wattnow

THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS

JUNE 2024

SAIEE

CONTENTS

SAIEE @SAIEE SAIEE

Dear **watt**now reader,

Rotating machinery has been a part of our everyday lives since 1891. This sector has expanded to include a wide range of machines, such as pumps, compressors, turbines, and motors, which play a key role in various applications, from power generation to manufacturing processes.

This issue features Motors and Drives. Our first feature article, "The Evolution of Partial Discharge Testing in Electrical Equipment," on page 36, gives you a historical view of how PD became integral to today's engineering industry.

"Air Compressor Technology Innovations" discusses how this industry constantly evolves and how you should stay ahead of technological advances. You can read it on page 46.

The July issue will feature Smart Buildings, and the deadline is 10 June. Please send any article/news contributions to minx@saiee.org.za

Here's the June issue; enjoy the read!

Minx

MANAGING EDITOR
M Avrabos

TECHNICAL EDITOR
J Buisson-Street

EVENTS
G Geyer

TRAINING ACADEMY
Z Sibiya

MEMBERSHIP
C Maseko

ADVERTISING
Avenue Advertising

SAIEE HEAD OFFICE
18A Gill Street, Observatory, JHB
T 011 487 3003
www.saiee.org.za
Office hours: 8am - 4pm

ISSN: 1991-0452

Pascal Motsoasele
2024/5 SAIEE President

president@saiee.org.za

That is the email address we have created for our members to contact me. We created it because I want to connect with our members, to enable me to act on their mandate and possibly be a conduit to convey their aspirations regarding the Institute into the radar of the Council. To date I have received two emails from our wider membership, with suggestions and what I may regard as points to consider. This is much welcomed; I encourage you to use this email address to contact me on any matters related to our beloved Institute.

The month of May has been relatively quiet in respect of my activities. On the 3rd of May, I was at the SAIEE House in Observatory, where we met with the Institute's external auditors in what I would describe as a "meet and greet" session requested by our Honorary Treasurer, Prof. Pat Naidoo. We then made them aware of our plans and intentions for the year, some of which I think I should share with the wider membership and mention here, for your information:

- The Institute is registered with the CIPC as SAIEE NPC. We are pursuing further registration with SARS as a PBO and the Department of Social Development as an NPO. These were resolutions of the Council last year in response to the changing times we operate in, where we are faced with challenges around membership value and our stagnating membership numbers, concerns around our financial sustainability, and possible legal ramifications in terms of our standing as a legal entity under the laws of the land. There is a report on this, and I am willing to share it with our members should they wish to know more about the changes and what prompted them.
- Therefore, as Council, we resolved to establish a Board of Directors for SAIEE NPC. Currently, we are in the process of organising a training intervention called Governance for NPOs, which will be conducted by IoD-SA. It is our hope that the training will enhance the Board's knowledge and empower the Board members to assume fiduciary responsibilities. Again, feel free to reach out and solicit more information in this regard.

The project to roll out an audio-visual conferencing facility at the Council Chambers has been completed. The Council meeting held on the 3rd of May 2024 was our first meeting using this facility. The meeting was planned as an online event, but since I was at the Chambers that day, we used the opportunity to test the system. There are two cameras; one is on the podium side facing the audience, and the other is installed on the side of the room and facing the podium side. These come with the option to set them up such that they follow the speaker across the room.

At the Council meeting held on Friday, May 3rd, 2024, the Council resolved to enforce bylaw B7.2.1, which states that members who consistently absent themselves from Council meetings should be terminated as Council members if the situation is not corrected after two months of being notified of their non-compliance. I intend to contact members absent from our meetings without registering a meeting apology with our secretariat.

Our next Council meeting, scheduled for the 7th of June 2024, will be an in-person meeting, with the option to join online via MS Teams for those members far removed from SAIEE House.

We have several events coming up soon. We are still finalising the President's Invitation Lecture, which will likely be held at the University of Johannesburg during the June or July month. Another flagship event is the Bernard Price Memorial Lecture, which is usually held in September at Wits University, but I will appraise you on it closer to the time. Any suggestions from you of notable speakers for these two events will be appreciated.

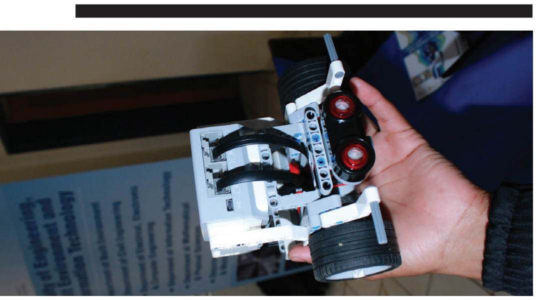
Yours in service of the Institute. wn

CUT, Eskom Expo, and SAIEE collaborate to offer robotics workshops in the Free State

Project coordinators: From left: Mr. Nicho Swartz, Ms. Sister Mapiyeye, and Mr. Lucky Mokalusi.

Facilitator and learners after a successful 3-day robotics workshop at Tlotlanang Combined School.

In educational institutions worldwide, spanning from primary schools to tertiary levels, the provision of Science, Technology, Engineering, and Mathematics (STEM) education faces a significant challenge due to the high cost and complexity of science equipment. Current robotic kits that promote STEM adoption include the EV3 MINDSTORMS and Spike Prime.



However, these techniques have not yielded prolonged results, resulting in sluggish STEM robotics adoption, particularly in Thaba Nchu and Botshabelo, located in the Free State. Affordability is a challenge for most schools, hindering their ability to acquire these robotic kits and the necessary training. Therefore, it is up to willing sponsors to step in and address this issue.

The Manager of the STEM Academy, Ms. Sister Mapiyeye, said that to contribute to a solution to this challenge, the Central University of Technology (CUT), Eskom Expo for Young Scientists, and South African Institute of Electrical Engineers (SAIEE) are collaborating on offering robotics workshops and mentorship to primary and secondary schools in the Free State.

As part of this collaboration, Tlotlanang Combined School in Thaba Nchu and Setjhaba se Maketse High School in Botshabelo have been selected to participate in the project in 2024, with 10 learner participants from each school. On Saturdays, a three-day robotics workshop was conducted for Tlotlanang Combined School, where the learners were exposed to cutting-edge robotics technologies.

The facilitator of the workshops and Chairperson of SAIEE Free State Centre, Mr Lucky Mokalusi, shared that the learners gained hands-on experience in building and programming robots. They also engaged in team challenges to enhance their creative and problem-solving skills.

"To ensure the sustainability of this intervention, continuous mentorship has been planned and will be provided to the learners. The purpose of the mentorship is to encourage and guide the learners on undertaking scientific research projects in preparation for the Eskom Expo Regional Science Fair scheduled

Facilitator assists the learners with their robotic prototype design.

to be held at CUT in August 2024", stated the Provincial Coordinator of the Eskom Expo, Mr Nicho Swartz.

For the research projects, the learners are expected to design a prototype to present at the science fair. Hence, the continuous mentorship will assist the learners in better understanding product development through 3D printing and Laser Cutting. The learners will be encouraged to participate in the World Robot Olympiad, First LEGO League, Virtual Gear Competition, and First Tech Challenge, exposing them to global standards that are largely unavailable in the Free State.

CUT students are coopted to support and mentor the learners throughout this project. In doing so, they have an opportunity to develop one of the graduate attributes, namely community engagement. wn

How to measure DC voltage with a digital multimeter

Steps for measuring DC voltage with a digital multimeter

1. Turn the dial to DC voltage. Some digital multimeters (DMMs) also include DC millivolts. If uncertain of which to choose, start with DC voltage, which handles higher voltage.
2. First, insert the black probe into the COM jack.

Steps for measuring DC voltage with a digital multimeter

3. Then insert the red probes into the V Ω jack. When finished, remove the probes in reverse order: red first, then black.
4. Connect the test probes to the circuit: black to the negative polarity test point (circuit ground), and red to the positive test point.
5. Read the measurement in the display.

OTHER USEFUL FUNCTIONS WHEN MEASURING DC VOLTAGE

6. Modern multimeters default to Autorange based on the function selected on the dial. To select a specific fixed measurement range, press the RANGE button multiple times until the desired range is selected. If the voltage measurement falls within the range of a lower DC millivolts setting, follow these steps:
   - o Disconnect the test probes.
   - o Change the dial setting to dc millivolts.
   - o Reconnect the test probes and read the measurement.
7. Press the HOLD button to capture a stable measurement. It can be viewed after the measurement is complete.
8. Press the MIN/MAX button to capture the lowest and highest measurements. The DMM beeps each time a new reading is recorded.
9. Press the relative (REL) or delta (?) button to set the DMM to a specific reference value. Measurements above and below the reference value are displayed

Contact COMTEST via email on sales@comtest.co.za for more information on FLUKE's "How to measure dc voltage with a digital multimeter"
Visit: www.comtest.co.za for more info. wn

From eco-friendly roofing and waste collection to AI-powered healthcare and farming, the 2024 Africa Prize for Engineering Innovation finalists revealed

The Royal Academy of Engineering will host the final of the 10th Africa Prize for Engineering Innovation, the continent's largest engineering prize, on 13 June 2024 in Nairobi, Kenya. From an initial shortlist of 16 innovators creating sustainable, scalable engineering solutions on the continent, four finalists have been selected to present their innovations to the judges in front of a live and online audience. Registration for this event is now open.

In 2024, the four finalists have developed solutions including an environmentally-friendly roofing material made from recycled plastic, a smart healthcare platform providing direct access to vital healthcare information via WhatsApp, a location-based mobile app connecting customers to independent agents for on-demand rubbish collection and disposal, and a solar-powered tool using AI and machine learning-enabled cameras to detect and identify agricultural pests and diseases.

These innovations directly address the UN's Sustainable Development Goals, including zero hunger, good health and well-being, sustainable cities and communities, reduced inequalities and climate action.

This year's winner will receive a prize of £50,000, with the other three finalists receiving £15,000 each. The prize is double that of previous years in recognition of the Africa Prize's ten-year anniversary. The other shortlisted innovators will also be given one minute each to present their innovations, and an audience poll will select one of them to receive an award of £5,000.

The 'One to Watch' prize is awarded in honour of an alumnus of the Africa Prize who passed away, Ghanaian Martin Bruce, co-founder of Young at Heart. It is awarded to a member of the shortlist, whom the audience identifies as one to watch in the future. The awards form part of the Royal Academy of Engineering's investment of over £1 million to African innovators through grants, prizes and an accelerator programme placed during the 10th anniversary year of the Africa Prize.

The 2024 Africa Prize finalists were selected from a shortlist of innovators applying engineering to solve problems their communities face. The finalist selection took place following an eight-month training and mentoring programme, during which experts provided tailored, one-on-one support designed to accelerate and strengthen the businesses of each member of the shortlist. Training covered business plans, scaling, recruitment, IP protection, sector-specific engineering mentoring, communication, financing and commercialisation.

Local supporters, industry peers, engineering and entrepreneurial enthusiasts, innovation hubs, investors, as well as media are encouraged to register to attend the Africa Prize final free of charge in person or online here. An online exhibition showcasing the Africa Prize 2024 shortlist can be viewed here.

The final will be held at the Mövenpick Hotel & Residences, Nairobi, where approximately 100 Africa Prize alumni from 20 countries will also attend to celebrate the tenth anniversary of the Africa Prize. wn

Construction Industry: The Right Software Delivers Greater RoI and much more

Peter Damhuis
Vice President, RIB Software

The uncertainty and risk involved in complex construction projects can typically lead to cost overruns, delays, and quality issues, leading to the low-profit margins the sector is notorious for. Net profit margins often hover between 2% and 10%.

RIB software vice president Peter Damhuis says the need to invest in construction software is almost non-negotiable as companies compete for the upper hand in potentially lucrative contracts.

"As construction software becomes increasingly sophisticated and offers ever-greater efficiencies, it is a key differentiator in ensuring construction companies are well positioned to win business and complete projects profitably."

When choosing software, construction companies need to consider upfront costs and how much the system will cost on an ongoing basis. "Too often, particularly if the decision-making process does not involve the key stakeholders who will feel its benefit, the selection can be based on price alone without a full understanding of its true cost and real ROI," says Damhuis.

When determining the true cost of software, many factors must be considered, including existing hardware and services, software fees and charges, embedding, upgrades, maintenance and admin, and product training and ongoing support. "For example, will your company need to make changes to its existing infrastructure to accommodate the software; what do the licensing or subscription fees look like or will it be a once-off purchase; will your business be looking to customise the software; or do you need ongoing maintenance, training and support? All of these are critical considerations," adds Damhuis.

Beyond these more obvious ROI elements, other factors should be contemplated.

THE WISDOM OF CHOOSING AN ENTERPRISE RESOURCE PLANNING SYSTEM

"Many construction companies choose a host of software programmes to handle different aspects of the business. If, however, they choose a fully integrated construction enterprise resource planning (ERP) system, the application will span the entire business and provide a centralised database function linking everything. Data of the entire business can then be handled by the system, with far-reaching impacts," explains Damhuis.

Redundant and duplicated data will be eradicated, freeing server and storage space. Licensing costs could be slashed as the business won't need to run multiple autonomous software packages for individual departments.

Software upgrades across multiple platforms will also reduce downtime, as the system is set up to cover all departments, with upgrades and enhancements planned for and built into the software architecture.

In addition, construction ERP software incorporates business intelligence and reporting functions that can pull data from all departments across every business function. This will identify areas that are succeeding above and beyond expectations while highlighting any areas that might be bleeding costs.

ANTICIPATING CHALLENGES BEFORE THEY CRIPPLE MARGINS

Construction companies often wish they'd identified an issue much earlier, as doing so would have saved significant time and/or money.

Damhuis says many stories in the construction industry operations have seen their entire margin wiped out by a simple error in estimating or cost assessment. wn

SBA Communications and Telecom Advisory Services Unveil first White Paper on African Telecommunications Tower Industry

SBA Communications Telecom Advisory Services are delighted to announce the release of a pioneering white paper titled "The Independent Tower Industry as a Key Enabler of the Development of African Telecommunications." This comprehensive document, the first of its kind for Africa, covers 14 African countries and focuses on the relationship between tower deployment and mobile sector performance from 2010 to 2022.

The econometric models consider variables such as 4G coverage, mobile broadband adoption, quality of mobile service, level of competition, and affordability of mobile service.

Authored by a team of industry experts, it explores key aspects of the African wireless industry, including the expansion of 4G and 5G networks, broadband adoption, wireless competition, and wireless capital spending. It also explores the critical role of passive infrastructure sharing in the development of the African wireless telecommunications industry.

"The whitepaper highlights the significant impact of independent tower companies on wireless connectivity in Africa, with countries exhibiting better coverage, use, affordability, and quality of wireless connectivity when there is a larger share of independent tower companies," explains Dr Raul Katz, one of the authors and president of Telecom Advisory Services.

KEY STATISTICS:

1. A 10% increase in the number of independent towers is associated with a 7.82% improvement in mobile affordability.
2. Independent tower companies contribute to better 4G coverage and access, with country leaders showing 8.09 percentage points higher coverage than the rest of the countries.
3. Improved infrastructure sharing regulation can lead to increased 3G/4G coverage, resulting in an increase in unique mobile broadband users and positive impact on economic indicators.

BENEFITS OF THE TOWER INDUSTRY

The tower industry plays a key role in the IoT and smart cities market spaces, presenting new opportunities for growth and innovation. The development of an independent tower industry is fundamental for the development of telecommunications in African countries, leading to improved service penetration.

Enhancing the telecommunications sector in Africa requires proactive policies and regulations that incentivise the development of the tower industry. By implementing the recommendations outlined in this white paper, African governments can maximize the potential of tower deployment, promote competition, and support the future growth of 5G networks.

For more information please visit: https://towers.sbasite.com/ wn

SAIEE Rotating Machine Section presented Best Paper Prize winner in webinar

Tarique Rouhani
Stellenbosch University

SAIEE RMS Committee members with Tarique Rouhani at SAIEE Head Office.

On the 23rd of May, the SAIEE Rotating Machine Section hosted its monthly forum meeting at the SAIEE Head Office in Johannesburg.

After the forum discussion, Tarique Rouhani, the SAIEE Rotating Machine Section Prize winner from the SAUPEC Conference held in Stellenbosch in January 2024, presented his winning paper, which discusses how generators for wind power conversion require a low torque ripple as a high torque ripple translates to vibrations in the machine, affecting its structural stability and causing excessive wear on the drivetrain components.

This paper involved the design and optimisation of a 3MW medium speed (375 rpm) Wound Rotor Synchronous Generator (WRSG) and Permanent Magnet Synchronous Generator (PMSG). These were compared to determine if the Wound Rotor Synchronous Generator is an excellent alternative to the Permanent Magnet Synchronous Generator. This was done through conceptual designs and finite element analysis using Ansys Maxwell and a genetic algorithm to reduce the torque ripple. The optimisation focused on determining optimal stator slot dimensions for both generators and rotor slot dimensions for the Wound Rotor Synchronous Generator. The optimisation processes reduced the torque ripple but at the cost of a loss in torque output for both the Wound Rotor and Permanent Magnet Synchronous Generator. The Wound Rotor Synchronous Generator had the best torque ripple reduction to output torque loss.

ABOUT TARIQUE ROUHANI

Tariq Rouhani is pursuing a master's degree in electronic engineering and working on a project on organ-on-a-chip technology as part of the biosensor node. He completed his Electrical and Electronic Engineering undergraduate degree at Stellenbosch University with a specialisation in energy systems. He is incredibly passionate about his field and has developed excellent problem-solving skills, which he applies with unwavering determination. Click here to watch the webinar recording. wn

M&C coordinates skills for rapid repair at Northam Platinum mine

Danie Gouws, M&C's Chief Field Service Technician (in orange shirt), assists the mine's technical personnel install the rock-winder motor into the man-winder position.

Marthinusen & Coutts (M&C) recently successfully met an extremely tight deadline it had been set as a contract condition for the repair of a 94t 4736kW DC mine winder motor that had failed at Northam Platinum's Zondereinde mine near Thabazimbi in Limpopo Province in July this year.

The motor had driven the man-winder hoist serving the mine's No.1 shaft.

M&C was given just five days to perform all the necessary repairs after taking delivery of the motor at its Cleveland, Johannesburg, workshop.

"The clock started ticking when we took delivery of it on July 24, with the repairs having to be completed and the motor fully reassembled by July 29, when it was due to be collected and returned to site for re-installation," said Owen Kilian, M&C's Projects & Field Service Manager.

One of the damaged motor's field coils had to be rewound, and the insulation, which had deteriorated over time, was replaced.

"We also chemically washed all the parts in our Power Generation workshop in Benoni and dried out the halves in our dedicated drying-out ovens," Owen said. The contract also incorporated M&C's having to provide a field service team to assist mine personnel in transferring an identical motor driving the rock-winder hoist at the No.1 shaft to replace the other. This kept the man-winder hoist working, minimising the disruption of underground operations while the failed motor was being repaired.

"The plan was to install the repaired motor to drive the rock-winder upon its return, which our field service team was also assigned to assist in installing as part of our contract," Owen explained, adding that an additional five days was allowed by Northam under the repair contract for the on-site work undertaken by M&C's field service team. Some repair procedures were also done on-site, including refurbishing the armature of the repaired winder motor.

"We worked 24 hours a day over the ten days we spent on the total project for the two winders. Without the excellent teamwork we were fortunate enough to share with the expert mine personnel and their rigging subcontractors, we wouldn't have completed the job in the limited time we were given," Owen commented.

"ACTOM Industry, representing the OEM for the winder motors, proved invaluable in ensuring that everything was done in accordance with the OEM's quality standards," he added.

Greener digital content supports Net Zero goals

Web sites and digital content can increase organisations' carbon emissions and hamper efforts to achieve Net Zero status.

This is according to Andri Johnston, Digital Sustainability Lead at Cambridge University Press & Assessment, who was addressing a webinar on Sustainability in Digital Media hosted by the Institute of Information Technology Professionals South Africa (IITPSA) Social & Ethics Committee.

Johnston outlined Cambridge University Press & Assessment's efforts to reduce its carbon footprint as it moved from print to digital content. "There's been a huge shift to digital in the tertiary, academic and educational field, so while we work hard to reduce carbon emissions in the print industry, there is also work to be done on the digital side. We have made a commitment to be carbon zero on all energy related emissions by 2048, with a 72% reduction by 2030," she said.

Johnston noted that Scope 1 (direct) and Scope 2 (indirect) emissions were easier to control, but said Scope 3 were the hardest to track and mitigate. "These come from printing, freight and digital emissions. The shift from print to digital in the publishing industry holds a large carbon benefit by reducing the paper, print and freight emissions. But there will always be carbon emissions from our digital products. Going digital does not offset emissions," she said.

To calculate carbon emissions from digital media products, Johnston's organisation calculates emissions from data centres, networks and end users. "We use Google analytics to collect data around how customers access our data, the time they spend browsing, theIR country, device, amount of page views and page weights," she explained.

Page weights – the size of each web page – can make a significant difference in digital media emissions, Johnston said.

"We ran a project using the DIMPACT tool over the last four years, and saw a significant increase in our carbon emissions because we keep adding journals, text books and content to our websites, with more value-adds and 'extras' like media and videos. We realised our digital emissions would continue to rise, and this is the case with any digital product where you keep adding content and updates. And the more people access the platforms, the more the emissions will rise as well."

"The images and colours sites use have an impact – for example, green is a good colour to use to be energy-wise. High resolution images and PNG images result in more emissions than small images," she said. "Emissions can be reduced by reducing embedded videos and instead linking out, and reconsidering approaches to SEO – not tracking just for the sake of tracking."

"Also important is where the data is hosted and where people are accessing it from. We started thinking about how to build better products with simple sustainability principles and guidelines," she said.

The organisation produced a Sustainable Web Guide to make web projects energy efficient and produce the least amount of carbon emissions possible. Among the recommendations in the guide are to use less media, content and code, use renewable energy in the data centre and CDN, and keep sites and content as simple as possible. The Digital Sustainability Guide was created with Wholegrain Digital

ETHICS IN DIGITAL PUBLISHING

Josine Overdevest, Chair of the IITPSA Social & Ethics Committee, said sustainability was a key part of ethical practice: "You are acting ethically when you do good for yourself, your organisation and others. For example, contributing to sustainable development goals and AI for good, considering society as a whole and also the planet."

Overdevest said: "Digital sustainability is the application of digital technologies and proactive steps in its design, development, deployment and regulation, to accelerate environmentally and socially sustainable development while mitigating risks and unintended consequences. Digital technology can combat climate change on the offense and the defence. However, digital transformation can also have negative impacts."

"We can use digital technologies to mitigate climate change through climate modelling and monitoring, sustainable energy, carbon management, sustainable transportation such as electric vehicles and ride sharing, sustainable agriculture and moving from a linear economy to a circular economy," she said.

"Digital technology also enables climate change adaptation – for early warning systems, climate information and data management, remote sensing and mapping, data to support the development of climate resilient infrastructure, virtual and augmented reality, and community engagement and empowerment – for example platforms where people can become more involved and informed."

The negative impacts of digital transformation can include energy consumption, e-waste generation, a growing digital divide, human rights violations, over-consumption and misinformation – which can lead to divisions with disastrous results, she said.

Overdevest highlighted a short video released by the IITPSA to illustrate the importance of ethics in ICT. To view the video, click here. wn

SAIEE Student Membership Fees waived until 31 August 2024!

The South African Institute of Electrical Engineers (SAIEE) is always looking at novel ways to grow the institute and to ensure sustainability.

OUR GROWTH COMES IN TWO FORMS:

1. From new members who are already in the field, and

2. From organic conversion from student members to members/associates.

Any organisation worth its salt knows that the most significant contribution to an institute comes from converting its student members into members. Being an SAIEE student member costs R205, payable annually.

IS THIS COST REASONABLE OR NOT?

As students at Higher Education Institutions (HEI), which constitute South Africa as either a University, University of Technology or TVET College, we know that tuition fees are expensive. This was evidenced by the 2018 student strike at Wits University, which resulted in the government resolving to offer free education through the National Student Financial Aid Scheme (NSFAS) scheme.

Typically, any social club or grouping must register at the HEI to be recognised, and after that comes the hard slog of recruiting other like-minded individuals to join the cause. In our instance, Electrical Engineering students should get involved with the HEI student chapter.

To date, there has been a vexing question about what a reasonable amount to charge for student membership is.

The SAIEE has decided on the following:

1. The SAIEE Student Membership fees remain current and will remain the same for the next five years.
2. The SAIEE Student Membership fees will be waived until 31 August 2024.
3. The waiver in point 2 above is communicated to student members as a discount for the recommended period.

For more information on SAIEE Student Membership, feel free to contact our dependable Membership Team via the following details:

Connie Makhalemele
T: 011-487-9045 or email
connie@saiee.org.za

Thandolwethu Lefutso
T: 011-487-9050 or email
thando@saiee.org.za

Alternatively, navigate to the SAIEE website Membership pages for more information: bit.ly/JoinSAIEE wn

SAIEE

JOIN SAIEE

- the gateway for a successful career

Make a difference today - join us!

The South African Institute of Electrical Engineers (SAIEE), founded in 1909, strives to provide leadership to all its engineering practitioner members in becoming more effective in providing and enhancing the quality of life of all communities in Southern Africa.

AS A STUDENT, YOU ARE THE FUTURE.

Any engineering student signing up between 1 March and 31 August 2024 will receive free membership for the year. Apply now!

Click here on how to become a member today!

SAIEE

For more info, email Dudu Madondo - reception@saiee.org.za

SAIEE UKZN Student Chapter shines at Careers Expo

The SAIEE UKZN Student Chapter had an incredible experience at the annual Careers Expo held at the Nelson Mandela Community Youth Centre in Chatsworth on Saturday, May 11th, 2024.

Hosted by the inspiring Dreamcatchers, this event attracted a diverse audience, including learners, students, graduates, educators, and job seekers.

Participation in this event provided an excellent platform for us to engage with attendees and share valuable insights regarding electrical, electronic, and computer engineering career paths.

We were thrilled to contribute to the event and interact with individuals interested in pursuing careers in our field.

During the expo, we had the pleasure of awarding prizes to five lucky winners - congratulations to all the recipients!

Overall, the Careers Expo presented a fantastic opportunity to connect with future engineers, promote our organisation, and contribute to building a brighter future for our community.

We thank everyone who stopped by our stall and the organisers for their efforts in coordinating such a successful event. wn

#SAIEEFSC at the CUT Virtual Career Fair & Roadshow

Central University of Technology (CUT) Faculty of Engineering Built Environment and Information Technology (FEBIT) invited the South African Institute of Electrical Engineers (#SAIEEFSC) to collaborate at their Virtual Career Fair and Roadshow on May 7th, 2024. This Career Fair offered a unique opportunity to promote #SAIEEFSC, the CUT Student Chapter brand, and career opportunities to a wide audience of potential students and members.

During the event, a live presentation was shared with a diverse pool of students, graduates, and seasoned professionals actively seeking career opportunities in Electrical Engineering. Insights about the industry, career paths, and available positions were shared.

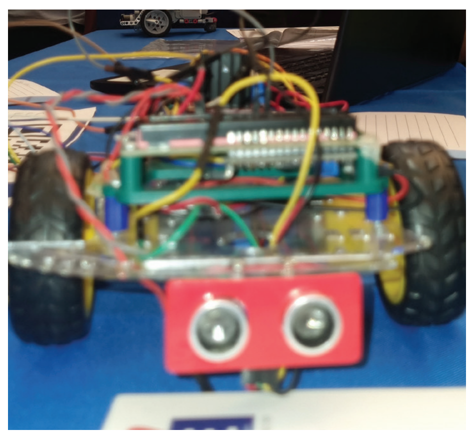
Notably, a recruitment drive for Mentors for continuous mentorship was announced, aiming to encourage and guide learners on undertaking scientific research projects in preparation for the Eskom Expo Regional Science Fair scheduled to be held at CUT in August 2024.

The collaboration between the Science Technology STEM Academy of the CUT, Eskom Expo for Young Scientists, and the #SAIEEFSC involves offering robotics workshops and mentorship to primary and secondary schools in the Free State.

The initiative aimed to equip learners with hands-on experience in building and programming robots by providing workshops and mentorship programs to schools. Additionally, by engaging CUT students as Mentors, the project will promote community engagement with service-learning principles.

The Mentors will be mainly #SAIEEFSC members and/or students who attended and successfully completed the Advanced Robotics Course at CUT in cooperation with the University of Applied Sciences, Aachen, Germany.

They will facilitate and guide the learners in designing a prototype to be presented at the science fair. wn



Universities in South Africa

It is only through education that people are able to improve themselves. One of the most important factors for escaping from poverty is education. The only way a society can continue to grow and prosper is through proper education at all levels.

Cape Peninsula University of Technology
Call Centre: +27 21 959 6767

Central University of Technology, Free State
Bloemfontein Campus:
+27 (0)51 507 391
Welkom Campus:
+27 (0)57 910 3500

Durban University of Technology
Switchboard: 031 373 2000

Mangosuthu University of Technology
Call Centre : 031 907 7111

Nelson Mandela University
Call Centre : 041-504 1111

North-West University
Call Centre : 0860 169698

Rhodes University
Call Centre : +27 46 603 8111

Sefako Makgatho Health Sciences University
Call Centre : (012) 521-4111

Sol Plaatje University
Call Centre : 053 491 0000

Stellenbosch University
Call Centre : +27 21 808 911

Tshwane University of Technology
Call Centre : +27 21 808 911

University of Cape Town
UCT switchboard: +27 (0)21 650 9111

University of Fort Hare
East London: 043 704 7000
Bhisho Campus : 040 608 3407
Alice Campus: 040 602 2011

University of Johannesburg
Call Centre : +27 11 559 4555

University of KwaZulu-Natal
DBN: +27 31 260 1111
PMB: +27 33 260 5111

University of Limpopo
Switchboard: (015) 268 9111
(015) 268 3332 / (015) 268 3276

University of Mpumalanga
Switchboard: (013) 002 0001
info@ump.ac.za

University of Pretoria
Switchboard: +27 (0)12 420 3111
info@up.ac.za

University of South Africa
Switchboard: 012 441 5888
study-info@unisa.ac.za

University of the Free State
Bloemfontein Campus: +27 51 401 9111
Qwaqwa Campus: +27 58 718 5000
South Campus: +27 51 401 9111

University of the Western Cape
Call Centre : +27 21 959 2911

University of the Witwatersrand
General enquiries : +27 (0)11 717 1000
Admission enquiries: +27 (0)11 717 1888

Vaal University of Technology
Call Centre : +27 (0)861 861 888
Admission enquiries: +27 (0)16 950 9356

University of Zululand
Switchboard : +27 (0)35 902 6000

Walter Sisulu University
Mthatha Campus : 047 502 2844

SAIEE CUT Eco-Vehicle Skills Race

On May 18th, the UFS campus buzzed with excitement as it hosted the highly anticipated Eco-Vehicle Skills Program event. This competition, aimed at promoting sustainability and innovation, saw participation from two enthusiastic CUT teams. The event comprised three distinct races designed to test different aspects of the eco-vehicles' performance and the drivers' skills.

COURSE 1: SMART LAP

The first course, known as the Smart Lap, challenged drivers to balance speed with energy efficiency. The objective was to complete the lap as quickly as possible while conserving the vehicle's energy. CUT 1 emerged victorious in this course, demonstrating an impressive blend of speed and strategic energy management.

COURSE 2: OBSTACLE COURSE

The second race, the Obstacle Course, added a layer of complexity as drivers navigated through a series of cones. Precision and agility were crucial, as hitting the cones would result in penalties. CUT 2 excelled in this challenge, showcasing remarkable control and speed, and clinched the win.

COURSE 3: ENDURANCE

The final race, the Endurance course, tested the vehicles' ability to sustain performance over an extended period. The goal was to complete the most laps without depleting the vehicle's energy reserves. CUT 2 again proved their mettle, winning the Endurance challenge, while CUT 1 secured the fifth position.

INTERVIEWS AND INSIGHTS

After the thrilling races, team leaders (Mr Thabo Letooane and Mr Thekiso Boqo) from both CUT teams shared their experiences and challenges during post-race interviews. The Engineering Mediators highlighted the rigorous preparation, the strategic adjustments made during the races, and the learning curves associated with managing energy efficiency and vehicle control.

PROMOTING SUSTAINABILITY

A key theme of the event was sustainability and the use of recyclable materials. This was evident in the design of the eco-vehicles and at the pit stops. Each team's pit stop featured decorations symbolising recyclable materials and sustainability, which were judged on their creativity and relevance.

ACKNOWLEDGEMENTS

The event was made possible through the generous support of our sponsors, SAIEE FSC, who provided crucial funding for the participating SAIEE students. Special thanks also go to Kovsie Act, the event facilitators, whose efforts ensured the competition ran smoothly and successfully.

CONCLUSION

The Eco-Vehicle Skills Program event at the UFS campus was more than just a competition; it was a celebration of innovation, sustainability, and teamwork. Through these challenges, students honed their technical skills and gained valuable insights into the importance of sustainable practices.

This event stands as a testament to the bright future of eco-friendly engineering and the potential of young minds to drive positive change in our world. wn

REVIVE

REVIVE ELECTRICAL TRANSFORMERS (PTY) LTD

Revive Electrical Transformers (Pty) Ltd is one of the leading manufacturers of distribution transformers in South Africa, with two manufacturing facilities in Gauteng: Steeledale and Kliprivier.

Established in 1997, our company has grown tremendously along the way and acquired the knowledge and experience needed to make us experts in our field.

Our business prospects are based on sound manufacturing and quality processes, a sound fiscal discipline, and growing customer base.

The company has been awarded various accreditations and conforms to most local specifications and international requirements.

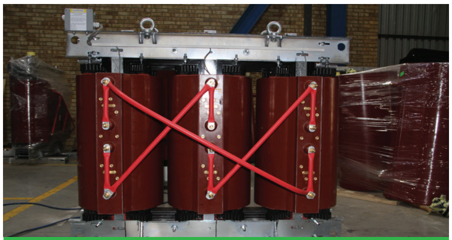
Product quality, delivery and after-sales service is paramount to our organization.

TRANSFORMERS ARE OUR BUSINESS

OUR PRODUCTS

- OIL DISTRIBUTION TRANSFORMERS
- OIL MINI-SUBSTATIONS
- NECRT
- PV SOLAR TRANSFORMERS
- CUSTOM-BUILT TRANSFORMERS
- SURGE ARRESTORS
- CAST RESIN DISTRIBUTION TRANSFORMERS
- CAST RESIN MINI SUBSTATIONS
- SWER TRANSFORMERS
- WIND FARM TRANSFORMERS
- COMPLETE SUBSTATIONS
- AUTO RECLOSURES

Dry-Type Mini Substation



Cast Resin Transformer

Complete Solar Substation

BBBEE Level 1

CONTACT US

+27 87 135 0149 • sales.revive@ret.co.za

27 Waterval Road, Kliprivier, Johannesburg, South Africa

SAIEE Remembers Fellow Hermann Broschk

Hermann Otto Broschk
1937 - 2024

HERMANN OTTO BROSCHK, born in 1937, left a legacy in the electrical engineering fraternity. He sadly passed away peacefully on May 10, 2024.

After matriculating, Hermann completed a four-year apprenticeship as an electrician. He obtained his National Diploma at the Witwatersrand Technikon.

Hermann joined the Electricity Supply Commission (Eskom) and completed an engineering pupilage in their generation department, where Brown Boveri offered him a position. After two years, he was delegated to Switzerland and Germany for specialist training on projects and products, specialising in high-voltage switchgear. He was appointed project engineer on his return to South Africa.

Hermann was involved in several large projects, including Cahora Bassa, Ruacana interim hydro station, 400 & 275 kV substation equipment and protection and control, and a large diesel generator plant and industrial turbines. In 1975, he joined the AEG-Telefunken group as a department manager in the High Voltage Department and again spent time in Germany on a specialised GIS High Voltage Switchgear course. He was promoted to Divisional Manager on his return. After several years, he became the Director of AEG Energy Control, formally ANGCON Technologies, who locally designed and manufactured the first pre-payment meters in South Africa. He was appointed Marketing Manager of the T&D Division when AEG & GEC Alstom merged. After retiring from Alstom, he became a specialist consultant.

Hermann became an SAIEE member in 1961 and an SAIEE Fellow in 1989. He served on the SAIEE Council for 13 years and chaired various committees, including Membership, Technology & Knowledge Leadership, Events, Publications/Journals, and Outreach. He has also been Chairman of the Bursary committee since 1991. Hermann celebrated his 50th year as an SAIEE Member in 2011.

Hermann was a Member of the International Council on Large Electrical Systems (CIGRE) and served as its honorary treasurer and executive committee member from 1998 to 2011.

The SAIEE President, council, and staff offer our heartfelt condolences to Hermann's family and friends. Hermann will be sorely missed. wn

OPINION PIECE

Let's talk about the well-lit elephant in the room

Nato Oosthuizen
Partner & Renewable Energy Expert, BDO

With the country maintaining more than a month of uninterrupted electricity, many people are rumbling about the elephant in the room. With the spotlight shining directly on voting day, 29 May, it's difficult not to be suspicious that the sudden lack of power cuts is a simple election tactic. Nato Oosthuizen, Partner and Renewable Energy Expert at BDO, shares his insight on where the country is at with load-shedding and reasons why he is cautiously optimistic about the potential for a brighter future for South Africa.

With the country maintaining more than a month of uninterrupted electricity, many people are rumbling about the elephant in the room. With the spotlight shining directly on voting day, 29 May, it's difficult not to be suspicious that the sudden lack of power cuts is a simple election tactic.

Nato Oosthuizen, Partner and Renewable Energy Expert at BDO, shares his insight on where the country is at with load-shedding and reasons why he is cautiously optimistic about the potential for a brighter future for South Africa.

The beginning of May marks the longest period the country has had uninterrupted power since 2022. As much as people enjoy the respite, many cannot help but notice that it comes just as political parties ramp up campaigns before the country goes to the polls on 29 May. This is especially pertinent because this year, the ruling African National Congress risks losing its parliamentary majority – something it has held tightly onto for the last 30 years.

However, while it is easy to be sceptical, considering that in 2022 and 2023, the country experienced over 205 and 332 days of load-shedding, respectively, we cannot ignore some of the key factors contributing to grid stability.

According to the South African Reserve Bank's (SARB) Monetary Policy Review for April 2024, improvements in power stability are happening quicker than previously projected. This has lessened the scale of the economic impact loadshedding is to have. But why the recovery?

Firstly, Eskom has fixed some of its biggest plants. The utility has reported a 9% reduction in unit breakdowns since April 2023 and spent 50% less on diesel this month compared with last year. According to its Group Chief Executive, Dan Marokane, even though the reduction may seem minimal, it is critical for managing the intensity of load-shedding. The utility predicts that the country can expect the power to be maintained within Stage 2 for the winter months.

Secondly, Eskom has finally agreed to move away from monopolistic control and invited the private sector and international funders to participate in the recovery process. President Ramophosa confirmed in March this year that, under the leadership of its new Group CEO, Eskom is finalising an agreement with businesses to deploy additional independent skilled experts to support the utility.

The ongoing state-incentivised rooftop solar projects aimed at reaching an installed capacity of 6,000MW by year-end have also contributed significantly to national energy needs. South Africa has been slowly increasing its investment in renewable energy, particularly solar and wind, which may be starting to pay dividends in terms of power supply stability. The government's commitment to renewable energy in its Integrated Resource Plan indicates a strategic shift

that might be beginning to influence the power landscape positively.

Finally, changes in management and an aggressive maintenance-led recovery strategy - the utility achieved a 65% Energy Availability Factor (EAF), an essential performance metric for Eskom as it directly affects load-shedding - is securing victory in the power utility's efforts to enhance its fleet's reliability and efficiency. The return of Medupi Unit 4 (800MW), Koeberg Unit 2 (980MW), and the synchronisation of Kusile Unit 6 (800MW) will add another 2,580 MW to the grid in the next six months, which also will help reduce load-shedding.

However, as the private sector starts to entrench its alternative energy footprint with the increase and expansion of solar rooftop solutions and private IPPs servicing the mining, industrial, corporate and private markets, and the country starts to feel the impact of this progression, a decline in revenue for Eskom will start to become increasingly evident. This could spell even tougher financial times ahead for the utility, and some difficult decisions may need to be considered, such as business restructuring and perhaps even retrenchments – a move that would have political ripple effects.

This could be the real elephant in the room, and one can only hope that on post-election day, the new leadership of the country will have the courage to do what is necessary to keep improving Eskom's financial sustainability.

If not, we stand to lose the momentum we have gained as average electricity prices will have increased by 5.5 times the expected 2010 level by 2024/25.

CPI inflation and bailouts are not sound strategies for keeping the lights on, so we ask, what is the plan? wn

OPINION PIECE

Making digitisation and sustainability work for the channel

Ahmed El-Besary
Vice President, Channel Sales & Marketing
Anglophone Africa, MEA at Schneider Electric

2023 was marked by increased emphasis on digital tools and its impact on companies' sustainability goals, with the energy management and automation industry working hard to demonstrate its benefits tangibly. In fact, according to the Schneider Electric report The Path to Net Zero Buildings, digital and electric solutions can cut carbon emissions in office buildings by up to 70%.

Similarly, vendors have proactively driven digitisation and sustainability across their channel programmes, realigning it to incentivise and encourage partners to embrace this digital transformation and subsequent sustainable practices.

However, to support the channel successfully, vendors are equipping their partners with the necessary knowledge and tools to navigate and succeed in this terraformed digital landscape effectively.

SUSTAINABILITY INTEGRATION IN PARTNER PROGRAMMES

Incorporating sustainability initiatives such as our EcoXpert partner programme allows our channel partners to gain the requisite industry knowledge and skillsets needed to digitise for a more sustainable future.

The programme has been designed to educate, support, and create opportunities for collaboration. This enhances partners' sales prospects by enabling them to offer tailored solutions and drives long-term profitability by tapping into the expanding market.

This mindset will also put our partners in good stead in the future. Customers will undoubtedly continue to evolve, and so will their demand for digitised solutions that realise their sustainability goals.

This shift towards digitisation and sustainability benefits individual partners and reinforces vendors' positions as frontrunners in the industry. These vendors create a more sustainable future for all by driving positive change.

VENDOR LEADERSHIP

Leading by example is as relevant today as it was 50 years ago. The vendor community must continue to lead the way towards a more sustainable future. Multinational technology vendors must fulfil their environmental commitments and empower channel partners with the knowledge, tools, and solutions necessary to achieve sustainability goals.

Also, vendors are expected to deliver transparent sustainability reports, measurable progress in decarbonising supply chains, and diverse portfolios of sustainable and efficient products and solutions. By meeting these demands, vendors strengthen their reputation as innovative, responsible, and climate-conscious companies.

The energy management and automation industry's approach to driving digital transformation and sustainability within channel partner programmes sets an important example for other sectors. By equipping partners for the digital landscape, integrating sustainability initiatives, and meeting customer demands, vendors are enhancing their partners' success and contributing to a more sustainable and resilient future. Lastly, our partners are invaluable in enabling Schneider Electric to meet its sustainability goals, such as providing 50 million people access to clean electricity, training one million people, and supporting 10,000 entrepreneurs by 2025. Our Access to Energy programme has connected more than 25 million people in Africa and trained 28,000 in 90-plus training centres in 27 countries. wn

SOUTH AFRICA GOLDEN BRIDGE

SOUTH AFRICA INTERNATIONAL INDUSTRIAL EXPO
& CHINA (SOUTH AFRICA) INTERNATIONAL TRADE EXPO

SOUTH AFRICA GOLDEN BRIDGE

TOGETHER, GROWING INDUSTRIES

- Exhibitions
- Display Center
- Overseas Warehouse
- Supply Chain
- B2B Meeting

Golden Bridge Expo South Africa Ltd is a newly established international economic and trade platform integrating exhibitions, long-term display center, overseas warehouse, supply chain, and sharing economy. Golden Bridge focuses on accurate match-making service for every exhibitor and visitor, organizes large-scale offline exhibitions and online match-making activities all year round.

Golden Bridge is committed to becoming a bridge for business and industrial owners from South Africa, southern Africa and the vast African region to conduct economic, trade and technological exchanges with the world.

The 3rd SAIIE 2024 will take place at Exhibition 1 & 2, Sandton Convention Centre, Johannesburg from 19-21 September 2024, covers 10500 m2 Exhibition Area with 380 Booths as well as the 'Exhibition + Warehouse' model. Business people will be able to check the samples of settled enterprises and negotiate with them at any time. It is conducive to shortening the delivery time of products and improving trade efficiency. It does provide the visitors with convenience in trade links such as sample check and transportation.

OPINION PIECE

Localise lithium and cobalt battery manufacturing to move Southern Africa up the value chain

Viren Sookhun
Mananging Director, Oxyon

Lithium, nickel, and cobalt are three critical minerals used in the manufacture of electronic vehicle (EV) batteries. All of these minerals are mined in Southern Africa. However, the raw materials are exported, batteries are manufactured in other countries, and the finished product is shipped back.

This is a significant opportunity missed to move countries like South Africa and Namibia up the value chain, create greater economic stability, and improve the cost-effectiveness and carbon footprint of EVs in the region.

MINERAL WEALTH

As the global focus is shifting toward creating more sustainable solutions and away from the widespread use of fossil fuels, EVs are an increasingly popular transportation option. EVs run off batteries, and the manufacture of these batteries is poised to become a massive industry in the near future. Several types of batteries are currently in use, each with various pros and cons and different compositions requiring different minerals. Not only are the three main minerals (lithium, nickel, and cobalt) all mined in Southern Africa. The other minerals commonly used are mined, including manganese, iron, graphite, aluminium, and copper.

Mining these minerals locally and then exporting them for manufacture before re-importing them as a finished product reduces the cost-effectiveness of EV batteries in the country. It also represents the loss of an opportunity to move up the value chain and increase the profits and economic gain generated through these minerals. If EV battery manufacturing could be localised, the Southern African region could capitalise on this growing market, stimulate economies, and boost job creation while making EVs more affordable for local users and reducing their carbon footprint further.

LEVERAGING THE OPPORTUNITY

Manufacturing EV batteries in South Africa has many benefits; however, for this to become a feasible option, there need to be off-takers for the mines – if they have no local manufacturers to sell to, they have few options other than to export their goods. This will require collaboration and cooperation between government and the private sector.

The government needs to incentivise the investment required into manufacturing, processing, and the supply chain in general, and the private sector must leverage these opportunities. At the outset, bringing in the skills required to set up the processes, advise and consult, and ensure that the necessary skills transfer and development takes place will also be required.

We need to create opportunities locally, driven by government incentives and grants, and to take the long-term view of economic prosperity, we need to drive this industry forward.

There is immense potential in the EV battery manufacturing space, which could feed into other areas of EV manufacturing and assembly and the different areas of the economy, helping to drive foreign investment and economic growth, job creation, and sustainability in the economy and the environment. wn

TRANS-AFRICA PROJECTS

Power Generation | Transmission | Distribution

an Eskom and FLUOR joint venture company

ENGINEERING DESIGN

POWER GENERATION BALANCE OF PLANT

Our prowess in power generation balance of plant encompasses a range of critical services to ensure efficient power generation. We provide comprehensive solutions to optimise power generation processes, including structure designs, foundation concepts, and substation designs incorporating AIS and GIS systems. Our team can create detailed designs tailored to match your precise requirements.

SUBSTATIONS

At Trans-Africa Projects, we specialise in the design and consulting of substations. We cover all aspects of substation design, from primary plant conceptualisation to detailed design and implementation. Our consulting services provide substation and line audits, ensuring the safety, reliability, and efficiency of electrical infrastructure.

TRANSMISSION LINES

Our team excels in the designs of standard, compact, or multi-circuit transmission lines, providing optimal layouts for urban and rural electrification initiatives. We leverage our experience to perfect new or refurbished line layouts. Our specialists have the knowledge and technical skills to deliver steadfast solutions.

TOWNSHIP ELECTRIFICATION

Electrification planning and design services tailored to meet the unique challenges of township electrification projects. We work to develop comprehensive electrification plans that address the specific needs of township communities. From initial feasibility studies to detailed design and implementation, we provide solutions to ensure the successful electrification of townships.

RURAL ELECTRIFICATION

In rural areas, reliable electricity access is essential for economic development and quality of life improvement. Our rural electrification services focus on developing sustainable solutions that bring electricity to remote communities. We specialise in designing cost-effective and scalable electrification systems that leverage renewable energy sources and innovative technologies to meet the energy needs of rural populations

Email us today to explore how Trans-Africa Projects can support your project.
Let's power Africa's future together.

+27 11 205 9400

info@taprojects.co.za

OPINION PIECE

Restructuring Electricity Tariffs for South Africa's Socio-Economic Development

The global energy landscape is grappling with the competing objectives of balancing energy security, equity, and sustainability, commonly called the energy trilemma. Critically, South Africa faces the challenges of below-cost-electricity tariffs and stark socio-economic disparities demonstrated by its high levels of poverty and inequality.

By Matthew Mflathelwa
SANEA Board Member

These unique challenges necessitate that electricity tariffs be designed to ensure businesses' financial considerations and sustainability of electricity utilities while simultaneously addressing social responsibility.

Historically, much debate has been about the South African electricity tariff's adequacy to account for the actual cost of producing electricity versus the country's diverse needs and economic circumstances. On the one hand, a non-cost reflective tariff will place electricity utility under an increasingly severe financial strain, usually accompanied by an extensive borrowing plan with extreme debt servicing costs. On the other hand, there is a limit to how much the tariff can be increased before impacting households' socio-economic needs and affordability, further exacerbating poverty and ultimately hindering socio-economic development.

BALANCING COST REFLECTIVITY AND SOCIAL EQUITY

Today, South Africa finds itself at a crossroads, needing to transition to a more cost-reflective tariff while balancing its socio-economic challenges. Historically, this balance was addressed through various subsidy models such as Free Basic Electricity and Inclining Block Tariffs, which one could argue did not quite address the issue. This resulted in the burden of electricity costs falling disproportionately on low-income households as there was an inadequate differentiation between tariffs for poor people versus those who could afford the actual costs.

Reflecting on these developments and considering the future of the electricity supply industry, it is time for a comprehensive restructuring of the electricity tariff. This restructuring should balance the imperatives of cost reflectivity with that of social equity and be guided by three principles: fairness, affordability, and sustainability.

Fairness refers to distributing the burden of the electricity cost more equitably among all customers, considering their ability to pay. An example of how this can be achieved to ensure everyone has access to essential energy services is by charging higher rates for those who consume more electricity while providing subsidies (inside or outside of the tariff base) to low-income households.

Affordability is the second important element, which is critical in a country with high unemployment and poverty rates. An ideal electricity tariff should be structured so that electricity remains affordable for every household and business, irrespective of income level or size.

Larger power producers will need to support the migration to more cost-reflective pricing, which will, in turn, help

ensure the sustainability of the electricity sector while providing subsidies to low-income households. Of course, this must be done without leading to tariffs that will undermine South Africa's objectives of stimulating industrialisation and manufacturing.

The principle of affordability should be implemented without constraining economic growth and, thus, job creation. Economic growth spurs employment opportunities and is one of the most effective and durable mechanisms for alleviating poverty.

Sustainability refers not only to the environmental aspects but also to the financial dimension. Sustainability is essential for the electricity sector's long-term viability and supply security. A restructured tariff should incorporate incentives for energy efficiency, the adoption of low-carbon generation and cost-effective reduction, thus promoting the transition to a more sustainable and resilient energy system. Examples of such incentives include rebates or discounts for investment in energy-efficient appliances, solar panels or implementing differential pricing for renewables-generated electricity. Such considerations may be more valuable to commercial and industrial users who have made commitments to decarbonisation and need to secure reliable, clean energy with long-term price certainty.

CHALLENGES TO MIGRATING TO RESTRUCTURED COST-REFLECTIVE TARIFF

Even though the benefits of transitioning to an appropriate restructured tariff outweigh the costs, it may pose challenges in the short term. The considerable benefits of aligning electricity tariffs with socio-economic needs include increased social cohesion, inequality reduction, and economic growth stimulation.

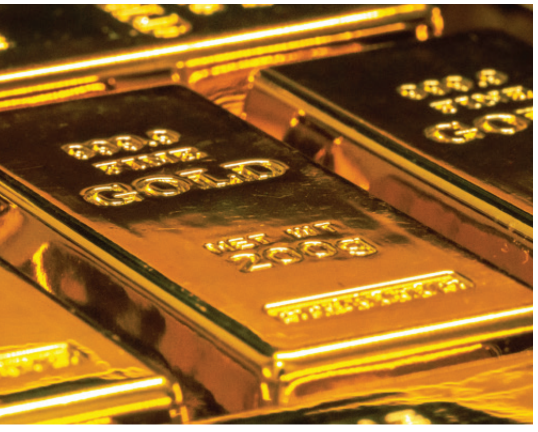
In addition, encouraging energy conservation and clean energy technology and usage can reduce reliance on fossil fuels, thus mitigating the impacts of climate change. The transition to a cost-reflective tariff is imperative for utilities to become self-sufficient and profitable rather than relying on government bailouts.

South Africa desperately needs a restructured electricity tariff. This can be achieved by embracing the principles of fairness, affordability, and sustainability, allowing utilities to not only move towards a more cost-reflective tariff but also contribute to the socio-economic and environmental imperative.

Policy direction is needed to guide South Africa in balancing the energy trilemma and ensuring sustainability and growth. We will play our part to enable bold action and innovative thinking to ensure a brighter, more equitable energy future for all South Africans. wn

© Opinion Piece courtesy of SANEA.

3 Simple Steps to Harnessing Hidden Potential



Your employees are your hidden potential for reducing energy use, greenhouse gases (GHGs), and operational performance. You can tap into this hidden potential by implementing an effective suggestion campaign.

By Andrew Cooper
MBA, B.Sc, B.Comm, P.Eng, CEM, CPEnMS, CMVP, CRE
Strategic Energy Management Consultant
SYNERGISE

How do you engage your employees with an effective suggestion campaign? Based on the results of an award-winning campaign I initiated, which resulted in an incredible 127 suggestions and helped us to exceed our energy target for the year, you take three simple steps.

What are the three simple steps? Incentivise, simplify and recognise.

First of all, **incentivise**. If there's a prize to be won, people will come. If I knew why, I'd be in psychology instead of energy management. It's just human nature.

I had noticed during health and fitness campaigns that pizza-guzzling, beer-swilling couch potatoes would transform into health-conscious fitness advocates for the six weeks of the campaign, just for the chance to win a cap with a company logo.

These incentives do not need to be expensive, but they should encourage participation and reinforce the message you are trying to convey.

Simplify. If it's too complicated, people will hate it. If I knew why, I'd be in psychology instead of energy management. It's just human nature. People want to take the path of least resistance, so make it as easy as possible to submit and track suggestions.

Technology can make this simple for you. Using SharePoint and Power BI, standard Microsoft products, you can develop a simple online system that is easy to access, easy to complete, easy to manage, and monitor.

Three ideas to help make this simple:

- The online suggestion form is only one click away from the home page.
- Keep it short. One minute or two if you type like I do, and it's done.
- Enable folks with no computer access to call in and ask that a suggestion be entered for them.

Recognise. What gets recognised gets repeated. If I knew why, I'd be in psychology instead of energy management. It's just human nature. People like to be recognised, so why not recognise them?

Recognise weekly prize winners via communication bulletins and get supervisors to recognise team members who make a suggestion each week publicly.

Feedback is critical as it lets people know you hear them, appreciate their suggestions, and are taking action. Receiving suggestions and then not giving feedback is actually worse for engagement than not asking for suggestions in the first place.

Once again, you can use technology to facilitate feedback.

- Set up interactive reporting displays to allow folks to see the status of their suggestion.
- Use SharePoint workflows, for example, to notify people whenever an update is made to their suggestion.

You must ensure people do not think their suggestions are being ignored. You cannot just ask for suggestions, then sit back and hope the magic happens.

Reviewing and processing suggestions, implementing feasible options and accurately measuring results takes dedication, discipline and hard work. It is probably one of the reasons many suggestion campaigns fail. Done properly, though, the results will be worth it.

If you take a moment to look, you will find hundreds of suggestions to improve efficiency, safety or production discarded or ignored like a single sock.

Effectively implementing a suggestion campaign can engage your employees and be worth millions of dollars to your company. It just takes three simple steps.

Incentivise, simplify and recognise. wn

MZANZI MEDIA
& ENTERTAINMENT FUND

A Journey of Innovation and Impact with MMEF

In May 2023, the Mzanzi Media and Entertainment Fund (MMEF) was launched with a mission to transform South Africa's media and entertainment landscape.

Under the expert management of Unum Capital (Pty) Ltd (FSP: 564) and administration by Lifecycle Investment (Pty) Ltd (FSP: 52896), MMEF quickly established itself as a pioneering financial catalyst for the industry.

The fund targets a benchmark of Consumer Price Index (CPI) + 500 basis points, reflecting its goal of delivering substantial returns.

The First of it's Kind in South Africa

Investment Achievements

As of May 2024, MMEF has deployed R 43,150,871.92 into the production of TV series, set to premiere on major streaming platforms like Netflix and Amazon. This substantial investment underscores the fund's commitment to fostering high-quality media content and supporting the growth of South Africa's entertainment sector.

MMEF's performance has been impressive, with the fund yielding 8.69% in 2023 over just four and a half months and achieving a 7.59% return so far in 2024. For April 2024 alone, the fund reported a yield of 1.77%, demonstrating its consistent performance and robust investment strategy.

Strategic Focus and Early Success

MMEF's strategic focus is on five key revenue streams:

1. **Feature film TV Series Production:** Financing high-quality movies and series for streaming platforms like Netflix and Amazon.
2. **Media Buying:** Investing in advertising space, both digital and traditional.
3. **Outdoor Media:** Funding for billboards and other outdoor advertising mediums.
4. **Equipment Purchasing:** Providing resources for acquiring production and broadcast equipment.
5. **Infrastructure Development:** Investing in the necessary infrastructure to support media production and distribution.

By July 2023, MMEF made its first public offering, a significant milestone that allowed the fund to attract a broad range of investors. This move was part of a broader strategy to leverage deep industry insights and financial expertise to support and grow high-potential media projects.

Approval by JSE's JPP Platform

A pivotal moment in MMEF's journey was its approval on April 23, 2024, by the JSE's Johannesburg Private Placements (JPP) platform (FSP: 51709).

JPP is a strategic extension of the Johannesburg Stock Exchange (JSE), designed to facilitate private placements and connect innovative projects with investors.

This approval validates MMEF's strategic vision and opens up new avenues for raising capital, enabling the fund to attract more investments and scale its impact.

Looking Ahead

MMEF's journey from inception to its current status as a high-performing fund is a testament to its strategic focus and the expertise of its management team. The fund not only aims for financial success but also champions inclusivity and sustainability through investments aligned with Broad-Based Black Economic Empowerment (BBB-EEE) principles.

As the fund continues to grow and invest in transformative media projects, it remains dedicated to delivering exceptional returns to its investors and contributing to the vibrant cultural fabric of South Africa.

The approval by JPP further solidifies MMEF's position as a key player in the industry, providing a secure and efficient environment for high-value investments.

Join the Journey

Investors looking to be part of this exciting journey can explore the fund's latest performance and opportunities through the detailed fund fact sheet available here.

For more information or to start the investment process, please contact Unum Capital's Client Support team via phone 0113842965 / 0113842963 or email clientsupport@unum.co.za or visit the official website www.jpp.mmefund.co.za

The Mzanzi Media and Entertainment Fund is not just an investment; it's a gateway to the future of South African media and entertainment.

FEATURE

The Evolution of Partial Discharge Testing in Electrical Equipment

Partial discharge (PD) testing is routinely used on all types of medium- and high-voltage equipment as a factory quality assurance test for electrical insulation and as a tool to detect deterioration in the electrical insulation of operating equipment. Today, dozens of vendors supply PD instruments, but the first PD tests were made by researchers over a century ago in an effort to understand PD.

By: G.C. Stone, Consultant, and Andrea Cavallini, University of Bologna

This article traces some of the key developments that led to the current state of this technology and outlines some of the challenges with PD testing, such as measuring PD during high-voltage DC tests and short-rise-time impulse voltage tests.

Partial discharges (PD) are small electrical sparks that can occur in the insulation systems of medium- and high-voltage electrical equipment, including power cables, transformers, switchgear, and stator windings. In most equipment, the occurrence of PD indicates that the equipment may fail soon since PD acting on organic insulation such as polyethylene, epoxy, oil, and/or paper quickly degrades the insulation.

In some cases, PD indicates another problem, such as a poor electrical connection in a transformer or loose coils in the slot in a motor stator.

For decades, PD testing (also called corona testing) has been a required factory acceptance test for many types of equipment. More recently, off-line and on-line PD testing have become valuable tools to determine when maintenance or replacement may be needed in equipment that has been installed and operated.

Today, PD testing in OEM and end-user facilities is widely applied, but this was not always the case. Research on how to measure the current pulses associated with PD evolved as electronic hardware and software tools advanced.

This article reviews some of the key developments and credits some of the important researchers. Further details and more references can be found in Chapter 1 of a recently published book on PD measurement.[1]

This article also provides information on measuring PD in DC equipment and energized apparatus with short-rise-time impulse voltages, which are the focus of research today. We do not discuss PD measurement using acoustic, ultraviolet, or chemical test methods here. See Stone et al[1] for more information on these methods.

EARLY HISTORY

PD testing dates back to the 1910s when, in one of the first English-language papers, Prof. Edward Bennett used a coupling capacitor with an oscillograph to measure PD from high-voltage transmission line equipment. The oscillograph is a relatively fast-responding electromechanical device like an X-Y chart recorder.

Between 1910 and 2023, more than 8,200 papers on PD and corona measurement on HV equipment have been added to the IEEE and IEE/IET databases alone.

A review of a sampling of these papers

reveals five distinct areas of development for PD measuring equipment:

- Radio interference voltage (RIV) frequency domain methods
- Time domain analog detection up to 1 MHz using oscilloscope displays
- Transition to digital detection
- Measurement of PD at frequencies from a few MHz to the GHz range
- Computer-based processing

RIV TESTING

RIV testing was the first widely applied method to measure PD, although that was not the original purpose of the test. RIV is variously defined as radio influence voltage or radio interference voltage. The original purpose of this test was to determine the level of corona interference (in microvolts) that an overhead transmission line or its associated insulators or transformers produce in AM radio receivers. If the RIV level is too high, complaints from the general public about poor analog radio and analog TV reception could be expected. The PD sensor was an antenna or some type of coupling capacitor. The signals were measured by a specialized radio receiver (sometimes called a radio noise meter), usually with a center frequency of about 1 MHz (within the normal AM radio broadcast band) with a narrow bandwidth of about 10 kHz. The instrument's output was a meter that displayed the quasi-peak, which was the weighted level of the electrical noise produced by the PD activity. In addition, a demodulated signal from the corona could be listened to on a speaker or headphones.

Although early receivers were made by researchers, commercial RIV instruments were eventually made by Stoddart Aircraft Radio Co. in the USA in 1944 (Figure 1) and by Siemens in Europe, among others. In 1940, the National Electrical Manufacturers Association (NEMA) published NEMA 107, Methods of Measurement of Radio Influence Voltage (RIV) of High Voltage Apparatus, a standard test method for measuring RIV that is still in print.

Radio noise meters fundamentally measure corona from transmission lines, but researchers began using RIV methods to detect PD in oil-paper-insulated power cables and oil-filled power transformers. In 1924, W. Del Mar applied RIV detection to measure the PD in oil-impregnated cables to determine the maximum design electric stress for the insulation by measuring the PD inception voltage.[2] In 1965, at least two papers described PD measurement in power transformers for factory QA testing using the RIV method following NEMA Standard 107, which is revised periodically. The PD sensor was often the capacitance tap on the transformer bushing, normally used to measure the transformer voltage. In Chapter 6 in the Bartnikas/McMahon book on corona,[3] Dr. Thomas Dakin from Westinghouse suggested that the RIV type of PD test was still the most common type of factory PD test for transformers up to at least 1979 when the book was written.

Figure 1: Stoddart RIV Instrument Circa 1945
Photo Courtesy Michael Heller,
Das Rundfunkmuseum, Cham, Germany

Although not widely recognized at the time, John Johnson of Westinghouse made a critical advance in the late 1940s with the application of RIV testing to

 continues from page 39

online insulation condition assessment.[4] We believe these were the first on-line measurements not intended to measure radio interference from transmission lines. PD pulses were initially detected across a resistor between the stator neutral and ground using an early oscilloscope or noise meter to measure the signal.

In the 1980s, Jim Timperley adapted the original RIV method to on-line generators, together with Johnson's neutral detection.[5] Instead of measuring the PD level using a noise meter, he used a specialized radio receiver commonly used for electromagnetic compatibility applications (i.e., measuring the RF signals emitted by electronics, power supplies, etc., to ensure they did not cause other equipment to malfunction). These commercial instruments, which are close cousins of RF spectrum analyzers, produce a plot of RF signal magnitude in µV vs. frequency. He initially explored frequency ranges up to a few MHz, but later expanded the range up to 100 MHz. The PD sensor was usually a high-frequency current transformer (HFCT) mounted on the generator neutral. Timperley preferred to call this version of the RIV test the electromagnetic interference (EMI) test. There are many ways to estimate peak PD activity; Timperley used the definition of quasi-peak in the IEC/CISPR 16-1 standard. The test is still performed by a few utilities today, although some have rebranded EMI testing as an electromagnetic signature analysis (EMSA).

TIME DOMAIN ANALOG PD DETECTION USING OSCILLOSCOPE DISPLAYS

The time domain method of PD current pulse measurement uses analog electronics and displays the PD on an oscilloscope to compare PD pulses to the 50- or 60-Hz AC cycle. PD current pulses occur in specific regions of the AC cycle depending on its cause and/or location within the insulation system.[1,3] The modern (at that time) PD instrument depended on the development of better oscilloscopes. The oscilloscope can trace its history back to the development of the cathode ray tube (CRT) by Nobel Prize winner Dr. K.F. Braun of Germany in 1897. His CRT was used by many researchers in the early 1900s to visualize the voltage and current waveforms of discharges.

Many researchers made improvements to CRTs over the decades, but it wasn't until Tektronix invented the Tek 511 oscilloscope in 1946 that oscilloscopes became externally triggered, calibrated, easy-to-use devices for PD research. The Tek 511 could record signals up to 10 MHz, which corresponds to a 30 ns pulse rise time. This led to the belief that PD pulses had rise times of several tens of nanoseconds instead of a few nanoseconds or less as is known today.[1] It was logical that specialized oscilloscopes became incorporated into the first commercial PD instruments.

COMMERCIAL PD MEASUREMENT

Commercial PD measurements in the time domain using an oscilloscope display started in the 1950s with the work of Dr. George Mole of the British Electrical Research Association (ERA). Mole produced a PD measuring system including a 1 nF high-voltage PD coupler, a detection impedance using RC or RLC components, a method of synchronizing the PD to the AC cycle, analog filters, and a display based on a cathode ray tube.[6] A feature of the display was the use of an ellipse (Lissajous figure) to display the 50 or 60-Hz AC waveform. This allowed a single-channel oscilloscope to display the AC

Figure 2: Still-Working Late-1970s ERA Model 3S Manufactured by Robinson Instruments
Photo courtesy Mladen Sasic, Iris Power L.P.

voltage and the PD in a single trace, as well as effectively doubling the sweep time base compared to a conventional horizontal oscilloscope time base. That is, the effective sweep speed was 1 ms/division, instead of 2 ms/division with a conventional 50- or 60-Hz sine wave, enabling the very short-duration PD pulses to be more easily seen compared to the AC cycle. The Mole instrument, and later versions up to the ERA Model 5, were manufactured by Robinson Instruments in England. Figure 2 shows the ERA Model 3 and the AC voltage ellipse on which the detected PD pulses are superimposed.

After the commercial success of the early ERA detectors, many companies around the world made similar devices including Biddle Instruments (now part of Megger) and Hipotronics (now part of Hubbell) in the USA and Tettex Instruments (now part of the Haefley/Pfiffner Group) in Switzerland. This generation of PD detectors worked in what became the IEC 60270 frequency range (up to about 1 MHz). In contrast to RIV methods, these detectors could display PD pulses on an oscilloscope screen with selectable narrowband or wideband frequency ranges. These analog instruments could accommodate a wide variety of coupling capacitors and test object capacitance, usually with various impedance matching units (sometimes referred to as quadrupoles) having different resistance, capacitance, and inductance (if present). The output was an oscilloscope screen as well as a meter that recorded the peak (or quasi-peak) PD magnitude. Permanent recordings of the oscilloscope screen were made with a Polaroidinstant camera, and the magnitude of individual pulses was estimated using a ruler.

In the 1950s, the availability of commercial PD instruments led to an explosion in applications for all types of high-voltage equipment. One of the pioneers of this new era was Prof. Frederik Kreuger of Delft University in the Netherlands. His PhD work led to the 1965 publication of the first English-language book about PD measurements. After a short stint at ASEA in Sweden, Kreuger worked for Dutch cable manufacturer Nederlandse Kabelfabriek for most of his career. Kreuger, who died in 2015, investigated various PD detection methods and their sensitivity, did research on the best PD detection methods for each type of HV equipment (especially power cables), and developed what is now known as the Kreuger PD bridge to suppress disturbances. Reasoning that how quickly PD would cause cable insulation to fail would depend on the number of electrons bombarding the insulation, he explored how to calibrate the detected signals from mV into apparent charge (pC). His work led directly to the development of the first international standard for application to PD measurements: IEC 270, Partial Discharge Measurements, which was superseded by IEC 60270, High-Voltage Test Techniques — Partial Discharge Measurements, in 1968.

Another leading researcher in this era was Dr. Ray Bartnikas. Like Kreuger, Bartnikas began his career with a cable manufacturer, Northern Electric in Canada, before continuing his research into PD measurement at the utility Hydro-Québec's Research Institute (IREQ). Bartnikas investigated optimal methods and limitations for calibrating PD in terms of apparent charge and was key to the effort to develop ASTM D1868, the first American standard on PD detection, in 1973. Bartnikas also edited a book on PD measurement and interpretation,[7] published in 1979, that is still in print. Bartnikas, who died in 2022, was also active in the digital era with the development of PD pulse magnitude analyzers.

The research of Kreuger and Bartnikas, together with the commercial availability of relatively portable PD measuring systems, led to the widespread application of PD measurement in factories for quality assurance testing of HV equipment as well as in research applications. By the end of the 1960s, virtually every manufacturer of HV equipment, plus every high-voltage

 continues from page 41

laboratory, had at least one of these analog detectors. The instrument shown in Figure 2 was owned and used by the former British utility CEGB until Iris Power acquired it in the 1990s for its museum. The oscilloscope screen shows the typical elliptical trace of a 60 Hz sine wave with PD from a superimposed twisted pair of insulated wires.

DIGITAL PD DETECTION

Research into digital techniques to measure PD mainly started with Bartnikas and his pulse magnitude analyzer in 1969.[8] These early digital circuits used discrete transistors to segment the pulse magnitudes into several magnitude bins (or magnitude windows), and then count the number of pulses in each bin over a set time interval. In Figure 3, the output was a two-dimensional plot of pulse magnitude (horizontal scale) vs. a usually logarithmic vertical scale of pulse count rate (number of pulses per second per magnitude window).

Another important step was taken independently in 1976 by Dr. Andreas Kelen of ASEA in Sweden and Professors Austin and James in the UK.[9,10] They combined homemade, pulse-pulse-counting electronics with the digital computers then available to count not only the number of pulses per magnitude window but also the pulses at different parts of the AC cycle. Many such research instruments that could record the number and phase position of the PD pulses were described in the 1980s. In 1988, Bernhard Fruth and colleagues from ABB Corporate Research in Switzerland developed a system called phase-resolved partial-discharge analyzer (PRPDA) using the IEC 60270 frequency range. They were probably the first to use the term.[11] The PRPD plot has now become a quasi-standard two-dimensional color-map display of the three-dimensional matrix of PD pulse magnitude (vertical or y-axis) vs. AC phase position (horizontal or x-axis) vs. pulse count rate (z-axis) represented by changes in pixel color. An example is shown in Figure 4.

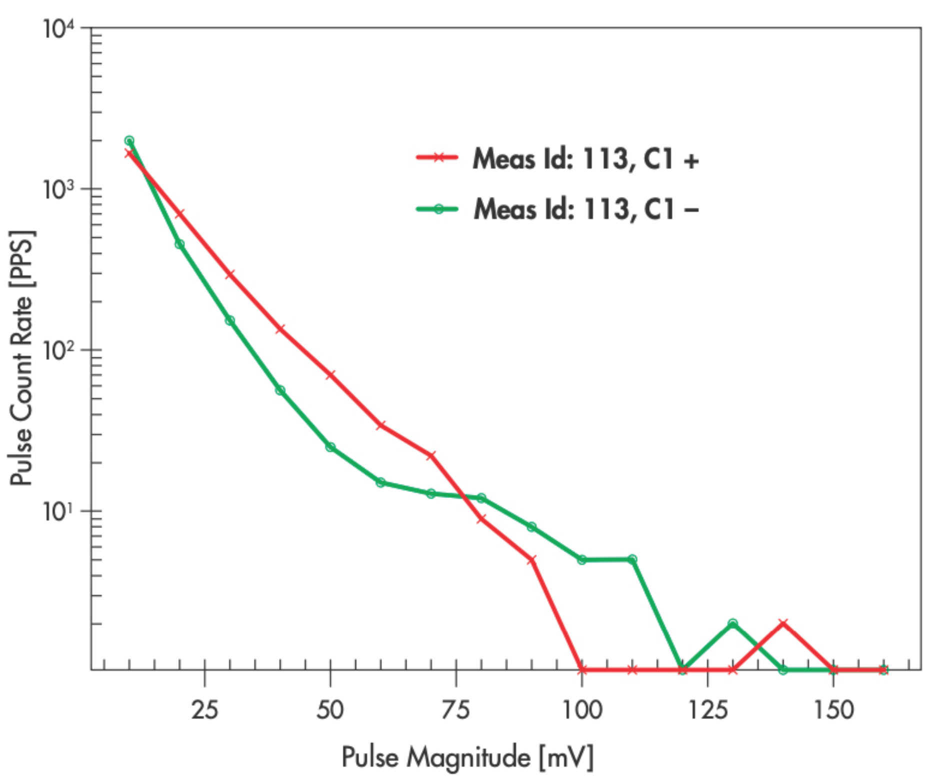


Figure 3: Pulse Magnitude Analysis Plot for Each Polarity of PD Pulses
Photo courtesy Iris Power L.P.

The number of pulses recorded in each magnitude and phase window is shown as a color (the color key is shown on the right). This data was collected by a commercial detector working in the IEC 60270 frequency range (i.e., less than 1 MHz).

One of the first widely used commercial IEC 60270-compliant digital PD instruments was made by Power Diagnostix, which was founded in 1992 by Detlev Gross and Fruth. Fruth used his prototype PRPDA developed at ABB Corporate Research and worked with Detlev Gross, who had started his own electronics company in 1986, to develop the insulation condition monitor (ICM).

After the Power Diagnostix (now part of Megger) ICM instrument was introduced, companies including Hipotronics, Lemke, OMICRON, TechImp, Tettex, and many others introduced similar IEC 60270-compliant instruments using mainly digital technology. G.C. Stone, A. Cavallini, G. Behrmann, and Claudio Angelo Serafino[1] provide further information on some of the methods used by commercial PD instruments to digitally capture and measure PD in the IEC 60270 frequency range. Very few analog PD instruments are currently being used due to the convenience and flexibility of digital PD instruments, as well as their ability to share data files with computers for display and data manipulation.

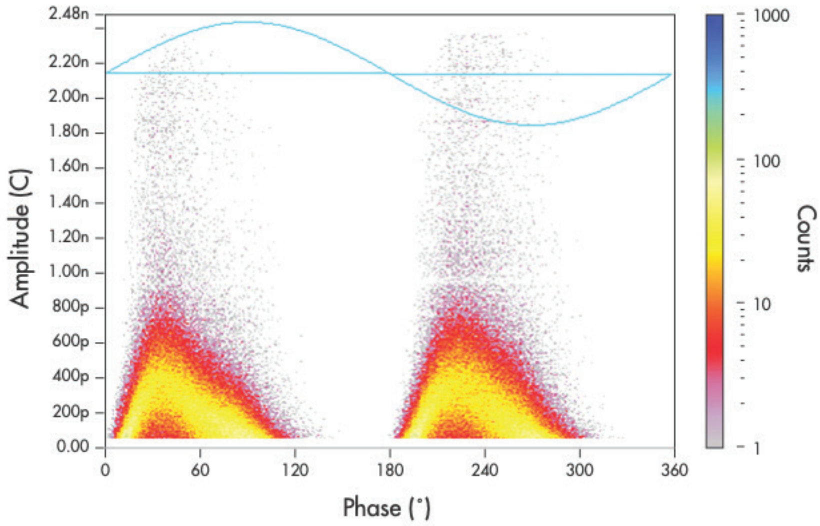


Figure 4: Phase-Resolved PD (PRPD) Plot of PD Magnitude vs. AC Phase Position
Image courtesy of Iris Power L.P.

VHF AND UHF PD DETECTION

The development of better oscilloscopes led to a better understanding of the nature of PD current pulses. Tektronix introduced the Tek 465 scope in 1972. Except for the cathode ray tube (CRT), it was among the first oscilloscopes to use solid-state electronics with a 100-MHz bandwidth. Of special importance for PD measurement was the introduction of a Tek 466 single-shot analog storage oscilloscope in 1972. The Tek 466 had a 100-MHz bandwidth, so it could display a single PD pulse with a rise time as short as about 4 ns.

The development of the analog Tek 7104 oscilloscope in 1978 allowed the PD current pulses to be accurately recorded for the first time since it had a bandwidth of 1 GHz (corresponding to a 0.3 ns rise time), and its microchannel image intensifier plate made clear photographic recordings of single PD current pulses possible for the first time. With each increase in oscilloscope bandwidth up to the 1-GHz range, the rise time of the PD current pulses was found to be shorter than previously believed.

The realization that PD contained frequency components up to 1,000 MHz led many researchers to investigate PD measurement in the VHF (30–300 MHz) and UHF (300–3,000 MHz) frequency ranges. Measuring PD in the higher frequency ranges reduced the risk of false indications from the severe electrical interference that is typically found in on-line PD measurement and directly led to the widespread use of on-line PD measurement in GIS, transformers, and rotating machine stator windings.[1]

The development of 1-GHz oscilloscopes in the late 1970s led to a tremendous amount of work on PD pulse shape. In 1982, the theoretical foundation for PD measurement above the IEC 60270 frequency range was presented by Dr. Steven Boggs, who worked for the utility Ontario Hydro in Canada and continued his research at the University of Connecticut in the USA.[12] Boggs recognized that what he called ultrawide-band (UWB) PD detection with a sensor close to the PD site would have superior ability to suppress interference, especially during on-line PD measurements. He and his colleagues first applied VHF and UHF detection of PD to gas-insulated switchgear (GIS) and rotating machine stator windings. They recorded the pulse shapes from many test objects and defects. These included PD pulses recorded from electric trees growing in epoxy, which had rise times of about 500 ps and a pulse width of 1.5 ns (full width, half maximum).

Boggs used various types of capacitors and antennas to achieve a bandwidth of several hundred MHz in GIS. In 1991, Dr. Brian Hampton and his colleagues at the University of Strathclyde in Scotland published the design of a practical PD sensor for GIS combined with a continuous UHF PD monitoring system. The sensor was a circular plate installed on the inside surface of GIS maintenance hatch covers (inside the GIS enclosure). These acted as near-field antennas to pick up the electric field of the PD pulse as it passed through the coaxial waveguide formed by the GIS. Similar UHF sensors are now widely installed in GIS and large power transformers.

In the late 1970s, Stone (who in 1990 co-founded Iris Power, now part of Qualitrol Corp) and his colleagues at Ontario Hydro Research began measuring PD in the 30–300-MHz range in operating generators.[13] The advantage of the VHF frequency range is that the high-voltage PD couplers could be much smaller (80 pF) and thus fit within the generator frame. The time-of-arrival principle could be used to separate stator PD from power system disturbances using a pair of sensors per phase.[1] In addition, disturbance suppression based on digital rendering of the pulse shape was possible.[14]

 continues from page 43

In the late 1980s, Ross Mackinlay and his colleagues at EA Technologies (originally the Electricity Council Research Centre) in the UK introduced a different type of VHF sensor they called the transient earth voltage (TEV) sensor[15] that detected voltage transients from PD within medium-voltage metal-clad switchgear that would leak out at vents or door edges to create pulses on the outside metal panels enclosing the switchgear. The transient could be detected at a capacitive probe placed against the surface of the switchgear. Together with suitable instrumentation, this technology is now widely applied for on-line PD detection in metal-clad switchgear.

From a commercial point of view, the extension of PD instruments to frequencies higher than 1 MHz (in what is now termed an IEC TS 62478-compliant PD instrument) began in 1986 when FES International (later known as Adwel and now part of Iris Power L.P.) introduced an instrument called the PDA-H to measure PD in operating hydro generators in the VHF range (Figure 5). The PDA-H measured the PD from a pair of permanently installed 80 pF couplers in each phase of an operating hydro generator. The instrument was controlled by an early PC, which also served as the display device.

In 1991, Iris Power introduced the PDA-IV, an all-digital instrument working in the VHF range that separated power system disturbances from stator winding PD on a pulse-by-pulse basis and displayed PRPD plots on a built-in LCD.

A year later, they introduced the TGA-S, which worked in the UHF range with a special electromagnetic coupler called a stator-slot coupler (SSC) installed in hydrogen-cooled turbine generators. A UHF all-digital continuous PD monitor for GIS was introduced by DMS. Now a part of Qualitrol Corp, DMS was founded by John Pearson, Brian Hampton, and Owen Farish of Strathclyde University in 1994, and the PD monitor was based on the technology they developed at the university. This was also the world's first commercial continuous on-line PD monitor.

Today, there are dozens of companies making VHF and UHF PD instruments, most of which are used for on-line PD monitoring.

POST-PROCESSING SIGNALS

Digital PD instruments facilitated an interface to computers, which lead to the development of software tools to analyze PD data. These tools use signal magnitude, phase position, count rate, and applied voltage at the time of the pulse to calculate various indicators of PD activity (quasi-peak magnitude, PD power, PD current, quadratic rate, etc., as outlined in IEC 60270) after the data has been stored in memory. This post-processing can help separate interference pulses from test-object PD pulses and aid in identifying the causes of PD in a test object. This was important since as PD technology spread from research/high-voltage test labs to HV equipment owners and testing service companies, PD test equipment users wanted to be able to interpret PRPD patterns without having to be experienced PD researchers.

Figure 5: First Commercial Digital Instrument Measuring PD in the 30- to 300-MHz Range
Photo courtesy Mladen Sasic, Iris Power L.P.

In 1986, the first notable contribution in post-processing was made by Dr. Tatsuki Okamoto and Dr. Toshikatsu Tanaka of CRIEPI in Japan, who applied statistical analysis of the PD patterns concerning the AC phase angle. A few years later, Prof. Edward Gulski of Delft University also used statistical methods based on normal distribution to analyze PRPD patterns. This work was eventually commercialized in a Haefely PD detection system. Prof. Alfredo Contin (University of Trieste) and Prof. Gian Carlo Montanari (University of Bologna) applied statistical analysis to PRPD pattern analysis using the Weibull probability distribution. In all these early examples, the idea was to classify various PRPD patterns to determine the root cause of the PD. Although such techniques are not widely used today, they were the forerunners of other methods that have gained popularity.

In 2004, Andrea Cavallini and his colleagues at the University of Bologna and the University of Trieste in Italy were likely the first to use non-statistical post-processing methods to separate pulses of different shapes — a key step to suppress disturbances, as well as to identify different types of PD sources (e.g., differentiate void PD from surface PD). They developed what is known as the time-frequency (T-F) map method.[16] Each pulse after A/D conversion was processed into the frequency domain at the same time as an indicator of pulse length was captured. A map was created with two axes (time and frequency) with the transformed pulse shape and frequency of each detected pulse. Cavallini discovered that disturbances and different types of PD sources tended to cluster in different regions of the T-F map. The clusters can be identified by a skilled observer or using specialized pattern-recognition algorithms. In many cases, each cluster had a unique PRPD pattern, and with experience, the patterns could be associated with different defects or disturbance sources. The technology was first applied to power cables and then spread to other types of HV equipment. This post-processing technology led to the founding by Montanari and his colleagues of TechImp (now part of Altanova/Doble).

Another commercial post-processing method was developed by Prof. Ronald Plath, Caspar Steineke, and Harald Emanuel at MTronix (now part of OMICRON). The key feature of this post-processing method is to simultaneously capture the signals from all three phases.[17] The response to an event (a PD pulse or an interference pulse) on all three phases is measured and correlated on a three-dimensional plot of the pulse magnitude in each phase. The 3PARD plot consists of thousands of pulses.

Various types of PD and interference create clusters in different regions of the diagram. As with the T-F method, clusters are identified, and they usually display a unique PRPD pattern that identifies the nature of the interference or PD sources. The method was first applied to off-line power transformer testing (which requires a three-phase test set to energize the transformer), then deployed for on-line transformer monitoring. Most recently, it has been extended to on-line monitoring of stators windings, GIS, and power cables.

continues from page 44

The MTronix device was further specialized by developing band-pass digital filters able to process the PD pulses in real time. By selecting three different filters, maps similar to the 3PARD plot can be achieved, leading to the separation of PD pulses based on their features in the frequency domain.

In addition to these post-processing methods, many other signal-processing methods have been applied, often using various forms of artificial intelligence or fractal analysis. To date, this work is primarily experimental and has not been widely applied in practical PD measurements.

CURRENT DEVELOPMENTS

Although plenty of evolutionary developments are still occurring for on-line PD testing of 50/60-Hz electrical equipment, most of the main innovations today are concerned with measuring PD in HVDC equipment and equipment within or connected to modern inverters.

The HVDC application is due to the widespread installation of long, transmission-class DC power cables for submarine links and offshore wind turbines. PD in DC applications is fundamentally different from that in AC applications since PD occurs infrequently, and of course, it cannot be displayed against the 50/60 Hz (or other AC frequency) in a PRPD plot. Although IEC 60270 does discuss DC PD measurement, there is still no widely adopted method of collecting and analyzing the data. A summary of the current status of PD measurement technology in DC applications can be found in G.C. Stone, et al.[1]

The other very active area for PD detection technology concerns inverters, cables, and motor windings associated with variable-speed drives. Modern drives mainly use voltage source inverters (VSI) that create thousands of short-rise-time voltage impulses per second. Even in relatively low-voltage applications (400 V and above), these voltage impulses are known to cause PD that can lead to rapid failure of switching modules, power cables, and stator windings.[1]

The main technical issue is separating PD from the comparatively very-large switching voltage transients. In the past, VSIs used IGBTs as the switching device, which produced voltage impulses as short as 100 ns or so. Various VHF and UHF electromagnetic antennas were developed to detect PD while suppressing the switching transients. Such couplers have been implemented in modern voltage surge testers made by Schleich and Baker Instruments (now Megger), among others. However, as new switching technologies based on SiC and GaN field-effect transistors are being commercially introduced (especially in VSIs supplying electrical vehicle and aircraft motors), voltage transients have rise times as short as 10 ns or so. This is very close to the rise time (and frequency content) of the PD impulses themselves, making it challenging to extract the PD from the transients.

CONCLUSION

Historical review is always somewhat subjective. However, we have tried to summarize the key technical advances and companies that have pioneered the development of PD measurement technology. This technology is now widely applied for on-site, off-line, and on-line PD measurement. Although PD measurement technology is now advancing at a modest pace in 50/60 Hz applications, rapid developments are expected in high-voltage DC and impulse voltage applications.

This article was adapted from Practical Partial Discharge Measurement on Electrical Equipment, a new book written by the authors and published by Wiley/IEEE Press. We would be grateful to be informed of errors or omissions in this article. wn

REFERENCES

12TH CESA YOUNG PROFESSIONALS SUSTAINABILITY IMBIZO 2024

13-14 AUGUST
PREMIER HOTEL MIDRAND

ONLINE REGISTRATION AND CALL FOR ABSTRACTS IS OPEN!

REGISTER TO ATTEND AND GET 2 CPD POINTS

SUBMIT A 1 PAGE ABSTRACT OF THE TOPIC THAT INTERESTS YOU BY 5 JUNE 2024!

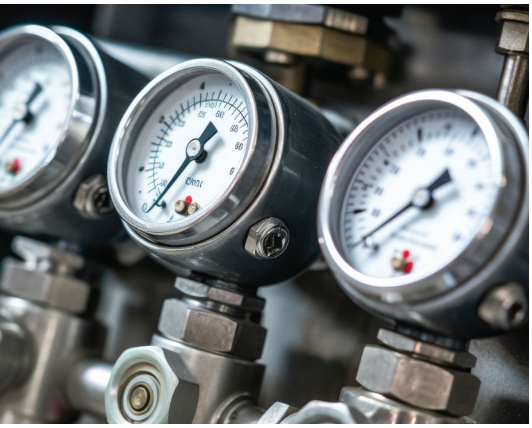
SCAN HERE

FOR MORE INFORMATION, CONTACT BONOLO NKGODI AT **BONOLO@CESA.CO.ZA**

GOLD SPONSORS: Investec ZUTARI IMPACT. ENGINEERED. AON

Air Compressor Technology Innovations

- STAYING AHEAD IN A COMPETITIVE MARKET



In the highly competitive world of industrial manufacturing, innovation is key to staying ahead. For any air compressor manufacturer, this means constantly evolving and improving their products to meet the ever-changing demands of the market. From energy efficiency and sustainability to smart controls and noise reduction, the latest innovations in air compressor technology are transforming the industry.

This article will delve into these advancements, exploring their impact on various industries, the leading manufacturers driving these changes, and the challenges and opportunities they present.

Air compressors, a staple in numerous industries from manufacturing to healthcare, have undergone significant technological advancements over the years. The push for more efficient, reliable, and environmentally friendly equipment has led to breakthrough innovations that not only enhance performance but also contribute to global sustainability goals.

As we delve deeper into each aspect, we'll explore how these innovations are shaping the competitive landscape and what it means for manufacturers, end-users, and the industry as a whole.

OVERVIEW OF AIR COMPRESSOR TECHNOLOGY

TYPES OF AIR COMPRESSORS AND THEIR APPLICATIONS

Air compressors come in various types, each suited to specific applications. Reciprocating air compressors, for instance, are ideal for intermittent use in small-scale operations, while rotary screw compressors are used for continuous, large-scale operations due to their high efficiency and reliability. Centrifugal compressors, on the other hand, are used in high-speed applications like turbochargers and chillers. Understanding the different types of air compressors and their applications is crucial for manufacturers and end-users alike, as it informs design choices and purchase decisions.

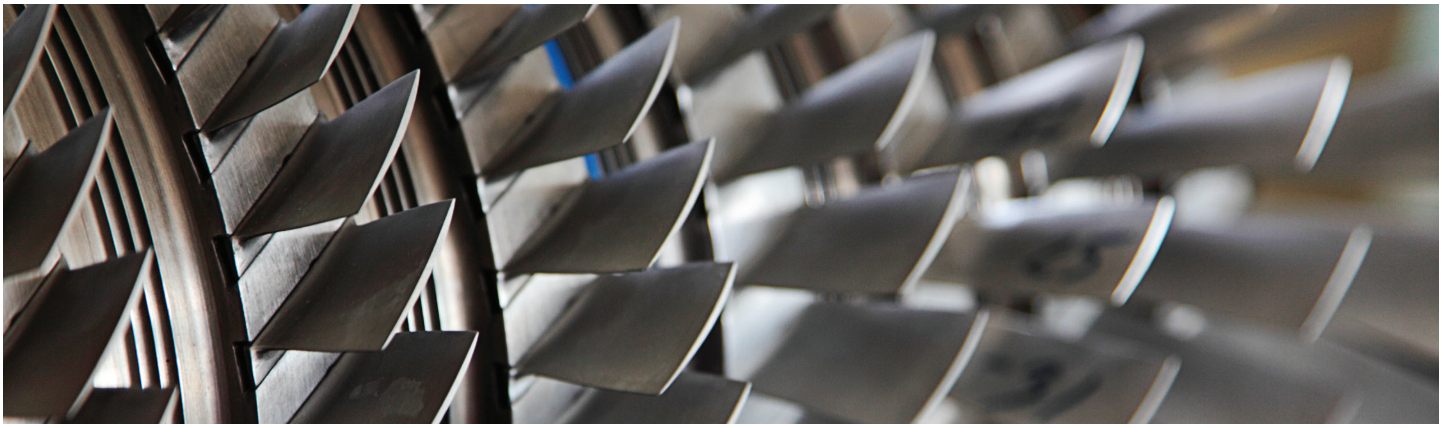
HISTORICAL DEVELOPMENT AND EVOLUTION

The history of air compressors dates back to the industrial revolution when they were first used to power pneumatic tools and machinery. Over the years, advancements in technology have led to improvements in efficiency, reliability, and performance. For instance, the introduction of electric motors in the late 19th century replaced steam as the primary power source, significantly enhancing efficiency. More recently, the advent of digital technology has enabled features like automation and real-time monitoring, further improving performance and ease of use.

IMPORTANCE IN VARIOUS INDUSTRIES

Air compressors play a critical role in various industries. In manufacturing, they're used to power pneumatic tools, operate machinery, and perform quality control tests. In the healthcare industry, they supply compressed air for medical equipment and drive surgical tools.

The food processing industry uses air compressors for tasks like product handling, packaging, and bottling. Given their wide range of applications, advancements in air compressor technology can have far-reaching implications across multiple sectors.



LATEST INNOVATIONS IN AIR COMPRESSOR TECHNOLOGY

ENERGY EFFICIENCY AND SUSTAINABILITY

Energy efficiency is a major focus in air compressor technology innovations. Manufacturers are developing models that consume less energy, thereby reducing operational costs and environmental impact.For example, variable speed drives (VSD) adjust the motor speed according to air demand, significantly reducing energy consumption during periods of low demand. Additionally, heat recovery systems capture waste heat generated during compression and reuse it for space or water heating, further enhancing overall energy efficiency.

SMART CONTROLS AND AUTOMATION

Smart controls and automation are transforming the way air compressors operate. Intelligent control systems can monitor and adjust compressor operation in real time based on various parameters, optimizing performance and energy efficiency. For instance, predictive maintenance algorithms can detect potential issues before they lead to breakdowns, minimizing downtime and repair costs. Furthermore, integration with Internet of Things (IoT) technology enables remote monitoring and control, adding a layer of convenience for users.

NOISE REDUCTION & SILENT OPERATION

Noise pollution is a significant concern in many industrial environments. Recognizing this, manufacturers are developing air compressors with noise-reduction features for silent operation. These include sound-proof enclosures, anti-vibration mounts, and low-noise fans. Some models even incorporate innovative design elements to reduce noise at the source. For example, scroll compressors, with their quiet, smooth operation, are increasingly being chosen for applications where noise levels need to be kept to a minimum, such as in medical or dental offices.

LEADING MANUFACTURERS AND THEIR CONTRIBUTIONS

PROFILES OF TOP AIR COMPRESSOR MANUFACTURERS IN CHINA

China is home to several leading manufacturers of air compressors, including Kaishan Compressor, Guangdong Baldor-tech Co., Ltd., and Zhejiang Kaishan Compressor Co., Ltd. These companies have made significant contributions to air compressor technology, with innovative products that push the boundaries of efficiency, reliability, and performance. Their commitment to research and development, coupled with their understanding of market needs, has positioned them as leaders in the industry.

BREAKTHROUGH PRODUCTS & TECHNOLOGIES

Leading air compressor manufacturers have introduced several breakthrough products and technologies. For instance, Atlas Copco's GA VSD+ range of compressors integrates variable speed drive technology, advanced motor design, and intelligent control systems to deliver exceptional energy efficiency. Similarly, Kaishan Compressor's KRSP series features a two-stage compression design and high-efficiency motors for superior performance and energy savings.

COLLABORATION WITH RESEARCH INSTITUTIONS AND UNIVERSITIES

Collaboration with research institutions and universities is another strategy employed by leading manufacturers to drive innovation. These partnerships facilitate knowledge exchange and provide access to cutting-edge research, enabling manufacturers to stay ahead of technological trends. For example, Ingersoll Rand collaborated with the University of Minnesota to develop a new type of compressor that uses shape memory alloys, potentially revolutionizing the industry.

IMPACT OF TECHNOLOGY ON MARKET COMPETITION

DIFFERENTIATION THROUGH INNOVATION

Innovation is a key differentiator in the competitive air compressor market.

Manufacturers who continually invest in R&D and introduce innovative products can set themselves apart from their competitors. By offering features that enhance performance, increase efficiency, reduce noise, and improve user experience, they can attract more

continues from page 49

customers and gain a larger market share. For instance, Atlas Copco's GA VSD+ range of compressors, with their exceptional energy efficiency and smart controls, have been highly successful in the market, setting a new standard in the industry.

MARKET SHARE AND COMPETITIVE POSITIONING

Technology also plays a significant role in market share and competitive positioning. Manufacturers who lead in technological innovation often command a larger market share and enjoy a stronger competitive position. For example, Kaishan Compressor, with its innovative KRSP series and commitment to sustainability, has established itself as a leader in the Chinese air compressor market.

CHALLENGES AND OPPORTUNITIES FOR NEW ENTRANTS

For new entrants, the highly competitive and technology-driven nature of the air compressor market presents both challenges and opportunities. On one hand, the high level of technological sophistication and the presence of established players can make it difficult to break into the market. On the other hand, there are opportunities for those who can bring fresh ideas and disruptive technologies. For instance, a startup that develops a radically more efficient compressor or a novel noise reduction technology could carve out a niche for itself in the market.

REGULATORY COMPLIANCE AND STANDARDS

SAFETY REGULATIONS AND CERTIFICATIONS

Safety is a paramount concern in the design and operation of air compressors. Manufacturers must comply with a range of safety regulations and obtain necessary certifications. These may include pressure equipment directives, machine safety standards, and electrical safety standards. Compliance not only ensures the safety of the product but also enhances its credibility in the market.

ENVIRONMENTAL COMPLIANCE AND GREEN TECHNOLOGIES

Environmental compliance is another key consideration for air compressor manufacturers. Regulations pertaining to energy efficiency, greenhouse gas emissions, and waste disposal must be adhered to. To this end, manufacturers are investing in green technologies, such as energy-efficient designs, heat recovery systems, and eco-friendly refrigerants. Some are also adopting sustainable manufacturing practices, such as recycling and waste minimization, to further reduce their environmental impact.

QUALITY ASSURANCE & INDUSTRY STANDARDS

Quality assurance and adherence to industry standards are vital in maintaining the reliability and performance of air compressors. Manufacturers often follow standards set by organizations like the International Organization for Standardization (ISO) to ensure the quality of their products. These standards cover various aspects, from design and manufacturing processes to testing and performance evaluation. Compliance with these standards can enhance customer confidence and boost sales.

STRATEGIES FOR STAYING AHEAD IN THE MARKET

INVESTING IN RESEARCH AND DEVELOPMENT

Investing in research and development is a crucial strategy for staying ahead in the air compressor market. It enables manufacturers to develop new technologies, improve existing products, and anticipate future trends. For instance, Kaishan Compressor invests heavily in R&D, with a dedicated team of researchers working on projects ranging from energy efficiency to noise reduction. This commitment to innovation has helped the company maintain its leadership position in the market.

BUILDING PARTNERSHIPS & COLLABORATIONS

Building partnerships and collaborations is another effective strategy. By collaborating with suppliers, customers, research institutions, and even competitors, manufacturers can gain new insights, access advanced technologies, and expand their market reach. For example, Ingersoll Rand's collaboration with the University of Minnesota has led to the development of a new type of compressor that could revolutionize the industry.

UNDERSTANDING CUSTOMER NEEDS AND PREFERENCES

Understanding customer needs and preferences is essential for developing products that resonate with the market. This involves conducting market research, soliciting customer feedback, and staying attuned to industry trends. By aligning their product development efforts with customer needs, manufacturers can create products that not only meet but exceed customer expectations.

BENEFITS AND CHALLENGES OF TECHNOLOGICAL INNOVATION

ENHANCING PERFORMANCE AND RELIABILITY

Technological innovation can significantly enhance the performance and reliability of air compressors. Innovations like variable speed drives, advanced cooling systems, and smart controls can improve efficiency, reduce energy consumption, and minimize downtime. However, implementing these technologies can be challenging, requiring technical expertise and a deep understanding of compressor operation.

REDUCING COSTS AND IMPROVING ROI

By improving energy efficiency, technological innovation can help reduce operating costs and improve return on investment (ROI). For instance, an energy-efficient air compressor can lower energy bills, while smart controls can prevent costly breakdowns through predictive maintenance. However, these technologies often come with a higher upfront cost, and businesses need to consider the total cost of ownership when making purchase decisions.

NAVIGATING INTELLECTUAL PROPERTY & PATENTS

Technological innovation often involves navigating intellectual property and patent issues. Manufacturers need to ensure that their innovations do not infringe on existing patents, which requires thorough patent research and legal expertise. On the other hand, securing patents for their own innovations can protect them from competition and potentially open up new revenue streams through licensing.

SUSTAINABILITY AND ECO-FRIENDLY INNOVATIONS

GREEN TECHNOLOGIES AND RENEWABLE ENERGY INTEGRATION

With growing concern over climate change and environmental degradation, sustainability has become a key focus in air compressor technology.

Manufacturers are developing green technologies, such as energy-efficient designs and heat recovery systems, to reduce their products' environmental impact. Some are even exploring the integration of renewable energy sources, such as solar or wind power, into their compressors.

LIFECYCLE ANALYSIS AND RESPONSIBLE MANUFACTURING

Lifecycle analysis and responsible manufacturing are also important aspects of sustainability. Manufacturers are increasingly considering the entire lifecycle of their products, from raw material extraction to end-of-life disposal, and striving to minimize their environmental impact at each stage.

This involves using recyclable materials, reducing waste during manufacturing, and designing products for easy disassembly and recycling.

CONTRIBUTION TO GLOBAL SUSTAINABILITY GOALS

By adopting sustainable technologies and practices, air compressor manufacturers can contribute to global sustainability goals. For instance, energy-efficient air compressors can help reduce greenhouse gas emissions, contributing to the goal of mitigating climate change. Similarly, responsible manufacturing practices can help conserve resources and reduce waste, aligning with the goals of sustainable production and consumption.

PIONEERING THE FUTURE OF AIR COMPRESSORS

Technological innovation is reshaping the air compressor industry, driving improvements in performance, efficiency, and sustainability.

While these advancements present challenges, they also offer exciting opportunities for manufacturers willing to embrace change and stay ahead of the curve. As we move forward, it will be interesting to see how these trends evolve and what new innovations lie on the horizon. wn

© Article courtesy of Diversitech Global

Sustainable Electricity Generation

"When it comes to creating a more sustainable planet, the need for renewable energy can't replace the need for safe energy. With nuclear power, you get the best of both worlds." Westinghouse Nuclear Electric

By: Fred Catlow MSc, FIEE, FSAIEE

Sustainability is one of the most commonly used words of the twenty-first century. Generally, if something is sustainable, it can keep going continually, it is viable, and it is fit for purpose. Above all, it is reliable, dependable, and can be trusted. In sports, sustainability is defined as stamina, effort or staying power. When it comes to other forms of energy, the Sun comes to mind as a sustainable source of energy, but because of the rotation of the Earth and the influence of the atmosphere above it, no place on Earth can be described as possessing sustainable solar energy since it is inconsistent, it is intermittent and varying in intensity.

Wind energy definitely cannot be described as sustainable by any stretch of the imagination. One only needs to watch a child's windmill on the beach to realise how the wind fluctuates randomly in direction, and its intensity can vary between zero and hurricane force. A power wind turbine is not a child's toy and has mechanisms to compensate for the yaw, but whilst it may endeavour to maximise the energy intake that it receives, it has no more control over it than the child's windmill on the beach, simply because the source of the energy is not inherent in the turbine, which is only a converter from one form of energy to another and the output is dependent on the weather, which is randomly variable (i.e., the external force of the wind is subject to the temperature, pressure and composition of the atmosphere and in particular to the water vapour content of the atmosphere).

When we refer to electricity, sustainability can be interpreted as security of supply. Under such a criteria, coal and other 'fossil fuels' such as oil and natural gas, on which people have been dependent for many years, could definitely be included. Currently (2022), fossil fuels contribute well over half of total global consumption, although attempts exist to replace them with other sources. It will not happen quickly and will take many years.

One of the meanings of sustainable is 'endurable' or 'to endure', and this can be extrapolated to give a wider sense of the employment of long-lasting technologies and methods for human survival on earth, hence expanded definitions, such as the three pillars theory; of social, economic and environmental factors, claim that sustainability is a social goal for people to live together. This has been developed further by the United Nations (Department of Economic and Social Affairs, Sustainable Development) into seventeen criteria, many of which are subjective and appear to have little relevance to dependable electricity, although one (#7), in particular, refers to 'Affordable Clean Energy'[1]. By implication, they eliminate fossil fuels, which are not only considered exhaustible (as opposed to renewable) but to be neither socially nor environmentally acceptable.

This leaves nuclear power as the only energy source capable of satisfying the future's electricity needs in a sustainable and eco-friendly manner[2].

Commercial nuclear energy for has been in use since the 1950s[3] and was encouraged by President Eisenhower in his "Atoms for Peace" address to the United Nations in 1953. Although there may have been some setbacks, nuclear power has been a reality for more than 70 years and has by and large fulfilled its promise, however its rapid growth in the late 1960s and 70s was brought almost to a standstill due to bad publicity and misleading information fomented by: 'environmental activists'; the sensational science fiction movie "The China Syndrome" released in 1979; ignorance and the Three Mile Accident (TMI-2) in the USA in 1979. Nuclear energy has been proven for over 70 years to be safe and reliable. The nuclear industry has had fewer deaths or injuries than almost any other human activity. That is despite major accidents at Three Mile Island (TMI-2) in 1979; Chernobyl Unit 4 in 1986 and Fukushima Daiichi units 1, 3 & 4 in 2011. Nuclear energy is a natural phenomenon that we have been living with since the world began, and we need to understand that. It offers enormous benefits for the future of life on Earth and humankind. It is only a hideous monster when men make it so.

Two of the major concerns are the proliferation of dangerous radioactive materials and nuclear waste. The safe management of nuclear materials, including nuclear waste, is governed by regulations and the relevant Regulatory Authority; when these are followed, there is little danger. However, as in the case of knife crime, if there is abuse, it should be a criminal matter, wherever in the world it occurs[4]. Countries must be meticulous in their handling of nuclear materials. It is the responsibility of the International Atomic Energy Association (IAEA) to police and report any misconduct by license holders and, if necessary, to revoke their licence[5].

NUCLEAR ENERGY

Science tells us that according to the 'Big Bang Theory,' the four fundamental forces of nature: the strong nuclear force, the weak nuclear force, electromagnetism and gravity existed 14 billion years ago at the start. At the end of the Planck Epoch, gravity separated to leave the electro-nuclear force. This fundamental force is present in all matter[6] and is an inexhaustible supply of energy which is common to the entire Universe. Thanks to John Dalton and his "Atomic Theory", we know that all matter is made up of fundamental particles which combine in different configurations to give each element (of substances) its own characteristics, which are unique to each and different from every other.

Some of these elements are 'top heavy' and are unstable and disintegrate naturally without any prompting. Under certain conditions, energy can be released by combining (fusing) light elements into heavier ones as far as the element 'iron' or by separating (fissioning) heavier elements into lighter ones – up to iron. Electricity generation is achieved through the heat energy released from fission (and eventually

 continues from page 53

fusion) of radioisotopes. Nuclear energy is fundamental to nature's forces and inherent to life on Earth.

NUCLEAR FISSION

Fission is a process which occurs naturally on Earth. It is a process in which unstable heavy radioactive elements randomly disintegrate over time, transforming themselves into other lighter, more stable elements by randomly emitting particles and generating heat in the process. This occurs within the Earth and heats hot springs and health spas at various locations. However, to make commercial use of the process, apart from where geothermal energy is viable, the natural rate of fissioning must be accelerated through a controlled 'chain reaction' which is started by 'bombarding' the radioactive element ('fuel') with neutrons so that a continuous, and dependable source of heat is produced at a uniform and consistent temperature which can be controlled as required. The amount of heat generated over time (kWh/ MWh) is determined by the reactor's design and the fuel choice. Currently, most, if not all, the operational reactors utilise the element uranium as a fuel. There is sufficient fissionable uranium on earth and in the sea to last for the foreseeable future, especially if we recycle and reuse[7] that which has already been deployed (since only 5% of the fuel is used before refuelling is necessary) or convert non-fissionable uranium 238 into fissionable plutonium 239. Moreover, an inexhaustible supply of potential alternative nuclear fuels (e.g., thorium) exists should the need arise, not only on Earth but also in the universe.

New radioisotopes are being constantly created, a process that will continue for billions of years.

NUCLEAR FUEL

The fuel most commonly used is uranium oxide. Uranium occurs naturally on Earth mainly as two different isotopes in proportion: 99.28% non-fissionable U-238 and 0.71% fissionable U-235. Natural uranium has been deployed in some reactors, such as the British Magnox and the CANDU (Canadian Deuterium Uranium).

Both these reactors have some disadvantages. The most popular reactor design at present is the PWR (Pressurized Water Reactor) which uses cheaper natural water both as a reactor coolant and moderator[8] (as does the Boiling Water Reactor) but which requires the fuel to be enriched to between 3% - 5% U-235 to sustain a chain reaction since natural uranium cannot supply sufficient neutrons to overcome the neutron absorbing properties of the water. When fission occurs, the uranium splits into other elements, such as barium and krypton, emitting two or three neutrons in the process. These strike other uranium atoms, which become unstable and split, creating a sustainable 'chain reaction.' If too many neutrons are absorbed by non-fissionable substances, a chain reaction cannot be established or maintained; if, on the other hand, the rate of fission becomes too great, the process is controlled by inserting neutron-absorbing control rods into the reactor or by regulating the boron[9] concentration in the cooling water. During the fission process, 'poisons' such as xenon and samarium are produced, which are high absorbers of neutrons and can bring the chain reaction to a halt. When there is sufficient impurities/'poisons' build up, the chain reaction cannot continue; the fuel is regarded as 'spent' and must be replaced by fresh fuel.

On a PWR (Pressurized Water Reactor), one-third of the fuel is replaced approximately once every 18 months. In general, the higher the enrichment, the longer the interval between fuel replacement, although there is a 'trade-off' since enriched fuel costs more. Fuel for commercial use can legally only be enriched to a maximum allowable of 20%.

NUCLEAR FUSION

Fusion is the opposite of fission, combining lighter elements such as hydrogen and helium to fuse into heavier elements and release heat. Fusion takes place in the stars to produce enormous quantities of heat. Our local star, the Sun, radiates light and heat to keep the Earth and other planets in the Solar System warmer than they would be otherwise.

The Sun also emits harmful radiation, most of which is absorbed by the Earth's atmosphere and the Earth's magnetic shield. However, there is background radiation to which everyone is subjected; this increases with height above sea level and location since radiation from the Sun and space is also enhanced by radiation within the Earth, such as radon emission (from the ground).

Commercial use of nuclear fusion is not possible at present, but research projects producing encouraging results are raising hopes that it will be developed for future use.

CURRENT SITUATION

Before embarking on the subject of distributed small modular reactors (SMRs), I wish to review the current situation in the world.

According to the World Nuclear Association, there were 437 operable reactors in the world at the end of 2022;

not all of these reactors generated electricity as a number were shut down at various times for maintenance, refuelling or other reasons[10]. These were capable of delivering 394 GW(e) (Giga; 10^9=one thousand million; watts of electricity) from 32 different countries which comprise approximately 10% of global electricity (many of these reactors are providing up to and more than 100% of their rated capacity). All plants' average capacity factor (see below) is approximately 80%. The figure for North America is more than 90%.

More than 70% of the world's reactors are of the PWR Light Water type produced by different suppliers in various countries. Approximately 12% are Boiling Water Reactors, BWR LW type. Some others are British Advanced Gas-Cooled Reactors (AGR) and the Canadian CANDU heavy water reactor.

62 new reactors are planned or under construction in 17 countries, three of which, Bangladesh, Egypt and Turkey, have never had nuclear power previously. These will contribute a further 65 GWe, bringing the total (assuming there are no shutdowns) to 459 GWe. Germany[11] and California appear to be the exceptions and would prefer to close their existing nuclear plants, they are in the minority as many countries, after due deliberation, have chosen nuclear over other forms of generation. Under the auspices of the IAEA, the first-ever Nuclear Energy Summit was held in Brussels on 21 March 2024 following the acceptance of nuclear as a 'green' energy at the 2023 COP28 UN Climate Change Summit in Dubai regarding the key role of nuclear in promoting sustainable development.

SAFETY

Early Generation I and II nuclear power units, whilst proving to be safe, are

not very forgiving and do not tolerate 'fools' gladly, but if they are operated in accordance with accepted procedures by competent, skilled, well-trained operators, they are extremely safe. "As of 2003, and since the first US nuclear-powered submarine (USS Nautilus), the United States Navy had logged over 6,200 "reactor years" with no radiological accidents".

Unfortunately, commercial operations are not the same as military ones. Private companies exist to make a profit and sometimes 'cut corners' (unless the law forbids it) since they are in competition and will not spend money unnecessarily. This often means cutting staff to a minimum and not training them adequately. Moreover, personnel work to union rules and keep to the allotted time for which they are paid, even if a job is not finished and left in an unsatisfactory state at the end of a shift. Under these circumstances, safety is sometimes compromised.

Three Mile Island Unit 2 (28 March 1979): The first major nuclear accident to occur in the United States was at Three Mile Island Unit-2, near Harrisburg, Pennsylvania, in March 1979. Near panic was aroused by the accident, which was exacerbated because a scary science fiction film, "The China Syndrome", was being shown at cinemas then. The film portrayed what could happen if a major 'loss of coolant accident' (LOCA) took place at a nuclear power station. The film was a typical 'blockbuster' and was suitably spun in drama and sensationalism to arouse emotions, especially fear.

The Kemeny Commission was set up by President Carter to analyse the accident. The Commission's main recommendations were that the control

 continues from page 55

room design and layout needed to be overhauled and enhanced and better monitoring systems should be introduced; operating, maintenance and test procedure standards were introduced, and operator training was improved. It was made mandatory that operators would be trained on plant simulators in the future, which would include all known accident scenarios and were to be tested by competent trainers.

An organisation called "Institute of Nuclear Power Operations" (INPO) was created, and as a result, the performance of nuclear power plants steadily improved from the 60% - 70% capacity factor in the 1970s to better than 90% in the 1980s and 1990s. This meant that there were fewer outages. Thus, despite the additional training costs, plants were operated more efficiently and because of the higher output for the same operating costs, power plants became safer and more profitable as a result of the improved performance.

Chernobyl Unit 4 (26 April 1986): The amazing thing about Chernobyl is that inadequately trained operators were instructed to perform a low power experiment on unit 4, a live plant, at night when the demand was low. They were unable to take the plant down to the desired levels as instructed and disconnected emergency safety features in the process in an attempt to reach their objective.

They lost control of the reactor and as the reactor got hotter there was a steam explosion which destroyed the plant.

Contrary to what some might think, the explosion that occurred was a steam explosion not nuclear, which is impossible on a commercial power station. Apart from the fact that the operators were not competent, one of the major problems was the design of the reactor, a Russian RBMK which lacked a building to contain the radioactive gases released. Another major omission was that the local population had not been supplied with iodide tablets to protect them against the effects of radiation.

Fukushima Daiichi Units 1-4 (11 March 2011): The accident at Fukushima was indirectly caused by a natural event, the "Great Töhoku Earthquake and Tsunami". However, nuclear power plants are designed to cope with natural events (and deliberate attacks). It could be argued that Tokyo Electric Power Company (TEPCO) was remiss in that the plant had first been commissioned in 1971 and it had been proposed that a re-examination of the design parameters and safety based on estimated worst case earthquakes and tsunamis should be undertaken. Whilst there were suggestions that the sea defences at Fukushima should have been strengthened to cope with such an event, the main problem was the failure to keep the (BWR) reactor cool after it was shutdown. The coolant pumps were not available due to loss of off-site power and flooding of the emergency diesel generators.

In the three major accidents that have occurred, human factors have played a major part. Engineers have subsequently developed improved simplified designs to produce reactors that are fail safe and near 'foolproof'. Emergency Safety Systems which are reliant on pumps have been eliminated as far as possible so that residual reactor cooling is performed by passive systems. Involvement by operators in accident situations has been reduced to a minimum so that plant can be 'walk away'. It is better to devote time by many heads in a quiet stress-free office environment to anticipate and plan for emergency situations before they occur than by one person under the high pressure to make 'on the spot' decisions in a critical situation. However, it is as well to remember that whilst there have been three major accidents over a span of 32 years, hundreds, in fact more than 99% of nuclear power plants have been performing satisfactorily day after day for 40 years or more until they were eventually retired of old age.

Generation I: Most, if not all, of the Gen I reactors, such as the British Magnox, the early CANDU, the Russian RBMK and the earlier versions of the Westinghouse PWR and the GE BWR- 1, have now been retired and taken out of service.

Generation II: Most of the reactors currently in use are Gen II and are generally more advanced versions of the originals, e.g., WH-3LP; three loops of approximately 300 MWe make up a total output per unit of approximately 900 MWe. With design advancements, many of those in operation have been made up to 1,000 MWe and more. Furthermore, as many of the hundred or so operating reactors in the United States were coming to the end of their 40-year life span, their owners applied for a 20-year extension to 60 years and more with suitable upgrades where necessary, especially as the alternative appeared to be costly decommissioning without any compensating income.

Generation III: After the accident at Three Mile Island Unit 2, and in line with the recommendations of the Kemeny Commission, which deliberated for a period of ten years or more, reactor suppliers embarked on new designs to eliminate the 'human factor'[12] and promote reactors that could fail-safe without having to start pumps or other devices as far as possible. They turned their attention to simplifying their designs as far as possible.

Advanced Reactors – Third Generation reactors have:

- a standardised design for each type to expedite licensing, reduce capital cost and reduce construction time,
- a simpler and more rugged design, making them easier to operate and less vulnerable to operational upsets,
- higher availability and longer operating life - typically 60 years,
- reduced possibility of core melt accidents,
- minimal effect on the environment,
- higher burn-up to reduce fuel use and the amount of waste,
- burnable absorbers ("poisons") to extend fuel life.

Generation IV: Gen IV reactors are intended to advance Gen III reactors. Six designs have been selected by the Generation IV International Forum (GIF), which represent advances in sustainability, safety, economics, reliability and proliferation resistance.

These will undoubtedly include small modular reactors, SMRs, and innovative high-temperature / fast reactors.

China claims to have the world's first Gen IV SMR, the HTR-PM, a 250MWt high-temperature gas-cooled pebble bed reactor, which went into commercial operation in late 2023.

PRODUCTIVITY

As mentioned previously, with better operator training and improved plant monitoring systems, the plant capacity factor rose from about 70% to better than 99% on some plants. Statistics for 2022 show that nuclear plants worldwide contributed 2,632.03 TWh of electricity from 392GWe of installed

capacity. This compares with 2,098.46 TWh of electricity from 906 GWe of installed wind capacity and 10,212.22 TWh from 2041 GW of installed coal capacity; 6,443.6 TWh from 1,950 GW of installed capacity for gas; 4,288.59 TWh from 1,560 of installed capacity. This shows that for every gigawatt of installed capacity: nuclear produced 6.71 TWh; coal 5.00 TWh; gas 3.30 TWh; 2.74 TWh and wind 2.31 TWh. Nuclear, like for like, generated three times more electricity than wind. The installed capacity for coal is based only on the first top countries, so the final figure for productivity could be slightly worse.

However, this clearly illustrates that nuclear power is more productive. It is unclear if the production costs are better as this depends on the cost per unit. Nuclear power stations have a bad reputation for being expensive to build and subject to delays and cost overruns[13]. However, they are cheaper to run once operational with low fuel, maintenance and operating costs. The longer the lifetime of the plant, the cheaper it becomes since, unlike wind and solar, they are relatively inexpensive to maintain[14] and fuel.

ENERGY DENSITY

Energy Density may be defined as the energy per unit volume of a particular fuel. Since nuclear has a higher energy density than other fuel types, it not only means that nuclear is more effective and can produce more electricity, nuclear plants can occupy less space, and therefore, the global electricity demand can be met using less of the Earth's surface. In contrast, hydro, solar and wind are land 'hungry' and occupy large areas of land and coast, making them unsustainable. Because they will not be available to generate electricity on demand at all times, they

 continues from page 57

require 'backup' from other sources and therefore need expensive extensions to the grid. They can never be sustainable.

Nuclear generators do not require extensions to the transmission system and can operate 'off-grid' like nuclear submarines. A submarine reactor, with all its auxiliary systems, could be accommodated in a small to medium house or other building; a large 1,000 MW reactor, plus auxiliaries in a shopping centre, Most of the space would be occupied by the auxiliary systems such as the cooling system, pumps, heat exchangers (steam generators) safety systems etc., and because of that, despite the superior energy density would occupy a similar land area, notwithstanding exclusion zones, to a coal or gas-fired station, although, coal stations require a very large amount of space for ash and coal dumps.

According to IAEA Infographics, the energy that can be derived from 1.1 kg of uranium is equivalent to 87,975 kg of coal or 47,110 kg of natural gas. This makes renewable power sources look incredibly expensive even though large nuclear power plants are capital-intensive.

AVAILABILITY, RELIABILITY & CAPACITY FACTOR

Availability (A) is defined as:

"The degree to which a system, subsystem or equipment is in a specified operable and committable state at the start of a mission, when the mission is called for at an unknown, i.e. a random, time."

It can be expressed as is a ratio of the expected value of the uptime of a system to the aggregate of the expected values (E) of up and down time (that results in the "total amount of time" (t) of the observation window). See Figure 1.

The Availability Factor is defined as the amount of time that a power plant can produce electricity over a certain period divided by the period's length.

The IAEA tabulates the Energy Availability Factor for all operating plants in different countries over a period of three years 2020 – 2022. The USA has the top availability with an average of 92.8% (93.1% for 2022 from 95 reactors); other countries above 90% are China, Finland, Germany, Netherlands. Romania, Slovakia, Slovenia.

The Capacity Factor is frequently less than the Availability Factor since the plant is often run at less than full capacity, i.e., when the demand is low. However, it is a good measure of the plant's performance over a continuous period of time, normally a year. See Figure 2.

The average capacity factor for vaious types of plants for the year 2018 is given as follows:

Nuclear	92.6%
Geothermal	77.3%
Gas	73.3%
Coal	54.0%
Biomass	49.3%
Hydro	42.8%
Wind	37.4%
Solar (PV)	26.1%
Solar (CSP)	23.6%

$$Availabiliy\,(A) = \frac{(E[uptime])}{(E[uptime] + E[Downtime])} = \frac{(E[uptime])}{t}$$

Availability (A) can also be expressed as a ratio of Mean Time To Failure (MTTF); mean Time to Repair (MTTR) and Mean Time Between Failure (MTBF)

$$Availability\,(A) = \frac{(MTTF)}{(MTTF + MTTR)} = \frac{MTTF}{MTBF}$$

Figure 1

$$Capacity\ Factor = \frac{(Electricity\ ,\ MWh\ that\ was\ generated\ )}{(Electricity\ that\ could\ have\ been\ generated\ ,\ Plant\ rated\ Capacity)}\ x\,100\quad\%$$

Figure 2

These values have probably changed since then, in particular wind is likely to have changed slightly with taller, larger turbines and solar (CSP) may have changed significantly through use of salts combined with battery storage. Nuclear may also have increased.

Reliability (R) is the probability that an item will operate satisfactorily at a given point in time when used under stated conditions in an ideal support environment.

In order to achieve as high a probability as possible the nuclear industry has taken the following steps:

- Sound plant and system design incorporating 'Design in Depth Philosophy' (not the same as redundant systems);
- Use of FME(C)A[15] and FTA[16] tecniques in plant design;
- Components tested to military standard MIL-STD-810;
- Redundant essential sub-systems, e.g., numerous safety trains using voting systems;
- Reliability centered maintenance techniques;
- Human factors engineering to avoid human errors (clear unambiguous instructions and procedures; logical plant layout and monitoring; highlight critical functions; use artificial intelligence, AI, where beneficial)
- Intensive training and testing of control room operators on electronic simulators of the plant (or plant type) incorporating all known accident and emergency conditions
- Quality assurance (QA) applied to all parties in the supply chain.
- Apply rigid QA testing and maintenance of computer software.

Nuclear power stations frequently attain a Capacity Factor of 99.9% or better on many reactors.

ASSESSING THE ECONOMIC VIABILITY OF A MAJOR CAPITAL PROJECT

Some guidelines are provided by the World Bank. A Feasibility Study is required to assess the project. The following criteria may be used:

Technical feasibility: Can the project be implemented as planned, using proven technologies, and without unreasonable technical risks?

Legal feasibility: Are there any legal barriers to the project? For a PPP (Public Private Partnership), this includes due diligence to identify any legal constraint preventing the government from entering into a PPP contract.

Environmental and social sustainability: at a minimum, does the project comply with national environmental and planning standards?

In some cases, a higher bar may be set, such as compliance with the Equator Principles—a set of standards on managing environmental and social risk from project finance transactions based on World Bank Group standards, set out in detail (Engel et al. 2009). This is discussed in greater detail in "Environmental and Social Studies and Standards" whether it is financially viable, economic viability.

Even though nuclear power produces more electricity per installed MW of plant, financing them is not simple as the perceived risks are high, especially among those who prefer investing in a technology they think they understand, such as wind power.[17]

 continues from page 59

Nuclear plants are capital intensive and only begin to produce a return on investment after many years, apart from which construction times are long (typically 5 years without hassle) before they begin to provide any saleable electricity.

On the other hand, offshore wind power projects can be expected to take 13 years or more with some extremely unpredictable construction problems. The cost of decommissioning and waste disposal must be included, although waste disposal can be the subject of an agreement with the supplier. Plants that perform well yield a high return on investment when they operate successfully over a period of 40 to 60 years. France has proved over 50 years that nuclear power is viable and has provided the most reliable and cheapest electricity in Europe.

Private investors often prefer gas plants which provide a quicker return on investment since they are relatively cheap and quick to build, however they are prone to the market price of gas which can fluctuate widely depending on political and market conditions whereas the cost of reactor plant maintenance and nuclear fuel tends to remain stable.

Nuclear fuel is only required once every 18 months and can be purchased at opportune times. Where governments are involved, financing is generally between governments. Russia, which sells the most plants, especially to third-world countries which, are tempted by the generous terms offered by the Rosatom, the Russian Export Company. China is also keen to enter the export market and partly financed the Hinckley 'C' project in conjunction with the suppliers EdF (Electricité de France). Even though China are keen to export its own power plants, it bought several from Russia as part of an agreement to solicit Russian help and technology transfer to build 'fast' reactors, of which Russia is currently the world leader after the cancellation of such plants in Western countries.

Rosatom recently sold 4-units to Turkey (VVER1200); 2 to Belarus; 2 to Iran; 4 to Egypt; 6 to India; 2 to Hungary; 2 to Bangladesh; 8 to China; 4 to Slovakia (VVER440). South Korea sold units to the UAR.

The World Nuclear Association quotes information about the economics of nuclear power plants:
"For any infrastructure project, in addition to the actual capital expended, there is a cost to pay related to the provision of that capital. Loans raised to cover the investment costs must be repaid to lenders at agreed intervals, and similarly, equity investors will demand a reasonable rate of return.

Among electricity generation technologies, the cost of finance is particularly important for the overall economics of nuclear power plants due to the capital expenditure profile. Nuclear power plants are more complex than other large-scale power generation plants, and so are more capital-intensive and may take longer to construct. A nuclear power plant will typically take over five years to construct, whereas natural gas-fired plants are frequently built in about two years.

Once in operation, the high capital costs of nuclear construction are offset by low and stable variable costs, but financing the upfront construction costs presents a challenge."

"The cost of capital is typically a key component of the overall capital cost of nuclear power projects. Over a long construction period, during which there are no revenue streams from the project, the interest on funds borrowed can compound into significant amounts. In a business plan, the cost of capital is often calculated at various discount rates to discover whether capital expenditure can be recovered. If the cost of capital is high, then the capital expenditure rises disproportionately and may undermine the project's viability."

At the present time, the most expensive nuclear power station in the world is probably the EPR (European Pressure Reactor) undergoing construction at Hinckley 'C in the U.K., with a strike price £92.50 / MWh (2012 prices)[18]

In September 2016, the government confirmed it would give EdF a contract for difference for power from the project, imposing significant new safeguards for future foreign investment in critical infrastructure. In July 2017, the estimated construction cost had climbed in two years to £19.6 billion and was revised to £20.3 billion, accounting for the fifteen months estimated delay cost, with a start date between 2025 (unit 1) and 2027 (unit 2). On 23 January 2024 EdF announced "UK's Hinkley Point C nuclear power plant, which was expected to be completed in 2027 and cost up to GBP26 billion, is now unlikely to be operational before 2030, with the overall cost revised to between GBP31 to GBP34 billion (in 2015 prices)"[19]

When it is completed, Hinckley Point 'C' will be the most expensive power station in the world. But to get there, "it will need to overcome an extraordinary tangle of financial, political and technical difficulties." One of the unexpected problems was COVID-19.

SAIEE KWA-ZULU NATAL CENTRE

INNOVATE TO ELEVATE

Engineering Leaders

SECURING THE FUTURE

26 June 2024 // **9** AM – **13** PM

About the Conference

As we manage the dynamics of technological change in the electrical engineering profession, this transformative leadership conference brings together engineering leaders from diverse backgrounds and industries. It features insightful keynote sessions focusing on securing a sustainable and resilient future. This conference catalyses industry leaders to ignite innovation and develop a skill set beyond traditional engineering education. If you're looking to advance your engineering career, we invite you to join Krystle Annamalai, SAIEE KZN Centre Chairperson, and other industry leaders at our upcoming one-day in-person conference.

Join us kznc@saiee.org.za

Durban Botanic Gardens
9A John Zikhali Rd, Berea, Durban, 4001
RSVP: kznc@saiee.org.za by 7 June 2024
www.saiee.org.za

Entrance fee:
SAIEE Members Free
Non - Members - R500/p

WHAT YOU WILL LEARN

Artificial Intelligence

Artificial intelligence (AI) engineers are responsible for developing, programming and training the complex networks of algorithms that make up AI and requires engineering expertise.

Sustainability

We focus on minimising waste, reducing pollution, using renewable energy sources, and creating long-lasting, efficient systems that future generations can enjoy.

Upskilling for the Future

While your initial degree equipped you with a strong foundation, staying ahead of the curve and keeping your skills relevant requires continuous learning.

Digital Transformation

Automating repetitive, manual tasks using digital technology can drastically increase productivity and efficiency within the engineering industry.

Sponsorship opportunities available - contact kznc@saiee.org.za

 continues from page 60

Stuart Crooks, managing director of Hinkley Point C, said that the COVID-19 pandemic had caused a 15-month delay to the project, adding: "Going first to restart the nuclear construction industry in Britain after a 20-year pause has been hard. Relearning nuclear skills, creating a new supply chain and training a workforce have been an immense task that others will benefit from for decades. Like other infrastructure projects, we found civil construction slower than we hoped and faced inflation, labour and material shortages on top of COVID and Brexit disruption."

Tom Greatrex, chief executive of the UK's Nuclear Industry Association, said: "The more nuclear stations we build, the quicker and cheaper it will become, so instead of building one plant at a time with long gaps in between projects, a programmatic approach, as outlined in the government's Nuclear Roadmap is vital to ensuring we build expertise, maintain workforce capability, and increase efficiency. Hinkley Point C is the most significant green energy project ever in the UK and represents the revival of an industry after a generation of not building any new plants. It has revitalised the supply chain, creating thousands of skilled jobs in the process, and will provide vital lessons for the rest of the industry."

LICENSING

When a licensee decides to start a new nuclear reactor, they must ensure a Quality Assurance Department is established to guide them through the applicable rules and regulations.

Before any new plant can be started anywhere in the world, it must receive a site license. To do this, the reactor must be of an approved design for the country where it will be located, and the site must have been approved for its intended use. Before construction begins at the site, the owner must submit a Preliminary Safety Analysis Report (PSAR) or Pre-Construction Safety Analysis Report to the appropriate licensing authority. When this has been approved, work can begin. A further one or two safety reports are required, depending on the rules of the country in question: a Post Construction (POSAR) or Intermediate Safety Report (ISAR) and a Final Safety Analysis Report (FSAR). submitted and approved by the appropriate Local Licensing Authority before the plant can be fully activated. Various stages will have been set, each of which must be signed off by the regulator before proceeding to the next stages.

RADIATION

The possibility of radiation exposure is extremely remote.

Most people receive a higher exposure to radiation from their annual holidays, business trips, normal activities and natural background radiation than from nuclear power stations.

There are special risks of exposure from particular locations with a high degree of granite, radon emissions, hot springs or other reasons. Enhanced radiation can also be received from flying in aeroplanes, sunbathing or outdoor activities such as mountaineering and hill walking. Certain foods, such as bananas, also contain high radiation, although all foods emit radiation to some extent. Air also emits a certain minimal radiation. Exposure to X-rays and other medical diagnostic techniques also exhibits a risk, however small.

NUCLEAR WASTE MANAGEMENT

There are recognised procedures for dealing with nuclear waste safely, and it is the responsibility of the management of each facility that a policy is in place which is endorsed by the licensing authority and is followed by site personnel.

This will include categorising and sorting the waste into high-active waste (HAW) and very low-level waste (VLLW) and treatment. HAW comprises; high-level waste (HLW) which is normally spent fuel which is only about 1% by volume but contains 95% of the radioactivity; intermediate-level waste (ILW) waste which is normally liquids or sludge from water treatment resins and is about 6% of the volume; low-level waste (LLW) this covers more than 90% of the volume of the waste and can be stored in buried containers. Low-level waste, which is included in the total inventory of LLW but "with very specific limits", can be disposed of with general industrial waste in designated landfill sites or incinerated to reduce its volume[20]. In total, the volume of waste is very small compared to, say, coal-fired power stations.

ENVIRONMENT & WILDLIFE FRIENDLY

With the possible exception of geothermal and natural hydroelectric facilities, nuclear power plants are the cleanest and most environment-friendly of all the means of generating electricity. Coal is probably the dirtiest and produces the most waste with 'mountains' of coal ash etc., but all fossil fuel plants are polluters to some extent even though the pollution is minimal in the case of gas.

Wind and solar 'pollute', industrialise and damage swathes of rural areas and are unfriendly to wildlife. It was significant that the city of Pripyat in Ukraine reverted back to nature after the people were evacuated, and it was devoid of human life. Nuclear power plants live in harmony with nature, and this is characterised by the recreational facilities that are offered by many nuclear plants, although some of these have had to be closed to the public due to anti-nuclear activists.

REPROCESS, REUSE, RECYCLE

Whilst some countries' policy is to dispose of spent fuel as HLW in deep geological repositories, others have adopted the 'closed fuel cycle.' Spent fuel still contains 95% reusable fuel but requires reprocessing to remove the impurities which have been produced during fission.

Reprocessing costs money, but this can be amply recovered using this reprocessed fuel as MOX (mixed oxides) in fast breeder reactors, which can convert non-fissionable natural uranium into fissionable plutonium. In this way, the inventory of spent fuel and depleted uranium can produce many times the original fissionable fuel; hence, they are called 'breeder' rectors.

SMALL MODULAR REACTORS (SMR)

SMRs are a relatively new phenomenon; many will classified as Gen IV, but some will be able to trace their heritage back to the submarine reactors and the Westinghouse S1W prototype reactor in 1953, more than 70 years ago. Why has it taken so long? Each successive improvement, from S2W to S5W, was factory-built and tested on land or in seagoing submarines. They were designed by Westinghouse, received funding from the US Navy and U.S. Federal Government and tested by Argonne National Laboratory.

The 10 MW reactor of the USS Nautilus would fit comfortably into the average house and would occupy only a fraction of the space of a similar-rated wind generator. Moreover, it performed

satisfactorily in Arctic waters underneath the North Pole. It proved that it could operate well without a grid connection or any other kind of support save that of its own crew. Something impossible with any other kind of fuel, especially wind and solar power, on which the decision makers so misguidedly squander so much taxpayers' money without their consent!

SMRs have suddenly blossomed out into the 'in thing' of the moment, and there are many different designs, too numerous to list here, but which can be found on the IAEA PRIS, World Nuclear Association, Wikipedia or other websites, including those of the manufacturers and suppliers. These range from the traditional light water-cooled reactors (LWR):

- PWRs (CNNC, ACP100; Westinghouse, AP300; NuScale, VOYGR; Rolls-Royce UK-SMR)
- BWRs (GE-Hitachi BWRX-300)
- High temperature gas cooled reactors: HTGCR (CNNC, HTR-PM)
- Molten salt reactors; MSR (Moltec)
- Liquid metal-cooled fast reactors: LMFBR (Terra Power, Natrium, TWR; Rosatom; BREST-OD-300, SVBR-100)

This list is not complete but is intended to give some idea of the extent and variety of projects, including operating reactors. The Wikipedia list is a concise starting point with more details from IAEA and WNA.

In October 2023, a press release announced that the British Government had selected six companies to compete for Government contracts to supply small modular reactors to operate as energy providers in Great Britain. Energy Security Secretary Claire Coutinho said: "Small Modular Reactors will help the

 continues from page 63

UK rapidly expand nuclear power and deliver cheaper, cleaner, and more secure energy for British families and businesses, create well-paid, high-skilled jobs, and grow the economy."

It is recognised that SMR technology promises economical and reliable energy for the foreseeable future.

It has all the advantages of conventional nuclear power, e.g., safe, reliable, sustainable, low and stable operating cost, and environmentally friendly, plus the additional advantages:

- versatile
- can be located anywhere (on land; on the surface, stationary or mobile; below the surface: in shallow coastal water; either floating or fixed; permanent or temporary)
- compact, minimum space, unobtrusive
- can operate off-grid without backup
- 'stand-alone' safety features; minimal manual involvement
- factory-built – one of a kind: QA tested in factory
- modular, installation can be tailored to suit demand – i.e., units can be added or subtracted, physically or switched in and out
- construction schedule maintained as problems were resolved in the factory
- simpler and quicker site preparation
- distributed generation; units can be located close to where power is needed
- can be used for district heating, water desalination, production of hydrogen
- can be privately owned by commercial enterprises or municipalities
- extra transmission network connections are highly unlikely
- do not have to operate at full capacity but can load follow

Small Modular Reactors are undoubtedly the future production units of heat energy for electricity generation and other purposes such as district heating, desalination, hydrogen production and many other uses. Nuclear energy batteries and radioisotope Thermoelectric Generator (RTEG) have already been used on space missions and for exploring the Martian surface powered by the Multi-Mission Radioisotope Thermoelectric Generator (MMRTEG).

Tests are also ongoing with nuclear reactors for space propulsion; since they are already used in submarines, space is the logical next step.

I believe that the ultimate goal would be for every household to have its own domestic nuclear power battery unit. Hopefully, this would end the obsession with destroying our planet, countryside, and fishing waters with unnecessary, 'half-baked', and ineffective 'electric power sources.'

ACKNOWLEDGEMENTS:

I wish to acknowledge those who have helped me over the years, beginning at school with my Physics master, who introduced us to John Dalton's Atomic Theory. I did have some exposure to nuclear energy at university and in my college apprenticeship at Metropolitan-Vickers, and I was later appointed Lead Engineer for Control and Instrumentation on the Koeberg Project Team.

Subsequently, I worked at Sizewell and at Vulcan on the Dounreay Site. I am grateful to the authors for the various sources I referenced in this article. wn

Download full referenced paper here.

MEMBERSHIP FEES EFFECTIVE 1 DECEMBER 2023

The Council meeting held on 1 September 2023 approved subscription & entrance fees as from 01 December 2023 as per schedule indicated below.

PLEASE NOTE: In terms of Bylaw 3.2 annual subscriptions are due on 1st December 2023

MEMBERSHIP FEES CAN BE PAID IN MONTHLY RECURRING PAYMENTS

Council agreed to a discount for fees paid before 31 March 2024. Members are therefore encouraged to pay promptly to minimize increase impact.

Grade of Membership	Annual Subscriptions paid before 31 March 2024		Annual Subscriptions paid after 31 March 2024		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	173	150	208	180	208	180
After 6 yrs study	1 800	1 565	2 160	1 878	2 160	1 878
Associate	1 800	1 565	2 160	1 878	2 160	1 878
Member	1 989	1 730	2 387	2 076	2 387	2 076
after 6 years	2 325	2 021	2 789	2 426	2 789	2 426
after 10 years	2 433	2 116	2 919	2 539	2 919	2 539
Senior Member	2 433	2 116	2 919	2 539	2 919	2 539
after 6yrs/age 40	2 637	2 293	3 164	2 751	3 164	2 751
Fellow	2 637	2 293	3 164	2 751	3 164	2 751
Retired Member (By-law B3.7.1)	1 118	972	1 342	1 167	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 R3337.00 which includes an entrance fee of R950.00. On election to the applicable grade of membership the new member's account will be adjusted accordingly and refunds/additional payment made on request. Entrance fee for Students is free and new Student applicants require payment of R208.00.

2. Transfer fee to a higher grade is free for all grades of membership.

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 of the next higher grade.

4. Members elected after May 2024 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 2024.

2024 SAIEE MEMBER BENEFITS

STUDENT MEMBER

- Jobs portal for WIL
- Mentorship
- Exclusive Networking Events
- CPD training discounts
- Charge Reward Programme earnings
- Bursary programme
- Publication access (**wattnow** & ARJ)
- Site visits
- SAIEE Centres

ASSOCIATE MEMBER

- Jobs portal access
- Mentorship
- Exclusive Networking Events
- CPD training discounts
- Charge Reward Programme earnings
- Bursary programme
- Publication access (**wattnow** & ARJ)
- Site visits
- SAIEE Centres

MEMBER

- Jobs portal access
- Mentorship
- Exclusive Networking Events
- CPD training discounts
- Charge Reward Programme earnings
- Long standing member gifts
- Bursary programme
- Publication access (**wattnow** & ARJ)
- Site visits
- SAIEE Centres

SENIOR MEMBER

- Jobs portal access
- Services Directory
- Mentorship
- Exclusive Networking Events
- CPD training discounts
- Charge Reward Programme earnings
- Long standing member gifts
- Bursary programme
- Publication access (**wattnow** & ARJ)
- Site visits
- SAIEE Centres
- Eligibility for nomination as Center Chair

FELLOW

- Jobs portal access
- Services Directory
- Mentorship
- Exclusive Networking Events
- CPD training discounts
- Charge Reward Programme earnings
- Long standing member gifts
- Bursary programme
- Publication access (**wattnow** & ARJ)
- Site visits
- SAIEE Centres
- Eligibility for nomination as Center Chair
- Eligibility for nomination as an Office Bearer

MEMBERSHIP UPGRADE DISCOUNT STRUCTURE

LENGTH OF MEMBERSHIP	DISCOUNT UPON UPGRADE
10 - 19 years	5%
20 -39 years	10%
40+ years	15%

Become a member today and start earning the rewards!

The South African Institute of Electrical Engineers | T: 011 487 3003 | www.saiee.org.za

SAIEE OFFICE BEARERS

P MOTSOASELE
2024 SAIEE PRESIDENT

V RAMNARAIN
DEPUTY PRESIDENT

P MADIBA
SENIOR VICE PRESIDENT

PROF W CRONJE
JUNIOR VICE PRESIDENT

PROF J DE KOCK
IMMEDIATE PAST PRESIDENT

PROF P NAIDOO
HONORARY TREASURER

J DANIEL
HONORARY VICE PRESIDENT

2024 OFFICE BEARERS

President	P Motsoasele	Deputy President	V Ramnarain
Senior Vice President	P Madiba	Junior Vice President	Prof W Cronjé
Immediate Past President	Prof J de Kock	Honorary Treasurer	Prof P Naidoo
Honorary Vice President	J Daniel		

PAST PRESIDENTS

Dr H Geldenhuys, Dr A Hay, J Machinjike, TC Madikane, Prof S Maharaj, I McKechnie, P Moyo, A Mthetwa, Prof P Naidoo, P van Niekerk

FELLOWS

J Buisson-Street, Prof C Gomes, C Matlala, J Motladiile, A Mtshali, Prof D Nicholls, Prof J Pretorius

SENIOR MEMBERS

T Cornelius, Dr L Masisi, S Mollo, Dr F Manganye, C Mohloki, P O'Halloran, M Rikhotso, K Setlhapelo, V Shikoana, R Singo, W Stucke

MEMBERS

W Fischer, K Katyora, S Mabuza, V Mahlasela, L Maphumulo, L Modiselle, E Ndlovu, Prof F Nelwamondo, T Nhlapo, M Ramutumbu

SECTION CHAIRPERSONS:

Building Services	A Chivaurah	bssection@saiee.org.za
Electronics & Software	R van Heerden	essection@saiee.org.za
Historical Section	TBA	hs@saiee.org.za
Power & Energy	M Soni	pesection@saiee.org.za
Rotating Machines	A Singh	rmsection@saiee.org.za
Systems	T Ramagofu	systemsection@saiee.org.za
Telecommunications	TBA	telsection@saiee.org.za

CHAPTER CHAIRPERSONS:

Cybersecurity Chapter:	M Taljaard	csc@saiee.org.za
Entrepreneurship Chapter:	Y Mabuto	entrepreneurchapter@saiee.org.za
Lightning Chapter	H Hunt	lightningchapter@saiee.org.za
Load Research Chapter:	M Soni	lrchapter@saiee.org.za
Nuclear Chapter:	D Nicholls	nuclearchapter@saiee.org.za
Railway Chapter	R Kopa	railwaychapter@saiee.org.za
Women in Engineering:	M Phoshoko	wie@saiee.org.za

SAIEE

Eastern Cape Centre
Chairman | Philip Nicholson
E | ecc@saiee.org.za

Free State Centre
Chairman | Lucky Mokalusi
E | fc@saiee.org.za

Central Gauteng Centre
Chairman | Mantsie Hlakudi
E | cgc@saiee.org.za

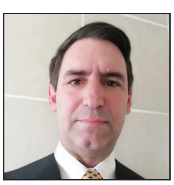
Kwa-Zulu Natal Centre
Chairman | Krystle Annemalai
E | kznc@saiee.org.za

Mpumalanga Centre
Chairman | Morné Rossouw
E | mpc@saiee.org.za

Northern Cape Centre
Chairman | Vacant
E | ncc@saiee.org.za

Southern Cape Centre
Interim Chairman | Thabo Yiga
E | scc@saiee.org.za

Vaal Centre
Chairman | Dewald Diedericks
E | vc@saiee.org.za



Western Cape Centre
Chairman | Heinrich Rudman
E | admin.wcape@saiee.org.za

JUNE 2024

05/06/2024	ARC Flash
06/06/2024	Photovoltaic Solar Systems
11/06/2024	Fundamentals of Medium Voltage Protection
11/06/2024	Design of Economical Earthing Systems for Utility Installations
18/06/2024	KZN Centre webinar: Cigre Explained - methods of uprating lines
18/06/2024	Technical Report Writing
19/06/2024	Operating Regulations For HV/MV Systems - ORHVS
20/06/2024	Energy Storage Chapter webinar: BESS deployment for Grid Stability
25/06/2025	Project Management For Engineers
26/06/2024	KZN Centre one-day conference | KZN Botanical Gardens

JULY 2024

09/07/2024	Partial Discharge
10/07/2024	New Engineering Contract (NEC)
10/07/2024	Fundamentals of Power Distribution
16/07/2024	Introduction to 5G Communication
16/07/2024	Enhancing the Municipal Electrical Revenue Value Chain
23/07/2024	Earthing & Lightning Protection - Gqeberha
23/07/2024	KZN Centre webinar: An exploratory investigation into Big Data for Grid Stability

SAIEE Sections, Chapter & Centre Events

SAIEE Academy Online Training

SAIEE Academy Classroom Training

View past events & webinars on SAIEE TV here.