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SYSTEM TECHNOLOGIES

SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | OCTOBER 2020

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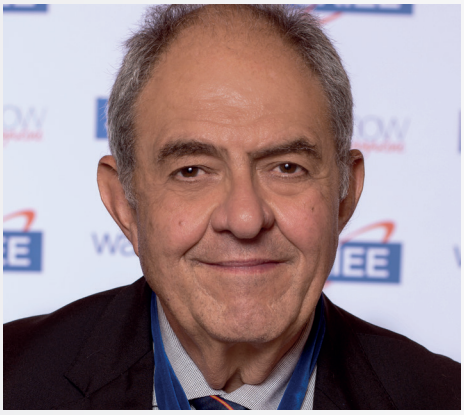

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BOVA is a leading brand within the safety wear industry, recognised for delivery of quality footwear, workwear and fall arrest equipment throughout Africa and beyond. BOVA prides itself on being ENGINEERED WITH PURPOSE, providing the correct protection for the required application, which is why we are proud to introduce BOVA ARC; an innovative range of PPE, engineered for specialised thermal protection against the hazards of an arc flash.

INHERENT

"existing in something as a permanent, essential or characteristic attribute".

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When it comes to safety - quality and reliability cannot be compromised. That is why the BOVA ARC Flash Protection range has been manufactured using our specially engineered I-ARC material that is INHERENTLY flame resistant.

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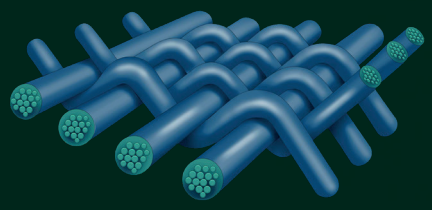
- Performance vs weight advantage - the same and often better thermal protection at a lighter weight fabric (CAT 2 garments on 215 gsm fabric versus competitors up to 100 gsm heavier).
- Does not contain harmful chemicals.



All of this helps to prolong the life and appearance of the garment, to ensure our garments keep delivering on your safety needs. There should be no compromise on the best balance of protection and durability.

Tel: +27 87 057 7770

PRODUCT LIST

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  ARC JACKET | S - 5XL
- **CAT 2**: Rating: 13 CAL/CM²
  ARC TROUSER | S - 5XL
- **CAT 2**:
  ARC FLASH BALACLAVA | ONE SIZE FITS ALL
- **CAT 2**:
  ARC FLASH GLOVES | ONE SIZE FITS ALL
- **CAT 2**: Rating: 13 CAL/CM²
  ARC FLASH CHAMBRAY SHIRT | S - 5XL
- **CAT 2**: Rating: 13 CAL/CM²
  CHINO TROUSER | S - 5XL
- **CAT 4**: Rating: 52 CAL/CM²
  ARC JACKET | S - 5XL
- **CAT 4**: Rating: 52 CAL/CM²
  ARC BIB AND BRACE | S - 5XL
- **CAT 4**: Rating: 52 CAL/CM²
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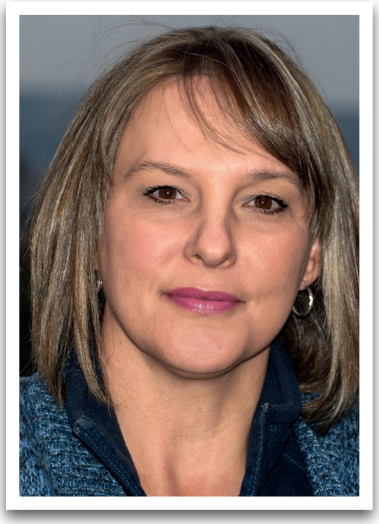


The recent advancements in the Internet of Things (IoT) are giving rise to the proliferation of connected technologies. With many companies, in South Africa, gearing towards smart cities, we decided to take a look at System Technologies.

Our first feature article describes how Smart Metering currently stands in South Africa. The fact remains that South Africa does not, however, have a national plan to roll out smart meters in the country as such. Meters currently installed followed a utility-specific approach based on the available funds when such a utility decided to roll out smart meters—faced with limited resources available to roll out Advanced Metering Infrastructure (AMI) in utilities. Read the article on page 28.

Page 32 sports a prospectus on "The role of Smart Metering in Utilities Business" from 2020-2040. It is estimated that, by the end of 2020, the value of the IoT market will be $1.07 billion (Worldwide Internet of Things Forecast report, 2015-2020), and spending on new technologies (i.e. smart things) will grow dynamically, especially in the area of smart cities.

Across the board, industries are undergoing a digital transformation, and the utility industry is no exception. This transformation is happening on a macro scale as an industry, and on a micro-scale at the utility level. Read more in this article on page 44, entitled "Creating A Smart City Roadmap For Public Power Utilities".

Dr Brian Austin has also written us a historical article on Sir Basil Schonland's other legacy. Read more on page 56.

This online version of wattnow is interactive. So, on the contents page, click on the page number of the article you are interested in, you will be taken directly to the page. When you are finished reading, select the endnote (wn) which will return you to the contents page.

Here's the October issue,
enjoy the read!

The South African Institute of Electrical Engineers (SAIEE) invites you to join us for a two-day webinar series titled Unlocking and Enabling Storage as a sector for South Africa.

Due to growing concerns about the environmental impacts of fossil fuels and the capacity and resilience of energy grids around the world, engineers and policymakers are increasingly turning their attention to energy storage solutions.

For this reason, the SAIEE is launching the Energy Storage Chapter. We know that energy storage can help address the intermittency of solar and wind power. It can also, in many cases, respond rapidly to large fluctuations in demand, making the grid more responsive and reducing the need to build back up power plants.

The two-day virtual discussion takes place from 3-4 November 2020 and will feature high-level industry speakers such as:

- **MRS SY GOURRAH** - SAIEE President
- **PROF CHANDIMA GOMES** - Professor of High Voltage Engineering
- **PAUL VERMEULEN** - Chief Engineer: Renewable Energy, City Power
- **BARRY MACCOLL** - Senior Regional Manager for the Electric Power Research Institute covering Africa, South East Asia and Oceania
- **FREDRIC VERDOL** - Senior Power Engineer, World Bank
- **PROF PAT NAIDOO** - Professor of Research: Sustainable Development City of Johannesburg Research Chair: Green Economy and Innovation
- **SIJU JOSEPH** - Manager: Ancillary Services. System Operator Eskom Transmission

Registration is completely FREE; all you need to do is confirm your attendance by clicking on the button below.

For any registration queries, please contact Melissa.bender@za.messefrankfurt.com

CONFIRM YOUR ATTENDANCE HERE

Dear Valuable SAIEE member,

SAIEE CHARGE REWARD PROGRAMME

We are pleased to announce further information regarding the Charge Rewards Programme. As a start, the name has been finalized as the "Charge Rewards Programme", with a related awesome logo to go with it. I hope you like it! Secondly, applicable points for corresponding qualifying points accumulation and redemption events are now published.

Dating back from the 1st of December 2019, SAIEE members in good standing (fees paid in full) will be awarded their Charge points for qualifying past events. Additionally, members in good standing will be able to accumulate Charge points for qualifying events from now on. Accumulated points can be redeemed for qualifying events as published. Accrued points are valid for five years, after which they expire and a new cycle begins from a zero base.

As a member, you will receive a unique URL that will take you to your page that provides the number of points accumulated to date in due course.

Please familiarise yourself with the Charge Rewards Programme and accumulate those points! I welcome your comments/suggestions to improve the Charge Rewards Programme. Please forward those to leanetse@saiee.org.za, and let's get the SAIEE working for you!

For more information, on how this programme works, click here.

Yours faithfully,

Leanetse Matutoane
Operations Manager

CHARGE REWARD PROGRAMME

MEMBER LOYALTY

We appreciate our Member's support for 110 years

REWARD

A unique reward programme exclusive to SAIEE Members

FEEDBACK

We received your feedback and we listened to added benefits

LOYALTY CARD

Earn Charge Rewards by attending events, courses or writing articles

SATISFACTION

We want you, our Valued Member to feel satisfied when working with us

LOYALTY PROGRAM

Redeem your Charge Points towards CPD credits

QUALITY

We guarantee top quality events, courses, and services

SERVICE

We are here to serve you, our Valued Member better

RESPECT

We respect you and want to see value for your hard-earned money

SUPPORT

We are here to answer any queries you might have

For more information:

Visit your Membership Porthole on the SAIEE Website:
www.saiee.org.za

Alternatively, call Connie on 011 487 3003.

SAIEE

CHARGE

rewards programme

G20 Energy Ministers strive for sustainable development and market stability

HE Yury Sentyurin, Secretary General of the Gas Exporting Countries Forum (GECF) participated in the G20 Energy Ministerial Meeting and reaffirmed its commitment to greater international cooperation in ensuring the resilience of energy systems and affordable and secure energy for all.

The two-day deliberations acknowledged the unprecedented impact that the Covid-19 pandemic has had on energy markets and paved the ways for the sector's recovery efforts.

The Meeting assumed vital importance against the backdrop of a global pandemic and was devoted to the energy market stability amidst low oil and gas prices and lacklustre demand.

The final Communiqué crystallised the resolve of the G20 countries to utilise the widest variety of technologies and fuels to ensure a stable and uninterrupted supply of energy for economic growth. It is not a coincidence that, as per decision of the G20 Members, the GECF has become a part of the dialogue and was directly referred to in the final Communiqué.

It noted that in order to enhance energy security, *"the role of open, flexible, transparent, competitive, stable and reliable energy markets, as well as stable, predictable, necessary, fair, and non-discriminatory, regulatory frameworks in promoting market stability and investments"*.

On this note, the GECF, alongside the IEA, IEF, IRENA, OPEC, and other peers, was invited to further consider this matter in their respective work programmes.

In the context of circular carbon economy for cleaner and more sustainable energy systems, the Communiqué highlights the crucial role of the GECF and other relevant international organisations in promoting public and private investments, innovative public as well as private financing, policy enablers, and cross-sector collaborations.

These steps are largely in line with the previous G20 announcements, including the 2020 Statement of the G20 Extraordinary Energy Ministers Meeting, 2019 Communiqué of G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth in Japan and the 2018 Communiqué in Argentina. wn

Schletter Installations for the Largest Solar Park in Austria

The Schletter Group has delivered the mounting systems for the largest open area plant in Austria. Special solutions were required for the foundation of the plant with a total size of almost 15 MW located on a decommissioned landfill site.

"The project is out of the ordinary not only because of its size," emphasizes Schletter's open-area technician Stefan Reitz, who planned and supervised the project. A total of 280 tons of mounting material, delivered by 19 trucks, were used on site. A further aspect was also paramount: *"It was important that the foundations did not damage the surface sealing of the landfill,"* Reitz explains. *"Conventional pile-driven foundations were out of the question, so we developed a new solution together with the customer KPV Solar GmbH."*

The materials stored in the landfill are enclosed by an underground foil. The foundations could therefore not be driven into the ground deeper than 30 centimeters.

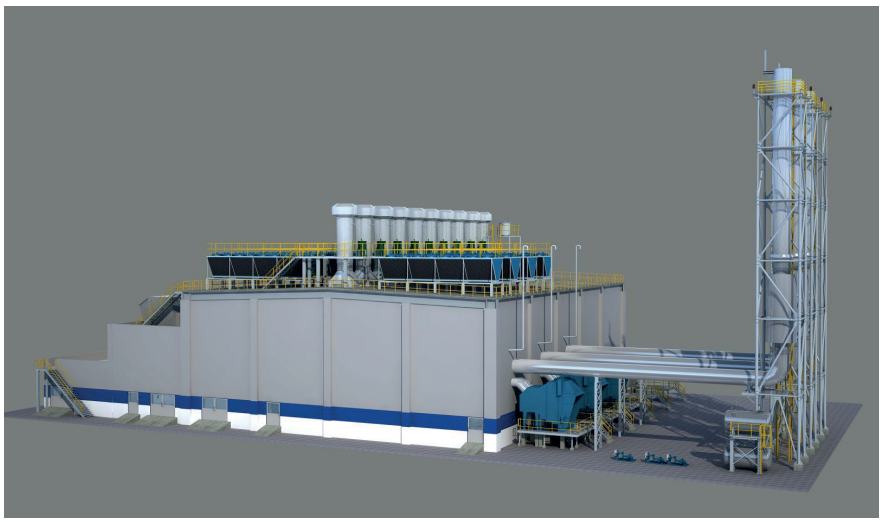
In order to connect the module tables to the ground in such a way that they still meet their static requirements, Schletter used a combined solution of pile-driven and concrete foundation: the supports were aligned and driven about 30 cm into the ground. An above-ground foundation was then poured with in-situ concrete to anchor the piles.

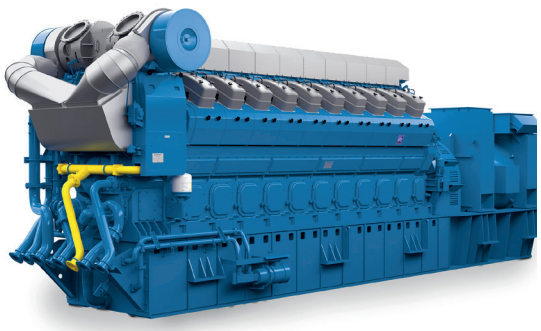
The Schletter "FSDuo" twin-post system was used, which is particularly economical due to its short installation time and high spans. Thanks to its adjustable tilt head, even steep slopes can be compensated. A total of 34,600 modules were mounted on it in an east-west orientation in the first construction phase. They generate around 10.96 GWh of solar power, which corresponds to the annual consumption of around 3,400 households. By completion, the system will grow by a further 10,400 PV modules, bringing its total output to almost 15 MWp at the end of the project.

Reinhard Konrad, the responsible sales representative at the Schletter Group, thanked the Schletter team for its work on this large-scale project.

"Everything ran on time and according to plan, our colleagues did a great job," says Konrad. *"The cooperation with the customer KPV and NwComp Solar GmbH was also extremely efficient and smooth."* NwComp Solar installed the system on site.

The plant is operated by the Austrian electricity company VERBUND and OMV AG, one of the largest listed industrial companies in Austria. The first construction phase has already been completed. The second construction phase should be completed by the end of the year. wn





Rolls-Royce to deliver 29 MW gas power plant for Dhamra LNG regasification Terminal in India

Rolls-Royce has signed a contract with Dhamra LNG Terminal Pvt. Ltd. (DLTPL) for the complete Engineering, Procurement and Construction (EPC) delivery of a 29 MW gas-based power plant for an Indian LNG terminal. DLTPL is a joint venture between Indian multinational conglomerate Adani Group and French energy major Total S.A, located on the eastern coast of Odisha in India. The LNG terminal will function as a reception facility for import of LNG, where LNG tankers can directly unload cargo and converting the LNG gas from liquid state to gaseous state.

The highly efficient power plant will meet the baseload capacity of the LNG terminal and will offer high reliability and availability of more than 98 %. The core equipment for the new gas- based power plant will include three 9.6 MW gensets, based on the 20-cylinder Rolls-Royce Bergen B35:40 gas engines. These medium-speed gas engines are characterized by high availability and low operating costs. The engine's efficient combustion technology, in addition to being fuelled by a clean LNG fuel, also ensures low environmental impact coupled with improved performance.

Dhamra LNG CEO, Mr. S.P.Singh, said: "We are delighted to have a Rolls-Royce company supplying us with the critical power system for our upcoming terminal in Odisha. Rolls-Royce's selection followed a thoroughly competitive tendering process and we are reassured by their extensive experience in the area of power systems both globally and for Indian LNG terminals."

When commissioned in the end of 2021, the Dhamra LNG Terminal will be the second LNG plant in India that is powered by Rolls-Royce Bergen medium speed engines. Rolls-Royce has earlier supplied and commissioned a 28 MW power plant in 2018, running on LNG fuel to the Indian Oil Corporation LNG Terminal at Ennore, Tamil Nadu.

Designed for an initial capacity of 5 million tonnes per annum (MTPA), expandable up to 10 MTPA, the proposed Dhamra LNG import and regasification terminal will initially have two full containment type tanks of 180,000 m3 capacity each. Rolls-Royce will be managing the engineering, procurement, and construction of the new gas power plant for the LNG terminal.

Rolls-Royce has been a pioneer in the development of the modern lean-burn gas engine concept. With a robust design and proven reliability record, these gas engines have been successfully installed globally across industries. With thousands of installations globally, Rolls- Royce is trusted to deliver complete power solutions to a variety of applications, such as utilities, independent power producers, healthcare, mining sites, greenhouses, hotels, data centres and manufacturing facilities. Rolls-Royce medium-speed generating sets are manufactured by the subsidiary Bergen Engines in Norway.

Read more about Rolls-Royce power generation based on medium-speed engines here. wn

What is this new IO-Link Technology?

IO-Link is the first standardized short distance, bi-directional, digital, point-to-point, wired, industrial communications networking standard (IEC 61131-9) worldwide. It is used for communicating with digital sensors and actuators to either a type of industrial fieldbus or a type of industrial Ethernet.

The powerful point-to-point communication is based on the long established 3-wire sensor and actuator connection without additional requirements regarding the cable material. So, IO-Link is no fieldbus but the further development of the existing, tried and tested connection technology for sensors and actuators. wn
Contact INSTROTECH for more information on SIKO IO-Link capable products on 010 595 1831 or sales@instrotech.co.za

SIKO AP10 Electronic position indicator

ABB supports launch of engineering scholar-ship programme for Africa

ABB is proud to announce its support of the inaugural Ashesi-ETH Master's in Engineer-ing Programme in partnership with two world-leading universities for technology and the natural sciences, namely ETH Zurich and Ashesi University Accra.

Curated by ETH Zurich and Ashesi Accra and in close collaboration with leading global technology Swiss multinational companies ABB, Barry Callebaut, Bühler, LafargeHolcim and Nestlé, this programme for highly-talented engineering students aims to ensure that graduates effectively contribute towards economic development across Africa through the transformation of society and industry to achieve a more productive and sustainable future.

Once all upcoming milestones have been achieved, this first-of-its-kind master's programme is set to begin in August 2021 or as soon as possible thereafter. It will be facilitated by Ashesi University, while the education and lecture pro-gramme will be driven by both Ashesi University and ETH Zurich. This collaborative approach is designed to support capacity building through the development and strengthening of skills, processes and resources required to drive the success of the programme, establish its sustainability beyond this initial collaboration and foster knowledge transfer between the two institutions.

"ABB is excited to be part of such an impactful initiative that aims to bridge the gap between higher education and the reality of working in industry," said Carolina Granat, Head of People Development at ABB. *"At ABB, we remain commit-ted to educating and training highly-skilled leaders and entrepreneurs who can accelerate economic and social devel-opment by applying global innovations to solve complex problems in Africa."*

ABB's contribution to this programme continues the company's longstanding support for education in communities across the world, from providing mobile science laboratories for underprivileged students in India and mentoring young engineers in Hungary to Instituto ABB's 20+ years educating children from the favelas of São Paulo.

The programme is targeted at undergraduate students with an engineering background across any country in Africa. wn

For more info, email media.relations@ch.abb.com.

Maintaining Backup Battery Systems for Maximum Usage and Reliability

Standby battery backup systems play a critical role in keeping essential operations functional in the event of a utility outage.

Facilities like data centers, hospitals, airports, utilities, oil and gas facilities, and railways can't operate without 100 percent backup power reliability. Even standard commercial and manufacturing facilities have backup power systems for their emergency systems, alarms and controls, emergency lighting, steam and fir control systems.

Most backup power systems use an uninterruptable power supply (UPS) and a string of batteries. The UPS backs up the digital control system (DCS) to keep control of plant operations until systems can be safely shut down or until the auxiliary generator kicks on.

Although most batteries used in modern day UPS systems are "maintenance free," they are still susceptible to deterioration from corrosion, internal shorts, sulphation, dry-out, and seal failure. This article outlines best practices for keeping these "battery banks" at optimum performance, so that if an outage does occur, the backup is ready.

Fluke BT521 Battery Analyzer with lead probes

For more info email here. wn

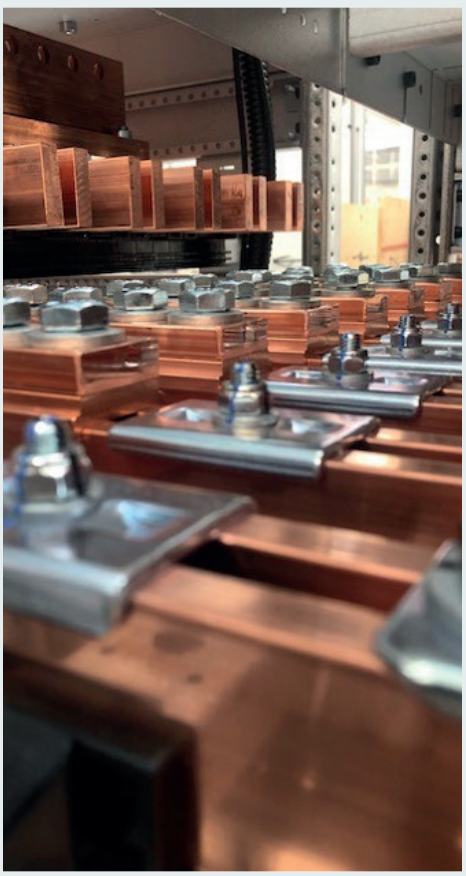
Data Centre Panels for Local Installation

JB Switchgear Solutions (Pty) Limited was recently awarded a contract for the design, manufacture, and supply of five (5) 6300 Amp, 400 Volt, 70kA low voltage power control centres for a data centre installation

These power centres in conjunction with generator sets and battery banks, form part of the power solution to maintain a reliable power supply to the data centres.

The power centres are designed and manufactured to comply fully with IEC 61439, IEC/TR 61641 and SANS 1973-1. In addition, the products carry full type test certification and feature excellent technical characteristics which make it a leading product in its field.

JB Switchgear have an excellent reputation and track record for supplying a comprehensive range of panel designs to cater for specific applications and environments. wn



IEF and GECF Heads discuss expanded cooperation in first meeting

Energy Forum (IEF) and the Gas Exporting Countries Forum (GECF) conducted the first virtual meeting between new IEF Secretary General HE Joseph McMonigle and HE Yury Sentyurin to review ongoing and future cooperation.

The GECF and IEF have had a close relationship dating back to 2010 and cemented further in 2011 with the MoU, focused on exchange of data and market research, as well as joint high-level activities and events.

In the area of high-level activities, HE Yury Sentyurin participated in the 16th IEF Ministerial Meeting, held under the auspices of HE Narendra Modi, Prime Minister of India in New Delhi in 2018. The GECF leadership also attended the 7th and 8th Asian Ministerial Energy Roundtables in 2017 and 2019, respectively, which typically gather both IEF and GECF Energy Ministers, heads of the major international organisations and expert community.

On reciprocal basis, the IEF leadership attended some of the major GECF events, including the 4th and 5th GECF Summits. Further, at the launch ceremony of the GECF Global Gas Outlook in 2019, the organisation was awarded with a 'Friend of the GECF' token, marking yet another milestone in the relations between the Forums.

During the meeting, HE McMonigle invited Secretary General Sentyurin to attend the next IEF Ministerial Meeting scheduled to take place in 2021. Furthermore, the upcoming 7th IEF – IGU Ministerial Gas Forum, hosted by Malaysia on 3 December in 2020, represents another significant opportunity for mutual engagement in a virtual setting.

In turn, HE Sentyurin invited HE McMonigle to be a keynote speaker at the signature GECF Monthly Gas Lecture Series. These lectures feature policymakers and experts who share their knowledge and insights on contemporary issues related to the gas industry and its interconnected influencers of geopolitics and economy.

Both IEF and GECF officials discussed their respective participation in the recently held G20 Energy Ministerial Meeting and exchanged views on the importance of the stability of energy markets in the economy recovery from the pandemic.

With the annual GECF Global Gas Outlook attracting the attention on a global scale, the heads of both organisations also discussed the growing presence of the GECF at the IEA-IEF-OPEC Symposiums on Energy Outlooks, where the GECF successfully added value at the 9th and 10th editions in 2019 and 2020, respectively.

Secretary General Sentyurin said: *"We are looking to ramp up our participation in the IEA-IEF-OPEC Symposiums on Energy Outlooks. This is an area where the GECF is ready to demonstrate our hallmark capability of energy forecasts and become a full-fledged partner organisation."*

His Excellency Joseph McMonigle said: *"The GECF actively participates in the Joint Organisations Data Initiative and the IEF energy dialogue at ministerial and senior expert level meetings, including in the context of the trilateral programme of work with the International Energy Agency and Organization of the Petroleum Exporting Countries."*

The GECF became the only gas organisation to join JODI-Gas in 2014 when it became an official partner of the programme. Secretary General Sentyurin highlighted the GECF's engagement at the 6th Meeting of Heads of JODI in 2018 and JODI Inter-Secretariat Meeting, as well as other JODI and JODI-Gas events, as a showcase of the GECF's commitment to this important programme.

Secretary General Sentyurin noted: *"I am proud of our association with the IEF and would like to reiterate our intention to continue supporting the IEF and the JODI initiative into the future for the benefit of our respective stakeholders."*

His Excellency Joseph McMonigle added: *"I look forward to expand our engagement into new areas and strengthen our collaboration during my Secretariat."*

The GECF regularly organises JODI training sessions for its members, in addition to presenting speaking opportunities to IEF officials in its thought leaders' meetings. wn

Danfoss efficiencies help South African farmers to free up energy and achieve production goals

In recent years, South African energy security has been constrained, while the country is also recognised by the Development Bank of Southern Africa as being a water-scarce country. The importance of energy efficiency in assisting with adequate irrigation is of paramount importance.

Danfoss, together with engineering components provider BMG, an authorised DrivePro® service partner of Danfoss, supplied a commercial maize farmer with the technology required to combat challenges around electricity sufficiency, for more effective irrigation purposes and in order to increase production capacity. This initiative has since been followed by other commercial farmers in the wider area.

Mick Baugh, Electronics Manager, Electromechanical Division, BMG, explains, *"Pumping and irrigation were the largest consumers of power on this maize-producing farm. The project required assisting the farmer, who was limited by a power supply of only 200 kVA +/- 300 A, to significantly reduce the cost of irrigation per hectare. Additionally, the farmer wanted to expand his crop production to include pecan nuts, but was unable to because of these limitations. The cost of irrigation per hectare therefore needed to be reduced, and the limited power supply needed to be used more efficiently."*

Govender clarifies, *"In this case, the energy shortage was the farmer's main concern, with costs being a secondary consideration. We were therefore looking to free up the existing electricity supply in order to use it elsewhere and thereby increase production capacity. The use of variable speed drives on a pump set was the perfect solution to provide the benefits required."*

"Danfoss VLT® AQUA Drive FC 202 Variable Speed Drives, which offer additional energy savings when compared with most traditional variable speed drive controls, have been designed for water and wastewater applications, including irrigation," Danfoss spokesperson says. *"These variable speed drives were fitted to all pumps in this installation and controlled by pressure transducers that were set to match the varying demands of different irrigation requirements. The only peripheral component required was a pressure transducer. Pump controllers and valves were not necessary for flow-control in this system."*

After the installation of the variable speed drives and programming the set point to 2.8 bar, the Danfoss-BMG team were able to run this same pump set with an absorbed power of 51 kW, a saving of 24 kW or 50 A. It is noteworthy that the farmer began with a set of three variable speed drives on three pumps and, because of the energy saving, he eventually installed variable speed drives on every pump on his farm.

"At the last count," says Baugh, *"there were over 20 variable speed drives on the farm, with a projected annual power saving of 155,491 kW. After the installation of variable speed drives on all pump sets, the power supply is used more efficiently, resulting in improved crop production and expansion of the farmer's supply of maize, which now also includes pecan nuts."* wn

Avnet Leveraging EMEA's Proven Success in Global Sales, Supplier and IoT Solutions

Avnet EMEA, the regional business organization of Avnet, Inc.), a global technology distributor, will "step into the ring" to help drive greater alignment and best practice sharing across Avnet's global demand generation, supplier development and go-to-market strategies for its IoT and Avnet Integrated capabilities. Effective immediately, Phil Gallagher, Interim CEO of Avnet. Inc. announced the appointment of EMEA president Slobodan Puljarevic and Mario Orlandi to lead these efforts, while continuing to jointly manage the EMEA region.

In their new assignments, the EMEA presidents will split their new global responsibilities. Slobodan Puljarevic will oversee global supplier management, Avnet Design Services and the design chain strategy in support of the value proposition to accelerate growth for Avnet. Mario Orlandi is responsible for driving closer alignment between Avnet's global IoT capabilities and Avnet Integrated solutions with Avnet's core electronic components selling strategy. By extending and differentiating Avnet's overall value proposition with leading-edge IoT and integrated solutions capabilities,

Mario Orlandi

Slobodan Puljarevic

customers will be able to enrich their products with IoT technology and state of the art embedded computing, server and display solutions.

Phil Gallagher, interim CEO of Avnet, Inc., said: *"Avnet EMEA has been a long-standing successful model within Avnet for demand creation, solution selling, process improvement and fast execution. To learn from and share their best practices globally, I have appointed Puli and Mario as new members of the global executive leadership team to help guide our global strategy and operations. Together with the other regional business leaders, they will drive Avnet's key organizations to develop a second-to-none customer journey, from design to manufacturing, from small orders to large supply chain engagements. I look forward to even greater collaboration and input from our regions at the executive level."*

As both Puljarevic and Orlandi take on global responsibilities within Avnet, the company also announced the promotion of two top executives to "Speedboat" presidents. Effective January 1, 2021, Thomas Staudinger, senior vice president sales & marketing at EBV Elektronik will succeed Slobodan Puljarevic as President of EBV Elektronik and Gilles Beltran, vice president sales at Avnet Silica, will succeed Mario Orlandi as President of Avnet Silica. wn

Tech students conquer all odds to fulfil their dreams

Three remarkable young women beat the challenges and distractions of lockdown to achieve success

Three young women have risen above tricky circumstances exacerbated by the Covid-19 lockdowns to keep up with demanding study schedules and remain an inspiring force for their families and friends. Glory Matshete (28) from Brits in the North West, Sibaxolise Mningiswa (20) from Port Elizabeth in the Eastern Cape and Maishibe Thobela (20) from Pretoria in Gauteng are united in one thing: a thirst to make their dreams come true, no matter what.

They are now in their second year of a three-year Bachelor of Information Technology degree at South African ITversity Belgium Campus, sponsored by the Datatec Education and Technology Foundation. The three women are aiming to carve out IT careers for themselves in the fields of science, technology, education and mathematics (STEM).

"I grew up in a little village called Rivala in Limpopo," says Glory. *"I was timid and didn't know how to interact with people, so I always felt very alone. School activities like drama became a heaven for me because they allowed me to step out of my shell and show my classmates what I was made of."* That determined spirit became a golden thread throughout Glory's schoolgoing days and is still there now that she's at varsity. *"My folks struggled financially, but somehow we made a plan as a family."*

Like Glory, Sibaxolise struggled with self-confidence, and although she attended good schools, she felt her career choices were limited: *"It was doctor, teacher, nurse or lawyer, and none of those interested me."* Then, in Grade 9, Sibaxolise began computer lessons and developed a curiosity to know what was going on in the box behind the screen. *"I was more interested in the how than anything else."*

For gregarious Maishibe, it was just a question of where she fitted in. *"There was a stage in life when I thought I would become a professional tennis player after winning a few tournaments."* Then, listening to the experiences of a friend of hers who was studying at Belgium Campus, Maishibe realised that IT was the best option to allow her to pursue her real passion, that of being an entrepreneur.

For these determined and hardworking young women, navigating the tricky lockdown landscape over the last five and a half months hasn't been easy. But with the help of the university, and the Datatec Education and Technology Foundation, they've prevailed. Belgium Campus quickly scaled activities to allow students to attend lectures

Glory Matshete

Sibaxolise Mningiswa

Maishibe Thobela

online using Microsoft Teams and Zoom videoconferencing.

It wasn't a trouble-free transition, with the challenges of lack of equipment and a stable power supply, unreliable internet connectivity and sometimes unaffordable data. *"The change from quiet campus life to studying back at home with my folks and family in the background was a big one,"* admits Glory. But failure wasn't an option. *"My mother was my champion. Every time life knocks her down, she gets back up and tries once more."* It's this resilience, learned from her elders, that Glory believes will allow her to achieve practically anything she's willing to work for.

For Sibaxolise, there was self-doubt and procrastination: not having the person-to-person support of her study mates, she had to find a way of muscling up self-motivation. To manage her overall workload, plotting a timetable and then actually actioning it (rather than "using it for decoration", she jokes) made a big difference. *"Talking to my mom, listening to Steve Harvey and watching TED Talks also helped."* If she were unsure of something in her coursework, she'd take a picture of what she was grappling with and email it to her lecturer, who would guide her.

It was time management and navigating distractions that challenged Maishibe. *"Being locked down at home came with household responsibilities, which meant that I had less of my own time. I had to negotiate with my parents so that they understood that my academics were my priority."* That said, her father, with his steadfast work ethic and desire to see others succeed, enabled her to keep focus, says Maishibe, whose life goals are "to make a difference in other people's lives, along with becoming the most generous person ever".

Wilna de Villiers, marketing and communications manager for the Datatec Group says, *"We're so proud of Glory, Sibaxolise and Maishibe, who passed their first year with flying colours and have done exceptionally well so far in their second year at Belgium Campus under challenging circumstances. Studying towards an Information Technology degree takes huge commitment and dedication, and we hope their stories will inspire many other women to choose STEM-related careers, which are so desperately needed in our country."* wn

Adaptors can be a danger to the South African consumer

The increased use of devices and appliances has resulted in the increased use of adaptors as well as adaptors-on-adaptors in South Africa. This creates a risk of fires, short circuiting and damage or malfunction of appliances.

South African National Standard (SANS) 164-0 covers the specific requirements for plugs, sockets and adaptors and will lead to a new range of plugs and sockets in South Africa. The South African Bureau of Standards (SABS) demonstrated the new range of plugs and sockets in a virtual media briefing held today.

"With the array of appliances and devices that have become commonplace in today's world, it is critical to ensure that the plugs and sockets are also changing to accommodate the more compact designs of plugs. New homes and offices should be fitted with the sockets according to the latest revision of SANS 164-0 and the different parts. We need to be aware of the improved switching arrangements of switched socket-outlets, the inclusion of the SANS 164-2, compact design for 16A plugs and most importantly the warnings that advises consumers not to use multiple adaptors, plugged into one another," says Jodi Scholtz, Lead Administrator of SABS.

"SANS 164-0 covers the general requirements for plugs and socket-outlets and is considered the base document for all the plugs and socket-outlets systems in South Africa. Every new building should have these new SANS 164-2 type of sockets and all appliances should be fitted with the new plugs. South Africa has been lagging with the implementation of these global changes and the continued use of adaptors onto adaptors will just lead to more dangerous electricity usage and malfunctioning of appliances," warns Gianfranco Campetti, Chairperson of the Technical Committee responsible for the development of SANS 164 series of standards.

Campetti explains that since the 1900's British standards have guided South African installations and appliances. In the 1960's British standards for plugs and socket-outlets introduced a "flat pin" design, not adopted by South Africa, which continued to use the large round pin (SANS 164-1) design, still in use today. Since then there have been 21 different types of plugs introduced, of various configurations and ratings. Most buildings still contain the traditional large 3-pin sockets and this has led to an increased use of adaptors. The revisions to the standard, published in July 2020 incorporates changes in technology covered in SANS 60884-1: Plugs and socket-outlets for household and similar purposes. SANS 60884-1 is an adoption of the International Electrotechnical Commission (IEC) 60884-1 standard which also covers the general requirements for plugs and socket-outlets.

NEW SOCKET INSTALLATIONS

In the last few years, various iterations of the new design have been available on the market, which accommodate the following type of plugs:

- 3 pin plugs (old type)
- Compact 3 pin plugs
- USB outlets
- Switches

SUMMARY OF THE AMENDMENTS IN SANS 164-0

- Reducing the minimum clearance of an adaptor body to socket-outlet surface to 8,0 mm from 12,0 mm.
- Introducing the symbol for adaptors not permitted to be plugged in one

New socket installations

Warning signs will appear on adaptors to prevent the use of multiple adaptors plugged into one another, thus avoiding the risk of electricity hazards due to overloading and poor connections.

another in order to avoid straining the socket-outlet. This was due to a safety risk to the consumer as the straining of the socket-outlet can cause a short-circuit between the neutral and live pins. This symbol has to be embossed on the adaptor to warn consumers on the danger of plugging adaptors from one another.

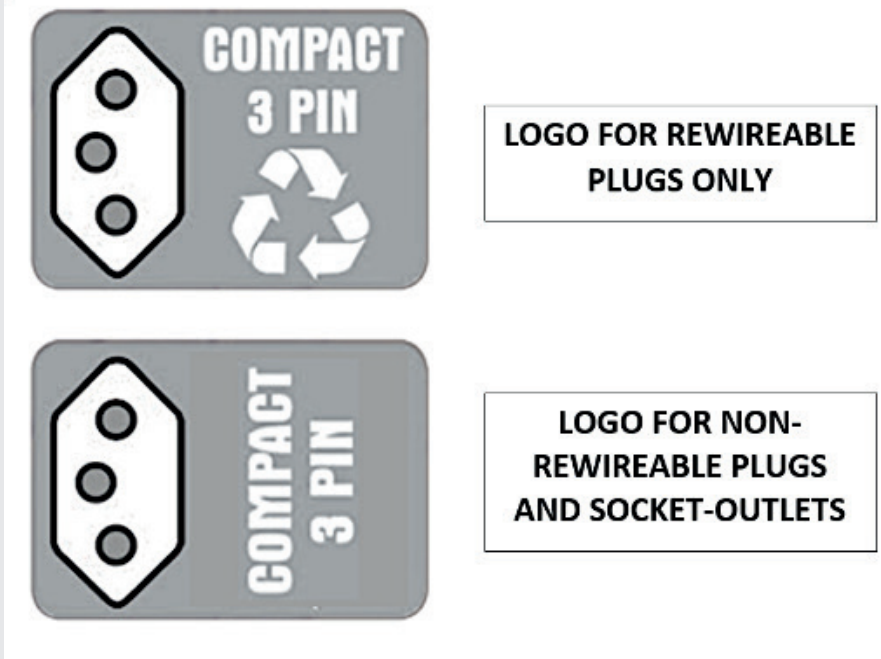
- Examples are provided to show how multiple switched socket-outlets for fixed installation should be switched.
- Since 2018 the wiring code (SANS 10142-1) requires socket-outlets in electrical installations to be of the SANS 164-2, at every socket outlet point, however other configurations (such as SANS 164-1) may also be installed onto the same outlet.
- The changes in SANS 164-0 are generic to all the SANS 164 series of standards namely Part 1 to Part 6. This means that SANS 164 series of plugs and socket-outlets have to comply with SANS 164-0.

The SANS 164 series falls under SABS Technical Committee (TC) 067 Sub-committee (SC) 03 titled Electricity distribution systems and components: Electrical accessories. The scope of the TC covers standards for electrical accessories such as switches, plugs and socket-outlets, home automation devices, connectors, adaptors, couplers, cords extension sets and conduits (cable management systems) for use in household and similar low-voltage applications.

The TC067 SC03 consists of representatives from associations, manufacturers, regulators, power utility, testing laboratories, government departments and academic institutions. Should any member of the public be interested in joining the SC, they are welcome to submit their interest via www.sabs.co.za.

IMPACT TO THE INDUSTRY:

The construction industry, electrical contractors and households needs to be aware of the amended requirements for South Africa. It is expected that new buildings will need to comply with the new standards within the time frame listed in the wiring code. wn



Some of the sockets for the compact 3 pin will indicate whether it can accommodate a rewireable plug or not as illustrated above.

Zest WEG In Zimbabwe Ethanol Expansion

Zest WEG is supplying a TGM planetary gearbox with a WEG variable speed drive (VSD) and a WEG medium voltage motor for a mill expansion by Green Fuel, Zimbabwe's leading producer of renewable fuel.

Leandro Magro, Steam Turbines Manager at Zest WEG

According to Leandro Magro, steam turbines manager at Zest WEG, the equipment is destined for the new sugar cane crushing mill #6 at Green Fuel's state-of-the-art ethanol facility at Chisumbanje in south-eastern Zimbabwe. The plant uses the latest technology to produce high-grade anhydrous ethanol, with a high-pressure boiler and a TGM steam turbine generator set increasing energy recovery. This allows the plant to be self-sufficient in its energy needs, and to generate excess electricity.

Green Fuel's ethanol project – awarded National Project status by Zimbabwe's government for its economic contribution – reduces the country's reliance on imported petroleum products. It also produces less greenhouse gas emissions than unleaded petrol, and can be sold significantly cheaper. The company employs over 3,000 people in its agricultural and industrial operations.

"The engineered gearbox for this project is custom-built by TGM in Brazil, a WEG Group company, and is supplied with a WEG VSD and WEG electric motor as a package," says Magro. *"The components in this solution are designed to deliver the specific torque required to crush the cane to the customer's specifications – reliably and efficiently."*

The output speed of the gearbox in operation is usually between five and seven revolutions per minute. To deliver the required rotating force, a 750 kW, 3,300 V WEG motor was specified, with a WEG VSD to facilitate speed variations. The volume and quality of cane being brought in from the fields to the mill varies during the harvesting season – usually from April to October or November – so the rate of crushing in the mill needs to be adjustable.

The TGM third-generation planetary gearbox is designed specifically for sugar cane mills, where torque variations are constant and robust construction is required. The bearings are designed to achieve more than 100,000 hours of operation. This means the equipment can run for up to 10 years before any major service intervention is required.

"WEG has supplied efficient and reliable equipment to Green Fuel since the beginning of its operation. During its plant expansion from 2017 to 2018 we supplied a planetary gearbox, motor and VSD for mill number 1," he says. *"Our current contract is for a second expansion, where Zest WEG*

TGM's gear manufacturing facility in Brazil.

will supply similar equipment to mill #6."

While the gearbox is manufactured and assembled in Brazil, the WEG VSD with integral transformer will be assembled in South Africa by Zest WEG. The transformer will step down power from 11kV to the required motor voltage of 3.3kV. Delivery will take place by year-end, although the high efficiency motor will be supplied earlier from WEG in Brazil. Installation of the equipment on site will be conducted in early 2021, over a period of about two weeks. Zest WEG will be involved in the installation supervision and commissioning, which includes the required tests before the start-up.

"We also assist with the start-up of the equipment at the beginning of the crushing season, to ensure that everything is running optimally," Magro says. *"Using several production facilities around the world, Zest WEG provides its customers in Africa an integrated solution that combines the highest quality of equipment with our in-depth industry expertise."* wn

The TGM planetary gearbox and WEG motor at Green Fuel in Zimbabwe.

The value of prepaid sub-meters:
enabling energy and business efficiencies

South Africa's electricity supply has been under constraint for over a decade now, and while steps are in progress to correct this at the macroeconomic level, the issues with Eskom continue to filter down to all consumers. The good news is that, from a business perspective, prepaid metering systems can play a significant role in helping with energy efficiencies.

Zachariya Lockhat, Head of Business Development at Recharger, a leading supplier of prepaid electricity sub-meters, tokens and token vending solutions, notes, *"Because Eskom raises regular ongoing requests for increased cost charges as well as debt relief, knock-on effects of these struggles therefore include the issue of costs as well as reliability. This means that the consumer, in an already constrained economic universe, needs to be able to find smarter solutions to manage costs.*

"A possible solution to the problem of managing costs more efficiently is prepaid metering, whereby customers buy electricity upfront and use it until the prepaid amount is consumed."

PREPAID METERING WORKS ACROSS SCALE

Lockhat notes that the potential business efficiencies to be gained are very clear from the perspective of the individual as well as in a landlord-tenant arrangement. *"However, we can and must think along bigger picture lines also. In addition to the residential sector of the market, prepaid metering also lends itself extremely well to commercial and industrial usage. For commercial usage, we see the use of prepaid metering systems in all commercial buildings, including hotels, offices and shopping malls. Industrial usage could include product manufacturing facilities and processing plants.*

"At the same time, prepaid meter usage has advantages for Eskom too: it will help to slow and hopefully reverse the poor monitoring and billing of electricity consumption, as well as illegal connections, which all result in an overall trend of poor revenue collection and even consumer disputes going to court."

PROBLEM/ SOLUTION SCENARIOS

Late last year, the South African Local Government Association (Salga) threw its hat into the ring to back a proposal from an inter-ministerial task team to install prepaid meters for electricity and water in order to recoup billions owed to municipalities. The debt is not only a problem for Eskom but is also a broader national issue because it has huge implications for the economy of the country. Part of the solution to deal with the debt owed could lie in the installation of prepaid meters.

While this issue continues, a study published in 2015 in the American Economic Review, as a joint undertaking between representatives of the University of California and the University of Cape Town, discussed a local example in which over 4,000 customers on monthly electricity billing were assigned prepaid electricity meters for their electricity consumption .

The study found that: *"Electricity use falls by about 13 percent as a result of the switch, a decrease that*

persists for the following year. This creates a trade-off for the utility: revenue from consumption falls but more of it is recovered on time and at a lower cost. The benefits to the electric utility outweigh the costs, on average, though results are very heterogeneous. Poorer customers and those with a history of delinquent payment behaviour show the greatest improvement in profitability when switched to a prepaid meter. These findings point to an important role for metering technologies in expanding energy access for the poor."

CONCLUSION

"We believe that prepaid metering offers an excellent solution for the developing world in terms of electricity consumption and its monitoring, billing and promotion of efficiencies," says Lockhat. *"We know that high rates of customers defaulting on utility bills present a barrier to the expansion of electricity access in the developing world.*

"Prepaid electricity metering, on the other hand, offers a technological solution to ensuring timely payment. We know that poorer households buy electricity more often and in smaller increments, and are most likely to buy on payday. These patterns suggest difficulties smoothing income, and reveal a preference for small, frequent purchases that is incompatible with a standard monthly electricity billing cycle.

"We propose that as a result of the wide-spread installation of prepaid meters, Eskom itself, as well as the municipalities and even right down to the landlords of buildings, would not have to spend as much time chasing after payments, physically cutting people off and/or spending time in court. All parties could, instead, benefit from an increase in payments and a decrease in time-wasting initiatives that would therefore, in turn, allow them to be more efficient with their core businesses," he concludes. wn

2020 SAEEC Conference

- Livestream event

We are proud to announce that Professor Adam Habib, Vice Chancellor of the University of the Witwatersrand and Mr. Brian Motherway of the International Energy Agency, will deliver the two keynote addresses at the opening session of the 2020 SAEEC Conference.

The SAEEC believes that energy is one of the single most important drivers of socioeconomic development and human well-being. Energy efficiency in particular, saves money amidst rising energy costs. It also drives innovative green technologies, supports a cleaner environment and will enhance competitiveness in a world committed to reducing GHG emissions through climate change.

The conference tracks cover topics of great importance towards gender mainstreaming, e-Mobility, alternative generation and finance and incentives on the Carbon Tax.

Join stakeholders from the energy sector to understand the policy frameworks and progress of initiatives that link your own efforts towards sustainable growth, and reignite the energy industry as a professional, a business or an organisation.

The SAEEC's continuous search for information dissemination, awareness, and linking stakeholders is represented in this, its flagship event, the 2020SAEEC Conference. Celebrating it's fifteenth year, 2020SAEEC has something for stakeholders across the energy industry:

- A world-class showcase featuring the latest energy-efficiency technologies, products, services and solutions
- A comprehensive overview of all economic, policy developments and industry trends
- Outstanding presentations from industry thought leaders
- Knowledge sharing and gathering to shape the critical decisions regarding your entity's energy and economic future
- Opportunities to make an impact in a burgeoning industry through sponsorship, attendance and exhibiting.

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- End-users of energy in the industrial, mining, construction and commercial sectors
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- Service and solution providers (ESCOs), engineers, facility managers, corporate directors, contractors, corporate directors, developers, architects, and other professionals
- M&V practitioners
- Climate change consultants
- Clients considering sustainability projects
- Product suppliers in the energy sector that service the end-user market
- Individual professionals in the energy sector
- Stakeholders in the legislative, authoritative, standardisation and government sector
- Educational institutions and students
- Government institutions
- Technologies and services

The 2020SAEEC Conference targets the complete spectrum of technologies and services relevant to our delegates. These include:

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- International and local standards
- Financial, tax and carbon incentives
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- Renewable, biofuel and alternative energy
- Low carbon transport
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- Co-generation and distributed generation

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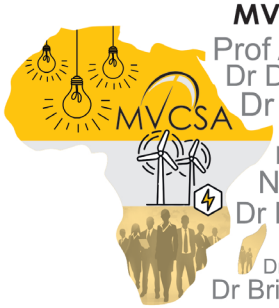
2020 SAEEC CONFERENCE

4-6 November 2020

DAY 1 TRACKS

AFRICA - THE POWERHOUSE
ALTERNATIVE GENERATION
GENDER MAINSTREAMING
MVCSA TRACK



Prof Adam Habib
Dr David Nicholls
Dr Sean Poole
Marco van Dijk
Douglas Cooper
Nadia Rawjee
Dr Mark Rawlins
Karel Steyn
Dr Herman Carstens
Dr Brian Motherway

DAY 2 TRACKS

URBAN EFFICIENCY
e-MOBILITY & ESCOs TRACK
THE NEXT GENERATION OF ENERGY LEADERS

Victoria Kate Burrows Carel Ballack
Simon Ngure Hiten Parmar EWSeta
Nalen Alwar Dr Jeremy Gibbert
Izelle Bosman Vanessa Barend-Jones
Dhevan Pillay

DAY 3 TRACKS

INDUSTRIAL EVOLUTION
A SHOWCASE ON ENERGY SYSTEMS
FINANCE & INCENTIVES

SAMER ZAWAYDEH DAN MATSAPOLA
Hugo Salamanca Albert Williams
Cornelius v Tonder Werner Botha
Andrew Rist Pieter d Villiers Zelda
ISO50001: Burchell
ENERGY SYSTEMS

- Lighting efficiency and management
- Measurement and Verification (M&V)
- HVAC systems and controls
- Building automation and optimisation
- Green building standards, technologies and maintenance
- Facilities management optimisation
- Supply chain management
- Thermal storage and load management
- Boilers and combustion controls
- Solar and fuel cell technologies
- Water-heating technologies
- Energy services and project financing
- Gender mainstreaming in the energy sector
- National energy management programmes
- Business and human resource structures

WHAT IS THE SAEEC?

The South African Energy Efficiency Confederation is a non-profit coordinating body for energy efficiency in Southern Africa. It is one of over 100 chapters of the Association of Energy Engineers (AEE). Our vision is to be the recognised link in energy efficiency for sustainable growth and prosperity in Southern Africa. We believe in the growth and enhancement of business sustainability with a specific focus on energy use.

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- Exhibition
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- Conference Programme

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Smart meters in South Africa

Utilities in SA have started installing smart meters sporadically, no large-scale rollouts yet. South Africa does not, however, have a national plan to roll out smart meters in the country as such. Meters currently installed followed a utility-specific approach based on the available funds when such a utility decided to roll out smart meters—faced with limited resources available to roll out Advanced Metering Infrastructure (AMI) in utilities.

BY EDISON M MAKWARELA
SENIOR CONSULTANT
– ESKOM SOC LTD

Many deployments were therefore regarded as pilots or the first phase of an envisaged future large scale deployment of smart meters (AMI include smart meter & associated field devices, network and systems). As it stands, most utilities have not yet secured funds to roll out smart meters in large scale. A national government strategy must be crafted as a matter of urgency to assist municipalities in rolling out smart meters.

At this stage, South Africa has moved beyond the question of whether smart meters are beneficial to utilities or not. Metering technology has advanced globally, such that smart meters have become the apparent technology of choice worldwide. The cost of smart meters and basic split prepayment meters have converged to such an extent that the difference between the two technologies is negligible, especially when the capabilities of these are compared. In the metering fraternity, it will not come as a surprise if meter manufacturers stop

manufacturing basic split prepayment meters in favour of only offering smart meters. In any case, current basic split prepayment meters are in general half-baked smart meters that already come with a lot of intelligent metering functionalities.

OBSERVATIONS FROM THE PILOT PROJECTS

Most of the smart metering pilots in South Africa have been running for five years which is long enough for us to learn what works, what does not work and what should be done to ensure that all the practical challenges are mitigated. Some of the observations from the current pilots are discussed below.

Current AMI deployments in South Africa are based on proprietary protocols to a certain extent. As we advance, there may be a need to remove what is currently installed to make way for products based on open standards and protocols. In addition, utilities are most likely going to be locked into certain suppliers if the use of proprietary products is allowed to continue.

Current standards such as NRS049 need to be firmed up and finalised so that there is no ambiguity when products are selected. The current NRS049 standard has several requirements that are indicated as "future requirements" that need to be either completed or removed from the document to avoid uncertainties.

The value of an AMI investment has not

been fully realised by utilities mostly due to limited data being collected, data collected not thoroughly analysed and that AMI installations lack a full functional Meter Data Management System (MDMS). It is imperative to understand that MDMS is not a luxury, but an integral part of the AMI system and without it, an AMI deployment is incomplete.

Most utilities still have the perception that smart meters are expensive, mainly because ever since the AMI pilots were commissioned, they have not gone back to meter suppliers to find out how much smart meters cost today. Where meter suppliers were consulted regarding the latest prices of smart meters, the small quantities offered by such utilities could not justify a reasonable discount on the proposed cost of meters based on the economies of scale.

Data costs are still high in South Africa, which harms operational costs of the utility in the long term. This has scared some utilities significantly smaller municipalities from going ahead with large AMI deployments, and they have limited resources.

Smart Meters are designated by the Department of Trade and Industry (DTI) to have 50% local content which has resulted in fewer meter manufacturers who are eligible to supply smart meters to state-owned entities. If a national programme to deploy smart is embarked on, more supplier may be required.

WHY ARE WE NOT REAPING BENEFITS FROM INSTALLED AMI?

Proprietary and unproven products have been installed in some cases, posing performance and reliability challenges. This leaves utilities wondering if the time is right to deploy smart meters or wait for the technology to mature before further deployments are considered. Needless, the technology has evolved.

Organisational processes were not aligned with AMI technologies. For example, AMI allows for remote disconnection/connection of meters. However, if the process still requires that a manual connection/disconnection process must be followed, the operational efficiency benefit of this technology is compromised and will not be realised.

Supporting organisational structures were not changed to accommodate AMI. A change in the technology of this magnitude must be supported by an appropriate system to complement the new technology. The pilot projects have proven that organisational structures designed for basic meters do not effectively support AMI, a new structure is required complemented by required skills:

- To operate the installed system
- To analyse the collected data
- To maintain the created telecommunication network
- To support systems that come along with smart meters

Poor telecommunication network reliability is some areas has reduced installed smart meters to basic meters that are offline as collected data cannot be remotely downloaded. While smart meters can be read manually via a local communication port, most utilities do not go this route as it is a costly exercise. After all, the sole aim of installing smart meters in this regard is to read the meters remotely.

MDMS was not fully implemented in most of the current deployments, and such, collected data is not thoroughly analysed. This means that collected information is not used to assist the utility in making informed strategic decisions based on the implemented technology.

Legacy systems cannot be integrated with the new AMI system. In some cases, legacy systems are too old such that they need be changed or upgraded if they were to be integrated with new AMI systems. The utility, therefore, incurs additional unforeseen costs to operationalise AMI fully.

URGENT CONSIDERATIONS TO ROLLING OUT SMART EFFECTIVELY

Based on the initial deployments ("Pilot projects") of AMI, the following is recommended to facilitate large scale deployments of AMI is South Africa:

- A national programme spearheaded by the government is required to facilitate deployments within municipalities to ensure that a common approach is followed.
- Complete NRS 049 and make it the de' facto standard for smart metering systems in South Africa
- Include the companion specification to ensure interoperability and interchangeability.
- User requirements specification for the Meter Data Management System (NRS document) is required to assist municipalities without resources with a document that will be used for procurement purposes and to lay down the minimum requirements for such a system.
- Compile a South African Code of Practice for Smart Metering Systems to safeguard the interest of utilities and customers. The current SANS 474 (previously known as the code of practice for metering) does not cover all aspects of smart metering and associated systems. Countries

who have already implemented AMI have a code of practice for smart metering in place

- Compile a Compliance Test Specifications for NRS049 to assist municipalities with the evaluation of bids. The STS Association of South has compliance test specifications for its standards that can be used as guidelines to compile compliance test specifications for NRS049. Many utilities in South Africa do not have resources to evaluate and test functionality compliance of smart meters and associated devices to NRS049.
- Establish a South African test house for DLMS/COSEM compliance. With interoperability and interchangeability of devices becoming a requirement in South Africa; sending devices to Europe may result in delays when the compliance of devices needs to be confirmed urgently to avoid extending project timelines.
- Ensure that several municipalities share one MDMS to save costs and to optimise the use of available resources that are already limited.
- Develop an accreditable AMI training to train current and new resources that will be required to maintain and support AMI.
- Ensure meters are future-proofed, i.e. removable comms module, open protocols and standards, interoperable & interchangeable
- It is critical to offer interoperability and interfaces between standards (i.e. OSGP, DLMS, and CIM, Meters and More, etc.) as going forward. It will be critical to consider the continuing evolution of communication technologies - the ability to mix and match various technologies, with different protocols.

CONCLUSION

The cost of smart meters, when compared to that of basic split prepayment meters, is undoubtedly forcing utilities in South Africa to adopt smart meters. Technology development, decarbonisation, free markets (Small Scale Embedded Generators, Independent Power Producers, etc.) and 4IR are other forces that are pushing utilities to adopt smart meters. All the above forces are not avoidable going forward, and they require smart meters. In South Africa, a national plan to roll out smart meters will go a long way in assisting municipalities in implementing smart meters uniformly. wn

The Role Of Smart Metering In Utilities Businesses

Prospects For 2020-2040

BY SYLWIA SOWA-HAWDZIEJUK

Smart metering is an intelligent measuring system that allows remote reading of consumption of utilities, and communication between meters and suppliers. Originally it concerned only electricity meters, now it also includes meters for water, gas, heating and other utilities, the consumption of which should be constantly monitored. Smart metering is closely related to the concept of the Internet of Things (IoT). The Internet of Things allows objects such as devices, sensors and readers to collect, process and exchange data via computer networks. The IoT combines three elements: hardware (devices that download data), IT systems (software, the cloud and cloud solutions), where information is stored, and communication technologies (connectivity), which are used to transfer data.

The key to IoT is data and the extent to which it can be used to improve business, protect the environment and make our lives easier. The term "Internet of Things" was first used in 1999, but only in recent years has it become common currency.

It is estimated that, by the end of 2020, the value of the IoT market will be $1.07 billion (Worldwide Internet of Things Forecast report, 2015-2020), and spending on new technologies (i.e. smart things) will grow dynamically, especially in the area of smart cities. According to forecasts, remote monitoring solutions, including resources such as SMART METERING solutions will have the largest market share (IoT in Smart Cities Market by Solution, Service, Application, and Region - Global Forecast to 2023, Markets).

They will revolutionize the utilities industry, and are the topic of this paper.

(R)EVOLUTION OF METERING SYSTEMS

Smart metering systems are intelligent measuring systems enabling remote data reading from meters. These are IoT solutions based on a combination of devices and cloud solutions. Some of them can be used on existing, traditional meter infrastructure, while others require new installations. They provide measurable value that allows the utilities sector to rationalize resource management. They also provide real business benefits and help build smart cities

Why is this happening?
What is the smart meters revolution?

To answer the question, we need to look back. Before the IoT, all measurements were carried out manually. Utilities enterprises did not have up to date flow or consumption data. Their information was based on historical readings, which caused many problems (both related to customer billing, fee forecasting, and the logistics of arranging readings). In a simplified view, it can be assumed that the evolution of obtaining meter readings proceeded in three stages:

1. Manual measurements

First, measurements were performed by technicians who had to do so manually, physically visiting a client's home while they were in. This method involved the need to maintain a large number of employees. It also generated high costs and caused huge logistics problems for distributors.

2. Measurements using wireless technologies

In the second stage, meter readings were made using wireless technologies (e.g. radio and GSM) or solutions with converters in meters, which enabled remote data reading using the "drive-by" method. In the case of such solutions, their range only allowed data to be sent up to a few meters. Physically, employees of the utilities sector still had to visit a given area. Neither did the companies have permanent access to up to date information.

3. Remote data measurement - smart metering

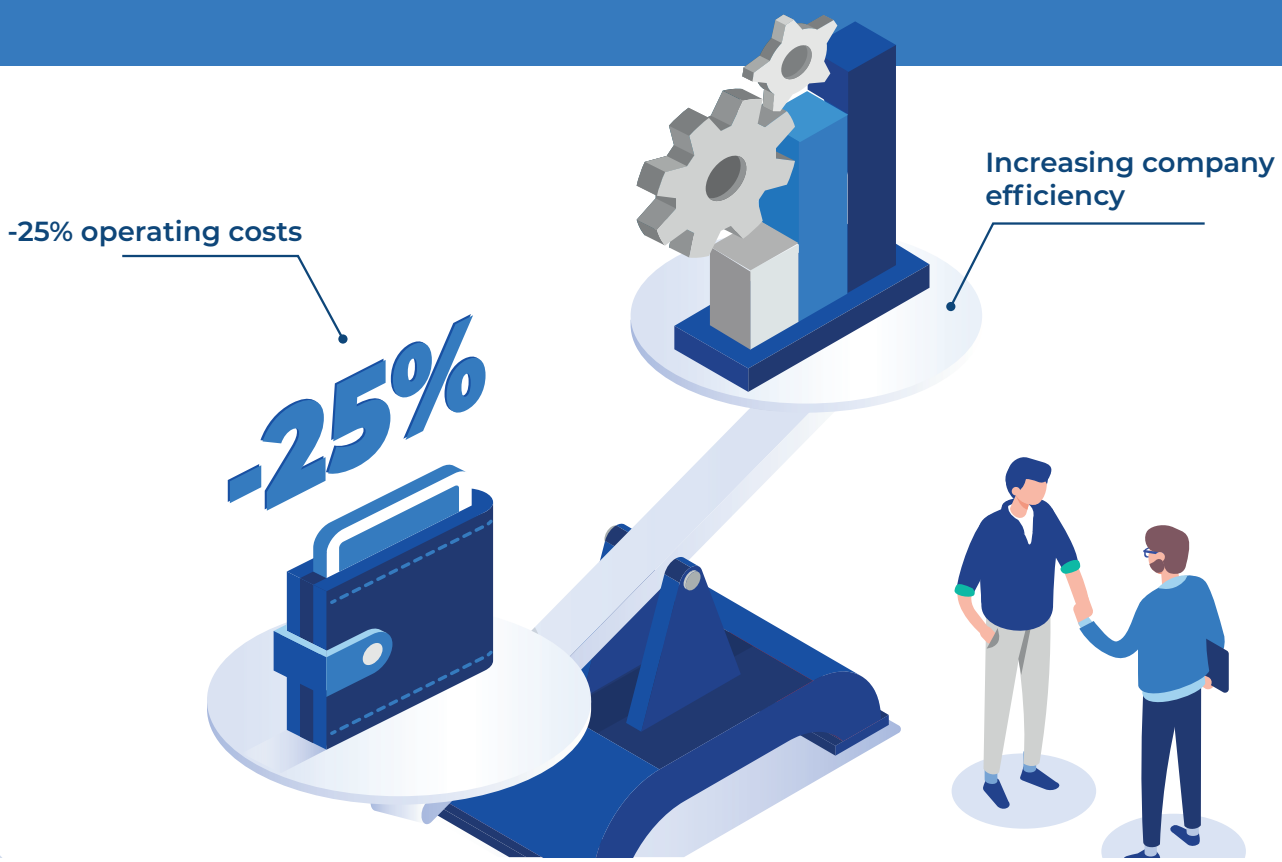
Now a new era of readings has begun. Smart metering systems are providing companies from the utilities sector permanent (24/7), fully remote access to data from meters. The latest information transmission protocols have enabled automatic, direct data transmission from meters to information systems (without the need for physical readings to be taken). Information can even be sent over very long distances, allowing suppliers (operators) to efficiently manage resources and detect leaks, anomalies and security breaches early.

REAL BUSINESS BENEFITS OF SMART METERING SYSTEMS

Monetize data in your business

According to the McKinsey report entitled "The Digital Utility: new challenges, capabilities, and opportunities" (2018), the digitalization of the utilities sector **reduced operating costs up to 25%** and increased efficiency in terms of safety, reliability and customer relations **by 20-40%**. However, organizations particularly benefit from the implementation of smart metering systems that allow:

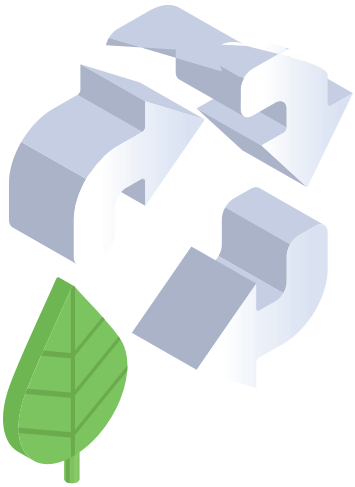
- ☑ 24/7 meter monitoring,
- ☑ Early detection of failures and security breaches
- ☑ Access to information about attempts to break into a meter or manipulate its Readings
- ☑ Generating alerts and reports
- ☑ Establishing business rules and processes
- ☑ Integration with systems such as Service Management or Billing
- ☑ Predictive maintenance
- ☑ Reduction of meter reading costs
- ☑ Reduction of customer service costs
- ☑ Reduction of losses caused by illegal consumption and failures
- ☑ Reduction in the risk of having to make compensation payments to companies due to suspension of supplies
- ☑ Data transmission from additional sensors (e.g. pressure sensors in pipes)



The implementation of smart metering systems allows effective resource management, network administration, rational, ecological water, energy, gas and heating management.

These solutions allow:

Economy (no need for a worker to be physically present where the meter is installed)



Environmental protection (smart metering enables rational management of resources and elimination of losses)

Analytical accuracy (without the need to estimate consumption)

Immediate detection of infrastructure problems (resource management is based on data that enables prevention of failures and anomalies).

Importantly, smart metering systems are based on the latest, standardized technologies (such as Narrowband-IoT or LTE Cat M1.) **Eliminating data loss** often occurs during transmission. In very rare situations in which devices lose a network connection, they send historical information to systems as soon as they are online again. This allows effective and reliable analytics.

BENEFITS FOR INDIVIDUAL USERS

Smart metering systems benefit not only resource providers but also individual consumers. Customers have the option of **accurate billing for resources consumed** (bills are issued on the basis of actual meter readings, without the need to forecast consumption and settle up for subsequent differences). Consumers are encouraged to reduce demand thanks to real-time data provided to them. This results in **lower bills and pro-ecological behavior**, such as the reduction of carbon dioxide produced, in the case of smart energy meters. Increasing awareness of the technological solutions available among utilities users contributes to the creation of a more competitive retail market. Such conclusions were reached by the British government agency BEIS (The Department for Business, Energy & Industrial Strategy), which commissioned the report "*Smart Meter Rollout Cost-Benefit Analysis*".

BENEFITS FOR TELECOMMUNICATIONS COMPANIES

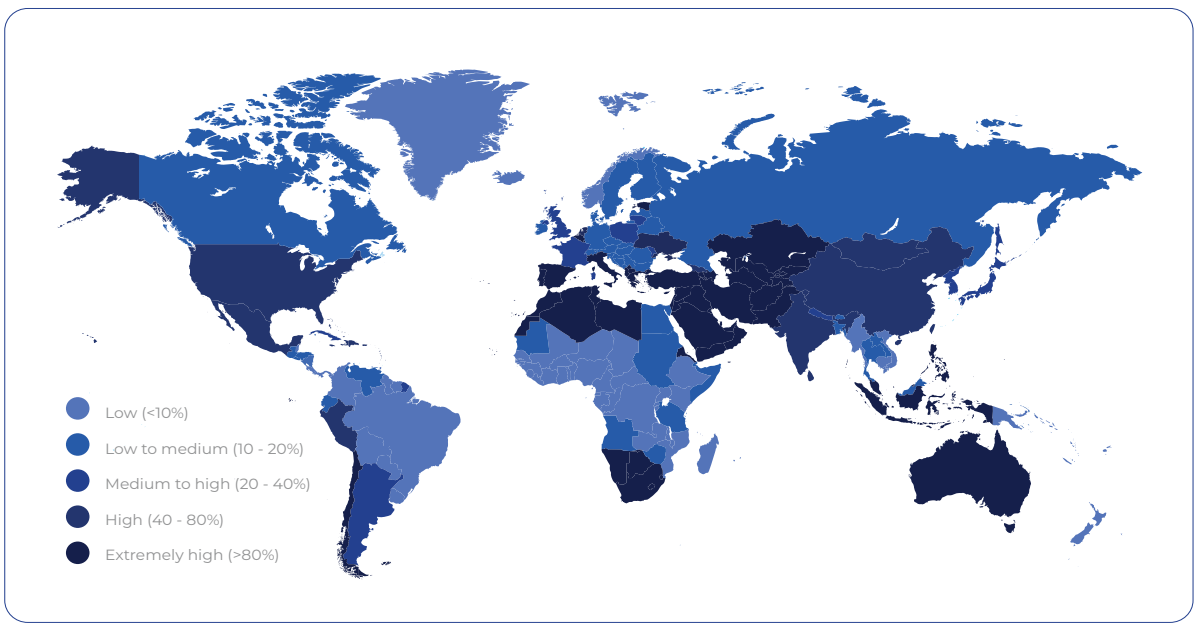
The operation of smart metering systems based on standardized communication technologies (e.g. Narrowband-IoT, LTE Cat M1.) opens up great opportunities for telecommunications system providers. By digitizing the utilities sector, they gain revenue from providing a connection between devices and the IoT platform, and contribute to the creation of green and smart cities, while protecting natural resources and the environment.

IMPACT OF SMART METERING SYSTEMS ON THE NATURAL ENVIRONMENT

The implementation of smart metering systems has a real impact on the natural environment. We are currently observing an increase in demand for resources, especially water and electricity. The **rapidly growing population** causes an increase in consumption among households, industry, agriculture and companies. **Climate change** causes real threats related to drought, floods and migration of people. The development of urban environments is also important. An increasing number of people are moving to cities, which increases the demand for all resources. It is estimated that *up to two-thirds of the world's energy and most other resources*[1] are currently being consumed in cities. According to the latest forecasts, **by 2025** they will need an additional **80 billion** tonnes of water. A change in supply and demand for water and other resources is therefore inevitable[2].

According to a World Resources Institute (WRI)[3] report, extreme water stress, i.e. the situation when the water present in the soil and/or its uptake is insufficient, as well as when the water intake exceeds the sustainable level, will affect as many as 33 countries by 2040. Of these, as many as 14 are located in the Middle East. This means that communities, businesses and agriculture in these areas will be more vulnerable to shortages. So now we need to implement new strategies to manage resources more efficiently (especially water) and implement solutions for detecting leaks. Smart metering systems perfectly illustrate this idea. They provide accurate data (including water consumption), but above all enable early detection of leaks and anomalies. Thus, they directly contribute to the reduction of use of natural resources. Smart metering systems give the opportunity to conduct sustainable water management, protecting natural resources.

Water Stress by country 2040[4]



The implementation of intelligent measurement systems is beneficial on the business side and necessary in the long term.

[1] https://smartamerica.org/teams/smart-cities-usa/
[2] Ibid.
[3] The report is available on the website: https://www.wri.org/blog/2015/08/ranking-world-s-most-water-stressed-countries-2040
[4] Source: World Resources Institute (WRI) website: https://www.wri.org/resources/data-sets/aqueduct-projected-water-stress-country-rankings

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MEASUREMENT SYSTEMS INFRASTRUCTURE (HES AND MDMS)

How do intelligent measuring systems work? In what contexts can we talk about smart meters? To answer these questions, we first need clarify two concepts: **HES** and **MDMS**.

HES (Head End System)

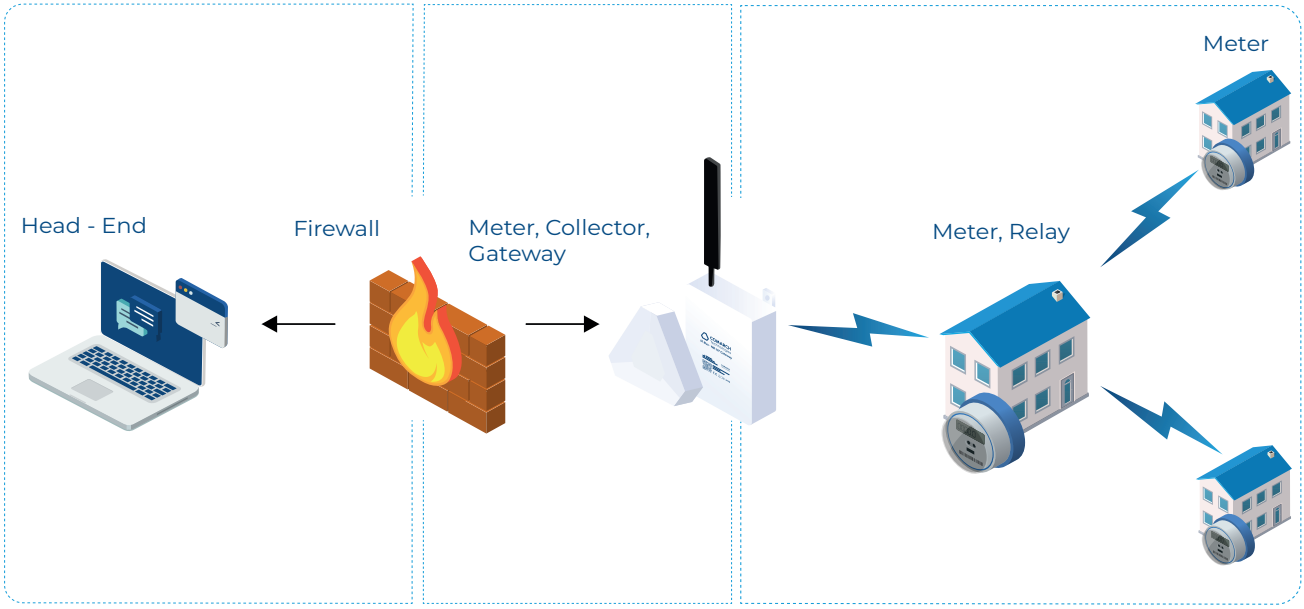
The HES system is a meter control system that communicates with the MDM(S) system, i.e. a system for measuring data management. However, HES is responsible for direct communication with meters, consisting of hardware and software that receives data from meters.
The collector (concentrator) is a kind of network gateway that serves as a communication node for HES (depending on the infrastructure, it can also be a meter). Its function is to be an interface between HES and meters (or other collectors). HES performs automatic measurements and data acquisition. However, it has limited ability to validate data before sharing it with other systems. Smart metering systems connect to the client's HES system, with operation based on retrofitting (digitalization of the current meter infrastructure, such as via Comarch Smart Metering).

MDMS (Meter Data Management System)

MDMS systems are meter data management systems. These are elements of the measuring network infrastructure used by public utilities. Their task is to collect data from the main system meter (HES) and then process it into information. The premise of MDMS is that the data it contains are managed for a long time. Importantly, this information can be processed and corrected by the system to generate valuable, verifiable reports and analysis for the customer.

Data stored in MDMS systems can (and should) be used by subsequent applications, such as:

- ☑ **Billing systems**
- ☑ **Invoicing systems**
- ☑ **Data analysis systems in connection with intelligent electricity meters**
- ☑ **CRM (customer relationship management) systems**
- ☑ **OMS systems (fault management systems)**
- ☑ **MWM systems (systems for managing work orders of clients and meters)**
- ☑ **Geographic information systems (systems providing load data for distribution planning and engineering)**
- ☑ **Transformer load management systems etc.**



In this way, smart metering systems open up great opportunities for resource providers who have the chance to monetize data.

PRACTICAL APPLICATIONS OF SMART METERING FOR THE UTILITIES INDUSTRY

Smart metering systems can be implemented in many areas. In some of them, state legislation imposes the need to replace existing infrastructure or does not create such an obligation for suppliers. Currently, intelligent measurement mainly concerns the following meters: rlectric energy, water, heating, gas.

Energy 4.0 and Smart Grids

We are currently observing increasing energy consumption. For example, in Poland it will increase by 55% by 2030.[5]
Such changes generate the need to ensure energy security, introduce solutions in line with the Energy 4.0 concept, and support the development of smart grids. Legislation is also of great importance here, as it imposes the need to replace traditional electricity meters with smart meters. Pursuant to *Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC,* by the end of 2020, 80% of electricity meters must be **"smart"** (meters must send data on consumption and potential alarms to a control panel). The introduction of such solutions is to allow for digital meter readings, ensure accurate billing of electricity bills, and contribute to increased energy awareness, reduction of energy consumption and reduction of CO_2 emissions.

An interesting example of a country that dynamically implements **smart meters systems for its citizens is the United Kingdom**. There, **by 2024**, every household is to receive a smart electricity meter from the supplier. The United Kingdom has also implemented a Data Communications Company (DCC) system. It assumes communication between smart meters, energy systems business systems, network operators, as well as other authorized users.[6]

[5] Source: report of the Polish Ministry of Economy called "Forecasts of demand for fuels and energy until 2030". It is available on the website: https://infrastruktura.um.warszawa.pl/sites/infrastruktura.um.warszawa.pl/files/dokumenty/prognoza_zapotrzebowania_na_paliwa_i_energie-ost.pdf.
[6] You can read more about this in the report "Smart Meter Rollout Cost-Benefit Analysis", which was commissioned by the British government agency BEIS (The Department for Business, Energy & Industrial Strategy).

Gas, heating and water metres

However, we can observe an increase in consumption not only in the electric energy sector, but also in gas, water and heating systems. For example, according to forecasts in Poland, by 2030 there will be an **increase in gas consumption by 29% and heating provided through municipal districts by 50%.**[7]

In all these areas, there is a need to introduce solutions that regulate consumption, including smart metering systems. Many of them are regulated by law. For example, *Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing* Directive 2003/55/EC contains information about the need to replace gas meters with smart alternatives, and the planned implementation of EU regulations regarding monitoring of resources and the reuse of water will impose the necessity to digitize enterprises in the utilities sector. wn

[7] Source: report of the Polish Ministry of Economy entitled „Forecasts of demand for fuels and energy until 2030". It is available on the website: https://infrastruktura.um.warszawa.pl/sites/infrastruktura.um.warszawa.pl/files/dokumenty/prognoza_zapotrzebowania_na_paliwa_i_energie-ost.pdf

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Creating A Smart City Roadmap For Public Power Utilities

Advancements in connected technologies, particularly communications networking and the Internet of Things (IoT), have transformed our lives and business. Across the board, industries are undergoing digital transformation, and the utilities industry is no exception. This transformation is happening on a macro scale as an industry, and on a micro scale at the utility level.

BY DELIA PATTERSON
SENIOR VICE PRESIDENT,
ADVOCACY & COMMUNICATIONS
AND GENERAL COUNSEL

With the wide deployment of advanced meters throughout the country, utilities now have their own platform by which they can design future applications and programs.

Grid modernization is often discussed in terms of automation and security — how will the utility of the future leverage new technologies to enhance grid resilience, integrate more distributed energy resources, and improve customer experience? In addition, what role will the utility play in smarter cities, with its critical infrastructure and services at the core of city operations?

As the leading resource for public power utilities nationwide, the American Public Power Association is guiding its members through this critical digital transformation process by laying out this roadmap for the Utility of the Future in smart cities. This roadmap is derived from the essential mission of public power utilities to provide safe, affordable, and reliable electric service to its communities, and is developed as part of the Association's Public Power Forward initiative.

This paper offers guidelines and recommendations for public power utilities, while recognizing that each utility is as unique as the community it serves. While each path towards smart city may be different, the fundamental goals are the same: to leverage the latest technologies and business practices for improved operational and energy efficiency with the mission of improving customer experience and benefiting the community at large.

SEEING THROUGH THE BLUR OF TECHNOLOGY

If one agrees that the first step for public power utilities is to recognize the importance of investments that transform and better a community and its residents, then the focus can shift to the technology that makes this transformation possible.

For utilities, the foundation of smart cities and a more connected, automated future, is the grid itself — the "smart grid." Utilities that have deployed AMI and can now connect to customers in real time have a platform and means of collecting important data. This data provides insight into load management and energy usage patterns. But smart grid infrastructure extends past AMI into automation and resiliency. Utilities are already feeling the challenges of grid transformation, from resource planning to ongoing maintenance and support.

The question facing many utilities today is how to take on more technology investments. What other technologies should utilities consider in laying out a roadmap for a smarter energy future and smart cities? What barometer should public power utilities use to determine which technologies or applications to begin with?

The industry is already swarming with millions of applications and solutions providers offering up answers to smart city adoption. Because the public power utility is owned and governed by citizens of the community, it is only natural that these customers be the focus of benefits and technology investment.

For public power utilities, this means asking, "Will this investment improve the community and the lives of the people in it?" Going back to the original definition of "smart," it also means asking if each technology decision is an intelligent and meaningful investment for customers and the community.

As a public power utility, you must understand your responsibility to the community to help guide the decision-making process. Keeping customer benefits front and center is likely to result in success, with both customers and stakeholders supporting your efforts.

The bottom line is that if the technology does not improve the lives of consumers, then the rationale behind investment is undermined. This is critical for public power utilities building the business case for large-scale technology transformation. In an environment governed by community stakeholders, the technology experts building the roadmap for a smarter future must be able to articulate the technology investment for customers—residential, commercial and industrial. This will not only dictate approval of such a plan and investment, but assure the support needed to undergo business, cultural, social and technological transformation.

WHERE DOES THE PUBLIC POWER UTILITY FIT IN?

Third party service providers are all throwing their hats into the smart city ring, seeing an opportunity to monetize the smart city transformation effort. Many of them are willing to work with public power companies to develop new technologies and services. But this investment, which is critical to advancement of smart cities, is challenged by the limited funds available through local government efforts.

According to the "Smart Cities Financing Guide," put out by the Smart Cities Council in conjunction with the Center for Urban Innovation at Arizona State University, smart city initiatives face major capital challenges. According to the report, the projects can expect to be funded through a mixed bag of investments including "Government-based financing tools, development exactions, public-private partnerships, and private fund leveraging options."[9]

The Association sees this overall industry challenge as an opportunity for public power utilities. Already the heartbeat of their communities, public power utilities are well-positioned to understand where cities need to go and how to take them there. The advantages to helping design the roadmaps for their own communities are:

- Control over strategic decisions in planning
- Reduced risk of monetary opportunity loss
- Reduced risk of core business loss
- Improved operational benefits to public power utility where they can identify synergies between grid modernization efforts and multi-use applications of existing technology investment
- Potential for seeking out future investment channels once utility blueprint and core direction is designed

There is risk for public power utilities not actively engaged in smart city conversations. These risks involve outside parties lobbying local government for new infrastructure guidelines and business strategies that may interfere with the day-to-day operations of the local utility. For example, telecommunications or cable companies are building new wireless networks or municipal Wi-Fi networks that can interfere with AMI.[10] Collaborative partnerships and communicating with local government can mitigate these types of risk. Therefore, SMUD's partnership with the City of Sacramento on 5G made sense, as there was a common need and synergies.

According to Bobbie Harris, SMUD Grid Planning and Operations Senior Project Manager, "SMUD worked collaboratively with the City of Sacramento to allow the City to directly connect small cells into their own wiring, while SMUD took care of wireless carrier billing. Due to this innovative arrangement, it assisted the City of Sacramento to quickly deploy 5G assets and become one of the first cities in the US to offer 5G Internet services to customers."

CPS Energy's partner engagement is another a good example of how close coordination with stakeholders is coupled with the desire to explore new products and services. The utility meets monthly with the city of San Antonio to discuss planning and product pilot opportunities under the SmartSA umbrella.[11] Recently, the utility established "innovation zones" throughout various parts of the community that Gold-Williams said serve as "a real-world testing ground to pilot smart city technology."

Another risk for utilities not engaging with the public and private sector on smart city initiatives is potential restriction from future business models. Therefore, public power utilities need to engage in conversations early in the process to make sure there is proper coordination, as well as to ensure their interests are not superseded.

[9] Burst, Jesse. "Smart Cities Financing Guide." Developed by the Center for Urban Innovation at Arizona State University.

[10] PG&E's final Electric Program Investment Charge (EPIC) report references the specific challenges of the states that the utility "does not have technology to continuously monitor, analyze/diagnose and identify RFI that may impact the 400 MHz, 900 MHz, and 2.4 GHz AMI networks. This is a key risk and obstacle as network utilization grows and the need for monitoring communication paths and identifying radio communication interferences becomes more time and cost pressuring."

[11] Excerpted from an interview with CPS Energy President and CEO, Paula Gold-Williams October 17, 2018

One area of contention and competition is the smart home. While it is common for utilities to offer demand response or smart thermostat programs, it is entirely possible that the local communications providers have competing smart home programs. These new in-home set top boxes or communications lines may interfere with expensive AMI investments. These products also compete with new electric infrastructure in the city. Whose pole goes in where and what will be connected to it?

Of course, there is the continued debate around who will own and monetize electric vehicle infrastructure and how much can be installed without interfering with load patterns. A utility's dynamic pricing programs should also correspond with electric vehicle mass adoption in urban areas. In a smart city, all these factors must be considered.

Again, SMUD, has been proactive in electric vehicle discussions with the City and other stakeholders.

SMUD was instrumental in forming the Sacramento Plug-in Electric Vehicle Collaborative which brings all the electric vehicle stakeholders together in the region to promote and plan for the use of electricity as a transportation fuel. The Sacramento PEV Collaborative includes: SMUD, City of Sacramento, County of Sacramento, SACOG, SMAQMD, Valley Vision, Universities and the Sacramento Electric Vehicle Drivers Association.[12]

In a smart city environment, the public and private sectors must align, and stakeholders - sometimes with opposing interests - must communicate and coordinate with each other. Given the role of local government in the design of the smart city, the public power utility must therefore play a critical role early on, well before the race for opportunity among third parties begins.

As the power utility is owned by its customers, it is imperative that public power utilities shape the vision for their service territories and their customers' experience. That means thinking about the future of smart technology holistically—and

not just in terms of electric, water, or gas service delivery. That is because public power utilities, along with all utilities, must tackle the daunting task of asking what they will look like in the future.

Innovation and forward thinking also play an important role in evaluating which new technologies and applications that are central to smart city planning. One example is how SMUD has taken part in Autonomous Vehicles in Sacramento. By working with the City and other stakeholders, they are promoting Sacramento as an Autonomous Vehicle certification center. According to Bill Boyce, SMUD Transportation Manager, "Since many if not most of the autonomous vehicle concepts are baselining electricity for the propulsion fuel, SMUD has a natural role in promoting AV's in our region. AV's are at the heart of many advanced smart city mobility concepts and we see this as a way to help improve the Sacramento region into the future."[13]

Again, as each public power utility serves a different and unique market, determining which innovative technologies make sense for their smart city roadmaps will become a more personalized decision. That decision, most likely will be determined jointly by the utility, the City and its relevant stakeholders.

[12] Correspondence with Chris Capra, SMUD News Media Services, November 2, 2018

[13] Correspondence with Chris Capra, SMUD News Media Services, November 2, 2018.

This paper began by talking about macro and micro-transformation efforts necessary to advance smart cities.

On the macro-level, the industry must unite in terms of identification of roles and responsibilities in the smart city development process. This means getting buy-in from leadership across the industry around defining the role of public power utilities in smart city advancement. It also means communication as an industry with key stakeholders at the national level to understand the importance of public power leadership in these efforts.

Then, on an individual level, public power companies must determine what specific criteria make up our independent smart city blueprints. On the micro-level, stakeholder engagement is critical. Communications and planning with other key infrastructure and service providers on the local level will ensure that all paths are unified and resources aligned. There is a strong chance that these sources will become critical supporters, if not necessary allies in the smart city development process.

Where does the public power utility begin in these dialogues? What key requirements must they develop to facilitate these conversations and ultimately change?

To communicate on the micro and macro-level, section IV of this paper outlines an initial set of questions that can help lead these conversations to a preliminary smart city blueprint. By creating a template for key criteria, The Association is helping public power utilities communicate their role and important requirements to national and local stakeholders as well as the community. The template will also serve as a guide for the development of internal processes at the public power utility to ensure a smooth transition into the smart city future.

SECURITY PLANNING

In the smart city ecosystem, public power companies are inviting new strategic partnerships and new connectivity options into the traditional utility network. With the introduction of advanced metering and network-connected grid operations devices (e.g., SCADA), as well as the overall adoption of wireless and Internet-based connections into utility communications, security has become front and center. How can utilities open their minds and innovate without the risk of compromising this new ecosystem?

As new complex digital ecosystems like smart cities emerge, utilities must consider cyber and physical security a top priority and assume these considerations into its strategic plan. For this reason, the Association is authoring a separate guide for public power utilities. The guide breaks down security concerns into four critical areas:

- **Protection** of utility assets
- **Detection** against intrusion
- **Intrusion** response
- **Recovery** and return of system to operation

While physical threats to the utility may appear more overt, cyber threats offer an additional layer of concern for public power utilities, particularly those considering smart city initiatives and new out-of-industry partnerships. All parties in these partnerships need to be aware of cyber risks and develop a culture of cybersecurity to protect the smart city ecosystem.

How do utilities prepare for the cybersecurity threats that are being introduced to new complex smart city networks?

The Association's Cybersecurity for Energy Delivery Systems (CEDS) program, funded through a cooperative agreement with the Department of Energy, helps advance cyber resiliency through security assessments, education, outreach, and introduction of new technology.

As part of this effort, public power utilities can use the separately created Public Power Cybersecurity Scorecard, which assesses a utility's capabilities and progress in the following domains:

- Cyber Asset Inventory
- Configuration Baseline
- Access Control
- Vulnerability Management
- Threat Management
- Cyber Risk Management
- Cyber Event Detection
- Cyber Incident Response
- Operational Resiliency
- Monitoring Cyber System Activity
- Cyber Threat and Event Information Sharing
- Supply Chain Risk
- Workforce Management and Cybersecurity Training
- Cybersecurity Program Management

The Public Power Cybersecurity Scorecard can be found at www.publicpower.org/resource/cybersecurity-scorecard.

Detailing the best practices and methodologies around utility cybersecurity far exceeds the space limited to this white paper. This topic should be top of mind for utility leadership and the IT and security experts designated as part of the smart city project management office (PMO) proposed in this white paper. The one thing to take away is that the smart city invites new partners into the utility network and communications supply chain, and these partner relationships must be underlaid with trust and strong data sharing and security processes in place, all while utilities protect the privacy of customer information.

An important consideration for utilities looking to adopt smart city models will be the allocation of often limited information technology resources. Recently there has been a trend within utilities to better align IT and operational technology (OT) resources. As public power utilities digitally

Power System Studies for Residential PV Installations

by Jolan van Papendorf (Pr. Eng.)

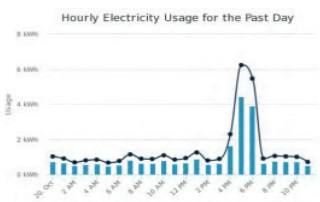
You wake up in the morning, put on the kettle for your cup of coffee. While drinking your coffee you switch on the electric stove and fry a bit of bacon and a few eggs for a nice English breakfast with your coffee. You're getting ready for work, get in the car and before you leave, you realize your neighbour's power is off. Upon further investigation, you notice the whole neighbourhood's power is off. What you didn't realise is that load shedding is currently underway in your neighbourhood. You were unaffected by this because you recently installed solar a PV system with battery backup for your home. This system was designed making use of power system studies which enabled you to hone in on the power consumption of your home and design an efficient solar PV, battery backup system.

What is a Power System Study and Why is it important?

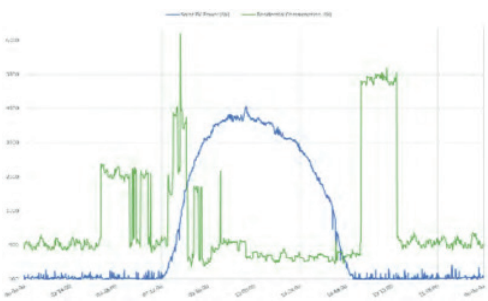
A power system study consists of various engineering analyses and investigations, the goal of which is to ensure a safe, efficient and reliable power system – both under normal and abnormal conditions. Some studies include (but not limited to): electrical load consumption and analysis, short-circuit analysis, harmonic and transient analysis, ground- and bonding analysis and even is some instances arc-flash and lightning analysis. This article will provide elaboration on load- and short-circuit analysis.

Load-Consumption and Flow Analysis

It is required that the existing profile of electricity consumption is measured and analysed. Consider Figure 1 which shows power consumption of a typical home. It shows increase power consumption at around 07:00 (typically due to a swimming pool pump or borehole pump) and also at 18:00 (typically due to warm water geyser).



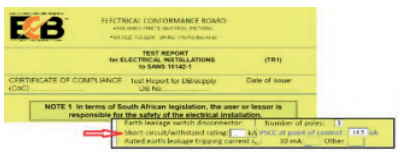
Comparing this with the typical power yield that can be achieved from solar PV in Figure 2 it can be seen that power consumption occurs when solar power is not generated.



Thanks to this load analysis, the simple solution (which would cost you nothing) is to reschedule those power consumers to operate within the window when solar power is generated. This optimisation will also help in reducing the prospective power rating of a solar PV installation (for example there is a massive cost-benefit when optimizing the battery backup capacity). This is but one of many benefits that a load flow analysis can provide when a PV installation for residential application is designed.

Short-Circuit Analysis

As part of your initial COC for your home electrical installation, the short-circuit fault rating needs to be identified. This is used to ensure the equipment like your DB's breakers is sufficiently rated to clear a short-circuit fault.



It should be noted that by installing a solar PV system, by law the initial COC will need to be amended with a supplementary COC associated with the new solar PV system. To note is that the solar PV system will contribute to the existing short-circuit fault rating of your home. A large contributor to the new solar installation would come from the batteries. These batteries can inject substantial fault current into the home distribution system. It is imperative to ensure your home's electrical distribution equipment is rated sufficiently to ensure the equipment can safely conduct the fault current without causing damage to people or equipment.

How can I do a Power System Study?

Although these studies can seem daunting at times, they are simplified by the use of advanced analytical and simulation software like DIgSILENT, ETAP, SKM Powertools to name a few. At Proconics we use these tools on a daily basis for studies of large power systems like ESKOM and petrochemical industry networks. However, these tools also come with a large price tag that is far beyond a residential consumer's budget. We have developed a simplified calculation tool that can assist with producing acceptable results within a reasonable margin of error. By using these tools, it can help a residential consumer design an efficient solar PV system while also benefiting from cost saving.

transform and prepare to work in more complex connected environments, there is a greater need to think about technology and connectivity holistically and improve collaboration between different IT and technology resources within the utility. This means not only including central IT in any kind of PMO, but also leveraging IT from other departments like water, public safety, transportation, etc. [14]

In the context of smart city, this is not only important for security purposes but also to better leverage innovation, resources and synergies throughout the municipality.[15]

While today's public power utility may already be conducting grid security exercises and information sharing with local, state and federal government agencies, there may be an opportunity to improve data sharing with new ecosystem partners as part of smart city initiatives. While information sharing agreements are not uncommon from utility to utility, smart city environments which invite in other sophisticated communications networks (e.g., transportation and communications) may also offer up an opportunity not just to accelerate a more convenient and automated lifestyle, but hopefully a safer and more secure one.[16]

As public power utilities work through their smart city roadmaps, such partnerships and data sharing plans should be critical parts of the conversation.

[14] Christopher Kelley, PMP, Vice President, Beam Reach Consulting Group, LLC

[15] Christopher Kelley, PMP, Vice President, Beam Reach Consulting Group, LLC

[16] Christopher Kelley, PMP, Vice President, Beam Reach Consulting Group, LLC

WHAT STEPS MUST UTILITIES TAKE?

It is time to break down what, specifically, public power utilities must do to engage and lead the smart city conversation.

The first step in the development of the smart city roadmap for public power utilities is to answer the following questions that identify critical information:

PEOPLE, STAKEHOLDERS AND PROCESSES

1. Which person at the public power utility is best poised to lead the smart city effort (CEO, CTO, CIO)?

a. Person must have control over people and processes at the utility
b. Person must have strong leadership and management skills
c. Person must have strong stakeholder communications skills
d. Is this the same person that will manage internal and external relations?
e. Can this person create and manage a project management office?

2. What does a smart city project management team or project management office look like?

a. Project lead (Reports to CEO, CTO or CIO depending on size of utility)
b. Process lead – responsible for development of schedules and core functions and processes
c. Regulatory/stakeholder contact – who can manage external communications with key stakeholders
d. Communications support – to develop public-facing materials and manage public relations as necessary
e. Representatives from energy efficiency, grid modernization, IT security, fleet management, reliability, security, metering, customer care and innovation

3. Identify the external stakeholders this group needs to engage and ask the following questions:

a. What does that engagement look like?
b. Is this a formal engagement or informal?
c. How frequently are they engaged?
d. What level of engagement is recommended and when?

MATERIALS

1. What materials must be developed to support the project management office and smart city efforts?

a. Smart city mission statement with goals as identified by utility that align with grid modernization efforts
b. Identification of clean energy and reduced carbon emission goals
c. Identification of key stakeholders in the community necessary to advance efforts
d. External communications plan to support community buy-in
e. Initial projected timeline by phases
   This is a living document that starts with the utility's operating plan and budget and then is reviewed by the project management office to overlay smart city considerations
f. Outline of project costs and funding plan
g. Identification of key milestones and metrics for the next 5-10 years

OPERATIONS: KEY IMPACTS

1. What are the key considerations across the utility for smart city activity?

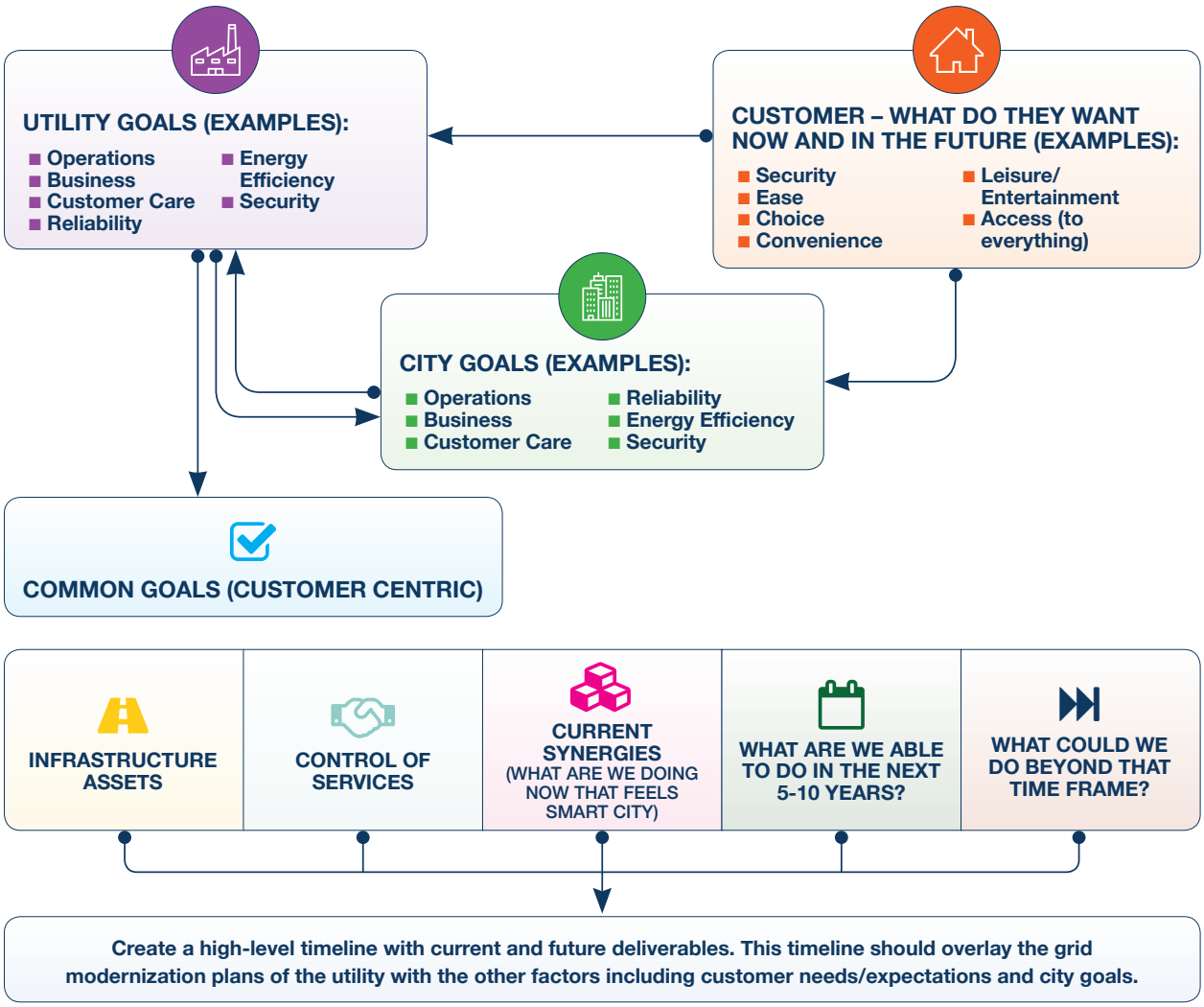
a. Identify top security concerns and process for development of smart city security plan
b. Identify areas within current energy efficiency group that map well to goals of smart city project. Identify exploratory future programs that may align with strategy
c. Identify key areas of automation that are currently part of grid modernization efforts and any alignments with smart city model; Identify opportunities to leverage current and future infrastructure for smart city efforts
d. Identify current synergies in disaster response policies and new areas for consideration
e. Look at overall goals of smart city and see where the utility can contribute in areas of lifestyle and convenience (in current service territory)
f. Identify key utility goals for operational efficiency and consider what smart city actions can help facilitate these goals
g. Identify what accounting and financial efficiencies may be achieved through smart city efforts

BUILDING THE ROADMAP

Now that the public power company has assembled the information necessary to start developing a roadmap, it can begin to think about an outcome and the path to get there.

Below is a proposed "map" to begin laying information down into a shareable internal and external document to help communicate internally and to stakeholders the public power company's smart city plan.

It is important to remember what was said in the beginning of this paper: Smart is the intersection of knowledge and connectivity, and the public power utility should focus on the customer. How will the utility make their lives and their communities better smart technology investments and applications?



Once this has been roughly thought through, the next steps are to:

1. Summarize this into a few slides to share externally
2. Identify other companies, partners, and service providers can help build this picture
3. Begin to share the story
4. Seek out support financially and through regulations where needed
5. Summarize and highlight customer benefits on dedicated slides

WHAT DOES THE PUBLIC POWER "UTILITY OF THE FUTURE" LOOK LIKE?

Across the industry, utilities are considering how to define the Utility of the Future. Yet, there are no standard guidelines or recommendations for utilities to set a future path. However, some aspects of the utility of the future are definite.

- The future is smart, and the utility must be as well
- The grid should evolve to adapt to changing technology
- The electric utility industry is undergoing digital transformation
- Future utility leaders and customers expect technology to drive convenience
- Customers are playing a more critical role in shaping the utility of the future – because they can
- Technologies and applications will disrupt the current environment and utilities must be prepared to embrace them
- The digital age is causing unprecedented challenges and opportunities for the electric grid and the grid must adapt

These themes will shape how public power utilities begin to define what the Utility of the Future. It will also help utilities understand the steps they need to take to evolve and become critical components of smarter cities. But, one size does not fit all. Each path forward will be unique – focused on the people and communities they serve.

As utilities begin to undertake the task of leading smart city development, they must consider that they are already in this role. As owners of much of the supply and demand for cities and towns around the country, public power utilities are helping to lead grid transformation efforts. It is not a stretch to think how these efforts will impact other facets of society, particularly when you put the customer in the middle of the conversation.

The Association supports public power utilities as they undergo their individual and collective transformation to utilities of the future and leaders in smart city efforts.

This roadmap serves as a first step in educating public power utilities as they begin adopting smart city programs. The Association will continue to work with its members to provide additional resources on smart cities, including webinars and other opportunities for public power utilities to share insights and lessons learned. Public power has always been at the forefront of promoting change in the electric industry, and the Association will work with its members to facilitate that change and development in the future.

Think data protection first, POPIA compliance will come

Information security and data privacy are at the core of the Protection of Personal Information Act (POPIA). Companies that prioritise the safeguarding of their proprietary and customer data will benefit from better business resilience in the face of increased cybercrime while simultaneously complying with the Act.

"A robust and resilient business should be your primary goal. Rather than focusing only on compliance, use this as an opportunity to sharpen your organisation's data protection capabilities. Once you understand how POPIA and other information security standards, such as ISO27001, can benefit your business, it's like hitting two birds with one stone: you take appropriate and reasonable steps to fine-tune how your business works with confidential information, and compliance follows naturally," says Charl Ueckermann, CEO at AVeS Cyber Security.

The elements required to protect personal information are the very same elements needed for the protection of other valuable information in a business. CIOs and IT Managers should address the confidentiality, integrity and availability of data, and cover both the cyber and physical security aspects of information protection. For instance, controls must be in place to stop employees from accessing or downloading information that they should not be privy to, as well as preventative measures and policies around sharing information in other ways, such as telephonically or by saving information onto a USB device and leaving it lying around.

The first step is to identify which information needs to be protected in the organisation: *"Any information that you deem as critical to your business or mentioned in POPIA should be protected. This can include information about employees and customers, product information, research data, financial information and other intellectual property,"* says Ueckermann.

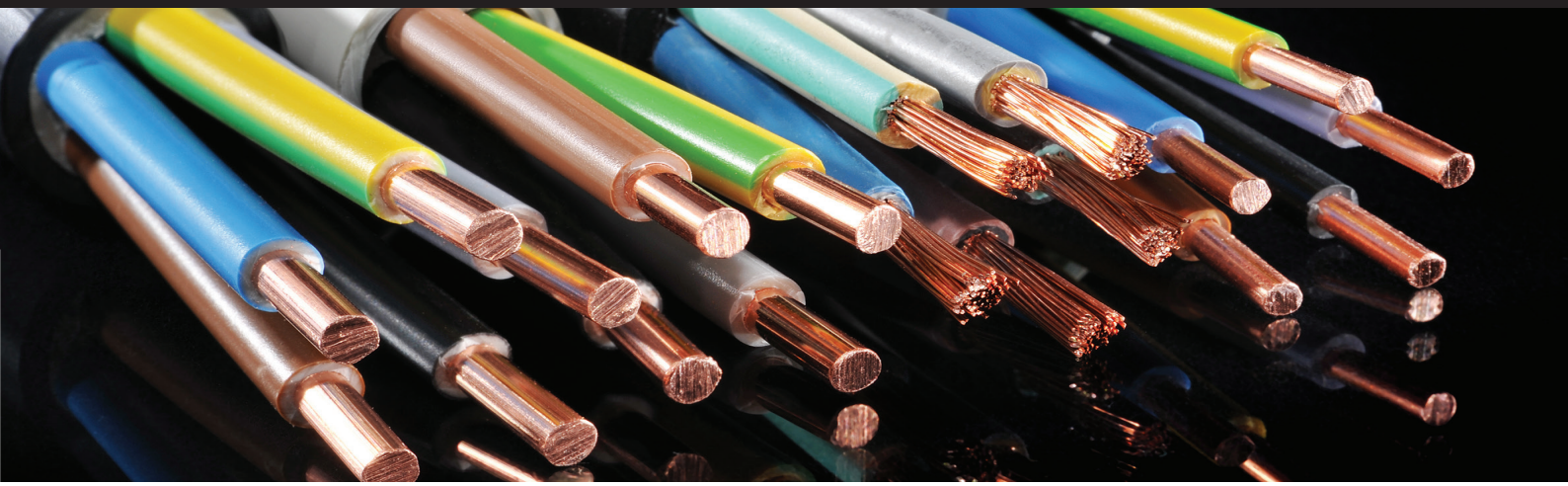
Starting with a facilitated POPIA assessment is a productive and cost-effective way to help a business determine how compliant they are with POPIA, which sections of the Act are applicable based on the nature of their operations, and which information should be protected. Different companies in different industries will need to take different steps. Additionally, what applies to a big corporate may not apply to a small or medium-sized business.

"A guided assessment further provides valuable insights into where there are gaps and how to prioritise addressing them. An implementation roadmap often follows a good POPIA assessment to show where to focus information protection efforts to meet POPIA's requirements timeously," says Ueckermann.

Ueckermann concludes saying that a proactive approach to information security now will help companies to ensure that their houses are in order, and done cost-effectively, before the POPIA grace period ends in June 2021. *"If you are not already thinking about information security, there is no better time than now. Look beyond compliance and focus on protecting your business, your intellectual property and the stakeholders that are linked to it. As you take steps to take control of your information and organisational processes, you will also prepare for POPIA. The great value-add of having control of your information is that breaches are less likely to be missed and you will have the tools and systems in place to respond quickly to, and recover from, security incidents."* wn

Copper Development Association Africa

Promoting the use of copper in Africa



Copper is found in all Energy Systems

Whether powered by sun, wind or water, efficient and renewable energy systems rely on copper to transmit the energy they generate with maximum efficiency and minimum environmental impact.

Superior conductivity of copper and recyclability

Copper is a preferred electrical conductor and an excellent thermal conductor. Superior conductivity allows smaller conductors to be used, saving space and cost.

Copper is infinitely recyclable without any loss of performance and is nearly indistinguishable from freshly mined copper. It is estimated that 80 percent of all copper ever mined during the past 10,000 years is still in use somewhere today. Estimates also reveal that 33 percent of today's world annual copper demand is supplied by recycled copper.

Copper's contributions towards reducing greenhouse gas emissions

Increasing the cross section of wires and cables, overhead railway lines, and motor and transformer windings can significantly increase electrical energy efficiency. Incorporating one extra kilogram of copper can save between 100 and 7,500 kilograms of greenhouse gas emissions (CO_2). Every conductor in an electrical system has a built-in resistivity. This means that part of the electrical energy it carries is dissipated as heat and lost as useful energy. Generating this wasted electrical energy produces carbon emissions and consequently contributes to global warming. An important initial decision, in seeking to reduce these losses, is to use copper as the conductor.

Renewable energy

Copper plays an important role in renewable energy systems. By using copper instead of other lower electrical energy-efficient metal conductors, less electricity needs to be generated to satisfy a given power demand.

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

Longer-term programmes, such as wind powered production processes and the electrification of thermal processes, are less certain and will require economic incentives and significantly more development to build technical viability. However, in light of the very large savings potentials, close to 300 million tonnes of CO_2 per year, they are worthy of further investment and investigation. It should be clear then that CDAA shares the European Copper Institute's vision for a low-carbon economy and will pursue it with all of the resources at its disposal. We urge policymakers to support a reasoned balance between the energy needed to manufacture the building blocks of that new economy and the overarching goals for reduced energy demand and carbon emissions.

The CDAA and ECI role in reducing energy consumption

The CDAA and European Copper Institute have developed strategies that will both trigger and support substantial carbon reductions in the downstream industrial, residential and service sectors.

Electric motors account for a large amount of the electricity consumed by industry. Energy-efficient motor driven systems could save electricity consumption, resulting in reduced maintenance, improved operations and reduced environmental costs.

Cable size is very important for the correct operation of any electrical circuit. Selecting too small conductors for an application could compromise the operation of the circuit: it causes voltage drop, poor performance and in extreme cases the cable temperature will increase enough to melt the insulation. On the contrary, selecting too large conductors increases costs and weight. Please view Leonardo ENERGY's website for courses offered:

http://www.leonardo-academy.org/course/index.php?categoryid=72

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Schonland's other Legacy

If he **is** remembered at all, Basil Schonland (1896 - 1972) will be the man some people might associate with the founding of the CSIR or having been Director of the UK's Atomic Energy Research Establishment at Harwell. Some others might just recall that he had been a pioneer in the study of lightning and they may also remember that he was the son of a famous father, the German-born and educated Selmar Schonland, who is commemorated by a herbarium that bears his name in Grahamstown and who also played a significant part in founding Rhodes University there.

BY DR B.A.AUSTIN

But the younger Schonland was a lot more than that. As well as being declared South Africa's scientist of the twentieth century he was also a soldier who distinguished himself in two world wars. His legacy, therefore, spans a breadth of scientific and military endeavour and it's within the second of those - his soldiering - that two technological fields were very significant in influencing both the course of two world wars and the subsequent peaceful progress of mankind. They were radio and radar and, when looking back on his career, Sir Basil Schonland may well have reflected on the not inconsequential part he played in the fundamentals of thermionic theory during the First World War and in overseeing both the development of radar in South Africa and its use in Britain during the second conflict. In doing this, he led Britain's Army Operational Research Group (AORG) which made massive contributions towards optimising the use of radar in anti-aircraft and coastal defensive applications before becoming scientific adviser to the commander-in-chief (Field Marshal Sir Bernard Montgomery) of 21 Army Group for the invasion of northwest Europe that brought the war to its end.

SCHONLAND THE SOLDIER

On 16th July 1915 Basil Schonland's name appeared in the London Gazette alongside those of other young officers who had been commissioned into the British Army. (Austin, 2001). Second Lieutenant B.F.J. Schonland RE was how it appeared without the umlaut above the 'o' as used by his father and by Basil himself until then. This precautionary measure was the suggestion of Schonland's family who felt that any overtly Germanic display might not serve his cause too well in an England then caught up in a savage war against the Kaiser.

Over the previous four months he had completed Part 1 of the mathematical Tripos. In fact he was one of Cambridge's Prizemen having achieved a well-deserved 'first'. This follows his B.A. degree in physics, awarded in December the previous year by Rhodes University College, Grahamstown. It had always been Schonland's intention to proceed to Cambridge in order to further his studies under Ernest Rutherford, the pre-eminent New Zealand-born English physicist of the day. But, having satisfied the examiners in Part 1 of the Tripos, Schonland along with many of his colleagues interrupted his studies and immediately presented himself for interview by an officers selection panel. With his academic background he was selected to join the Royal Engineers as a signals officer. Donning a uniform would not be a new experience, however, because for the previous two years the young Schonland had served as a private in the First Eastern Rifles, an Active Citizen Force unit of the

Union Defence Force (UDF). He now travelled, on 1st August, to the Signal Training Depot at Bletchley where the first phase of his training was to take place.

After learning the intricacies of squad drill and "turning by numbers" each young officer then took charge of a squad of soldiers in order to practise the words of command, learnt from their drill sergeants and often accompanied by descriptive terminology of a decidedly fruity kind.

Musketry and other necessary military skills were intensively practiced until these soldiers of a sort were deemed adequate to lead their men into action. Signals training started in earnest too with mastering the Morse code being of prime importance. Throughout all this Schonland felt in his element as he recorded in the diary he kept throughout this phase of his military career.

IN COMMAND

By October 1915 Schonland had been given his own command: 43 Airline Section with its 37 men and a sergeant old enough to be his father. Their job was cable-laying at the gallop as their teams of six horses and three riders, with another five alongside, pulled their cable carts and unwound miles of telephone and telegraph cable as they went. Good communications were the lifeblood of any military operation.

However, the latest invention in the military armoury was wireless. Its first use by the British Army during the Anglo-Boer War had been inauspicious until the Royal Navy took over the equipment and demonstrated its capabilities with all the aplomb that the senior service could muster (Austin,1995).

Fig.1 Second Lieutenant Basil Schonland in 1915.

More than a decade later the technology had made considerable strides and Schonland would soon become an expert in its use. The senior instructor in wireless was another Cambridge man, Edward Appleton, some four years older than Schonland, and destined to win the Nobel Prize in 1947 for his researches on the ionosphere in the 1920s. He and Schonland were to become occasional colleagues throughout the rest of their careers. The leader in Schonland soon became apparent and his men

respected him, both for his dedication to the task of training them and for his humanity. To his diary he confided that he "catechised" them on all aspects of soldiering and so prepared them for what lay ahead of his 43 Airline Section.

In January 1916, they were in France near the town of Cambrin. Just four months before, in that very vicinity, the British Army had lost 60 000 men killed, wounded and captured at the Battle of Loos. They had gained almost no ground in the process. Despite the carnage and atrocities of war, science appeared in strange places. Close to the front line where '43' happened to be laying their cables Schonland encountered another Cambridge man, Lawrence Bragg who, with his father William Henry, would be awarded the Nobel Prize for Physics in just a few months' time.

Their work on understanding the structure of crystals by means of their diffraction of Roentgen rays (the X-rays of today) was a fundamentally important discovery. But now Bragg was very differently employed. He was an officer in the Royal Artillery whose task was to try to locate the source of enemy gun-fire by means of "sound-ranging" using suitably displaced acoustic mirrors, as they were called, and then taking bearings on the directions of maximum sound intensity to locate their source. This technique would soon become the forerunner of a means of detecting enemy wireless transmissions and by a similar method of triangulation to determine the location of the transmitter. When wireless became radio, under the influence of the Americans, the technique of radio direction finding would become a powerful tool on the battlefield. All this fascinated Schonland and he communicated his enthusiasm to his younger brother Felix, in Grahamstown, in a simplistically coded message which somehow evaded the British Army's dedicated team of censors: *"Bragg (one day you will hear of him) is _____ing German _____s by means of a very cute invention"* he wrote.

After another four months, and now very close to the front line, Schonland and his men were recalled to Fourth Army HQ, located well back from hostilities. But it wasn't to last. On 1st July, what would, in the decades that followed, be called the Battle of the Somme commenced and '43' were in action again laying cables in and between the network of trenches that served as the fighting soldiers only protection against flying shrapnel and the scything steel of the machine gun bullets. Schonland now saw death at firsthand and, in a letter to his mother, he wrote: *'the whole earth shook and rocked and the air was full of shrieks and hisses of shells … while all around were the spurts of flame from the guns'.* A mere mile from there, immediately adjacent to the devastated village of Longueval, was Delville Wood where South African soldiers were fighting one of the greatest rearguard actions as part of the 9th Scottish Division (Uys, 1983).

"WIRELESS IS A FINE JOB …"

Wireless was now becoming an important adjunct to the fighting soldier and none more so than to the cavalry. It soon became Schonland's intention to immerse himself in this new technology. In August he handed over command of 43 Airline Section and was immediately attached to the Wireless Squadron of the Cavalry Corps or W/T CC In another letter home to his brother Felix he confided *"Wireless is a fine job and though I mustn't say much about it, it is very much connected with the fighting. For in these days of trench warfare telephone cables are useless and it is the only thing that will keep up communications. Of course you can't flag-wag in the trenches!"* In a remarkable four-part article Schonland wrote after the war he described the part wireless played during the Battle of the Somme (Schonland, 1919). In historical terms this was one of the first accounts of the use, by the British Army, of wireless communications during the First World War and it is a firsthand account because its author was in the thick of the fighting.

The first wireless set to be used in the British trenches was known as the BF set. This somewhat cryptic title presumably stood for British Field set but to its operators, for whom spades were spades, BF had another connotation entirely, probably not justified because those sets rendered extremely valuable service, particularly when they were the only means of communication (Austin et al, 2016). Nowhere was its role in the battle more impressive than on the Somme. Schonland related how, on a rise in the ground just a few hundred metres from the German fortifications at Waterlot Farm, near Longueval, one of a network of BF sets had been positioned to provide vital communications with Maricourt, some 5km further back. At the height of the battle the bombardment was so intense that it was impossible to keep erect the two 5m poles supporting the wire antenna and so the simple expedient of laying as much insulated wire as possible along the ground was tried. It worked and served to convince the many sceptics that these wireless "miracles" really did work. In describing the BF set as well as two others, the Wilson Set and

Fig.2 43 Airline Section in 1916.

the Loop Set, Schonland pointed out that their development was the work of the wireless experts at the Royal Military Academy in Woolwich and it was there that the latest piece of electrical wizardry, the three-electrode valve, was being pressed into service. By December 1916 Schonland was at the little walled town of Montreuil, at the Central Wireless School, where he swapped his pliers and soldering iron for the chalk and blackboard of the instructor. He was now acknowledged as an expert in wireless communications and his task was to train new officers coming into the Royal Engineers Telegraph Battalion in the art of signaling without wires.

THE WIRELESS EXPERT

Schonland soon displayed his competence as an instructor and he had a natural bent for teaching, both of which earned him lavish praise from the Chief Wireless Instructor, Major Rupert Stanley. Stanley was also quick to notice Schonland's flair for carrying out "important researches on Radio Signalling". With a fellow officer by the name of Spencer Humby, Schonland used one of the new three-electrode valves in an oscillating configuration. Though they were not the first, because both the French and the scientists in Woolwich were quick to exploit this important characteristic of the thermionic valve, the work of Schonland and Humby added to the rapidly accumulating store of knowledge in this most important new field. The publication of their results had to wait until after the war had ended because such things were highly classified. So, in 1919, an account appeared in the journal that had become the mouthpiece of the scientists working on radio-related phenomena (Humby et al., 1919). However, Schonland's colleague from both Cambridge and Bletchley, the ever-resourceful Edward Appleton, had managed to publish the results of his research on the thermionic valve as an oscillator without being delayed by such trifles of wartime (Appleton, 1918). By being able to generate an oscillating waveform, or continuous wave (CW), the thermionic valve revolutionized the rapidly developing field of wireless communications. As a result, the spark transmitters of the war era, of which the B.F. set was just one of many, were consigned to the museum. The completely new era of radio had arrived. Schonland, Humby and Appleton, among those pioneers, were to come together again during the next encounter with the Germans some twenty years hence.

In March 1918 Schonland was posted as Wireless Officer to the VI Army Corps and in June he was promoted acting Captain. His prowess was now well known and, after a spell of leave in London, he returned to France where he was placed in charge of all wireless in the First Army under the command of General Horne. At the age of 22 he had reporting to him approximately 30 officers and 900 men with an equipment complement of 300 wireless sets. By the war's end, in November 1918, Basil Schonland had been earmarked for the post of Chief Instructor in Wireless in the British Army and with it the rank of Major. But he graciously declined them both and set about resuming his academic career at Cambridge. For his military service was awarded the Order of the British Empire (OBE) in the military division in June 1919 as well as a Mention in Despatches the following month. No mean feat by any measure!

THE INTER-WAR YEARS

Schonland resumed his studies at Cambridge where he had left off four years before. Over the following two years he completed the mathematics and advanced physics Tripos with First Class Honours including a number of academic awards. He was then admitted to the Cavendish Laboratory by Rutherford who was arguably the greatest physicist in England at the time following his discovery of the atomic nucleus and was undoubtedly the towering figure in his Cavendish Laboratory. And there too were many distinguished scientists, of whom a significant number would go on to win the Nobel Prize (Chadwick, 1962). One of Schonland's first acquaintances at the Cavendish was Ernest Marsden, a man of his own age, who had already achieved some distinction, both in the laboratory where he, Rutherford and J.W. Geiger had made a startling scientific discovery at the University of Manchester, and on the battlefield where he had won the Military Cross. Their paths would cross again when war clouds once more were looming over the world. And there too Schonland met John Cockcroft, another Nobel laureate-to-be, with whom he was to have his longest and most fruitful collaboration.

By 1922, Schonland had completed his PhD and had published two papers in the Proceedings of the Royal Society on the scattering of beta particles. That same year he applied for and was appointed to a senior lectureship in the Department of Physics at the University of Cape Town. On arrival there his intention was to continue with his work on electron scattering and he did so for a few years, publishing no fewer than four papers in significant journals. However, he became increasingly aware of the remoteness of Cape Town from the centres of scientific excellence in Europe, and Cambridge particularly. Though he read the relevant scientific literature avidly he always felt that he was too isolated at the southern tip of Africa to be able to make a worthwhile and timely contribution to fundamental physics: the rate of progress being such that by the time the post arrived, in either Cape Town of London, the subject under discussion had advanced significantly. Ultimately, Schonland realised that he had reached something of an impasse in this area of specialisation given the practically insuperable difficulties that faced him in what was becoming a major area of investigation requiring the multidisciplinary firepower available at the Cavendish rather than those of a much less grandiose scale in Cape Town. This moment of truth and its implications for atomic physics in South Africa have been discussed most admirably by Hey (2020).

Basil Schonland therefore needed to find himself a field of research which had a distinct and local flavour and it presented itself when he, his wife, Ismay, and their two children visited Ismay's family farm near Somerset East over Christmas in 1925. It was while he was there that Schonland realised that the frequent thunderstorms and their accompanying displays of lightning provided him with a poorly-investigated natural phenomenon he could make his own.

He had become aware that the "atmospherics" that one heard on the wireless were caused by lightning and a scientific investigation of this process was already underway in England. It was being led by none other than Edward Appleton. And collaborating closely with him was R.A.W. Watt. Appleton had, by now, established himself as one the leading authorities on wireless phenomena and he was making significant progress on investigating mechanisms by which such signals propagate through space. Watt, who was soon to call himself Watson-Watt as a mark of some personal grandeur, would go on to be the father-figure in Britain of what would be called RDF, a cunning code-name intended to deceive an enemy. It would soon become universally known by the palindromic American name of radar. In pursuing their work Appleton and Watson-Watt had pressed into service a new instrument, which used a cathode ray tube, known as an oscillograph in England or an oscilloscope in the USA. The "scope" would soon become a standard measuring device in many research laboratories, including Schonland's.

And radar could not have functioned without it.

For the next dozen years Schonland immersed himself in the study of lightning, both as an optical phenomenon and as the source of considerable electromagnetic radiation at a much lower frequency such that it could be detected by radio receivers and similar field-sensing devices. But the Cape was the not the place to study lightning; its pyrotechnic displays were very much part of the summer season on the Highveld. During the university summer vacations, Schonland accompanied by his wife, would decamp to Johannesburg and the University of the Witwatersrand (Wits), specifically. There, on the top floor of its Physics Department, he was given the use of an office and on the roof above he erected a number of field-sensing devices which were connected to his recording instruments in the room below. Together, Basil and Ismay would spend hours recording the responses of the various instruments. Assisting them was one of Schonland's former students from UCT, E.C. Halliday. Eric Halliday had moved to Wits in order to make his own study of lightning-induced phenomena and he enthusiastically offered his services to Schonland. Soon Halliday and yet another UCT man, D.J. Malan, who was by this time lecturing at Wits, collaborated by taking a remarkable series of photographs of the lightning stroke using what was called the Boys camera. This was an instrument with a rotating lens that Schonland had borrowed after its inventor, Dr C.V. Boys, had managed to take but a single photograph of a lightning stroke in England. Halliday and Malan produced hundreds of photographs of lightning around Johannesburg in just a single lightning season. Soon, three locally-produced Boys cameras would form key parts of Schonland's lightning-measurement armoury and soon a number of papers describing their discoveries were published.

By 1930 Schonland had already established himself as one of UCT's leading researchers and his published work on atmospheric electricity had brought much sought-after recognition to the University. But fame travels far and his name had also come to the attention of the general manager and chief engineer of the Victoria Falls and Transvaal Power Company. He was Bernard Price, a prominent figure within the South African Institute of Electrical Engineers (SAIEE) with its headquarters in Johannesburg. In view of the increasingly important part that gold-mining was playing across the Witwatersrand, Price had become particularly concerned about lightning as it was, by far, the major cause of power-outages as a result of strikes to power lines and their infrastructure. He set up a committee within the SAIEE to make recommendations and invited Schonland to become its chairman. Even further afield, in London, Schonland's scientific publications had attracted the attention of the editor of Methuen's Monographs on Physical Subjects who invited him to write a book and, as a result, Atmospheric Electricity was published in 1932. It was the first of four books which would flow from the Schonland pen over the years. Atmospheric Electricity was joined that same year by one entitled Thermionic Vacuum Tubes written, perhaps not unexpectedly, by Appleton. A fascinating aside, but one that is particularly relevant in the South African context, is that Appleton's book on vacuum tubes was not the first on that subject. That honour probably belongs to H.J. van der Bijl who published The Thermionic Vacuum Tube and its Applications in 1920 following his sojourn in Germany and then at Western Electric soon to become the Bell Telephone laboratories in the USA. Van der Bijl, a graduate of Stellenbosch and Leipzig universities, is the same man who was behind the industrial monoliths of ESCOM (now Eskom) and Iscor upon which South Africa's future prosperity was both built and depended. During the Second World War he became General Smuts's Director General of War Supplies.

THE BPI

In April 1936 Schonland was offered the Carnegie-Price Chair of Geophysics at Wits and with it came the Directorship of the brainchild of the man after whom the Bernard Price Institute of Geophysical Research was named. This was just two months before Schonland was due to have been confirmed as the Professor of Physics at UCT.

The BPI, as it soon became known, was the first non-government funded research institute to be established at Wits. Until then very little research had taken place at the University (Murray, 1982). All was about to change and it changed very fast. Schonland set out his intentions to the Board of Control of the BPI in December. He would initiate an active research programme into lightning, thunderstorms and their accompanying atmospherics. Work on his on-going photographic and radio studies of lightning would proceed immediately. To follow would be entirely new work on the thermal characteristics of rock, seismic activity and the radioactivity of rocks in general. He also suggested that the BPI would begin to investigate ionospheric phenomena as well as meteorological events closer to the earth. A tall order

SAIEE
South African Institute of Electrical Engineers

110 YEARS 1909-2019 SAIEE

MEMBERSHIP FEES EFFECTIVE 1 DECEMBER 2020

The Council meeting held on 2 October 2020 approved subscription & entrance fees as from 01 December 2020 as per schedule indicated below.

PLEASE NOTE: In terms of Bylaw 3.2, annual subscriptions are due on 1st December 2020

MEMBERSHIP FEES CAN BE PAID IN MONTHLY RECURRING PAYMENTS

Council agreed to a discount for fees paid before 31 March 2021. Members are therefore encouraged to pay promptly to minimize increase.

Grade of Membership	Annual Subscriptions paid before 31 March 2021		Annual Subscriptions paid after 31 March 2021		New Members FEES * see Notes 1 & 4 below.	
	RSA incl VAT (R)	Outside RSA excl VAT (R)	RSA incl VAT (R)	Outside RSA excl VAT (R)	RSA incl VAT (R)	Outside RSA excl VAT (R)
Student	151	131	181	157	181	157
After 6 yrs study	1 570	1 090	1 884	1 308	1 884	1 308
Associate	1 570	1 090	1 884	1 308	1 884	1 308
Member	1 735	1 205	2 082	1 445	2 082	1 445
after 6 years	2 027	1 407	2 433	1 689	2 433	1 689
after 10 years	2 122	1 472	2 546	1 766	2 546	1 766
Senior Member	2 122	1 472	2 546	1 766	2 546	1 766
after 6yrs/age 40	2 300	1 595	2 759	1 914	2 759	1 914
Fellow	2 300	1 595	2 759	1 914	2 759	1 914
Retired Member (By-law B3.7.1)	975	675	1 170	810	n/a	n/a
Retired Member (By-law B3.7.3)	nil	nil	nil	nil	n/a	n/a

1. The fee for all new applications is R3010.00 which includes an entrance fee of R928.00. On election to the applicable grade of membership, the new member's account will be adjusted accordingly and refunds/additional payments made on request. Entrance fee for Students is free and new Student applicants require payment of R181.00.

2. Transfer fee to a higher grade is R504.00 for all grades of membership (except Student within 3 months of qualifying).

3. Members are encouraged to transfer to a higher grade when they qualify. It will be noted that the fees of Member and Senior Member grades after 10 and 6 years respectively are equal to the fees at the next higher grade.

4. Members elected after May 2021 pay a reduced subscription fee.

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

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

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

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

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

10. The members monthly magazine ("wattnow") is available on line and members who require a hard copy may acquire same on request and for a nominal fee subject to minimum uptake numbers.

11. Members who wish to pay their membership fees in recurring payments should activate the payments on their banking portal. Members will receive the early bird discount only if their fees are fully paid by 31 March 2021.

given that Schonland was the BPI's only member of staff!

However appointments soon followed. Another former student of Schonland's from UCT, Dr A.L. Hales, an applied mathematician, became the Director's mathematical assistant while at a more practical level J.A. Keiller took up the post of instrument maker. Radio techniques provide a powerful means of finding the source of a lightning flash by the noise or atmospherics they radiate. This requires using the technique, by then well-known as radio direction finding, whereby at least two widely separated receivers, equipped with directional antennas, would take bearings on those bursts of electrical noise. By simple triangulation of their two respective bearings the actual position of the lightning stroke that produced the noise could be determined. This required another receiving station well away from Johannesburg and one was already under construction in Durban at the Natal University College. The man behind it was yet another Schonland protégé, D.B. Hodges. Effective coordination of this activity required good communications between the two universities and for this purpose Schonland obtained from the Postmaster General a dedicated telephone line between Wits and Natal. The man who coordinated this was the Under-Secretary for Telegraphs who, in a part-time capacity, also happened to double as the Director of Signals in the South African Army. He was Lt Col F. Collins. In the not too distant future both Hodges and Collins would come together with Schonland to play a very different role in the struggle against the Nazis.

In May 1937 Schonland travelled to England where he had been invited to present the Halley Lecture at the University of Oxford. Established in 1910 this prestigious lecture in Oxford's calendar was in honour of Sir Edmond Halley, the discoverer of the regular periodicity (ca.76 years) of the eponymous comet. Schonland spoke about The Lightning Discharge. By all accounts it was a masterful lecture made all the more so by the many photographs of the discharges captured by the Boy's camera and also by the results already obtained at Wits from the measurements of the atmospherics. Schonland had, by this time, already come to delineate the lighting stroke into its constituent parts, the leader – both stepped and continuous – the return stroke, the dart leader and the still speculative pilot streamer. In years to come all those terms would be in common use and all had been coined by Schonland. He had put scientific names to the Mpundulu, (he spelt it in the style of the time as Umpundulo), the mythical thunder bird which the "the Basutos and the Barotses" associated with lightning (Schonland, 1950).

An announcement that was greeted with acclaim at Wits, and elsewhere too, was made in March the following year: Schonland had been elected as a Fellow of the Royal Society. This is the highest scientific honour Britain can bestow and it is a mark of considerable esteem from the scientific community-at-large. Schonland joined his six predecessors with South African connections including J.C. Smuts, in an honorary capacity, to have been so honoured (Mills, 2020).

It was fast becoming apparent that radio techniques were very important in both deducing the features of the lightning stroke as well as in determining its position. Soon Schonland was regarded as the radio expert in the country. He was less convinced of that himself and made another important appointment to ensure that he had, as his right-hand man, someone well-versed in the art of what, in years to come, would be called electronics. That man was Dr P.G.Gane, a geophysicist with considerable skills and flair as an electronics circuit designer. Gane became Chief Assistant to the Director early in 1938. A number of more junior appointments followed swiftly too. To provide specialist advice and assistance, when required, he appointed G.R Bozzoli from the Department of Electrical Engineering as a consultant whose expertise could be called on when needed. Bozzoli, Gane and Schonland would soon become key players in a venture none of them could even imagine at that moment. In years to come Bozzoli would rise through the ranks of the University to become its Vice-Chancellor in 1969.
Research at the BPI during 1938 and 1939 was very productive when measured by the numbers of papers published in the scientific journals, most particularly in Nature and the Proceedings of the Royal Society. And then war came and Schonland's institute found itself focused on a very different and top-secret, objective.

AT WAR AGAIN

On the 9th September 1939 Schonland received a telephone call from Pretoria. It came from the Director of Technical Services of the Union Defence Force who asked him to fly to Cape Town in some urgency. It was, he said, a mission of great importance to the war effort (Austin,1992; Austin, 2001).

South Africa had declared war on Nazi Germany just three days before and, in fact, only six days after Britain herself had mobilised the nation in order to meet its treaty obligations with Poland.

Along with its fellow Dominions, Australia, Canada and New Zealand, South Africa's small and ill-equipped armed forces were preparing for battle. Schonland's mission was to meet Dr Ernest Marsden, the Secretary of the New Zealand Department of Scientific and Industrial Research. As we have seen, Schonland and Marsden were acquainted having first met in the Cavendish Laboratory in 1919. Now they were to meet aboard ship. Marsden was on his way back to New Zealand from England where he had attended a special briefing at Bawdsey, the hush-hush research establishment not far from Ipswich where Britain's most secret weapon of the war was being developed. It was radar but known then by the enigmatic letters "RDF", forever confused with Radio Direction Finding for that was precisely what Robert Watson-Watt intended should happen so as to confuse the enemy (Watson-Watt, 1938). Such directing finding techniques had been used as far back as the First World War. But radar did not require the target to be transmitting at all.

The Chain Home (CH) system, as it was called, was already in operation along Britain's eastern and southern coasts. It consisted of a number of these RDF stations situated on suitably high ground close to the coast and their purpose was to detect enemy bombers as they flew in from their bases in Germany and occupied Europe. From each of those stations the bearings and even the approximate numbers of aircraft in a raid were passed by telephone to what were called filter rooms where the information from all the radars tracking the aircraft were coordinated, or "filtered", before being plotted on large-scale maps. From these maps the RAF officers, seated on a gallery above, were able to determine the most appropriate defensive measures needed to intercept the advancing Luftwaffe aircraft. RDF and its subsequent incarnation as radar was the weapon that "enabled Britain to survive and, arguably, saved western liberal democracy" (Zimmerman, 2001).

As early as 1938 Britain had decided, albeit tentatively, to inform those Dominions within its Empire of the existence of this remarkable new weapon so that they could make preparations to use it in their own theatres of operations. The telegram informing the four High Commissioners in London of the existence of this "distinguishing apparatus", as Churchill subsequently described it, was sent on 27 February 1939. It requested that someone "possessing the highest possible qualifications in physics" should be sent to England for a period of two the three months to become fully acquainted with the principles of "RDF". For reasons unknown (perhaps simply the expense involved) South Africa sent not a scientist but instead ordered a UDF officer serving in London to attend. Unsurprisingly the officer concerned was somewhat overwhelmed by the lectures given by Watson-Watt and his team of scientists at Bawdsey. However, the day was saved by the fact that Ernest Marsden, the New Zealand representative, would be calling in at Cape Town while on his sea voyage home. And Schonland, the obvious man who should have been sent to England in the first place, was to meet him. During the three-day voyage to Durban, Schonland and Marsden were ensconced in a locked cabin while Marsden described the details and the intricacies of RDF. Immediately on their arrival in Durban they made their way to the university where Professor Hodges, now head of the Department of Physics, met them. After administering his own version of the official secrets act, Schonland, with the assistance of Hodges and W.E. Phillips from the Department of Electrical Engineering, made glass photographic slides from the pages of Marsden's "RDF Manual". Marsden then resumed his journey to New Zealand while Schonland flew back to Johannesburg. Hereafter I shall use the term radar exclusively even though it only came into common use in England somewhat later.

Events moved extremely quickly from then on. Schonland reported back to the officer who had dispatched him to Cape Town and very shortly thereafter the Prime Minister, General Smuts himself, asked that the resources of the BPI be given over entirely to "work of a special nature" with no questions asked nor answers given. Immediately Schonland and his colleagues at the BPI fell under the jurisdiction of the South African Corps of Signals and its commanding officer, one Lt Col Freddie Collins, the man with whom Schonland was well-acquainted. Within just two weeks of the telephone call from Pretoria the project was underway. It soon became clear that no British radars suitable for coastal defence – the South African requirement – would become available until 1940. Schonland decided that the BPI would design and build its own radar "to teach ourselves [the] technique" (Schonland, 1951).

RADAR STARTS AT WITS

Schonland realised that despite his BPI scientists being familiar with the methods used by Watson-Watt and Appleton to track thunderstorms by conventional radio direction finding techniques he needed more expert assistance in order to design and build a radar transmitter and receiver. For that he turned to the departments

of electrical engineering at South Africa's universities. Bozzoli, already an associate of the BPI now became a permanent member of the radar design team and, essentially, was the chief engineer. He was joined by W.E. Phillips from Natal who had assisted in the making of the glass slides just a week or so before and by N. H. Roberts from the University of Cape Town. All were specialists in radio engineering.
This is not the place to go into the technicalities but suffice it to say that Schonland and his team of engineers, along with the BPI's own Philip Gane, decided to follow the principles of the British Chain Home Low (CHL) radar since it suited South Africa's specific needs for defence against attacks launched from the sea. Airborne attacks, such as those Britain had endured, were highly unlikely to occur anywhere near southern Africa. But the Kriegsmarine, Hitler's navy, was well capable of launching attacks against South Africa's very exposed major ports while submarines, the U-boats, had already been sighted. It would transpire that Japanese submarines (and even submarine-launched aircraft) were to be of great concern after Japan became part of the Axis powers in September 1940 (Brain, 1993).

The elementary radar set which was produced was operational within just three months. On 16 December 1939, a public holiday then known as Dingaan's Day in South Africa, Schonland and Bozzoli went to Wits to make some last-minute adjustments to the equipment and while there they carried out a trial run of the elementary apparatus. Two previous tests of the radar had failed to produce the telltale "blips" on the cathode ray tube of the display. In the first they had used a helium-filled balloon to suspend a mesh of copper wires as it floated skywards from a point a few kilometres from the campus. But no radar echoes were seen. Then Schonland arranged for a flight by a South African Air Force aircraft whose pilot had been instructed as to the course he had to fly. However, on the appointed day, he deviated from this carefully planned route and, instead, chose to fly over the house of his girlfriend in Roodepoort. Unsurprisingly no blips were seen at the BPI. However, that public holiday in mid-December was soon to become a landmark in South Africa's technological history for it was then that the first radar echoes were seen in the country.

Schonland himself observed the screen of the radar receiver in the BPI laboratory with its antenna on the roof; Bozzoli had erected the transmitter in a top-floor office of the Central Block, the main administrative building of the university. And above, on its roof, was the transmitting antenna. The communication between them went via the university's telephone exchange. Since radar antennas are designed to be directional so as to be able to determine the direction of a reflecting object – the target in the ultimate application – they agreed over the telephone in which direction to point their respective antennas. This involved a fair amount of stair-climbing but higher objectives took priority over the physical exertion that required. As they rotated their antennas in rough synchronism from north to west Schonland suddenly observed a signal on the display. He shouted to Bozzoli and so they carefully reversed the headings of the antennas and slowly brought them back to that previous position. Sure enough there was the echo. Both men now met on the roof of the BPI and peered in a north-westerly direction from where the reflected signal appeared to have come. And there, about 10km away, was Northcliff Hill and on top of it was its concrete and steel water-tower. Further careful variations of the antennas' headings confirmed, without a doubt, that they were indeed seeing a signal that had been reflected from what was initially thought to have been the water-tower but which, given the wavelength of the radar, was more likely Northcliff Hill itself. It was a memorable day and a remarkable one considering the total lack of familiarity about radar that any of Schonland's team had had a mere few months before. They had proved by way of a convincing experiment that their equipment did indeed work and it had taken them just three months to get there (Bozzoli, 1995).

SPECIAL SIGNALS SERVICES

News of their achievement, when it reached the UDF headquarters in Pretoria caused more than a flurry of interest. Colonel Collins immediately decided that Schonland and his collaborators at the BPI should go into uniform. Schonland himself resumed the rank of Major which he had held at the end of the First World War. Bozzoli, Gane, Phillips and Roberts were all made Captains while their two technicians, Keiller and a recent appointment from the Post Office, by the name of Anderson, became staff sergeants. They were known as the Special Wireless Section but not long afterwards, they and the ever-expanding complement of technically-qualified people who joined this highly-specialised unit within the Corps of Signals became the Special Signals Services, but forever after they were simply the SSS. One of those new recruits was a young physics graduate from Rhodes University by the name of F.J. Hewitt who brought with him a wealth of experience as a radio

enthusiast, well-versed in the art of constructing receivers, amplifiers and so on.

Schonland had christened this elementary radar the JB0, continuing the tradition of JB being the identifier of Johannesburg when he and Hodges in Durban (therefore known as D) had been monitoring the radio emissions from lightning while recording the bearings using their dedicated telephone line. His engineers now set about redesigning major elements of the JB0, based on their recent experience and Hewitt soon proved himself to be a key member of the team. What resulted, after many months of dedicated effort, was the JB1, constructed so that it was rugged enough to see service beyond the confines of a laboratory. Rapid testing took place just north of Durban when ships were tracked and the radar proved its effectiveness and its operators were its designers. Almost immediately the Chief of the General Staff saw what appeared to be a most important application for it.

The attack by Mussolini's army on Abyssinia from October 1935 until February 1937 had buoyed up Il Duce's forces - and himself - to the extent that they now set their sights on expanding the Italian empire southwards. On 6 June1940 South Africa declared war on Italy and ten days later the 1st South African Brigade sailed for Mombasa. Onboard one of the ships in the convoy were Gane, Hewitt and Anderson with their JB1 radar. Three days later Schonland flew to Nairobi. The JB1 was set up on what they called South Africa Hill at a place called Mambrui, 150km north of Mombasa, where its purpose was to provide radar cover for the aerodrome nearby. A notable feat of intuitive engineering took place there when the young Frank Hewitt corrected a fault in the JB1 brought about by the very unstable diesel-driven electric generator they had to use. In Johannesburg the radar had been happily powered by the city's very well-behaved electricity supply but that certainly wasn't the case in the wilds of Kenya. But Hewitt solved the problem much to the relief of his commanding officer. In the end Schonland's small team spent six months in Kenya where the radar functioned well even though targets were scarce.

Schonland himself flew back to the Union once he was satisfied that the JB1 was operating and serving a useful purpose. However, he returned in November to make a full assessment of the radar requirements in East Africa and based on this he then briefed Bozzoli at the BPI. By June 1941 a further six radars had been constructed, all of which were sent to East Africa along with their operators. Curiously, the British attitude towards both the South African "lash ups", as they were referred to by some, and their lack of appreciation of the delicacy of the political situation in South Africa, especially in the face of active subversion by the Ossewabrandwag, nearly led to an international incident. Schonland, perhaps somewhat naively, had made it clear to his British counterpart in Nairobi that the SSS was operating under the tightest of security because of the fear that Britain's "greatest secret", namely radar, might be leaked to the enemy by suspected Nazi sympathisers within DHQ in Pretoria. This was misconstrued by the RAF officer concerned to imply that the South African radar personnel, both in Kenya and back at the BPI, posed a threat to the secrecy of the British radar project! When word of this reached the ear of General Smuts he forthrightly disabused Anthony Eden, the British Secretary of State for War, of the veracity of such claims, when they met in Khartoum in October 1940 (Austin, 2001). Nothing more was heard of this slander.

Then, a complete about-face occurred. The Suez Canal had become a target of the Axis air forces, the Luftwaffe and the Regia Aeronautica. No British radars were available for its defence so a request went out to South Africa to supply three JB sets to provide that vital cover. Schonland, now a Lt.Col, immediately flew to Cairo. From then on things moved rapidly and after a technical assessment of the JB1 by the RAF, where it was found to be entirely suitable for the job in hand, three JB1 radars, plus their SSS operators under the command of Major Hodges, were transferred from Kenya to the Middle East where they were soon fully operational along the northern Sinai coast by mid-June 1941. The JB1s performed so well, while under close scrutiny by the RAF, that all British radars were withdrawn and the South Africans provided complete cover for the Suez Canal out to a distance of 120km. They finally returned home more than a year later.

ARMY OPERATIONAL RESEARCH GROUP

By March 1941 Schonland was on his way to England. The reason was to try to speed up the supply of British radars to South Africa. He also intended to offer his services to the British military in some useful capacity. Clearance for his action had come from the very top of the UDF, the Chief of the General Staff, General Sir Pierre van Ryneveld. Once in England, Schonland visited radar sites all around the country and it was soon clear to him that the anti-aircraft guns, which depended so much

Fig 3 SSS officers and senior NCOs in 1941.

on radar for target acquisition, needed the assistance of dedicated scientists. In fact, this had been achieved very early in the war when these scientific "nursemaids" were stationed at all the major gun emplacements across Britain. And the man behind that was John Cockcroft.

By now Cockcroft was wearing many hats, the most prominent of which was as the Chief Superintendent of the Air Defence Research and Development Establishment (ADRDE). The British penchant for long-winded titles, notwithstanding, this organisation played a crucial role in ensuring that anti-aircraft defences of the nation operated at maximum effectiveness. Before the introduction of radar to the gun sites it required, on average, 18 500 artillery rounds to bring down a single enemy aircraft. By 1944, following the introduction of the gun-laying radars (and their "nursemaids"), this figure fell by 75%. Though getting a little ahead of ourselves in this tale, those numbers appeared in a report entitled "The Operational Performance of Army Radar Equipment 1939-1943".

IT WAS WRITTEN BY BASIL SCHONLAND.

Things move quickly in wartime and the need for highly skilled and competent men, both soldier and civilian, imposed great demands on government and on the military hierarchy. Britain's dependence on radar, so starkly demonstrated during the Battle of Britain, was now paramount. The threat facing the nation was dire. All expectations were of an imminent invasion by the forces of Nazi Germany, codenamed Operation Sea Lion (Unternehmen Seelöwe). The fact that Cockcroft knew that Schonland was in England, and he also know that he had indicated his willingness to serve in any way he could, was all the incentive Cockcroft needed. By 1st August Schonland had been appointed as the Superintendent of what was soon to become the Army Operational Research Group (AORG).

Briefly, operational research, when it was first conceived just before the war, is the application of the scientific method to the solution of a multitude of problems that occur during military operations. It has since infiltrated into the civilian arena where it provides the backbone for much management theory. It began in the British Army as a loose grouping known informally as Blackett's Circus after Patrick Blackett (another Nobel laureate in the wings for his study of cosmic rays) who appointed a number of young scientists as operational researchers. They came from an eclectic mix of scientific disciplines, foremost among them were two physicists, as one might expect, but there were also physiologists,

mathematicians, an astrophysicist, at least one geologist, a surveyor and even an ornithologist and a zoologist. Since, in the first instance, they were to be employed on radar-controlled gun sites they were put through a rigorous (but non-mathematical) course of lectures on radio and radar techniques. Their teacher was J.A. Ratcliffe, a Cambridge physicist renowned as a lecturer (Ratcliffe, 1929).

In March 1941 Blackett moved to RAF Coastal Command to apply operational research methods to combat the formidable threat posed by the U-boats to Britain's vital sea routes. Ratcliffe, though fully committed to teaching the intricacies of radar to men of various scientific backgrounds, was now appointed by Cockcroft to replace Blackett and to assume the additional responsibility for what some referred to as a disheveled bunch of scientists and schoolmasters who were supposed to bring scientific rigour to the gun batteries across the land. But others wanted Ratcliffe too. The Telecommunications Research Establishment (TRE) had an urgent need to set up a radar school for the RAF and Ratcliffe was the man to do it. It was then that Cockcroft appealed to Schonland to take over the AORG.

Once Schonland had familiarised himself with the multifaceted organization he had inherited he set up two Operational Research Sections (ORS 1 and ORS 2). The first, under L.E. Bayliss, one of the physiologists, investigated fundamental gunfire-control problems while the other, under Dr M.V. Wilkes a mathematical physicist, dealt with all manner of technical problems associated with radar in the Army. Schonland himself, though doing no research, became the final arbiter when decisions had to be taken and he found himself working very long hours simply to stay on top of a multitude of problems. Soon, the "number of rounds per bird" began to decrease significantly. The number of different radar sets in use went the other way: from the gun-laying radar, the GL1, which soon reached GL3; then there was the CD coastal defence radar, ultimately Mk IV, the GCI Ground Control Interception radar, the CHL or Chain Home Low radar soon to become a significant part of the network of radar stations that ringed the South African coast. And finally, there was the SLC, known as Elsie, the Search Light Control radar where four antennas were mounted on a searchlight to locate the target in a highly accurate and vivid beam of light that sealed the fate of many a Luftwaffe bomber on their nightly raids over England. The process of introducing scientists to the AA gun batteries around the country required tact and understanding. One battery commander was somewhat exasperated by the invasion of scientists into his domain and he exclaimed, within earshot of the AORG personnel, that he had not joined the Army to become an electrician, or some Anglo-Saxon words to that effect. However it did not take the gunners long to appreciate how the accuracy of their "shoots" increased significantly after those nursemaids had plied their inexplicable trade on the innards of the fire-control systems that determined bearing and elevation of the guns based on the electromechanical predictors built into them.

OPERATION BITING, THE CHANNEL DASH AND NEW VISTAS FOR RADAR

In February 1942 Schonland was promoted to the rank of Colonel. Since he had never severed his connections with the UDF, the announcement came from the South African High Commissioner in London. The AORG was expanding rapidly. As well as gunnery and the associated radars Schonland's fiefdom now included sections dealing with signals in the field, armoured fighting vehicles, airborne operations, infantry weapons and tactics, lethality of weapons, mine warfare and flame throwers, battle analysis and the inevitable time and motion studies. That same month saw the British Army carry out a daring raid on a clifftop in France, overlooking the North Sea, near the town of Bruneval. The Bruneval Raid has since become part of Army folklore given its effrontery and particular daring. Its purpose was for a small group of sappers from the Royal Engineers to land by parachute in the company of their bodyguards, a battalion from the Parachute Regiment, and then to dismantle the German Würzburg radar up there and bring its key elements back to England for close examination by the scientists at the TRE. Schonland personally trained those sappers in the very greatest of secrecy so much so that none of his colleagues knew why he was away from his headquarters during the run-up to Operation Biting as it became known. The raid was a complete success and TRE gained a considerable amount of information about this German radar whose purpose was to provide early warning against RAF attacks.

However the boost to British morale by the success of the Bruneval Raid was soon tempered, that same month, by an equally daring break-out, by three ships of the German navy, from the French port of Brest where they had been undergoing repairs and were then trapped by the close attention paid to them by the RAF. As a result of meticulous planning

and superb seamanship the Germans sailed the battlecruisers Scharnhorst and Gneisenau, as well as the heavy cruiser Prinz Eugen, on what became known as the Channel Dash through the English Channel, up the North Sea to the German port of Hanover. And this happened under the noses of the British coastal defences and its much-vaunted air cover. Needless to say, Churchillian anger at this travesty soon reached the upper echelons of the three armed-services. One of the reasons why the Germans had been able to stage such an audacious dash for freedom was their use of carefully graduated jamming of the British coastal radars. The slow but inexorable increase in "noise" on the radar screen did not, at least initially, raise many concerns among the radar operators. It was, in fact, the first occasion in which so-called radar countermeasures were used. The escape of the three capital ships was seen as a major débâcle in Whitehall and recrimination soon followed. In future, complete responsibility for the investigation of all forms of radio and radar jamming would be taken away from the RAF, who had clearly been found wanting, and was passed to the Army. That meant Schonland and the AORG.

The man Schonland appointed to take on this task was J.S. Hey, a physicist who had come to the AORG with no knowledge of radio but who had learnt quickly when he attended Ratcliffe's special course on the subject. Hey took charge of what became known as the J Watch, a suitably non-descript name which disclosed nothing. He was equipped with a "J Van" that contained a number of monitoring receivers plus their appropriate antennas upon its roof. He had wireless communications with the coastal artillery and the RAF should it be necessary for a retaliatory attack to be mounted.

On 28th February, at the height of the Bruneval Raid, various radar sites around the coast began to report steadily increasing interference on their radar screens. It remained throughout the course of the next two days but disappeared at night. And the source appeared to be moving. The greatest fear at Britain's Anti-Aircraft Command was that the enemy may be using an airborne jammer and these reports seemed to confirm that they were. However, all the radar stations reported that the noise was at its most intense when their antennas were pointing in the direction of the Sun. This was astounding: the Sun, though an obviously powerful radiator of energy within the visible spectrum, was not believed, by the nature of the physics involved, to radiate significant amounts of energy at the much longer wavelength of the radio frequency spectrum. Hey was fully conversant with this but the evidence he had seen suggested otherwise. He immediately made contact with the Royal Greenwich Observatory who informed him that a large sunspot happened to be situated at the centre of the Sun's disc and hence any radiation from it would be directed earthwards. It was known that sunspots were associated with intense magnetic fields as well as energetic electrons and so Hey concluded that it was the sunspot that was responsible for the "jamming" of the British radars, at least on this occasion. He immediately reported his finding to Schonland who smiled and said, "Is that so, Hey? How interesting. Did you know that Jansky of Bell Telephone Labs in the USA had discovered radio noise coming from the Milky Way?". Hey did not but he immediately rushed off to the Science Library in London to read Jansky's published paper (Hey, 1973 and correspondence with the author 30.7.1997; Jansky, 1933)

What was almost as interesting as Hey's remarkable discovery of a completely new source of radiated energy at sub-optical frequencies was the reaction from the British scientific establishment, most notably Edward Appleton, when word eventually reached him of this astounding observation. Hey's conclusion that the sun was the source of that radiated energy was greeted with considerable scepticism after all, it rested on observations made by soldiers sitting in front of their radar sets and was interpreted by someone with no background in the subject, namely Hey! However, it was not long before confirmation of this solar phenomenon began to come in from other observers and there was no doubt that Hey had essentially pioneered a new aspect of astronomy in Britain: what would be called radio astronomy in the not-too-distant future. As soon as the war was over, and wartime restrictions on publishing began to be lifted, Appleton, true to form, lost no time in writing the first scientific paper of radio emissions from the sun (Appleton, 1945). Hey's paper actually announcing the discovery only appeared sometime later (Hey, 1946).

A recurring problem, particularly when British radars moved to much shorter wavelengths, were unusual echoes that appeared on the plan position indicator (PPI) screen in front of the operator and, for quite some time, they defied explanation. The PPI display is the form of radar display that most people are familiar with. It consists of a line, or trace, which rotates in synchronism with the radar antenna thereby producing on the screen a virtual picture of the environment around (or perhaps below in the case of airborne radar) the antenna. Both

the target's range and its bearing can be obtained from the PPI unlike the earlier form, called an "A" scope, where vertical lines displaced along a horizontal axis indicated returns from a radar target. But only range was given. Some other means was needed to obtain bearing information.

What appeared to be randomly distributed dot-like echoes on the screen were perplexing and since they corresponded with no observable artefacts they came to be called angels. Then, in the summer of 1941, evidence was presented which suggested that birds could reflect radio waves such that they could be detected by a radar set. Later that year there was no doubt about this when observed radar echoes were shown, unequivocally, to have come from gannets (Sula basana) that were clearly visible to the radar operators near Dover. Of course, in wartime such radar eccentricities were merely another distraction from the task in hand so as long as the operators could be trained to ignore those angels, birds or whatever, then the problem of detecting and tracking the enemy could continue. But false alarms still occurred and one even caused a scare that the invasion was under way.

Fig4 Colonel Schonland as Director the Army Operational Research Group in 1942.

However it was fortunate for the wider scientific community that among those AORG scientists with widely disparate backgrounds was one professional ornithologist by the name of David Lack. For a period of six months he had been based at a radar station on the Orkney isles to the north of Scotland where, given the profusion of sea birds in the vicinity, he was able to make many observations of radar echoes produced by birds and to be able to relate these to bird-type, their size, the speeds of flight and especially how some of those reflections could easily be confused with aircraft but more particularly with fast-moving ships. Again, as was the case of Hey, Lack was unable to publish anything in the scientific literature until after hostilities had ceased and clearance to do so had been given by the military authorities. But he wrote two secret AORG reports, in 1942 and in 1945 which contained significant amounts of scientific information on the interaction of birds with radar. Lack and his colleague G.C. Varley finally published a short letter in Nature in 1945 in which they described their observations including the tracking, by radar, of pink-footed geese (Anser brachyrhynchus) as they flew, at an altitude of 5000 feet (1520m) for 57 miles (91 km) in 99 minutes thus giving an average speed

of 35 m.p.h. (56 kph). At the time this was the longest timed track of any bird in flight (Lack et al, 1945).

As Lack himself described it, he was fortunate to serve under Lt Col. B.F.J. Schonland F.R.S. "that splendid South African, who first needed me as his personal assistant, but said I could go in the field after 6 months". Lack repaid Schonland's perceptive identification of particular scientific talent by becoming one of at least ten members, or former associates, of Schonland's Army Operational Research Group who were, or went on to become, Fellows of the Royal Society. And radar itself became a very important tool in the study of bird migration and their patterns of movement (Eastwood, 1967).

NORMANDY AND THE END

Schonland's final military appointment in England took place in February 1944 when he became Scientific Adviser to General (later Field Marshal) Sir Bernard Montgomery's 21 Army Group then preparing to became part of the greatest massed seaborne landing ever undertaken when, in conjunction with the Americans and the Canadians, they landed on the beaches of Normandy from D-Day, 6 June 1944, onwards. Schonland, now promoted to Brigadier, was attached to the headquarters of 21 Army Group which relocated to France some few weeks after those first soldiers had gone ashore. Montgomery, of course, was there almost with the first wave. On encountering Schonland for the first time he asked him what his purpose was and Schonland replied that he was there to observe the battles. To which Montgomery replied characteristically, "I observe my own battles". But mere Brigadiers are seldom seen in the company of Field Marshals and it was Montgomery's Chief of Staff, Major General F.W. de Guingand, who became Schonland's closest colleague during the onslaught that drove the Germans out of France and back into their own country and eventual surrender. After the war de Guingand emigrated to southern Africa where he pursued a successful business career and maintained occasional contact with Schonland on each other's visits home.

Schonland already knew what the future held for him. He had accepted an appointment from another General - Smuts in this case - who wished him to return to South Africa as soon as Germany's fate had been sealed. Smuts wanted Schonland to set up South Africa's own national scientific organisation which would become the focal point for research and development in the country once peace had returned. This he duly did and the Council for Scientific and Industrial Research (CSIR) was the result with Schonland as its first President. As the country's pre-eminent scientist in the pre-war years he almost filled the role as its elder-statesman but in his heart Schonland wished to return to his "little laboratory", as he called the BPI. But three years at the top of the CSIR soon became five and before he returned to Wits he had one more military function to perform. Acting on a suggestion of Schonland's, the Chief of the General Staff in Pretoria authorized Schonland to establish a most unusual and highly secret organisation within the confines of the CSIR. It was called the South African Corps of Scientists with Schonland as it commanding officer and all its members – commissioned officers all with not an NCO or mere ranker among them – were all scientists within the CSIR selected for the particular expertise they could bring to bear on a range of pressing military problems likely to confront South Africa (Austin, 2007).

When Schonland eventually returned to Wits, it wasn't long before his former colleagues in England came calling. However, that is a story that has been told elsewhere. All that remains of Schonland;s career as a soldier-scientist is perhaps best summed up in the worlds of one of his most remarkable AORG colleagues, E.W.B. Gill. As was required of all the section leaders in the AORG at the end of the war, Gill wrote a detailed report of the activities of his section that dealt with Signals in the Field. Of Schonland he had this to say (Gill, 1944).

"I think the first difficulty for posterity will be to get as good a man as the Brigadier to be in charge. He must be a good research scientist but not one whose interest is solely in his own line of research, he must be young in mind and active, he must suffer fools gladly, he must get on well with army officers, and above all he must be entirely outside political and departmental intrigues (though it is an advantage for him to be conversant with the elementary principles of these arts). The Brigadier had all these qualities but it will be damned difficult to find them combined in one man again for the next war". wn

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