look at the maximum peak voltage levels which will be generated by the selected VSD type. These values can vary from manufacturer to manufacturer. Additionally one should also consider the cable length as well as cable type used from the VSD to the motor as this will also have an impact on the peak voltages and Dv/Dt levels measured on the motor terminals. The longer the motor cable the higher the value of the peak voltage measured on the motor terminals.

QUESTION FOUR

How does one then protect the motor insulation on these submersible pump applications if they are controlled by a VSD?

ANSWER FOUR

The motor insulation can quite easily be protected against harmful peak voltages generated by VSDs through the use of sine wave filters or line reactors, depending on the maximum peak voltage levels the motor can withstand.

A sine wave filter, which is a combination of an inductor, capacitors and in some cases resistors, reduces the peak voltages generated by VSDs. The sine wave filter would be connected to the output of the VSD between the VSD and motor terminals. The sine wave filter will reduce the harmful peaks generated by the VSD and the resultant output wave form generated by the VSD after being filtered will be a relatively smooth sine wave compared to a typical PWM type wave form. The peak voltage levels are reduced well below Original Equipment Manufacturers stipulated values and would therefore not have a negative impact on the motor insulation ensuring the prevention of premature winding failure. wn

Information provided by Zest WEG Group

June

Movers, shakers and history makers

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

1 JUNE

2002 The first national law, in any country, prohibiting "light pollution" went into effect. The Czech Republic became the first nation to outlaw excess outdoor light.

2 JUNE

1896 Guglielmo Marconi applies to patent the radio, which was accepted 2 July 1897.

3 JUNE

1983 The science fiction film WarGames was released. It is credited with bringing the hacking phenomena to the attention of the American public, it ignites a media sensation regarding the hacker sub-culture. The film's NORAD (North American Aerospace Defense Command) set was the most expensive ever built at the time at a cost of $1 million dollars.

4 JUNE

1984 The cloning of DNA sequences from an extinct animal was reported from the quagga (a brown, horse-like beast with zebra stripes on the front of its body, which inhabited South Africa until it was exterminated by hunters in the early 19th century).

5 JUNE

1938 The first machine to produce intelligible speech-like sounds was exhibited by Bell Telephone scientists. Called "Pedro, the Voder," it was put on display to the public at the Franklin Institute, Philadelphia, Pa. The inventor was Homer Dudley with Richard Riesz and Stanley Watkins.

6 JUNE

1907 Persil, the first household detergent, was marketed by Henkel & Cie, of Düsseldorf, Germany as the first "self-acting" washing powder in the world. Persil was the combination of both washing and bleaching agents in one powder.

7 JUNE

1958 A seminal article that launched the widespread use of ultrasound in medical diagnosis was published in The Lancet by Ian Donald, an English physician. After a few years developing the experimental use of ultrasound, Donald had applied it to treat patients in his hospital.

8 JUNE

1953 The first U.S. propane fuelled gas-turbine locomotive was placed in service by the Union Pacific Railroad. It delivered more than 4,800 hp (more than three diesel units) and had the advantage of clean burning, which kept the turbine blades free from carbon deposits with less wear.

9 JUNE

1905 Albert Einstein published his analysis of Max Planck's quantum theory and its application to light. His article appeared in Annalen der Physik.

10 JUNE

1924 The first U.S. portable electrical stethoscope was demonstrated in Chicago, USA to amplify the sounds of the human body. It was designed by the Western Electric Company with Bell System engineers and electro-physiologist Dr. Horatio B. Williams.

11 JUNE

2010 The FIFA World Cup opened in South Africa. It was the first time it was held in Africa.

12 JUNE

1837 British inventors William Cooke and Charles Wheatstone received a patent for their electromagnetic telegraph. Their invention was put into public service in 1839, five years before the more famous Morse telegraph.

13 JUNE

2006 Chinese civil servants were ordered not to drive cars, use lifts or switch on air-conditioning for a day, as part of an energy-saving awareness campaign. Each day an estimated 1 000 new cars were being driven on the streets of Beijing, causing nitrogen dioxide levels to exceed World Health Organisation's clean-air guidelines by 78%.

14 JUNE

1951 The United States Census Bureau held a dedication ceremony for the first UNIVAC I. The UNIVersal Automatic Computer I, the first commercially produced computer in the USA, was to be used to tabulate part of the 1950 population census and the entire 1954 economic census. The UNIVAC I was the first computer to be 'widely used' for commercial purposes - 46 machines were built, for about $1 million each; compared to other computers of the era.

15 JUNE

1949 MIT's Professor Jay Forrester recorded a proposal for core memory in his notebook. In 1955 Forrester eventually installed a magnetic core memory in the Whirlwind computer.

16 JUNE

1960 Alfred Hitchcock's film Psycho was first released to movie theatres and received less than favourable reviews.

17 JUNE

1987 With the death of the last of the species, the dusky seaside sparrow became extinct.

18 JUNE

1940 Winston Churchill delivered his "Finest Hour" speech to the House of Commons. It was given just over a month after he took over as Prime Minister of the United Kingdom at the head of an all-party coalition government. This was the third of three speeches he gave during the Battle of France.

19 JUNE

1931 The first installation of commercial doors operated by photoelectric cell was completed. A magic eye controlled the automated swinging doors between the kitchen and main dining room of Wilcox's Pier Restaurant in West Haven, Connecticut, USA.

20 JUNE

1926 A wireless phone for cars was demonstrated in Berlin, Germany, by Herr Schaetzle.

21 JUNE

1948 The first stored-program computer, the Small-Scale Experimental Machine, SSEM, ran its first program. It was written by Professor Tom Kilburn and took 52 minutes to run.

June

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22 JUNE

1946 In a demonstration of the capabilities of jet aircraft, Army Air Corps pilots Kenneth Chilstrom and Robert Baird transported mail in a Lockheed P-80 Shooting Star. This was the first delivery of mail by jet aircraft.

23 JUNE

1868 The Sholes and Glidden typewriter, the first practical and commercially successful typewriter, was patented. The most notable aspect of the typewriter (which would later become the Remington No. 1 typewriter) was the QWERTY keyboard, which is still the most popular keyboard layout in the world.

24 JUNE

1910 Alfa Romeo Automobiles S.p.A., car manufacturers, was founded by Frenchman Alexandre Darracq as A.L.F.A. ("[Società] Anonima Lombarda Fabbrica Automobili", "Lombard Automobile Factory Company"), in Milan, Italy.

25 JUNE

1921 German chemist, Friedrich Karl Bergius invented a way to convert coal dust and hydrogen directly into gasoline and lubricating oils without isolating intermediate products.

26 JUNE

2016 The new locks that had been installed to expand the Panama Canal served the first ship. A Chinese vessel, carrying about 9,000 containers, entered the locks at Agua Clara that will double the capacity of the Panama Canal.

27 JUNE

1967 The world's first Automated Teller Machine was installed at Barclays Bank's Enfield branch, England. The device was invented by John Shepherd-Barron. The machine operated on a voucher system and the maximum withdrawal was £10.00.

28 JUNE

1998 Microsoft released Windows 98.

29 JUNE

1995 The space shuttle Atlantis docked with the Russian space station Mir for a mission which lasted until 4 July 1995. The docking tested a special module similar to those that would be used to link shuttles with the international station when it was completed. For those five days, the space vehicles formed the largest man-made satellite ever to orbit the Earth.

30 JUNE

1930 The first round-the-world broadcast, began in the U.S., using a series of short-wave radio relays and carried the voice of Clyde D. Wagoner. It took only one-eighth of a second and began in W2XAD, Schnectady through Holland, Java, Australia, across the Pacific Ocean and back to Schnectady. wn

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calendar

JUNE | JULY | AUGUST 2018

JUNE 2018

3 - 7	2018 Power Modulator and High Voltage Conference (IPMHVC)	Wyoming, USA	www.ieee.org
5 - 7	Fundamentals of Medium Voltage Protection	Johannesburg	roberto@saiee.org.za
6 - 7	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za
10 - 15	2018 IEEE 45th Photovoltaic Specialists Conference (PVSC)	Hilton, USA	www.ieee.org
12 - 13	AfricaRail 2018	Johannesburg	www.terrapin.com
13 - 14	SANS 10142-Part 1 & OHS Act	Johannesburg	roberto@saiee.org.za
13 - 15	2018 IEEE Transportation Electrification Conference and Expo (ITEC)	California, USA	www.ieee.org
19 - 20	Core Financial Management	Johannesburg	roberto@saiee.org.za
20 - 21	Network Frequency Controls	Johannesburg	roberto@saiee.org.za
24 - 27	Water Institute of SA Annual Conference & Expo	Western Cape	www.wisa.org.za
26	2018 PES-IAS PowerAfrica Conference	Western Cape	www.ieee.org
27 - 28	Carrier Ethernet 2.0 Fundamentals	Johannesburg	www.saiee.org.za
27 - 29	2018 15th Conference on the European Energy Market (EEM)	Lodz, Poland	www.ieee.org

JULY 2018

2 - 7	2018 IEEE International Congress on Internet of Things (ICIOT)	San Francisco, USA	www.conferences.ieee.org
3 - 4	Optical Fibre Technology and Networks (OFTN)	Johannesburg	roberto@saiee.org.za
4 - 7	8th Scientific Computing to Computational Engineering Conference	Glyfada, Greece	www.scce.gr
10 - 11	Smart Grid Systems	Johannesburg	roberto@saiee.org.za
17 - 18	Smart Procurement World Natal	Durban	www.smartprocurementworld.com
18 - 19	Substation Design And Construction	Johannesburg	roberto@saiee.org.za
17 - 19	PowerGen Africa & DistribuTech	Johannesburg	www.powergenafrica.com
21 - 23	2018 3rd Asia-Pacific Conference on Intelligent Robot Systems (ACIRS)	Singapore	www.acirs.org
24 - 26	2018 2nd International Conference on Biomedical Engineering (IBIOMED)	Bali, Indonesia	www.ibiomed.ugm.ac.id
26 - 27	LV, MV & HV Switchgear Operation, Safety, Maintenance	Johannesburg	roberto@saiee.org.za
26 - 27	Advanced MS Excel For Engineers	Johannesburg	roberto@saiee.org.za

AUGUST 2018

6 - 7	2018 Advances in Big Data, Computing & Data Communication Systems	Durban, RSA	www.icabcd.org
6 - 8	2018 IEEE Symposium on Safety, Security, and Rescue Robotics (SSRR)	Pennsylvania, USA	www.ssrr2018.org
10 - 12	2nd Industrial Engineering & Technology Management Conf.	New York, USA	www.icietm.com
13 - 15	2018 IIndustrial and Commercial Use of Energy (ICUE) Conference	Cape Town, RSA	www.energyuse.org.za
20 - 22	2018 Power Science & Engineering Conference	Vienna, Austria	www.icpse.org
27 - 30	2018 International Conference on Radar (RADAR)	Brisbane, Australia	www.radar2018.org

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