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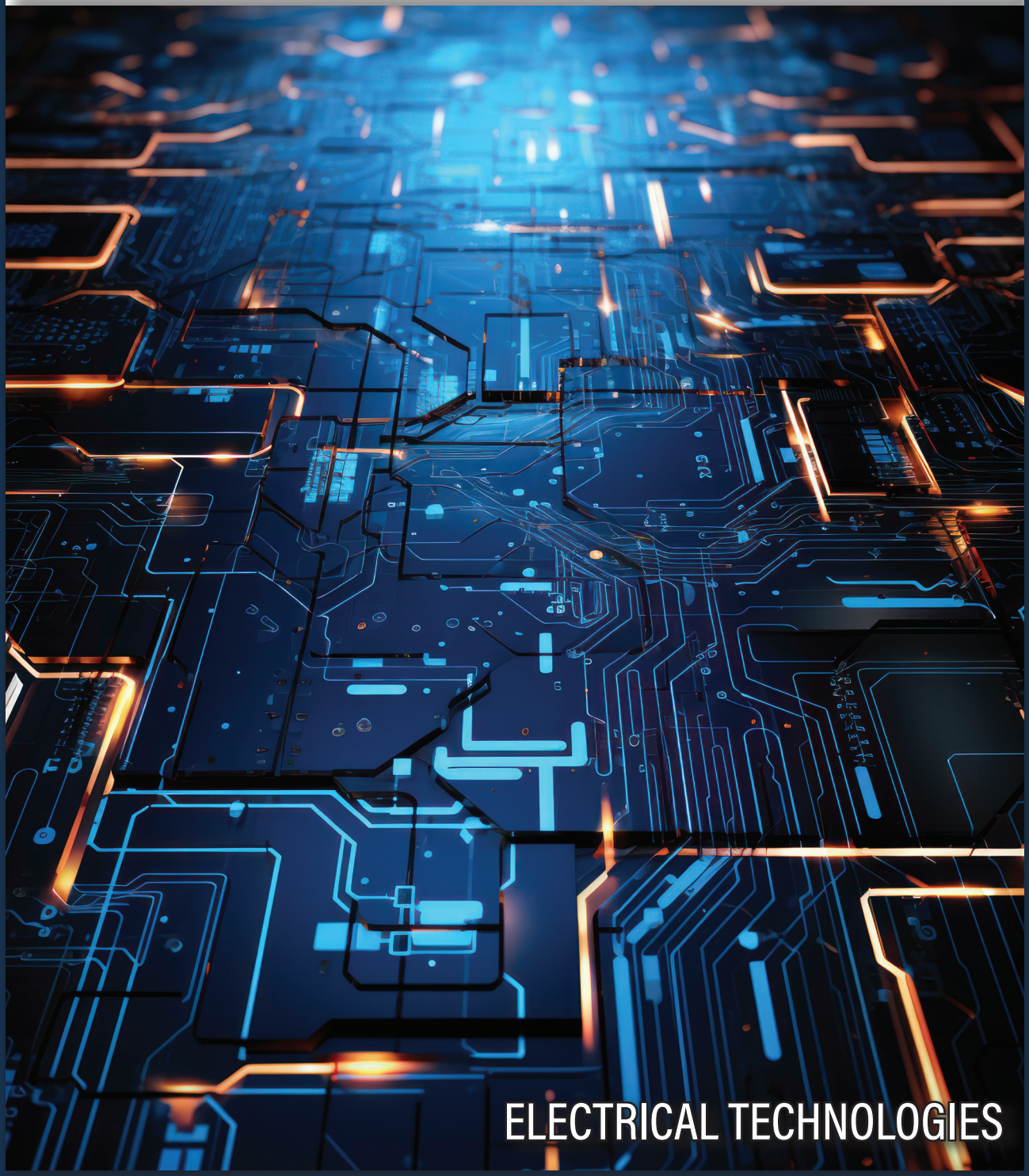
THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS



ELECTRICAL TECHNOLOGIES

APRIL 2024

SAIEE

CONTENTS

SAIEE @SAIEE SAIEE

Dear **watt**now reader

In today's rapidly evolving world, the demand for electricity continues to grow as our reliance on technology increases. Our daily lives depend more on electrical devices, from smartphones to electric vehicles. With this surge in electricity consumption comes the need for advancements in electrical technologies to improve efficiency and sustainability.

One critical development in the electrical field is energy storage systems. During peak demand, these systems store excess electricity from renewable sources like solar and wind power. This helps reduce strain on the grid and increase the integration of renewable energy sources into the power supply. Read our feature articles on pages 34, 38, and 42.

The SAIEE held its Annual Awards on the 15th of March; read more on page 4.

On the 19th of March, the SAIEE inaugurated its new President at our AGM - read more on page 8.

The May issue features Power, and the deadline is 15 April. Please send any article/news contributions to minx@saiee.org.za

Herewith the April issue; enjoy the read!

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SAIEE 114th Annual Awards

The SAIEE Annual Awards took place on Friday 15 March 2024 at The Venue, Melrose Arch.

On Friday, March 15, 2024, The South African Institute of Electrical Engineers (SAIEE) celebrated its annual award winners at an event held at The Venue in Melrose Arch, Johannesburg. The event was attended by engineering practitioners and their partners, who were dressed in their best attire. The Master of Ceremonies for the evening, Mr Kgomotso Setlhapelo, remarked that it was always refreshing to see the progress made in the industry by the winners.

By: Minx Avrabos

The 114th Annual Awards ceremony, held in collaboration with Revive Electrical Transformers, recognised significant contributions by individuals in the electrical, electronic, telecommunications, and computer engineering sectors in South Africa.

The SAIEE President's Award, sponsored by Revive Electrical Transformers and open to all living individuals, was awarded to Mr Gert de Beer, a Chief Electrical Engineer who has made considerable contributions to mega projects worldwide. He has also significantly improved the electrical performance of the Sasol plants in Sasolburg.

Dr Mpho Nkambule was awarded the SAIEE Engineer of the Year Award, sponsored by ACTOM, which is given to a SAIEE member who has worked energetically and voluntarily towards promoting electrical science and its applications to benefit SAIEE members and the Southern African community. Dr Nkambule is an electrical and instrumentation engineer with six years of experience, and he has expertise in various areas of electrical and instrumentation projects, especially those related to hardware and software design, installation, construction, and commissioning.

Ms Omaira Jajbhay won the SAIEE Engineering Excellence Award, sponsored by Lesedi Nuclear Services. This Award recognises a SAIEE Member, Senior Member, Fellow, or Council Member who has excelled in Electrical Engineering. Ms Jajbhay is an electrical engineer pursuing her MSc in Electrical Engineering. She has exceptional power system protection and solar power knowledge and has been involved in several local and international renewables and protection projects.

The SAIEE Women in Engineering Award recognises female members of the SAIEE who have excelled in Electrical Engineering and demonstrated their dedication to supporting the organisation's aims and objectives. The award is given to those with outstanding mentorship skills and integrity in their business dealings. This year, two deserving recipients were awarded the SAIEE Women in Engineering Award, sponsored by Schneider Electric. They are Ms Tshego Cornelius, a BSc Electrical Engineering graduate from UCT with over 14 years of experience in the energy and mining industries, and Ms Mantsie Hlakudi, who is a registered and certified Electrical Engineer with over 13 years of experience in Military, Distribution and Transmission.

The SAIEE Young Achievers Award is given to young professionals who have shown outstanding achievement, creativity, and leadership in electrical and electronic engineering, regardless of the size of the company they work for. This year's winner is Pitso Sekhoto, an ambitious young professional passionate about mentorship and leadership.

The SAIEE Centre of the Year Award is given to a Centre that meets its annual KPIs set by the SAIEE CEO and Finance

SAIEE Presidents Award, sponsored by Revive Electrical Transformers: From left: Paddy Padyachee (Revive Electrical Transformers) and Prof Jan de Kock (SAIEE President).

SAIEE Engineering of the Year, sponsored by ACTOM: From left: Mervyn Naidoo (ACTOM), Dr Mpho Nkambule (winner), and Prof Jan de Kock (SAIEE President).

SAIEE Engineering Excellence Award, sponsored by Lesedi Nuclear Services: From left: Jeremy Summers (Lesedi Nuclear Services), Omaira Jajhay (winner) and Prof Jan de Kock (SAIEE President).

SAIEE Young Achievers Award: From left: Leanetse Matutoane (SAIEE, CEO), Pitso Sekhoto (winner) and Prof Jan de Kock (SAIEE President).

SAIEE Women in Engineering Award, sponsored by Schneider Electric: From left: Sebolelo Hoohlo (Schneider Electric), Tshego Cornelius (winner) and Prof Jan de Kock (SAIEE President).

SAIEE Women in Engineering Award, sponsored by Schneider Electric: From left: Sebolelo Hoohlo (Schneider Electric), Mantsie Hlakudi (winner) and Prof Jan de Kock (SAIEE President).

SAIEE 114th Annual Awards cont.

SAIEE Centre of the Year:
The Free State Centre delegation with Leanetse Matutoane (SAIEE), Ms Refilwe Buthelezi (ECSA President) and Prof Jan de Kock (SAIEE President).

Committee. The Free State Centre was awarded the 2023 SAIEE Centre of the Year for meeting its KPIs.

The 2023 SAIEE Annual Awards, in collaboration with Revive Electrical Transformers, would not have been possible without the tremendous support of our sponsors. They are:

1. Naming Sponsor: Revive Electrical Transformers
2. Platinum Sponsor: Schneider Electric
3. Gold Sponsor: TransAfrica Projects
4. Silver Sponsor: Lesedi Nuclear Services
5. Silver Sponsor: Hyosung Heavy Industries
6. Welcoming Drinks Sponsor: Cullin Africa
7. Wine Sponsor: Proconics
8. Gift Bag Sponsor: LEDVANCE
9. Bronze Sponsor: ACTOM. wn

From left: Prof Jan and Elma de Kock and Maureen and Prof Pat Naidoo.

The SAIEE Annual Awards Master of Ceremonies, Mr Kgomotso Setlhapelo.

SAIEE Chief Executive Officer, Leanetse Matutoane.

Silver Sponsor, the Lesedi Nuclear Services team.

From left: Leanetse Matutoane (SAIEE CEO), Refilwe Buthelezi (ECSA President) and Prof Jan de Kock (SAIEE President).

Organisers of the SAIEE Annual Awards, from left: Gerda Geyer and Minx Avrabos.

From left: Jen & John Livock and Ryan & Nicky Read.

From left: Mr & Mrs Paddy Padyachee (Revive Electrical Transformers) and Leanetse Matutoane (SAIEE).

From left: Prince Moyo (SAIEE Immediate Past President), Nontokozo Moyo, Elma de Kock and Prof Jan de Kock (SAIEE President).

From left: Althea and Chris Campbell (CESA CEO), Elma and Prof Jan de Kock (SAIEE President).

Entertainer for the evening, Mr Gavin Sharples.

Teboho and Kamogelo Mache.

From left: Sharona & Veer Ramnarain (SAIEE Senior Vice President), Elma and Prof Jan de Kock (SAIEE President).

THE 2023 SAIEE ANNUAL AWARD SPONSORS:

SAIEE Inaugurates new President

Mr Pascal Motsoasele
2024 SAIEE President

On Tuesday, 19th of March, the South African Institute of Electrical Engineers held its Annual General Meeting (AGM) as a hybrid event and inaugurated its 115th President, Mr Pascal Motsoasele.

By: Minx Avrabos

Mr Leanetse Matutoane, SAIEE CEO, welcomed all guests and valued SAIEE members to the event. He introduced Prof Jan de Kock, the outgoing SAIEE President, who recognised the SAIEE past presidents in the room and online.

Prof de Kock gave an overview of his presidency in 2023 and discussed his theme "Load-shedding - can South Africa be saved?" and various initiatives' outcomes that sparked heated debates from multiple articles in the press to concrete plans of the Eskom Development Plan for the next ten years, which showed how constraint our grid was primarily in the Northern Cape and Eastern Cape. The SAIEE hosted Mr Magiel Viljoen in May last year, who discussed the possibility of blackouts worldwide, especially in South Africa, to which Prof de Kock said: "I'm pleased to announce that luckily we never had a blackout".

Prof de Kock relayed Isabel Fick's talk from the Eskom National Control Room on Grid Stability and measures taken to prevent blackouts.

Prof Jan Meyer from the TUD Dresden University of Technology, Dresden, Germany, presented the 72nd Bernard Price Memorial Lecture. His presentation focused on "Power Quality challenges that new technologies bring to distribution grids of the future."

After his feedback on his presidency, Prof de Kock introduced the incoming SAIEE President, Mr Pascal Motsoasele.

Pascal has 22 years of experience as an electric and water utilities engineer. He is a registered engineer (PrEng) with the Engineering Council of South Africa (ECSA) and represents ECSA in its Federation of African Engineering Organisations (FAEO) membership, where he serves as the Chairman of the FAEO Manufacturing Working Group. He also serves on the EXCO of the South African Council for Automation and Control (SACAC), the Industry Advisory Board of Unisa's College of Science, Engineering and Technology (CoSET), and as a Subject Matter Expert (SME) on several technical standards committees of the ISO, IEC and SABS.

He received the SAIEE Engineer of the Year Award for 2018 and the Chairman's Award for 2012 from the Utilities Technology Council in the USA.

He is a Consultant Automation Engineer at Rand Water's Strategic Asset Management division.

Pascal's academic qualifications include a BSc(Eng) from UCT, an IMDP from the Da Vinci Institute for Technology Management, an MAP from the Wits Business School, an MEng from Wits University and an MBA from Unicaf University. He has a white belt in Lean Six Sigma and completed the Programme in Senior Management Service (SMS) with the National School of Government.
He believes in lifelong learning: He is pursuing an Advanced Diploma in Industrial Automation Engineering with the Engineering Institute of Technology, Australia.

SAIEE Past Presidents in attendance at the SAIEE AGM.
From left Dr Angus Hay, Prof Jan de Kock, Prof Pat Naidoo, Prince Moyo, André Hoffmann, Pascal Motsoasele (2024 SAIEE President), Jacob Machinjike, Sy Gourrah and Andries Mthethwa.

Mr Motsoasele's inaugural presentation and his theme during his presidency is "Empowering the next generation of SAIEE members - making it fashionable to be and remain a member of the SAIEE" with the following hashtags: #PassOnTheBaton; #Sustainability and #Deliver!

"The South African Institute of Electrical Engineers (SAIEE) was formed 115 years ago. The question is: Is the Institute still relevant today? I submit to you that it is! The Institute has evolved from a fraternal boys-only club of yesteryear to a more inclusive and dynamic non-profit organisation whose primary purpose is to enhance the prestige of our chosen profession while simultaneously driving a philanthropic agenda.

Now more than ever, it is crucially essential for engineering institutes and their members to hone their expertise to address the current infrastructural challenges faced by our country," Pascal said.

During his talk, Pascal demonstrated why Institutes such as the SAIEE are so much needed today. He incorporated anecdotal tales reminiscent of the technological advancements due to the existence of engineers, from the development of the first car and steam engine right up to artificial intelligence and machine learning.

He narrated his life story of becoming an engineer in the industry from the turn of the millennium up to now!

His presentation touched on the following focus areas, which are aligned with my presidential theme:

- **Student Chapters** – He is passionate about helping the pipeline of SAIEE members. They are the future of the SAIEE.
- **Centres, Technical Sections & Chapters** – The provincial Centres, Sections and Chapters are at the coalface of our operations. We must support and fund their ideas and programmes as much as possible if this Institute is to survive another 115 years.
- **Individual Members** – We must enhance our value proposition to our current members. Make it prestigious to be a SAIEE member!
- **Partnerships** – We must offer a compelling and philanthropic value proposition to corporate partners, sponsors and donors. One that links to a compelling CSI programme that focuses on what the corporates, sponsors, donors and well-wishers are passionate about.

Pascal introduced the 2024 SAIEE Office Bearers and Council members. Find the list on page 64.

Watch the recording of the SAIEE AGM here. wn

From left: Elma de Kock and Nomsa Motsoasele.

From left: Pascal Motsoasele and Andries Mthethwa.

From left: Prof Jan de Kock and David Nicholls.

From left: Dr Angus Hay, Prof Pat Naidoo and Prof Willie Cronjé.

SAIEE Freestate Centre Annual General Meeting

Mr Lucly Mokalusi
2024 SAIEE Freestate Centre Chairman

South African Institution of Electrical Engineering (SAIEE Free State) hosted an Annual General Meeting (AGM) on March 8, 2024, at the Central University of Technology. #SAIEEFSC Special Committee Exco members and various stakeholders in the Electrical Engineering field were invited.

The agenda focused on the chairman's report (Mr Motoloki Lephoi), the treasurer's report (Ms Kholiwe Mbatha), the introduction of the new committee for 2024, and the chairman's lecture (Mr Lucky Mokalusi).

The incoming Chairperson emphasized the importance of working with young people, mainly focusing on the student chapter. He highlighted the organization's historical emphasis on knowledge sharing and expressed the need to continue this tradition to empower and educate the next generation of electrical engineers.

Mr. Thabo Letooane, the Student Chapter Chairperson, provided a comprehensive report for 2023/2024. He highlighted a significant increase in student membership, partially attributed to a successful campaign featured in the March 2024 issue of Wattnow magazine. The report also mentioned ongoing projects such as solar cars and industry visits, which offered valuable experiential learning opportunities for students.

The AGM also welcomed back former members, including Prof. Kusakana Kanzumba, who continues to see value in the organization. As the previous Chairperson, Prof. Kanzumba's willingness to sponsor future activities further underscored the enduring value and impact of SAIEE in Electrical Engineering. wn

Schneider Electric unveils affordable EasyLogic building management system product range

Mark Freeman
Schneider Electric

Schneider Electric, the leader in the digital transformation of energy management and automation, has unveiled its EasyLogic Building Management System (BMS) range, designed for basic building architectures, to the local marketplace.

Mark Freeman, Offer Manager Digital Building for Anglophone Africa at Schneider Electric, explains that EasyLogic is a complete and cost-effective range of field controllers and sensors that are both easy to install and scalable.

"The EasyLogic brand brings to market a very cost-effective solution that still delivers the reliability and robustness that the Schneider Electric brand is known for. While not offering the advanced capabilities of our premium range, the EasyLogic product still delivers a robust BMS solution," says Freeman.

The EasyLogic range is designed for basic heating, ventilation, and air conditioning (HVAC) applications and includes an integrated network of controllers, providing improved installation efficiency and energy use such as plant room and terminal units. This includes controllers for fan coil (FCU) and Variable Air Volume (VAV), as well as expansion modules. Also, the EasyLogic range is compatible with BACnet MS/TP for network communications and supports fundamental HVAC applications.

GAINING TRACTION

"Since its soft launch in the local and East and West African markets last year, the EasyLogic BMS range has been steadily gaining traction in the market, especially for cost-sensitive projects that require more affordable solutions," says Freeman.

"While smart building technology has seen a shift towards the integration of digital building management systems, not all projects have sufficiently large budgets for state-of-art premium solutions. With the EasyLogic brand, we are targeting end users who require a more affordable alternative, but still want to operate and control their buildings digitally."

He notes that another major benefit of using the EasyLogic range is that the solution can be tailored to practically any application and any size building and – once installed – will enable significant energy savings that will result in a good return on investment (ROI). wn

SAIEE KZN Centre hosted its 2023 Annual Awards

The SAIEE KZN Centre hosted its annual dinner and awards gala on November 30th, 2023, at the Suncoast Casino Barnyard Theatre. Guests were entertained with a live performance as we celebrated the industry's success and recognised the success and dedication of some individuals who have made incredible contributions to advancing the electrical engineering profession.

Congratulations to all award recipients: The KZN Women in Engineering 2023 awards, sponsored by Cabstrut, went to Omaira Jajbhay.

The Best Engineering Student 2023 Award, sponsored by Autotronix, was awarded to:

- Thandiwe Nyawose – DUT
- Siyabonga Zungu – MUT
- Fezile Mpanza – UKZN

The Significant Project 2023 Award, sponsored By Autotronix, went to

- Resham Singh
- Sinothi Sibisi
- Deshan Chetty
- Neren Devnarain

The KZN Young Achiever's 2023 Award, sponsored by Aberdare Cables, was awarded to Avarn Kooblal.

A very special thank you to our sponsors: Autotronix, Dromex, Aberdare Cables, Edison Power, Electro Mechanica, and Cabstrut. With your support, the event was a success. wn

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Static Power oversees provision of PV solar systems to ACTOM divisions

Two years ago Static Power, a division of ACTOM (Pty) Ltd, decided to extend its operations to cater to the growing trend by industrial and commercial businesses in South Africa to establish solar power generation systems of their own to offset both the unreliability of power supply from the national grid resulting from the ever increasing frequency of loadshedding and the higher electricity supply prices that Eskom has sought to impose on consumers.

The first step the business unit took was to appoint a suitably qualified and experienced PV solar practitioner as Engineering Manager to provide the overall leadership in marketing the new service, in which Static Power establishes the PV solar generation requirements of a potential customer, writes the specification and then goes to the market to assess suitable contractors, prepares tender documents and manages the tendering process and makes recommendations to clients accordingly, as well as taking overall project management responsibility for each project.

Jaco Weyers, who had handled various PV solar projects in South Africa over a period of 10 years prior to joining Static Power, was appointed to this key post.

During that period he managed two large PV solar farms in the Northern Cape for an independent power producer (IPP), then as part of a team of consulting engineers he assisted in designing and building a 50MW PV solar farm for the De Wildt agricultural area near Brits, North West Province, assisted in the design, procurement and erection of a 220kW dual-axis "proof of concept" tracking platform PV solar plant for the CSIR in Pretoria, and assisted in designing and building smaller fixed solar rooftop PV solar installations in Gauteng and Cape Town.

The new department has initially focussed on providing PV solar systems for divisions within ACTOM. To date it has sourced contractors for the design, supply and erection of PV solar generation systems for ACTOM Turbo Machines in Sasolburg, MV Switchgear at Knights, Germiston, and Reid & Mitchell (R&M) in Benoni.

All the above projects were done on a turnkey basis by contractors selected by Static Power through a tendering process.

"The client makes the final selection based on our recommendation and appoints Static Power to do the project implementation, project management, final handover and sign-off of each project to the client upon completion," Jaco explained.

ACTOM Turbo's 200kW capacity grid-tied PV solar system, commenced operation early last year. MV Switchgear's 1.1MW grid-tied PV solar system, which What's Watt featured in its June issue this year, went live in July, with an official handover event being held at Knights on July 19.

Reid & Mitchell has gone a different route than the other two divisions, installing a 50kW hybrid PV solar system, which, unlike the others, includes a lithium batteries backup system and is designed to supply continuous solar-generated power supply independently of the grid. The 1.1MW of power the PV solar system at Knights is capable of generating is just short of MV Switchgear's total power consumption at peak load and is about 50% of the peak load drawn by all the factories at the Knights site.

"Due to some unexpected complications that arose the system had to be partly redesigned during the course of the project," Jaco said.

"The roof was found not to be designed to handle the additional load of the PV solar system and some roof space was therefore unavailable for use in the project, so we had to redesign the project using the largest commercial solar panel available at that stage to make the most of the available area. A total of 1676 large panels therefore were used where the initial aim was to use 2230 small wattage panels," Jaco concluded. wn

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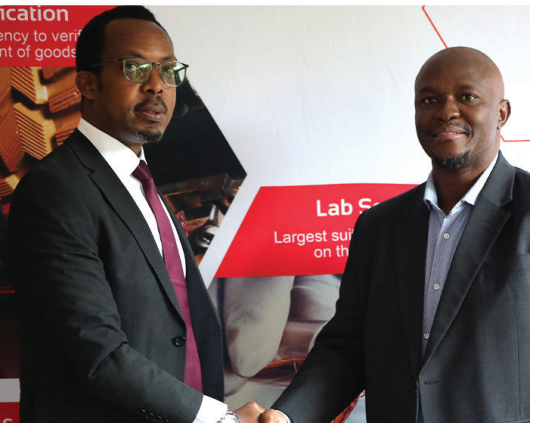
South Africa hosts the African Organisation for Standardisation Technical Committee 59



At the opening of the African Organisation for Standardisation Technical Committee 59 (ARSO/TC 59) to discuss technical standardisation within the African Automotive industry. From left Hermogene Nsengimana, Secretary General of the African Organisation for Standardisation (ARSO) and Lungelo Ntobongwana, Acting CEO of the SABS.

South Africa will host the African Organisation for Standardisation (ARSO) and its member national standards bodies of ARSO Technical Committee 59 – Automotive Technology and Engineering. The four-day event includes the participation of technical experts from the automotive industry across the African member national standards bodies.

"The African landscape for automotive requirements is changing rapidly as the demand for fuel efficient and low carbon emissions grows. South Africa is leading the continent with 931 new fully electric vehicles (EVs) sold in South Africa during 2023, a new record for the segment.

Continental growth is expected to increase as the SABS is at an advanced stage of offering a certification scheme for components of electric vehicles", says Lungelo Ntobongwana, Acting CEO of the SABS, at the opening of the Technical Committee Meeting that focuses on the Automotive Sector.

ARSO Technical Committee 59: Automotive Technology and Engineering is being held in Gauteng from 4-8 March 2024, with the objective of reaching consensus on the adoption of international standards and harmonisation of standards for the region in support of the African Continental Free Trade Area (AfCFTA). ARSO boasts a membership of 42 countries, representing 77% of the continent with more than 80 ARSO TCs that cover many industrial sectors of standardisation.

Ntobongwana explained that the SABS is an important thought leader in Standardisation at ARSO and actively participates in policy, governance and technical forums to ensure harmonisation and collaboration in implementing standards that support industrialization opportunities.

Africa, which is rich in natural resources is also ideally placed to take advantage of secondary markets, for example in the provision of manganese for batteries, solar technology to enable the use of electric vehicles and in developing technology that can customise vehicles for continental terrains.

Dr. Hermogene Nsengimana, Secretary General of the ARSO said during his address, that the established Strategy for the African Automotive Manufacturing Sector within the framework of the AfCFTA) highlights the need to take into consideration harmonized standards in tackling the challenge of imported vehicles, regional value chains, and the long-term goal of establishing a Common External Tariff for the sector.

As per this strategy, ARSO, the African Association of Automotive Manufacturers (AAAM) and Afreximbank are members of the AfCFTA Automotive Task Force and will oversee, guide and implement the strategy.

Seventy-three (73) African harmonised standards have been published and have been made available for use by the African automotive industry by ARSO and its Member States and stakeholders which include: The Democratic Republic of Congo, Egypt, Ghana, Kenya, Madagascar, Malawi, Mauritius, Morocco, Namibia, Nigeria, Rwanda, Seychelles, Sierra Leone, South Africa, Tanzania, Zambia, Zanzibar, Zimbabwe, The Tripartite Transport and Transit Facilitation Programme (TTTFP) and AAAM. wn

RS South Africa launches new campaign across its range of electronic products, services and design tools

Erik Wessels
RS South Africa Sales Director

RS South Africa, a trading brand of RS Group plc (LSE: RS1), a global provider of product and service solutions for industrial customers, has launched a campaign across its broad range of more than 250 000 electronic products.

"Electronics has been at the heart of our business for over 80 years, and we are still the ideal partner to help our customers source the products, services and design tools they need to get the job done," comments Erick Wessels, RS Sales Director.

"From board level components to development kits, connectors, or displays and optoelectronics, RS has a comprehensive range of products from over 700 electronics manufacturers including leading brands such as TE Connectivity, Amphenol, Molex, Infineon, ST, Microchip, Renesas, ams OSRAM, SEGGER, Würth Elektronik, and ebm-papst."

Key technologies for electronics available from RS include semiconductors in small pack and bulk options; passive components for electronics design; and displays and optoelectronics, including LED lighting parts, couplers, and indicators; development tools and kits, such as evaluation boards, emulation and simulation tools, programmers, prototyping tools and accessories; connectors, such as power, signalling and data connectors for board, panel and machine level applications; and on- and offboard power supplies; soldering; ESD control; test and measurement; and electronic tools.

In addition, the DesignSpark community connects over a million like-minded engineers from all walks of life, using RS's design resources to improve productivity and innovate responsibly, including programming software, CAD libraries, and tech updates.

For more information about the Electronics Campaign, visit: Electronics | RS (rs-online.com) and stand the chance to receive up to 20% discount.

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SAIEE Cybersecurity Chapter Call for Members

Operational Technology (OT) organisations increasingly adopt technology and integration to enhance product and service delivery. However, this transition also exposes them to heightened cybersecurity risks in a domain originally not conceived with security in focus. As a result, there is a pressing need for tailored security strategies that can effectively address the unique demands of the OT environment, characterised by high availability and low latency requirements.

By: Matthew Taljaard
SAIEE Cybersecurity Chapter Chairman

WHAT IS OPERATIONAL TECHNOLOGY?

The National Institute of Standards and Technology defines OT as systems or devices that detect or cause a direct change by monitoring and/or controlling devices, processes, and events. These systems physically impact critical domains such as electricity grids, transportation, manufacturing, and even Automated Teller Machines (ATMs) banks use.

A critical distinction between IT (Information Technology) and OT is their impact. In IT, disruptions often manifest as digital issues—such as data unavailability or system failures. However, in OT, the consequences are physical—ranging from halted manufacturing processes to power outages.

As technology continues to enhance these environments, safeguarding them becomes paramount. Thus, the demand for OT cybersecurity has become a critical imperative.

WHAT IS OT CYBERSECURITY?

Security can be divided into three fundamental priorities, often encapsulated in the CIA triad: Confidentiality, Integrity, and Availability. In IT environments, confidentiality takes precedence. For instance, a bank will withhold access to your online account until it can guarantee the confidentiality of your data and transactions.

However, availability reigns supreme in Operational Technology (OT). The security measures applied to operations must not compromise availability. Consequently, OT cybersecurity necessitates a distinct approach compared to its IT counterpart.

Trends Shaping OT Security in 2024

As we step into 2024, the landscape of Operational Technology (OT) security is undergoing transformative shifts. Industrial organisations are reevaluating their strategies, and one notable trend is the convergence of IT and OT. Here are the key trends that will redefine the sector:

Holistic Security: Beyond OT Silos

The convergence of IT and OT continues to accelerate. Organisations are integrating OT-related security products, from exposure management to collaboration between multiple OT security vendors.

A holistic view of security is essential. Successful strategies require evaluating security across the entire organisation, focusing on OT-specific vulnerabilities. Integrating IT and OT security is crucial to fostering a collaborative relationship between these disciplines. Evolving OT security playbooks must address various scenarios, incident response protocols, and strategic reactions. Urgency arises from the rise of ransomware attacks targeting OT environments. A more advanced, cost-saving, adaptable, and preemptive approach to safeguarding OT infrastructure is imperative.

SHIFT IN VULNERABILITY MANAGEMENT

Organisations are moving beyond fixing minor system issues to understanding how devices fit into the bigger picture. A partnership between IT and OT teams is necessary to reduce risks and vulnerabilities without compromising operational agility.

ADHERENCE TO CYBER REGULATIONS AND BEST PRACTICES

Organisations worldwide face increasing scrutiny. Compliance with new and updated cyber regulations for critical infrastructure is a priority. Adopting OT security best practices is essential to enhance resilience against evolving threats.

SIGNIFICANT CHALLENGES IN OPERATIONAL TECHNOLOGY (OT) CYBERSECURITY

The convergence of Information Technology (IT) and Operational Technology (OT) presents substantial challenges for securing OT networks. These challenges stem from the unique characteristics of OT environments and the increasing risk landscape. Let's delve into the key obstacles faced by organisations:

DUAL THREAT EXPOSURE: OT AND IT RISKS

Initially designed without cybersecurity considerations, OT networks are now vulnerable to both OT-specific threats and those originating from IT. Their interconnectedness allows threats to propagate from IT to OT, posing an immediate danger to OT networks. Organisations must address this dual exposure by implementing tailored security measures for both realms.

LACK OF CYBERSECURITY MATURITY

Many organisations need a mature cybersecurity posture in their OT environments. Legacy systems, some dating back 30 years or more, present vulnerabilities due to outdated security controls. Implementing security measures on these legacy devices is challenging, mainly when managed by Original Equipment Manufacturers (OEMs) without proper hardening procedures. The need for more skilled cybersecurity professionals exacerbates the problem, hindering effective defence strategies.

PHYSICAL CONSEQUENCES OF OT CYBERATTACKS

Unlike IT attacks, which primarily impact data and systems, OT cyberattacks can have physical consequences. Successful attacks can result in shutdowns, outages, leaks, and even explosions.

THIRD-PARTY CONNECTIONS AND REMOTE ACCESS

Third-party remote connections to control OT devices introduce additional risks.

Attackers exploit less-secured connections to hijack OT devices, disrupting production and operations. Organisations must carefully manage these connections while ensuring robust security controls.

HOLISTIC APPROACH AND SKILL GAP

Organisations need a holistic approach that bridges IT and OT security. Clear role responsibilities for IT and OT teams and external partners enable swift responses to cyber incidents. Increasing risk awareness and proactively involving all stakeholders are essential. Collaboration between the public and private sectors is crucial for threat intelligence sharing. Addressing the cybersecurity skills gap is vital to building resilience against evolving threats.

THE SAIEE CYBERSECURITY CHAPTER (SAIEE CSC)

The SAIEE created the SAIEE CSC to look into OT and OT Converged cybersecurity challenges. Champions in such organisations in South Africa should consider joining this Chapter to be part of this professional community.

Membership is open to SAIEE members or recommendations from existing SAIEE members who express an interest in addressing the challenges associated with Operational Technology (OT) and the convergence of Information Technology (IT) and OT security in South Africa.

By affiliating with the SAIEE CSC, you will be associated with an organisation committed to the following objectives:

- Addressing OT and IT/OT cybersecurity challenges in South Africa.
- Enhancing awareness of OT cybersecurity issues.
- Coordinating events and webinars and creating content on OT cybersecurity.
- Networking with industry peers to share industry developments, exchange knowledge and experiences, foster skill-sharing opportunities, and provide mentorship in OT cybersecurity.
- Producing summaries and analyses of OT cybersecurity matters in South Africa.
- Contributing to the activities and initiatives of SAIEE.
- Engaging with universities and promoting outreach programs.
- Providing opportunities to earn Continuous Development Points (CDP) through participation in CSC activities.

For more information about the Cybersecurity Chapter and details on how to join, kindly reach out to your local SAIEE representative or drop an email to csc@saiee.org.za

We anticipate your valuable involvement in this significant initiative. wn

Power Through Light

Our customers benefit from the transformation of light into actual savings through intelligent energy solutions, solar technology, and improved working and living environments with our lighting systems.

We are committed to contributing to a greener planet by reducing CO_2 emissions and waste through sustainable products, solutions and processes.

Ultimately, we put the power of light into the hands of our employees and stakeholders to contribute to a better quality of life on a greener planet.

LEDVANCE was introduced in 2016 as a spin-off from the lighting pioneer OSRAM. As a new brand with over 100 years of experience, we are proud of our manufacturing excellence, innovative spirit, and passion for lighting. Since then, we have developed an extensive luminaire portfolio, received several awards for our human-centric lighting (HCL) solutions, and emerged as one of the top players in the global lighting market.

Today, as the world faces groundbreaking challenges and transformations, from a cost of living and energy crisis to climate breakdown and environmental destruction, the story of LEDVANCE must also adapt and evolve. We want to stay true to our roots as industry innovators and push forward, find imaginative solutions to our customer's challenges, and develop into a broader company that goes beyond just lighting.

True to our new mantra, "Power Through Light", we want to empower our customers to harness the power of light like never before, both as a tool for illumination and power generation. Our intelligent energy solutions, solar technology, and advanced lighting systems for improved working and living environments mean that our customers benefit from this transformation with actual savings in energy costs. At the same time, we are committed to contributing to a greener planet by reducing CO_2 emissions and waste through sustainable products, solutions and processes.

Times are genuinely challenging, but we can improve people's quality of life with smart and simply powerful products and conserve the planet's resources by finding the right solutions with our customers. We have the courage and experience to accelerate converting all these opportunities into reality. Because what matters most is leaving a world where future generations can thrive.

Together, we make change happen.

LEDVANCE

HARNESS THE POWER OF LIGHT

LIGHT IS ALL AROUND US

A BEAUTIFUL AND DYNAMIC FORCE, FAR MORE THAN A SIMPLE SWITCH

Our mantra POWER THROUGH LIGHT reflects our mission to push the boundaries of what light can achieve, unlocking its potential to empower people in their daily lives. And this is just the beginning.
What if we re-imagined light as a fundamental force for change? Rethinking from the ground up and top down, we can create intelligent solutions that go beyond illumination, placing truly sustainable energy at everyone's fingertips. We empower people to harness this power of light, with our smart energy solutions, solar technology and advanced lighting systems for a better working and living environment, our customers benefit from real savings on energy costs.
Join us in harnessing the power of light.

FOR MORE INFO
SCAN QR CODE

Eastern Cape Centre Regional Conference

The SAIEE Eastern Cape Centre hosted its second annual regional conference on 26 January 2024 at Nelson Mandela University (NMU). The conference's purpose was to enable networking amongst members in the province while also hearing speakers on a variety of current technologies and issues in a face-to-face format. A site visit to the Electrical Engineering Faculty's research facilities was also included.

Philip Nicholson
Eastern Cape Centre Chairman
Pr Eng, SMSAIEE

The SAIEE Eastern Cape Centre hosted its second annual regional conference on 26 January 2024 at Nelson Mandela University (NMU). The conference's purpose was to enable networking amongst members in the province while also hearing speakers on a variety of current technologies and issues in a face-to-face format. A site visit to the Electrical Engineering Faculty's research facilities was also included.

Of the 36 registered delegates, 20 attended and enjoyed the excellent catering offered by the university. There were five presenters; three presentations are highlighted below.

Kumeshan Reddy, a post-graduate student at NMU, presented a research paper on Advanced Metaheuristics of Power Systems. Metaheuristic optimisation involves the optimising of multiple variables using computer algorithms. These are based on:

- Mathematical modelling of natural phenomena
- Evolutionary processes
- Human behaviour.

The easiest algorithm to implement for controlling power systems is the swarmed-based algorithm (inspired by swarms in nature):

- It allows for precise control of sensitive power systems
- It exploits controller capabilities better
- It can accurately solve multi-objective power engineering optimisation problems.

Another post-graduate student at NMU, Vukile Mnyande, presented research on the university's E-Mobility programme comprising two aspects of research:

- "Passenger vehicles using renewable technologies for South African motorists, namely hybrid, plug-in hybrid, pure electric, and hydrogen fuel cell technology." Electric vehicles' main advantage is superior energy efficiency (89% vs. 20% of internal combustion engines), which means lower running costs.
- The second aspect is transitioning to electric vehicle mobility, namely battery recycling, component manufacturing, charging infrastructure, grid capacity constraints, and managing the transition to electric vehicle manufacturing.

The main challenges unique to South Africa are energy security, import duties and taxes, range anxiety, supply chain disruption and cable theft to chargers.

Ivor Becks of ABB presented a Medium-Voltage Uninterruptible Power Supply product as a more efficient alternative to rotary systems that use a flywheel. According to ABB, it is suitable for data centres and grid support and can be paralleled up to 10 units, giving a maximum total storage capacity of 25 MW. wn


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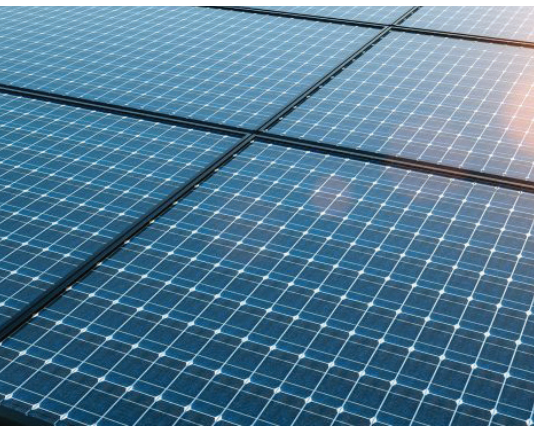
EXIT
eNtsa

The new material that will multiply the power of solar panels

- WE USE IT EVERY DAY AND DID NOT KNOW ITS POTENTIAL



Solar panels have advanced in efficiency, lifetime, and resistance, even though we have hardly innovated in materials. These days, we are reminded of the potential of monocrystalline silicon, and then it is time to talk about perovskite. However, a group of scientists has turned them around with a new material that will multiply their benefits: we show it to you.

By D. García
Courtesy of EcoNews

PEROVSKITE SOLAR PANELS, A REVOLUTION FOR THE PHOTOVOLTAIC SECTOR THAT WILL MAKE IT EASIER FOR US ALL

Perovskite solar cell is an emerging technology for manufacturing solar cells based on an unusually three-dimensional material called perovskite. The name originated from the structural form of the original substance- calcium-titanium-oxide — found in the Ural Mountains and commemorated to Russian mineralogist Lev Perovski.

Perovskite solar cells are thin films made of inexpensive and relatively simple perovskite materials. The light-absorbing layer is just like the transparent silicon layer, which functions the same way as traditional solar cells. However, they are characterised by a particular optoelectronic manner, which is favourable for the efficient conversion of sunlight into electricity. The simplest and most common perovskite solar cells currently use lead-containing perovskite materials.

ONE MORE STEP IN THE ECOLOGICAL TRANSITION: ADD THIS MATERIAL TO PEROVSKITE, AND SOLAR PANELS ARE TRANSFORMED

One of the reasons perovskite solar cells are a better solution for producing electricity is the possibility of combining them in a two-layered configuration with silicon cells that complement each other perfectly.

This cooperation ensures that, in total, the tandem cell performs better with greater efficiency than the efficiency produced by either cell independently. Tandem perovskite-silicon solar cells have several key advantages.

The proliferation of tandem cells would far surpass the efficiencies of existing silicon or perovskite cells, which are nearly 30%.

With only a thinning perovskite film in a tandem perovskite cell, less lead and other materials are needed than in thicker standalone perovskite cells.

Tandem cell technology can be used in an N-type PV cell manufacturing process that is compatible with prevailing industry trends.

Lower sensitivity to temperature variations can appear – the perovskite top cell also builds efficiency stability in high temperatures.

THE FUTURE OF TANDEM SOLAR PANELS: THESE ARE THE PROJECTS THAT ARE GOING TO CHANGE EVERYTHING

Joint perovskite—silicon cells can be considered the next-generation solar technology, which has developed greatly over the years.

In 2022, scientists at Oxford PV reported that a perovskite-silicon tandem solar cell designed to convert sunlight into a

new efficient record of 29.2% had been made at a special scientific conference.

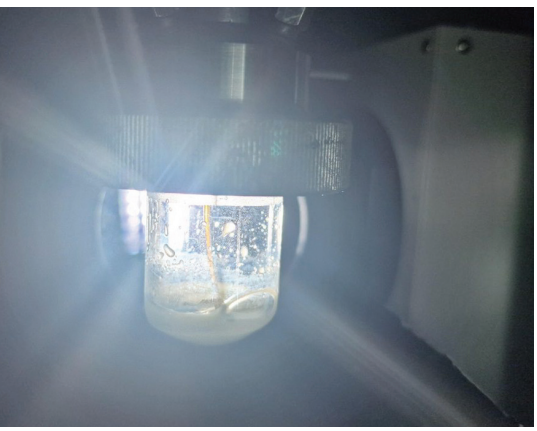
By doing that, their record was broken, and a new record was established, which is 29.1% held by Oxford PV, also. The creation of this perovskite-silicon tandem technology was the main goal of the institution, and the ideas look very promising for its mass production.

The firm is targeting 30% gains in the short term. The cells are equipped with a perovskite layer placed on top of a high-performance silicon solar cell, which allows for reaching a broader segment of the solar spectrum.

Further, companies are devoting themselves to manufacturing perovskite and silicon tandem solar cells, such as Polish company Saule Technologies, which previously reached a record-high 27.6 % efficiency for their tandem cell.

At this point, one idea should be clear: solar panels will not always be made of silicon; there are other materials with which we must innovate. Perovskite has a new ally we have known about for years, but we have yet to learn how it could help us. As you have seen, it has enormous potential to guarantee the conductivity and efficiency we need so much. wn

Scientists use copper to turn CO_2 into sustainable fuel



Adding copper to a photocatalyst quadrupled its efficiency and resulted in the formation of methanol instead of methane.

By Ameya Paleja
Courtesy of Interesting Engineering

Scientists have devised an approach where copper atoms help turn planet-warming carbon dioxide gas (CO_2) into a sustainable fuel.

The team succeeded in generating methanol, which can replace fossil fuels, by shining light on an activated material.

The build-up of CO_2 in the atmosphere is raising global temperatures and accelerating climate change.

CO_2 can be cycled back into products by-products of burning carbon-based fuels. These products can be used again, creating a circular economy around them.

However, these approaches require sourcing hydrogen gas, which also happens from fossil fuels, further increasing emissions.

Photocatalysis and electrocatalysis can use abundant sunlight and water to convert CO_2 into valuable products. However, the process could be more efficient.

So, to enhance the process, researchers from the University of Queensland, University of Ulm, University of Birmingham, and University of Nottingham teamed up.

NEW PHOTOCATALYST FOR CO_2 CONVERSION

In photocatalysis, sunlight is beamed on a semiconductor material to excite the electrons. These electrons travel through the material and react with carbon dioxide and water to make products such as methanol.

Although many materials have been used to achieve this, researchers have sought materials that can efficiently carry charges.

They heated carbon nitride to maximize its properties for photocatalysis. Using magnetron sputtering, the team deposited copper atoms that intimately connect with the semiconductor. The whole process did not use a solvent.

"In our approach, we control the material at the nanoscale," said Madasamy Thangamuthu, a research fellow at the School of Chemistry at the University of Nottingham.

"We developed a new form of carbon nitride with crystalline nanoscale domains that allow efficient interaction with light and sufficient charge separation."

HOW DID THE NEW MATERIAL PERFORM?

"We measured the current generated by light and used it as a criterion to judge the quality of the catalyst," added Tara LeMercier, a PhD student at the University of Nottingham who carried out the laboratory work.

"Even without copper, the new form of

carbon nitride is 44 times more active than traditional carbon nitride."

Adding just one milligram of copper to one gram of carbon nitride quadrupled the efficiency of the photocatalyst.

The researchers said in a press release that instead of making methane—another greenhouse gas—the semiconductor began producing methanol, a valuable fuel.

"It is vitally important to ensure the sustainability of our catalyst materials for this important reaction," said Andrei Khlobystov, a professor at the School of Chemistry at the University of Nottingham.

"A big advantage of the new catalyst is that it consists of sustainable elements – carbon, nitrogen and copper – all highly abundant on our planet."

The invention is essential in understanding photocatalytic materials that can aid CO_2 conversion. It allows for the creation of selective and tuneable catalysts, which can be scaled up by making changes at the nanoscale.

The Metal Atoms on Surfaces and Interfaces (MASI) for Sustainable Future Program in the UK is working to develop catalysts using abundantly available materials such as carbon and nitrogen. The idea is to use these materials instead of rare Earth elements. 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

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.

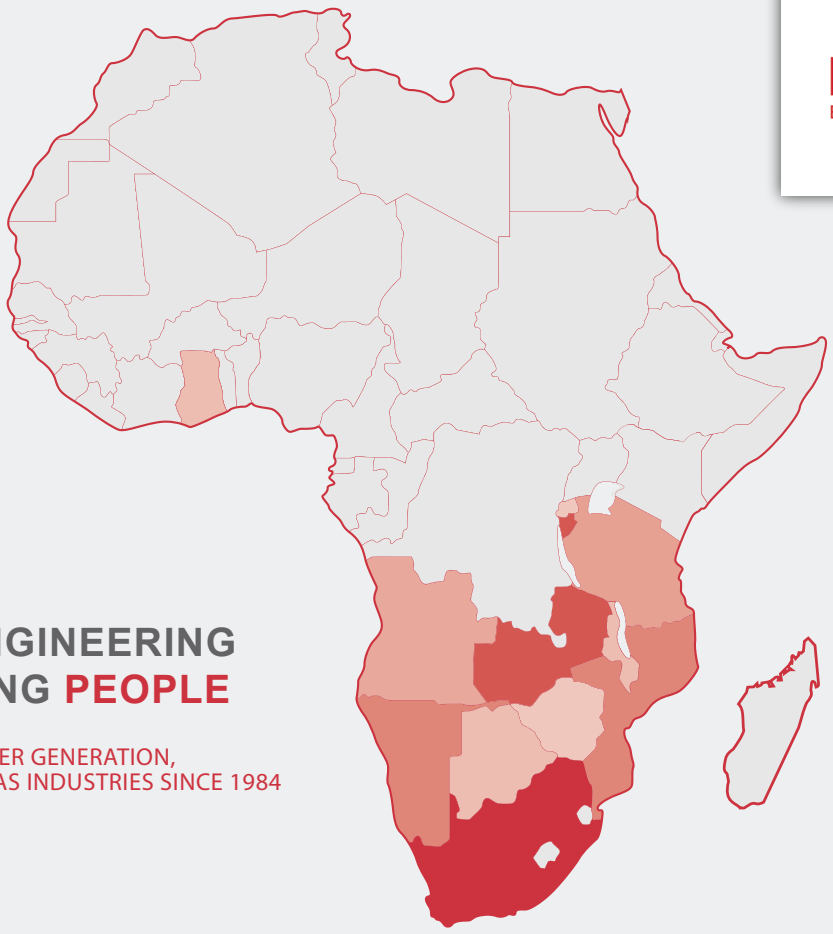
Any engineering student signing up between 1 March and 31 August 2024 will receive free membership for the year. Apply now!

Click here on how to become a member today!

SAIEE

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

LESEDI
ENERGY ENGINEERING



ENERGY ENGINEERING EMPOWERING PEOPLE

BY LEADING THE POWER GENERATION, MINING, AND OIL & GAS INDUSTRIES SINCE 1984

Oil & Gas

- EP&C of the Balance of Plant for Eskom's four Gas Turbine Power Stations constructed in Atlantis and Mossel Bay in the Western Cape, South Africa.
- Mechanical erection of 14x150MW gas turbines for Siemens and associated turbine halls.
- Since 1990, Lesedi has successfully completed projects across Africa, illustrating our expertise.

Mining

- Execution of turnkey engineering projects in the minerals processing and mining industries.
- Through its network of world-class technology partners, Lesedi offers gas-cleaning and emissions control plants for its clients.
- Lesedi provides systems for the capture of dust, tars, acid mists, SO2 and various other acidic gases and contaminants in the mining sector.

Nuclear

- 30 years of upgrade and maintenance projects at Eskom's Koeberg Nuclear Power Station in Cape Town, South Africa, including over 150 modifications on the plant.
- International maintenance services contracts in England, Brazil, China, France and the USA, resulting in over 75 interventions since 2006.

Technology Products

- Lesedi has successfully concluded agency agreements for several state of the art products and services such as CONCO System Inc. and Arkema (DMDS).
- Lesedi performs Mechanical Heat Exchanger and Condenser Tube Cleaning as the African distributor for Conco Services LLC based in the USA. Conco has cleaned over 100 million condenser and heat exchanger tubes, making it the number one condenser and heat exchanger performance company in the world.

Biomass, Waste to Energy & Solar

- Lesedi achieved preferential bidding status for two biomass projects for the South African RIEPPP (16.5MW - sugar cane & 5MW - wood chip).
- More than 20 projects under development in Africa.
- Our global partner has built over 100 bio-energy power plants, totalling more than 2,650 MW.

Thermal

- Balance of Plant for Eskom's Medupi and Kusile Power Station, the biggest dry-cooled power stations in the world.
- Turnkey Engineering contracts for plant life extension and major refurbishments icluding:
  - High frequency power supplies
  - Electrostatic precipitator
  - Ash handling systems

Lesedi is an Engineering Procurement and Construction (EPC), EPCm and Operations and Maintenance (O&M) contractor with a diversified service offering operating in the Power Generation, Mining as well as Oil and Gas sectors. Lesedi executes turnkey bespoke projects from concept and basic design to detailed engineering, procurement, project management, installation and commissioning, as well as project and contract management function.

Lesedi Renewable division capabilities also extend to include: Project Development for Biomass, Biogas, Waste to Energy, Hybrid (Wind, solar, battery) projects in the IPP markets.

BRAND PROMISE

We build trust by engineering integrated solutions that deliver quality to expectations.

Lesedi Skills Academy

The Lesedi The Lesedi Skills Academy (LSA) is the brainchild of Lesedi Nuclear Services. Lesedi (a majority shareholder in the academy) is a leading African engineering, procurement and construction (EPC), and maintenance company with a long history in nuclear, industrial power, mining, oil and gas industries. The Lesedi Skills Academy, a private training provider and an EME (75% BO; 42,62% BFO), opened its doors in 2015.

The Academy provides skills development and training (Mechanical Fitting, Boilermaking & Basic Welding), allowing young people, and previously disadvantaged individuals to enter the formal job market. Through focussed quality training, employed and unemployed learners are provided with the knowledge and skills to progress in the Engineering and related fields.

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www.lesedisa.co.za

Leon van Wyk
CEO - Lesedi Nuclear Services

Leon van Wyk
CEO | Lesedi Nuclear Services

Lesedi, a prominent African Engineering Procurement Construction and Maintenance company, is thrilled to announce the appointment of Mr. Leon van Wyk as its new Chief Executive Officer. This strategic decision marks an exciting milestone following the retirement of Mr. Francis Carruthers, the outgoing CEO and founder of Lesedi, after 22 years of dedicated service.

Leon van Wyk brings an extensive background and a proven record of success in Industrial Markets including utilities and mining portfolios, making him an exceptional choice to lead Lesedi into the future. With a master's degree in engineering and over a decade of experience in Power Generation and related sectors, Leon's vision for Lesedi is clear: "I look forward to leading Lesedi as one of Africa's foremost EPC companies. I believe we are renowned for our excellence in delivering high-quality projects with agility to meet client expectations. By embodying this vision, Lesedi will remain a trusted partner for clients, an employer of choice for top talent, and a catalyst for positive impacts in the EPC industry."

Van Wyk took over the leadership position from Mr Carruthers on the 1st of November 2023, and decided to pose a few questions to him:

WN: Congratulations on your appointment as CEO. What are your top short-term priorities?
LvW: Thank you, what a privilege to lead such a remarkable company and talented group of people. Lesedi has a rich history of achievements over more than 25 years, and we continue to go from strength-to-strength. We have focused considerably to diversify the business from a purely nuclear focused entity to a leading Engineering, Procurement and Construction (EPC) company. With growth comes challenges in organisational design, processes, procedures, and way of work. In the short-term our focus is to organise the company in well-defined business units focussing on distinct industry areas. We pride ourselves in being customer and client relationship driven and with a renewed outlook on business units gives, we can create better focus, increase efficiency, and become more agile. Secondly, but not less important, is our reaction to the changing energy landscape, and the support required to ensure stable, clean, and reliable electricity supply and how we will support the industry needs.

WN: Is this a good time to be in the nuclear industry?
JvW: Absolutely. We are currently experiencing a nuclear renaissance as we strive for a better and environmentally friendly power solution worldwide. I have no doubt that the energy landscape will transition more towards nuclear, not only in South Africa but also most international countries as nuclear has proven to be a safe and reliable way to sustainably ensure grid stability and energy security. South Africa and Lesedi's expertise are well suited and fully capable to support these initiatives and we look forward to the development of nuclear programs in different geographical regions.

WN: What are the opportunities for the industry at present?
LvW: At Lesedi we focus on various forms of power generation ranging from nuclear to renewables and all other forms in between. It is no secret that the

power infrastructure in South Africa has been neglected and run into the ground due to insufficient new investment in large generation capacity and the inability to do proper maintenance. It is encouraging to see that the private sector is starting to invest in larger scale power projects for both grid supply and embedded generation. Within the fact that the current fleet of power stations are to reach end of life shortly, South Africa needs a similar infrastructure build program for energy, like what we had in the 80's. This creates opportunities for a diversified energy mix to be created, that will create 1000's of jobs and significantly boost the economy.

WN: Has the latest draft Integrated Resource Plan (IRP 2023) allocated sufficient capacity to nuclear? If not, why do you think that is?

LvW: Eskom currently has an installed capacity of approx. 55GW which is a combination of thermal coal, hydro, gas, wind and nuclear, with nuclear contributing only 2GW to that total. On average, the base and peak load consumption is between 25 and 30 GW daily. Given the age of the Eskom fleet, majority of these assets will need to be replaced by 2050. The IRP makes provision for 18.5GW of nuclear by then, with the balance being required from a mix of existing coal and new renewables. It has been proven that the baseload component of renewables is well below the installed capacity nameplate value, and although it is absolutely required to have a portion of renewables within our grid, the stability will have to come from elsewhere. I therefore believe that the allocation of 18.5GW of nuclear by 2050 will be excellent if we can achieve this, but we will have to continue a further expansion program to cater for the increase in economic growth and the reliance to stable electricity to achieve that growth.

WN: Is one of the possible reasons related to concerns about safety? If so, what is the industry doing to counter that?

LvW: I believe that the general public is not well informed about the real safety levels that nuclear power generation has. Consider that Koeberg started construction in 1976 and to date has not had a single nuclear related incident. Further to this, technology advancements in reactor protection systems, materials of construction and lessons learned from the worldwide installed base of over 430 nuclear reactors, the technology advancements make power generation from nuclear arguably the safest form of power generation that there is. Lesedi will soon embark on a series of public publications highlighting the safety measures within the nuclear landscape and educate the public to be better informed on a proactive basis.

WN: What is the relationship between Lesedi and the Koeberg Nuclear Power Station?

LvW: Lesedi has a healthy long-standing relationship with Koeberg, and is one of the longest serving contractors to the power plant. We have conducted several safety related modifications, long term safety consideration design and maintenance interventions at the power station including general design improvements. Our teams have also assisted Eskom in more than 50 plant outages with general maintenance and refuelling activities.

WN: How is the project to replace the steam generators progressing?

LvW:The installation of the first three steam generators at Unit 1, was completed at the end of 2023 and the unit reached criticality and full load operation without any concerns. The steam generators are functioning well and have enabled the utility to implement their life extension program. We are currently busy to replace the second set of three steam generators on Unit 2 and at the time of writing all is well in line with the planned schedule.

WN: Is Lesedi involved in discussions about where a new nuclear plant might be located? Is a Koeberg II a realistic option?

LvW: We are not privy to the plans of the DMRE and the location that will be selected. We do believe that the Koeberg site is well placed to be the location since the site is already licensed and permitted for a further 4000MW of nuclear power, already consists of a healthy nuclear safety culture, has access to the grid and the required industry to support this expansion from an operational and maintenance perspective is already in place. wn

DC-DC Power Conversion Topologies for Battery Energy Storage Systems (BESS)

The adoption of renewable energy sources such as solar has seen drastic increases in recent years. Forces driving this development come from factors such as government incentives, improvements in the technology, and lower system costs. While photovoltaic (PV) systems are more justified now than ever before, one major hurdle that still stands is that energy from solar isn't produced when we need it the most.

Paper courtesy from onsemi

The demand on the grid rises in the early morning as people and businesses begin their days and, in the evenings, as people arrive home. However, energy generation from solar ramps throughout the day while the sun is shining, and ultimately is unavailable during high–demand times like in the evening after the sun has set. Due to this fact, renewables like solar are experiencing increased integration of energy storage systems to capture this energy for later use.

Energy storage systems coupled with photovoltaic solar power are typically in the form of battery energy storage systems (BESS). Improvements in BESSs like better, cheaper batteries are apparent, but less spoken about are the utilization of more efficient power conversion methodologies. Before going into details on modern power conversion topologies, it would be appropriate to discuss some important design considerations.

ISOLATED VS. NON–ISOLATED

Isolated power conversion topologies are incorporated in the DC–DC stage by using a transformer to magnetically isolate the primary and secondary sides. Therefore, the primary side and secondary side each have their own respective ground instead of sharing common earth ground. While isolated topologies are more expensive, bulkier, and less efficient due to the addition of a transformer, galvanic isolation is critical in grid–tied applications for safety reasons.

BIDIRECTIONAL POWER CONVERSION

Bidirectional topologies have enabled a reduction in the number of power conversion blocks needed to interface a low voltage BESS to the corresponding high voltage DC–bus. One such example utilizing two bidirectional power conversion blocks is onsemi's 25 kW Fast DC EV Charging Reference Design. This bidirectional converter interfaces with the grid to charge DC batteries in electric vehicles. The AC–DC stage utilizes a three–phase 6–pack boost active front end while the DC–DC stage uses a Dual Active Bridge (DAB) topology. The DC–DC DAB is one of the more popular topologies that will be discussed shortly.

HARD SWITCHING VS. SOFT SWITCHING

Traditional power converters utilize hard switching control schemes. The issue with hard switching is the overlap as the drain to source voltage (VDS) decreases and the drain current (ID) increases as a transistor switches from the on to off state and vice versa. This overlap creates power losses referred to as turn–on and turn–off switching losses. Soft switching is a control scheme used to limit the switching losses by delaying the ID ramp until VDS is near zero for turn–

on and the VDS ramp until ID is near zero for turn–off. This delay is referred to as dead time and our current/voltage ramps are referred to as zero voltage and zero current switching respectively. Soft switching can be implemented with resonant switching topologies such as LLC and CLLC converters to drastically reduce switching losses.

TWO–LEVEL VS. THREE–LEVEL TOPOLOGIES (UNIPOLAR VS. BIPOLAR)

Three–level converter topologies have an advantage over two–level topologies for a few reasons. First, three–level topologies have lower switching losses than two–level topologies. Switching losses are proportional to the voltage applied to the switches squared (V2), and with three–level topologies, only half of the total output voltage is seen by (some of) the switches. Other improvements come from lower current ripple and EMI. Again, only half the total output voltage is applied to the boost inductors, therefore reducing current ripple, and making this easier to filter. EMI is directly tied to current ripple, and with lower current ripple we also lower the EMI. EMI is further reduced due to the lower dV/dt and dI/dt from the lower peak–to–peak switching voltage.

WIDE BANDGAP TECHNOLOGY

Wide bandgap technologies such as Silicon Carbide (SiC) have further enabled efficiency increases in power conversion systems. Due to the inherent properties of these devices, they have many benefits over traditional silicon MOSFETs. Some important factors are higher breakdown voltage devices due to the higher breakdown field and bandgap energy, increased thermal conductivity for reduced cooling requirements, lower on–state resistance for improved conduction losses, and higher electron saturation velocity, enabling faster switching speeds.

DC–DC TOPOLOGIES

SYNCHRONOUS BUCK, SYNCHRONOUS BOOST, AND FLYBACK CONVERTER

A Synchronous converter is derived from the classic buck and boost converters. The synchronous converter is named so for its replacement of the diode with an additional active switch. A flyback converter is similar to a synchronous converter but adds isolation by replacing the inductor with a coupled inductor, also known as a 1:1 transformer. The addition of this transformer may provide the benefit of isolation but will likely require a voltage clamp snubber circuit to suppress the leakage current of the transformer. These converters are lower cost due to their simple construction and modulation schemes but tend to

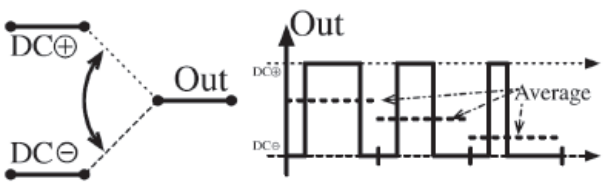


Figure 1: Two-level Topology Operation

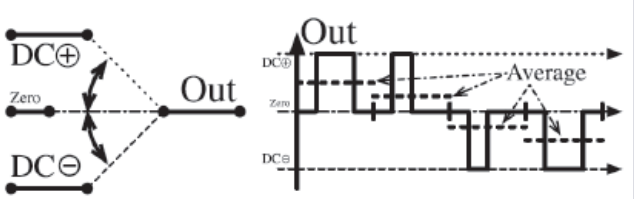


Figure 2: Three-level Topology Operation

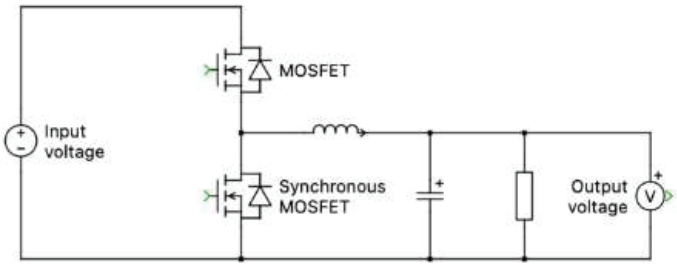


Figure 3. Synchronous Buck

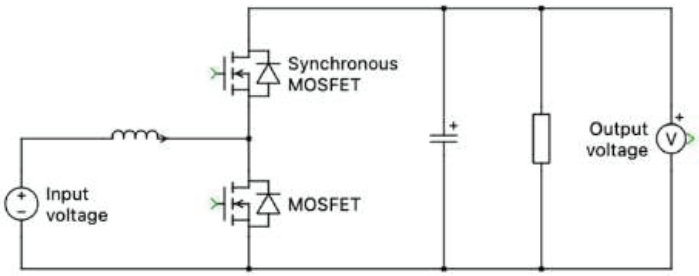


Figure 4. Synchronous Boost

have higher losses and electromagnetic interference (EMI) as opposed to some of the more advanced topologies.

SYMMETRIC BUCK–BOOST

The Symmetric Buck–Boost is an example of a three–level topology incorporated into higher power systems. As mentioned previously, with standard two–level converters, the voltage stress across the switches will be the total bus voltage, which for higher power systems could be 1000 V or more. This requires the use of 1200 V transistors and above in higher power systems. Three–level topologies like this symmetric buck–boost only require devices rated at half the bus voltage and have the added benefit of reduced switching losses, EMI, and smaller magnetics. Disadvantages are derived from the need for more switches and more complex control algorithms.

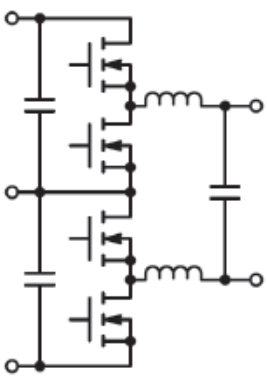


Figure 5. Three–level Symmetric Buck–Boost

FLYING CAPACITOR CONVERTER (FCC)

The Flying Capacitor Converter (FCC) is a three–level converter and with this configuration capable of bidirectional power flow. It consists of four switches, one inductor, and a flying capacitor connected across the two middle switches. Since this is a three–level topology, this also has the benefit of half the voltage stress across the switches due to the flying capacitor acting as a clamping capacitor (or a constant voltage source). Therefore, advantages of this topology are the use of lower voltage, higher performance switches, smaller passives, and reduced EMI.

A disadvantage of this circuit topology is that a startup circuit must be implemented to regulate the voltage of the flying capacitor to half the bus voltage to realize the benefit of using lower voltage switches.

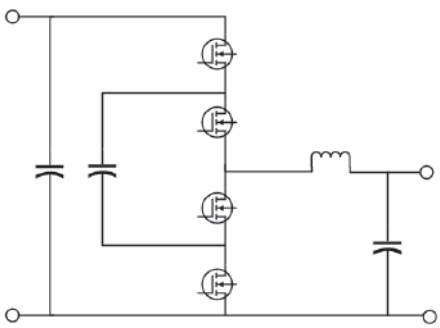


Figure 6. Three–level Bidirectional Flying Capacitor Converter

DUAL ACTIVE BRIDGE (DAB)

The DAB is one of the most common isolated bidirectional topologies. As seen in Figure 7 below, there is a full bridge configuration on both the primary side and secondary side. Each bridge is controlled to provide a square wave that is phase shifted with respect to each other to control the power flow direction. Some advantages seen with this topology are the fact that the voltage stress across each switch is limited to the bus voltage, that the current stress through all switches is about equal on both sides, and that there are no additional components (such as a resonant circuit) required to implement soft switching. Some disadvantages are that filtering circuits are important due to the high current ripple and the converter may lose soft–switching capability in light load conditions.

LLC CONVERTER

An LLC converter is a type of resonant topology that can take advantage of soft switching techniques. The figures below show this topology can be in either a half–bridge or full–bridge configuration on the primary side. LLC converters are typically operated in a unidirectional mode but can be augmented to operate bidirectionally by swapping the present diodes for active switches. The resonant tank of this circuit features a resonant inductor, a resonant capacitor, and a magnetizing inductor. One benefit

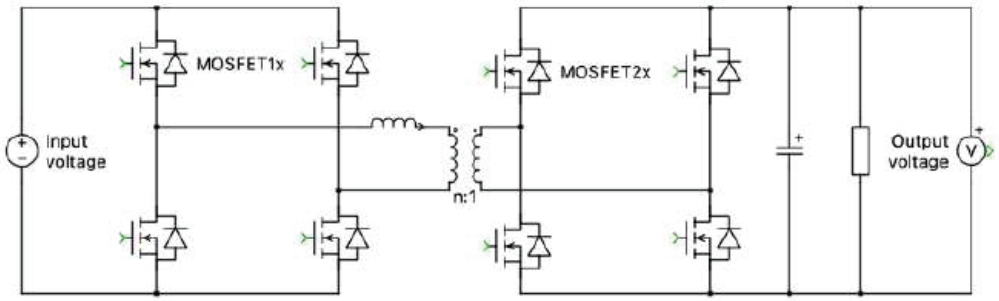


Figure 7. Bidirectional Dual Active Bridge

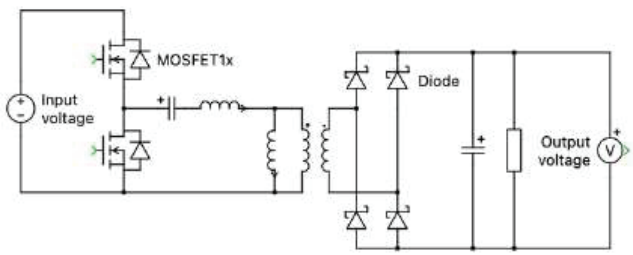


Figure 8. Half–bridge LLC Converter

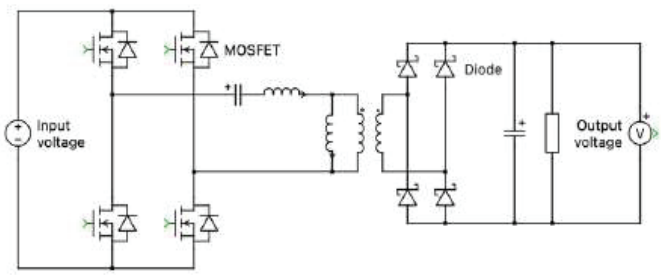


Figure 9. Full–bridge LLC Converter

over the previous DAB topology is maintaining soft switching over the full load range.

CLLC CONVERTER

The CLLC converter is another type of resonant topology that can take advantage of soft switching techniques and bidirectional power flow. It contains a resonant inductor and a resonant capacitor on both the primary side and secondary side. One benefit of this circuit and other circuits containing a full bridge on both the primary side and secondary side is the control schematics will be the same.

Additionally, like the previous LLC Converter, the CLLC is valid for soft switching over the full load range. However, one reason CLLC may be preferable over an LLC topology is due to the symmetrical resonant tank. The LLC topology has an asymmetrical resonant tank resulting in reverse operation being different than forward operation. The CLLC with its symmetrical resonant tank resolves this issue and therefore is easier to implement for bidirectional chargers.

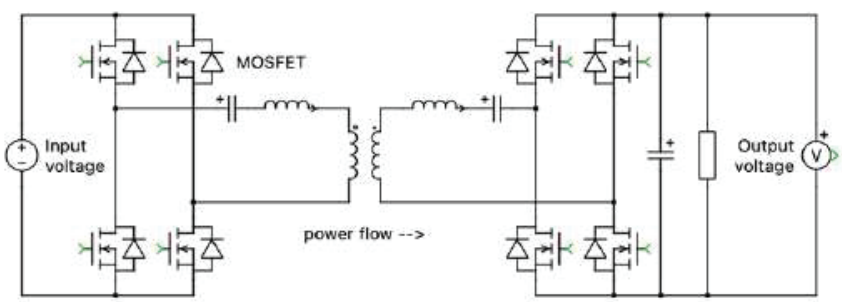


Figure 10. Bidirectional CLLC Converter

CONCLUSION

Battery energy storage systems are continuing to evolve and see greater adoption alongside renewable energy generation sources, creating the need for more efficient and more reliable power conversion systems. This paper discussed important features of modern power conversion systems and some common DC–DC circuit topologies that implement them. Many of the circuit topologies discussed in this paper can be simulated using onsemi's free–to–use, online, PLECS–based Elite Power Simulator for a more in–depth look at device–level and system–level efficiencies. For more information, please check out onsemi.com for the latest on industry–leading design resources and innovative technologies for energy infrastructure applications.

Comparing switching topologies for solar inverter designs

The increasingly urgent requirement to reduce carbon emissions has caused a surge in the popularity of renewable energy sources such as solar inverter systems. These require lightweight, efficient, and high power-density inverters which can be interconnected to the grid.

By Damijan Zupancic
Application Marketing Manager
Solar & ESS at Infineon Technologies

Traditionally, insulated gate bipolar transistors (IGBT) have been the preferred option for both three-phase and single-phase (≤10 kW) solar inverters while silicon super-junction (SJ) MOSFETs (600/650 V) have also been employed in some single-phase applications. However, IGBTs and Si SJ MOSFETs both limit the efficiency and power density that solar inverters can attain.

More recently, two alternative approaches have begun to attract attention – the first involves replacing IGBT and silicon SJ MOSFETs with wide bandgap devices like silicon carbide (SiC) MOSFETs while the second approach replaces traditional circuit topologies with a multilevel topology that can continue to employ lower voltage silicon MOSFETs. In this article, we discuss the relative merits of each approach and shows how they can both be used to achieve efficiency levels of up to 99% in solar inverter designs.

OPTION 1: SIC MOSFETS REPLACE IGBTS AND SI SJ MOSFETS

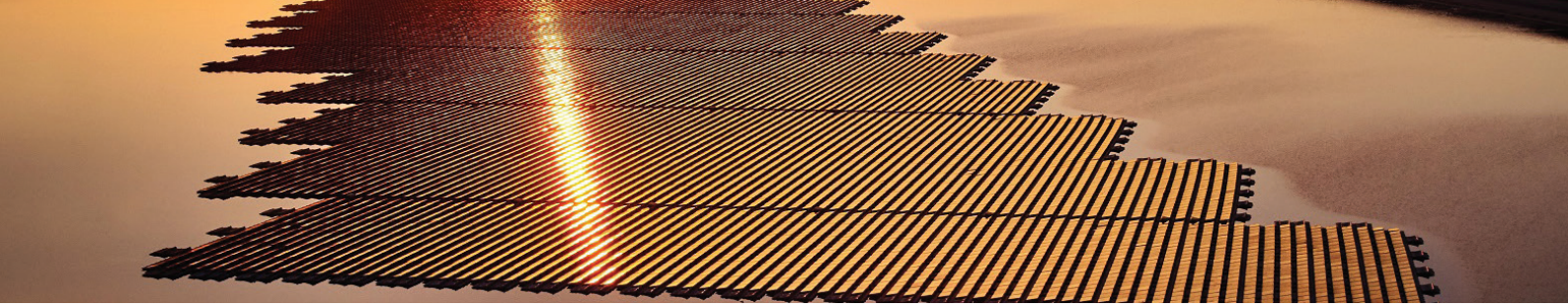
Due to their high switching losses, it only makes sense to use IGBTs in applications with switching frequencies below 20 kHz. SJ MOSFETs have high reverse recovery charge (Qrr), slow body diode, and relatively high $R_{DS(on)}$ which negatively impact their operation in inverter applications. These drawbacks limit the operating efficiency and power density achievable using either of these devices in typical single-phase solar inverter designs to a maximum of 98%.

On the other hand, SiC MOSFETs feature fast body diodes, have very low Qrr, and exhibit lower switching losses than IGBTs. Infineon's 650V CoolSiC MOSFETs can replace IGBTs and Si SJ MOSFETs without the requirement to modify the circuit topology used in an inverter. SiC MOSFETs can switch at higher frequencies, which means smaller filter components (inductor, capacitor) can be used and this has the benefit of reducing the size and weight of the inverter enclosure, delivering cost savings in line with increasing power levels. SiC MOSFETs also have significantly lower switching losses than SJ MOSFTETs.

Figure 1 shows how Infineon's 650V CFD7 CoolSiC MOSFETs against alternative SJ MOSFETs under identical operating conditi- ons and for the same $R_{DS(on)}$.

Figure 2 shows the conduction losses for three best-in-class switches from Infineon, including the IKW30N65H5 650V TRENCHSTOP 5 IGBT, the IPW60R031CFD7 600V CoolMOS CFD7 silicon SJ MOSFET and the IMW65R027M1H 650V CoolSiC MOSFET at junction temperatures of 25°C (left) and 125°C (right).

It is clear that while the conduction losses of IGBTs are significantly higher



than for the other devices at 25°C, losses do not increase further as the junction temperature increases to 125°C. It can also be seen that the conduction losses of the SJ MOSFET at 125°C are twice those at 25°C. Finally, losses in the SiC MOSFET only increase by approximately 20% over the entire temperature range, giving an advantage over silicon MOSFETs in high current, high-temperature applications such as a solar inverter.

SCENARIO 2: CHANGING TO MULTILEVEL CIRCUIT TOPOLOGIES

Topologies like Heric, H6, H6.5, employing 650 V IGBT and 650V SJ MOSFET devices are commonly used in conventional single- phase solar inverter designs. However, a new multilevel topology based on medium-voltage MOSFETs (150 V to 200 V) has emerged as potential alternative (Figure 3).

Compared to the conventional approach, the multilevel topology has the advantage of requiring a much smaller inductor and capacitor, thus enabling a higher power density solar inverter design that requires less cooling.

Furthermore, while adopting a multilevel approach requires using more medium voltage MOSFETs, the heat dissipated due to power losses is distributed across more devices, simplifying thermal management, and potentially enabling inverter designs that don't require fans or heatsinks. Semiconductor components

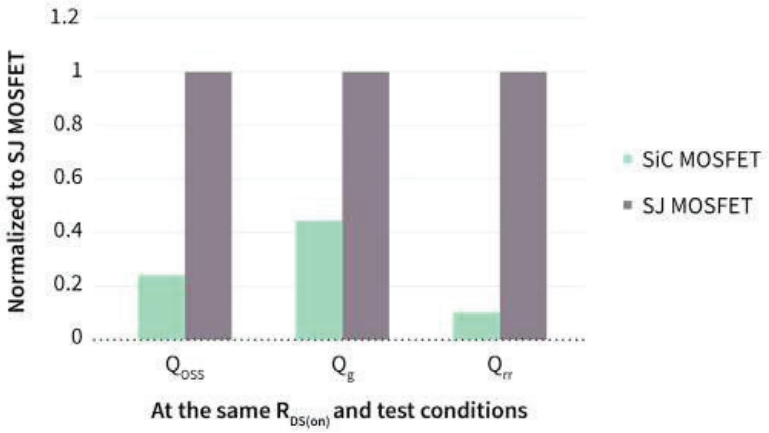


Figure 1 Comparing figures-of-merit for SiC and SJ MOSFETs at the same opera- ting conditions and $R_{DS(on)}$

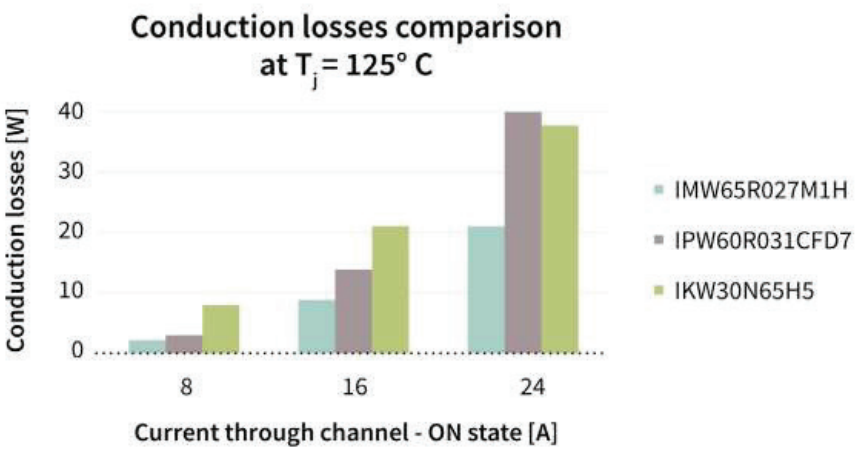


Figure 2 Comparing device conduction losses at 25°C (left) and 125°C (right)

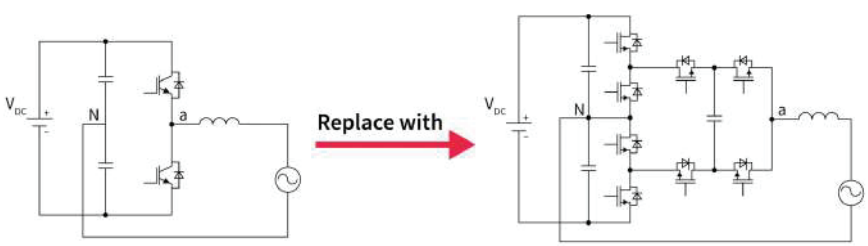


Figure 3 Replacing a two-level topology with a multilevel topology

typically contribute less than 10% of the overall bill of materials (BOM) in a single-phase string inverter (≥ 3 kW).

In comparison, the cooling system and passive components (capacitors and inductors), contribute 30-40% of the overall cost.

In addition, while the price of semiconductor components tends to reduce over time, the cost of passive components is relatively static.

Therefore, for existing single-phase solar inverters operating at power levels exceeding 3 kW, moving to a multi-level topology (which uses smaller passives and more semiconductor devices) makes sense because it can deliver cost savings. Inverters with higher power ratings can realize even greater cost savings by moving to a multi-level topology.

Another significant advantage of multilevel inverters is that the lower power loss per device allows smaller MOSFETs in surface mount (SMD) packages to be employed. SMD packages are ideally suited for use in automated pick and place processes, reducing system assembly costs.

Furthermore, smaller packages have lower inductance, which helps to improve switching performance at higher frequencies. Another significant advantage of multilevel inverters is their scalability to higher power levels using an almost identical design and board layout.

Table 1 Multilevel inverter specifications

Input DC voltage (V_{DC}), load	400 V, passive RL load
Switch type	2×BSC093N15NS5 (150 V/9.3 mΩ), overall 48 MOSFETs, gate driver: 12×2EDF7275F
The effective output switching frequency	40 kHz
DC relay switch (DRS)	2×IPT60R022S7
Max. continuous power	4000 VA

Table 1 Design specifications for the proposed multi-level inverter

However, it should be noted that compared to conventional topologies, multi-level inverters require a higher number of gate drivers and isolated power supplies.

4KW MV MOSFET MULTILEVEL SOLAR INVERTER WITH NO FAN OR HEATSINK

To investigate the performance of the proposed multi-level topology, Infineon built a 4 kW, five-level single-phase flying-capacitor-based active neutral point clamped multilevel inverter demonstration board (Figure 4) based

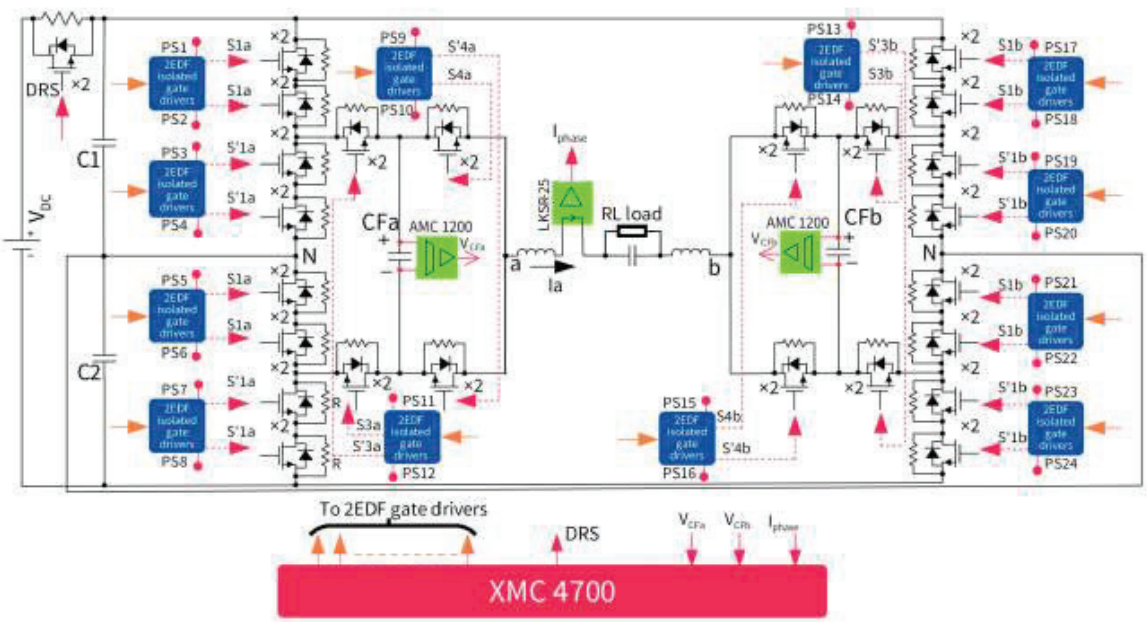


Figure 4 Schematic of the five level inverter design

on the design specifications shown in Table 1. An advantage of this multi-level design was it could use 150V 9.3 mΩ OptiMOS 5 150 V (BSC093N15NS5) MOSFETs, even though the bus voltage was 400 VDC.

Figure 5 shows the efficiency of this design measured with respect to output power. It delivered a maximum efficiency of 99.1% at ~2kW of output power. At full load (4 kW), it continued to deliver exceptionally high efficiency (98.7%) percent. A heat map of the board at full output power showed that the maximum component temperature measure was less than 85℃.

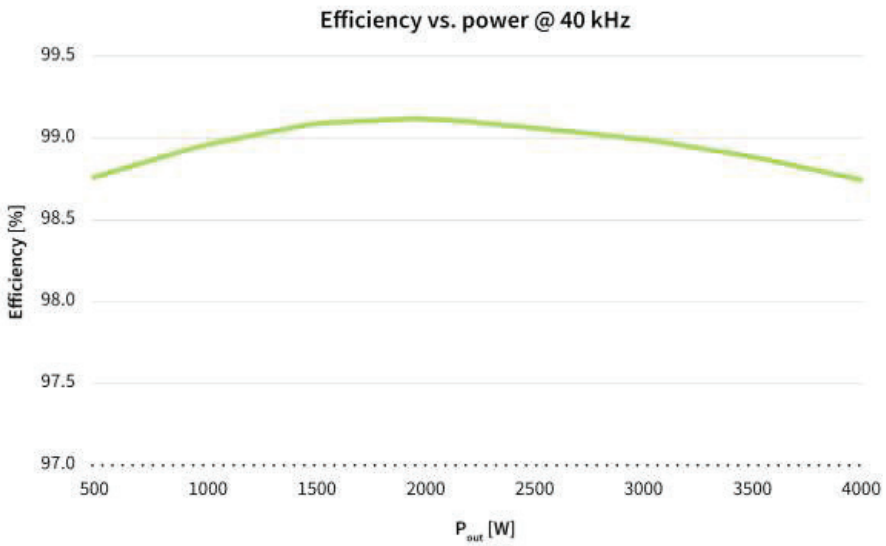


Figure 5 Efficiency vs. output power for the five level inverter (@ 40 kHz switching frequency)

These efficiency and temperature figures explain why this multilevel inverter can work continuously without the requirement for a heatsink or fan.

CONCLUSION

While replacing silicon-based devices with SiC MOSFETs is easier than changing the inverter topology, this approach does not improve efficiency and power density as much as the multilevel approach, meaning a heatsink is still required at lower power levels and forced cooling may be required at higher power ratings (> 5 kW).

While a multilevel topology is more complex, it can deliver in excess of 99% efficiency and high power density, making the design effort worthwhile. WN

A Review of The Model for Cognitive Robotics for Assistive Living and Medical Rehabilitation

This research presents a Brain-Computer Interface (BCI) system implemented in a robotic wheelchair to assist people with disability relating to the use of their body. There is a growing need to integrate the human brain (the nervous system) and the computer (network), especially in cases where medical interventions have failed, to improve the quality of life of people with body impairment.

By Adimchinobi Daniel Asiegbu (Cand. PhD)
University of Johannesburg

The brain, consisting of neurons (differentiated and specialised electrically active and signalling cells), generates, interprets, transmits, and receives varying electric fields with very low frequencies. Since power is directly proportional to frequency, the signal power in the neuron mesh is low but contains robust information that can be highly beneficial in the BCI architecture.

The human brain, involved in an intense active or mental action for an extended period, forms more neuronal networks (mesh) than the human brain, with less active mental activity for the same period. Low-frequency electromagnetic waves generated by the electrical activities in the human brain are obtained using an electroencephalogram (EEG). Thus, in this research, the electroencephalographic signals provide the opportunity for three basic mental tasks: the imagination of left- and right-hand movements and word production that starts in the same random letter.

The data set retrieved from this research is used to perform a real-time classification simulation, implementing the pseudo-online method to provide an initial view of the BCI configuration. Linear Algebra Discriminant Analysis (LADA) is applied to unveil the mental activity equivalent to the perceived tasks.

The retrieved data feature is extracted using Power Spectral Density (PSD), and Kullback-Leibler Symmetric Divergence (KLSD) reveals the appropriate frequency range and EEG channel required.

Then, a model for reclassification is presented to help with classifier stabilisation. Sampled class separation is presented in a data array visualisation form (the Sammon Map).

BACKGROUND/JUSTIFICATION

Various methods have been implemented to assist people unable to use their body to perform everyday activities like walking, talking, etc. One such method is the BCI coupled with a robotic wheelchair.

The BCI analysis is done to restore some or all the lost bodily functions using external devices like prosthetics and robotic wheelchairs. This will benefit patients who have partially or fully lost the ability to perform some everyday activities, like patients of Amyotrophic Lateral Sclerosis (ALS) or Duchenne Muscular Dystrophy (DMD).

The human brain is the control and central processing unit of the human body. It coordinates various activities, such as speech, hearing, balance, movement, temperature, sight, touch (pressure), and pain.

The transducers involved in performing these functions constitute the target organs. These target or transducer organs, like the eyes, ears, muscles, skin, vocal cords, etc., generate electrical activities by producing Action Potentials (APs); the APs produce and propagate appropriate electrical signals representing the stimuli.

These stimuli travelling through the myelinated insulated nerve fibres produce a low frequency and weak electric field since a current-carrying conductor produces an electric field, and the direction of the electric field is dependent on the direction of the current flow.

Also, the higher the magnitude of the potential difference between the conductor ends, the stronger the electric field strength. This allows transmitting or retrieving information from the brain to the prosthetics or the robotic wheelchair. In previous years, active research on assisting people with neural-related disabilities using the various CBIs has yielded good results. However, there is a need to deepen the analysis to ensure a better patient experience.

The CBI implemented in the robotic wheelchair can be a game changer by utilising the APs yielding electric field signals retrieved from striated muscle tissues using Electromyogram (EMG), semi-striated muscle tissues like the cardio or heart tissues, and smooth or semi-smooth muscle tissues like eye (muscle tissues) blinks, using the signals from Electrooculogram (EOG).

Also, the signals obtained using a camera can solve the problem of maintaining head or eye positions in space.

A BCI will be developed to allow a patient to be accustomed to the robotic wheelchair, particularly patients who lost virtually all voluntary movements, especially in Cerebral Palsy (CP) related conditions.

To achieve this goal, a speaker that receives a BCI feedback signal to generate the required sound is incorporated into the robotic wheelchair, limiting the options presented by the pre-defined places in the given environment, but with the option of using dynamic maps application for the movement of the robotic wheelchair.

PROBLEM STATEMENT

Due to the need to assist partially or fully locked-in patients to carry out major daily activities that will drastically improve the quality of their lives, the BCI is developed in a way that allows the acquisition of data through low-frequency signal retrieved by the EEG, which is related to the mental activities in the form of the electrical activities in the human (patient) brain. Researchers in the BCI have proposed a valuable method of processing the acquired brain electrical activities (signal), culminating in the extraction of features and the overall classification of the acquired data pattern. Some of these methods are outlined below:

- Performing offline overall classification tasks involving motor sensations in a period equal to 12s, selecting channel C3 and channel C4 of the EEG, signal filtration to isolate 8 – 12
- α-low frequency signal interval or band and 16 – 25 Hz β-low signal frequency range or band, and performing Linear Algebra Discriminant Analysis (LADA) by implementing Coefficients of Autoregressive Model (CARM), which serves as the classifier linear discriminant [1].
- The performance of motor task image offline task overall classification in a period of 9s, using the C3 channel and C4 channel of the EEG, with filtration of the low-frequency signal of 10 – 12 Hz range, using LADA for the data pattern classifier [2].
- Performing finger movements offline overall classification using pre-movement potential, also known as the Bereitschaftspotential in a period of 600 milliseconds using channel C3 and channel C4

EEG low signal filtration, resulting in two separate low-frequency pass range of 0 – 3 Hz and 9 – 31 Hz, realised by the application of Artificial Neural Network (ANN) for classification, and Common Spatial Subspace Decomposition (CSSD) of data classifier pattern [3], [4].

- Performing pseudo-online three mental activity or task classification using 32 electrode connections offering low-signal frequency filtration in the 8 – 30 Hz range. This is followed by using LADA for data classification, and feature extraction is achieved by Short-Time Principal Component Analysis (STPCA) [5], [6].
- Performing fully online pre-movement potentials classification with feedback from the patient, accomplished by applying 128 electrodes with the aid of LADA and Common Spatial Pattern (CSP) [7].

The research will assist patients with disability using BCI three brain activities with application to the wheelchair. These three activities are

- Left-hand movement anticipation
- Right-hand movement anticipation
- Anticipated word production having randomised letters at the beginning of the words.

The EEG complex time series signal exhibits characteristic fluctuations depending on the analysed channel in the recorded EEG signal [8], and it is analysed using the Auto-correlation Function (ACF) and Nonlinear Auto-correlation Function to estimate the best parameters to perform an online classification. Power Spectral Density (PSD) is used for feature extraction [9], Kullback- Leibler Symmetric Divergence (KLSD) is used for a feature selection process and data navigation [10], and LADA is used for classification [11].

SUB-PROBLEMS

The Sub-problem in this research includes the following:

1. The difficulty in precisely acquiring low-frequency signals emitted by the brain activities or mental tasks. These weak signals have been generated from low AP power sources, passing through different insulated and protected brain layers, and they are of low frequency.
2. The acquired signal data needs to be processed and related to real-life scenarios of imagined or anticipated tasks. This process is referred to as feature extraction. It must be done carefully to avoid misinterpreting or misrepresenting the anticipated tasks.
3. The issues with data pattern classifications after extracted features must be mitigated.
4. Achieving reclassification with the same sampling rate to improve overall outcomes in carrying out the mental tasks.
5. Difficulty associated with the stabilisation of classifications.

IMPORTANCE/BENEFITS OF STUDY.

After some practice, a method for stabilisation of classifications is achieved. This is very important in aiding the CBI application to the wheelchair and making it easy for the patient to use.

This research reveals that the time window can be related to the classification window, which aids the reclassification process.

The reclassification obtained is equal to the sample rate of the acquired signal, resulting in uniform information exchange.

Thus, the class with the highest classifier output is assigned the highest weight. The rest of the weight assignment continues in the same order. This means that the weight reflects the subgroup size of the classification window.

The weight is a handy parameter; it provides reliability to the CBI application to the wheelchair and accords importance to the imagined tasks, as ranked by the patient.

The mathematical tool of inverse probability of repeated tasks is used to calculate the weight. This gives more control to the patient or user, as the case may be.

DELIMITATION OF STUDY

Support Vector Machine (SVM) or Regularized Discriminant Analysis (RDA) classifiers associated method is not considered in this research because it will form part of extended research that offers the option of applying only mental tasks in the CBI control of the wheelchair.

Also, the replacement of randomised words with the imagination of foot movement is not considered in this research, as it will form part of future research in the CBI area.

REFERENCES

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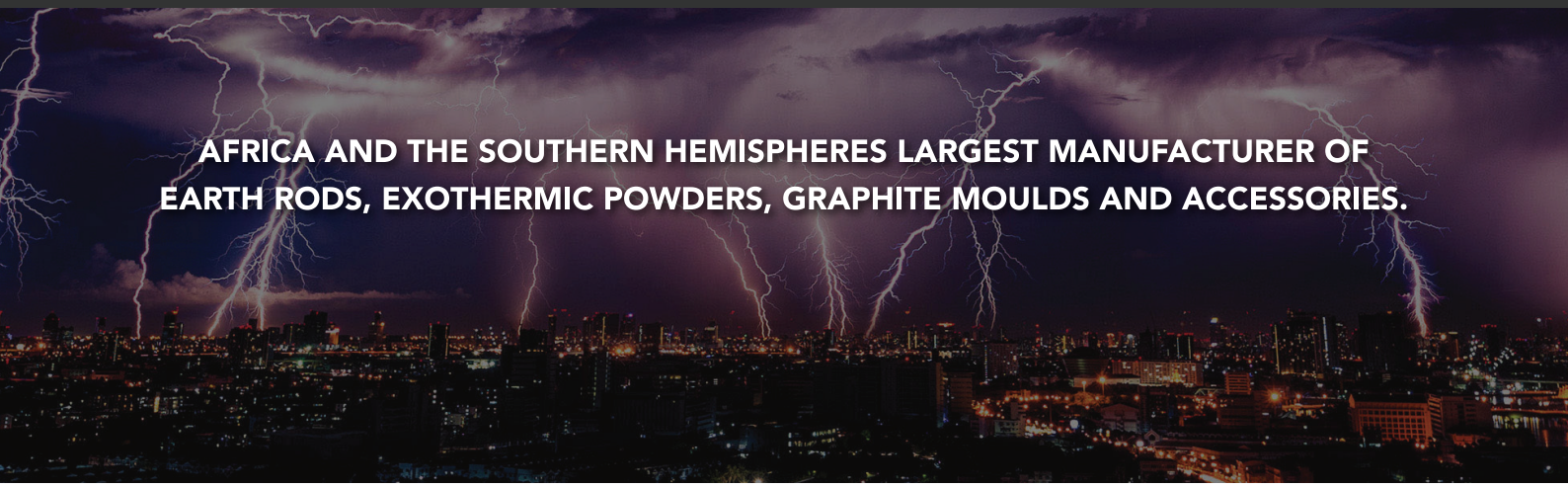
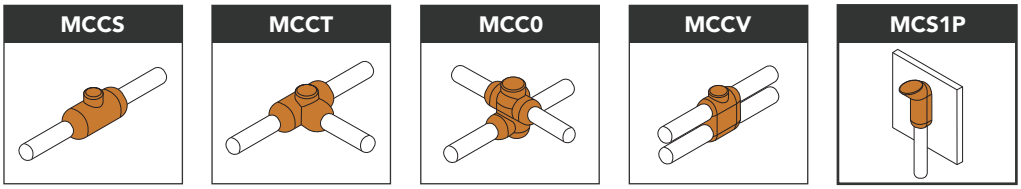


AFRICA AND THE SOUTHERN HEMISPHERES LARGEST MANUFACTURER OF EARTH RODS, EXOTHERMIC POWDERS, GRAPHITE MOULDS AND ACCESSORIES.



EXOTHERMIC CONNECTIONS

TOOLKIT

CONCRETE PRODUCTS

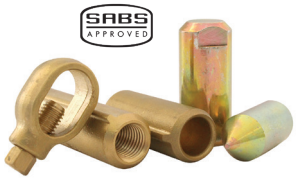
PLASTIC EARTH PITS

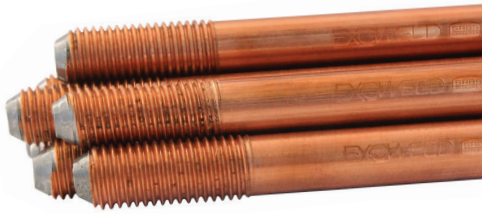
BSi British Standards

BACKFILL

IEC

EARTH ROD ACCESSORIES





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"this most excellent canopy, the air, look you, this brave o'erhanging firmament, this majestical roof fretted with golden fire, why, it appears no other thing to me than a foul and pestilent congregation of vapours."

Hamlet, Act II, Scene II, William Shakespeare.

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Air, claimed by Aristotle as one of Earth's four fundamental elements, was universally accepted more like a law of science than a stated opinion (openly disagreeing with Aristotle's authority and theories could have unhappy consequences, as Copernicus was to fear and Galileo was to discover); prevailed for more than 2000 years. The 'pneumatic' chemists finally found the natural elements of air, although they still supinely submitted to Aristotle's 'Law' by calling them "air". From 1774 through to 1776:

- Joseph Black discovered 'fixed air' (carbon dioxide).
- Daniel Rutherford discovered 'noxious' or 'phlogisticated air' (nitrogen).
- Henry Cavendish discovered 'inflammable air' (hydrogen).
- Joseph Priestly discovered 'dephlogisticated air' (oxygen), and, on a hint from Benjamin Franklin, Alessandro Volta, claimed to have found (methane) although it was probably already known as marsh gas.
- Antoine Lavoisier (1743-1794) was sceptical of Aristotle's theories. He debunked the phlogiston theory, which held that energy was a fluid that could flow from one substance to another, and renamed the discoveries 'gases.'
- John Dalton (1766-1844) finally 'killed off' Aristotle's 'elements,' forever, which had held back the progress of science, by his 'Atomic Theory', published in 1808, which opened up a path to the discovery of the natural elements we know today!

Scientists soon discovered the composition and percentages of gases comprising the Earth's atmosphere, as detailed in the British and International Standard BS ISO 14222:2022, "Space environment (natural and artificial). Earth's atmosphere from ground level upward," updated 2022.

The effect of the atmosphere on temperature was first observed by the French physicist and mathematician Joseph Fourier (1768-1830), who postulated that some of the infrared radiation as the Earth cools is retained by the atmosphere instead of returning to space. He wrote in 1824 that *"the temperature [of the Earth] can be augmented by the interposition of the atmosphere because the heat in the state of light finds less resistance in penetrating the air than in repassing into the air when converted into non-luminous heat (black body radiation -or infrared radiation)".*

In 1836, Claude Pouillet wrote; *"the atmospheric stratum... exercises a greater absorption upon the terrestrial than the solar rays".*

If atmospheric gases capture heat as the Earth cools, this could upset the heat balance, and in theory, the Earth could get hotter and hotter until there is 'runaway global warming.'

The Inter-government Panel on Climate Change (IPCC) states that by burning fossil fuels through industrial activity, we are causing anthropological climate change by emitting additional carbon dioxide into the Earth's atmosphere.

Additional heating has been termed 'the greenhouse effect', and the gases that absorb this infrared radiation have consequently been called 'greenhouse gases (GHGs).

GREENHOUSE GASES

John Tyndall (1820-1893) *"was the first to correctly measure the relative infrared absorptive powers of nitrogen, oxygen, water vapour, carbon dioxide, ozone, methane, and other trace gases and vapours. He concluded that water vapour is the strongest absorber of radiant heat in the atmosphere and is the principal gas controlling air temperature. Absorption by the other gases is not negligible but relatively small."*

Svante Arrhenius (1859-1927), a Swedish chemist, 1896 whilst trying to explain a reason for the Ice Ages, attempted to calculate the extent to which the burning of coal could impact the amount of carbon dioxide in the atmosphere and came out with the hypothesis that emissions from human activities could lead to some global warming. He stated in his book, ("Worlds in the Making" p54), *"Although the sea, by absorbing carbonic acid, acts as a regulator of huge capacity, which takes up about five-sixths of the produced carbonic acid, we yet recognise that the slight percentage of carbonic acid in the atmosphere may by the advances of industry be changed to a noticeable degree in the course of a few centuries."*

He also said, *"We may find a consolation in the consideration that here, as in every other case, there is good mixed with evil. By the influence of the increasing percentage of carbonic acid (carbon dioxide + water vapour) in the atmosphere, we may hope to enjoy ages with more equable and better climates, especially as regards the colder regions of the Earth, ages when the Earth will bring forth much more abundant crops than at present, for the benefit of rapidly propagating mankind."*

POLITICS AND NON-SCIENTIFIC CLAIMS

Although these observances had been known for many years, it was only in 2004, with the release of the science fiction blockbuster film, "The Day after Tomorrow", a film intended to shock and frighten people about the horrific consequences of 'runaway' global warming, fantasy climate change scenarios started to be pursued aggressively.

Now at the present day, the theory is supported by many prominent public leaders who have little or no scientific background, such as politicians, the current Pope, church leaders, including the Archbishop of Canterbury, Head of the Anglican Church, so-called 'environmental' organisations (the Sierra Club, Greenpeace, Friends of the Earth etc.,) Prince Charles (as he was then) and others. In 2006, the documentary *"An Inconvenient Truth"* was released.

In the same year, Presidential candidate Al Gore published a book (in which there were many inconsistencies and unproven 'facts') of the same name and made millions of dollars as an 'activist' from his lecture tours. Sensationalism prevailed over reason, logic and common sense. Similar to Aristotle's 'elements', 'Climate Change' became almost a religion threatening to persecute deniers and non-believers! Without authorisation, governments began to pour public money to subsidise and push carbon-free 'renewable energy' and the 'Green Dream' and 'Net Zero' policy of the European Union. Many politicians claim that Climate Change is the greatest crisis facing the Earth. The use of fossil fuels was decried as almost criminal, and the nuclear option was ignored. Only a few years earlier, fossil fuels were being promoted to undermine nuclear energy, even though nuclear energy was known to be carbon-free; in fact, if climate change can be proved, the only viable alternative to fossil fuels is nuclear energy, known to be the safest, cheapest, most reliable, cleanest, environmentally friendly sustainable energy which could easily replace many of the others but strongly shunned by 'environmental' organisations.

Many indeed paid scientists to support climate change theories, but as employees, their livelihood and that of their dependents rely on regular employment. Some have already been

dismissed for entertaining 'wrong' opinions. One of the prominent founder members of Greenpeace, Dr Patrick Moore, a Canadian Environmental Consultant, was ostracised for his support of nuclear energy. He stated, *"We have no reason to be against nuclear energy other than prejudice and stupidity"*; disappointment was expressed that 'environmental darling' of Gaia theory fame, Dr James Lovelock expressed support for nuclear energy. He stated, *"that only nuclear power can now halt global warming"* and urged fellow 'green' activists to drop their 'wrongheaded' objection to nuclear but 'environmental organisations' continued to ignore his advice and *'this mental error'* was seemingly overlooked and forgiven. He believed that *"nuclear energy is the only realistic alternative to fossil fuels"* and *"I have never regarded nuclear radiation or nuclear power as anything other than a normal and inevitable part of the environment".* He opposed the concept of *"sustainable development",* where wind turbines might power modern economies, calling it meaningless drivel[7]. He kept a poster of a wind turbine to remind himself how much he detested them. Dr Patrick Moore, famous radio & TV astronomer, openly supported nuclear as many rightly thinking scientists did. 'Environmental' organisations ran campaigns to berate nuclear, especially after nuclear accidents, particularly Chornobyl, with 'wild' outrageously false claims. If global warming and climate change were going to seriously affect 'the Planet', the obvious solution was to promote more nuclear energy, which was not only 'carbon free' but many times more effective than any other fuel by its very high energy density.

CARBON AND THE CARBON CYCLE

Carbon is the 'essence' of life; without it, there would be no food and no life on Earth. It is prolific on land (especially in rock on the surface and deep within the Earth), in the oceans and the air. Apart from the fact that there are millions of different organic carbon compounds, both natural and synthetic, carbon occurs naturally in many other forms, for example as diamond, graphite and carbonates but also as a small quantity of carbon dioxide gas in our atmosphere 0.0016% (after 4½ billion years of the Earth's existence, more than 99% of the original atmospheric carbon dioxide inventory has been 'sucked' out of the atmosphere and is now below ground).

Carbon is the only element with its own branch of chemistry, 'organic'—the chemistry of life! Carbon is an essential ingredient of all known life on Earth, as it is to all the food that sustains that life. This is all derived from carbon dioxide, an invisible, odourless natural gas that existed in the Earth's atmosphere from the inception of the Solar System.

Carbon dioxide is common throughout the Solar System. It has been there since the Earth began (almost 5 billion years ago), and like our near neighbours Venus and Mars, it was probably 95% or more of our atmosphere in the beginning. However, whilst our neighbouring planets still have 95% carbon dioxide, the Earth's atmosphere has changed over time by a large extent due to absorption in the oceans but uniquely through the occurrence of life on Earth which we are told began about 3 billion years ago, carbon dioxide now only constitutes approximately 0.04% of our atmosphere, plus 21% oxygen, this is because much of the carbon dioxide has been converted together with water into carbon compounds such as sugars and carbohydrates and oxygen through a process known as photosynthesis. It does this with the aid of chlorophyll (the pigment, ironically, which makes plants and the Earth look green – the green planet!), which provides the chemical energy derived from sunlight for photosynthesis to take place. Most of the atmospheric oxygen derived is from photosynthesis. The abbreviated chemical formula for this is:
carbon dioxide (CO_2) + water (H_2O) + energy ↔ carbohydrate (CH_2O) + oxygen (O_2)

The reaction is reversible, and the reverse process is known as respiration, in which carbon compounds (carbohydrates) are 'burned' (in humans) to provide energy for movement and to sustain life (e.g. from food)—carbon dioxide and water, which is returned to the environment.

This is known as the Calvin-Bensen-Bassham Cycle, alternatively, Calvin Cycle, named after Melvin Calvin, Professor of Chemistry and the director of the Bio-Organic Chemistry group in the Lawrence Radiation Laboratory at the University of California, Berkeley. *"Using the carbon-14 isotope as a tracer, Calvin, Andrew Benson and James Bassham mapped the complete route that carbon travels through a plant during photosynthesis, starting from its absorption as atmospheric carbon dioxide to its conversion into carbohydrates and other organic compounds."*

Calvin was awarded the Nobel Prize in 1961 for Chemistry *"for his research on the carbon dioxide assimilation in plants".*[1]

Photosynthesis converts atmospheric carbon dioxide into organic compounds. It is mainly responsible for producing and maintaining the oxygen content of the Earth's atmosphere and supplies most of the biological energy (sugars and carbohydrates) necessary for complex life on Earth.

Life on Earth depends on this dangerously low amount of carbon dioxide[11]; the rich and the poor are all in the same mould together! Without it, there will

be no 'green pasture beside still water where we can lie and rest our weary souls'; there will be no carbohydrate to 'give us our daily bread'; there would be no porridge for the Scots; the Irish potato famine will be like nothing in comparison; the starving millions of Asia would not have even a handful of rice, and without pasta, the Italians would be panicking and desperately taking out their Rosaries and praying!

Photosynthesis is the process that enables autotrophs to manufacture food. Autotrophs (e.g., plants, trees, grasses) are at the start of the food chain, beginning with carbon dioxide, water and sunlight. They not only produce a variety of foods for themselves but also other forms of life known as heterotrophs, that is: herbivores (creatures that feed on grass and plants such as sheep, cattle, rabbits, deer, elephants etc.); omnivores (those that feed on plants and animals such as humans, dogs, pigs, foxes etc.,); and carnivores (those that feed on other creatures such as spiders, lions, hyena, polar bears, sharks, eagles etc.)

When plants and animals die, much of this biological energy is eventually transformed into carbon compounds, 'fossil fuels,' such as coal, oil, and natural gas (methane), in various processes that take millions of years. Much of the carbon dioxide in the oceans is eventually converted from shells and crustaceans into sedimentary rocks, limestone, chalk, and sandstone.

Carbon is taken from the air and buried in the ground. This total organic reservoir is termed 'biomass.' When we study climate change, we are not concerned with all the ramifications of the Earth's carbon inventory but with the effect of carbon on climate change, which appears to be neither simple nor clear-cut. The combustion of coal and other fossil fuels is not the only release of carbon into the atmosphere; other sources are volcanoes and other natural events, such as the release from different reservoirs, which are part of the carbon cycle. Studies are currently taking place, and to date, they are inconclusive.

In effect, when we burn fossil fuels, we return carbon dioxide to the atmosphere from whence it came. This is part of the carbon cycle, of which there are many different aspects.

We are all told that carbon is an ever-present danger and that we must reduce our use of carbon products, urgently, at all costs, if we are to save Planet Earth and avoid a catastrophic end to life and living as we know it. (The opposite is much more likely). This sudden, startling revelation is because of the industrial use of carbon substances, particularly its combustion as an energy source. Over the past 200 years, global atmospheric carbon dioxide has risen from about 0.02% to almost 0.04%. This increase, it is feared, is promoting detrimental effects to the environment, such as global warming and climate change, which is believed to be causing ever more extreme heat events and more frequent extreme weather such as floods, drought, storms and fires, which will eventually destroy civilisation and make the Earth uninhabitable.

Climate activists claim that this trend to double atmospheric carbon dioxide could disturb the Earth's equilibrium and lead to changes beyond our control. The 'warmists', as the late Christopher Booker used to call them, want us not only to eliminate the use of carbon for industrial purposes but also interfere in natural processes that have been taking place for thousands of years such as stopping domestic herbivores eating grass (because of flatulence and the emission of natural gas) and being fed on new more expensive food which will cause market food prices to rise; or the elimination of peat for compost and other human uses, even culling domestic animals (as in Ireland, where the Government was (is?) offering €5,000 to farmers for each animal that they destroy) so that they are not available to the food markets.

The efforts to tax meat and dissuade people from eating it will likely lead to malnutrition (as Bear Grylls, once a dedicated vegetarian, discovered. Prime agricultural land is being taken up for solar power, farmers in Holland, Germany, and France have staged massive protests against Government policies, and sheep farmers in New Zealand are objecting to Government demands to reduce flocks. The price of battery-reared chickens from Thailand is claimed to be too low, but it is often the only meat many people can afford.

In the author's opinion, I believe that we should eventually stop burning fossil fuels but only when the time is right and it is economical to do so eventually; fossil fuel, especially coal, the mining of which is a highly dangerous occupation, can be replaced for many of its applications by better, 'green', cheaper, cleaner sources of primary energy, such as nuclear, it may not be classed as renewable but it is almost infinite, (enough to last for billions of years) and is much more effective; there will still be nuclear energy long after 'renewables' no longer exist (it yields a million times more energy per unit weight than coal and much more than weaker sources of energy such as wind or solar), it is much cleaner, safer, occupies less space, is friendly to wildlife and to the environment, (it does not compromise the beauty of nature) although there is a small amount of nuclear waste, which can be recycled or incinerated, it takes up a tiny fraction of the space taken up by mountainous slag heaps of ash and

toxic waste from coal power plants. Because of its high energy density, nuclear plants only need to occupy a minute of Earth's space compared to wind or solar power plants. It does not industrialise rural areas as do wind and solar. Unfortunately, current regulations require a large exclusion zone for 'safety' reasons, which is unnecessary. This 'exclusion' zone is frequently used for recreational purposes. However, at many plants, it is now closed to the public because of attacks by 'environmental terrorists' and 'anti-nukes.'

However, we cannot suddenly transition from our dependence on fossil fuels as this will cause immense hardship and damage to the economies of many countries and will lead to mass unemployment and possible starvation. It will take time before this can take place, and whilst countries such as China and India are endeavouring to reduce their dependence on coal, the transition must be smooth and dictated by market forces. The industry will still need oil and natural gas for decades to come, and in any case, it will always be present regardless of whatever actions we take to eliminate it. Climate change is a gradual process, and we cannot afford to be panicked into knee-jerk reactions. I believe that countries such as China, the USA, or India have no wish to destroy the planet, will proceed in their own good time to secure a sensible infrastructure, and will not want to make rash decisions. Currently, China leads the world in wind, solar, hydro and nuclear energy. All were achieved in a relatively short period.

We can take steps now to reduce carbon dioxide emissions sensibly by encouraging greater use of nuclear energy for generating electricity, marine propulsion, hydrogen production, district heating of urban areas, which is an alternative to gas boilers and cheaper than heat pumps, and water desalination. Small nuclear plants need to be sited adjacent to where the power is consumed, eliminating unnecessary and costly transmission lines and their pylons.

Unfortunately, at least initially, they will need to be protected from 'protesters and activists.' Nuclear energy does not require backup power. Nuclear submarines operate in the most remote and inaccessible places on Earth with no backup or transmission lines. They depend on the skill of their crews, who sleep, eat, and live for months on end in a confined space adjacent to a live reactor. Greater use of nuclear will lead to public acceptance in the long term as the public learns to trust it.

Instead of a network of pylons and transmission lines carrying electrical power over large distances, we need a network of SMRs (small nuclear reactors) to supply power to local urban areas and consumers as we did in the early days when urban electricity supply was begun and before we changed from direct current to alternating current necessitating transformers to convert the low voltage electricity to a high voltage for transmission over long distances. We will still need a grid, but it can be reduced significantly.

Forcing electric vehicles' pace is not sensible until there is sufficient electricity to charge their batteries. At present, they are unaffordable to the majority of people. A market exists for electric vehicles, which will grow with time, but it is not right to force the natural rate of change and punish those who are unable to afford them now. It is also not desirable to abolish plastics, either, as the resulting food waste will cause hardship. We have become dependent on plastic; who would want their printed material delivered soaking wet and fit only for the bin? We must learn to deal with plastic and waste misuse sensibly while keeping the enormous benefit it has given us!

ENERGY

Energy exists in various forms, such as Heat, Light, Sound, Electromagnetic, Mechanical, Chemical, Nuclear, and gravitational.

One of the most critical divisions is between 'potential energy' and 'dynamic or kinetic energy.' Potential energy is inherent in the fuel: Water is the 'fuel' for hydroelectricity. It possesses potential energy by virtue of its elevation above ground level and the pull of gravity (the force of gravity is constant, $g_n = 9.8 m/s^2$, and always present). When released by a gate the water gushes down a penstock and descends through a huge water wheel turbine which is driven to generate electricity.

In general, fuels with potential energy are reliable, and the energy is continuously available 'on demand' until it is spent.

Fuels such as coal, oil, gas, and biofuels require a continuous supply of fuel. Nuclear fuel can last many years but is normally available for about 18 months between refuelling outages, depending on the degree of 'enrichment' of the fuel. Geothermal energy uses heat energy from within the Earth when it was formed, and radioactive decay is constant regardless of the weather.

Fuels Possessing Potential Energy are Coal, oil, gas, biomass (other combustibles), hydroelectricity, geothermal and nuclear.

Kinetic (Dynamic) Energy is only available as long as a force is applied (according to Newton's Law): a flywheel possesses kinetic energy; it is fleeting and only lasts whilst a force is applied (momentum). Since kinetic energy

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is only available as long as a force is applied, it is unreliable and intermittent. Wind energy uses 'air' as a fuel. It is available when a force is present due to differences in atmospheric pressure (caused by temperature differences and atmospheric water vapour). It is not constant and varies (gusts) and changes direction (veers).

The Sun is an immense source of potential energy, but because of the rotation of the Earth, solar power is intermittent. It is at its greatest at the Equator, where the sun shines for 12 hours each day but varies from sunrise to sunset, rising to maximum intensity at midday. Its intensity is mitigated by the degree of cloud cover and atmospheric pollution, such as wind-blown sand from deserts (not necessarily created by human activity). Daylight hours at the Poles vary from zero on Midwinter's Day to 24 hours on Midsummer's Day; the sun's intensity is weak and is subject to weather conditions.

Other power types using kinetic energy are tidal and wave.

GENERATION OF ELECTRICITY

Relative contribution to global electricity by various means.

The data given below is taken from "Our World in Data" data given for the year 2022, authored by Hannah Ritchie and Pablo Rosado

[electricity consumption is given in TeraWatt hours (TWh) where 1 TWh = 1,000 million units (kWh) kilowatt hours equivalent to $1x10^9$ kWh or 1 million megawatt hours MWh 1 TWh = $1x10^6$ Mwh].

Coal: Despite efforts by 'environmentalists' to reduce coal consumption, coal is still the primary fuel used to generate electricity. Its consumption increased in 2022 to 10,212.2 TWh; coal is plentiful in many countries and is relatively cheap; the technology is well known, although techniques are used to make it cleaner and remove air pollutants & toxic substances, including efforts at 'carbon capture' despite high boiler pressure and temperature coal power stations are relatively safe. However, many accidents remain, especially in the coal mining industry. Coal power stations create large 'mounds' of waste in the form of ash and tend to be dirty.

Gas is the next most used fuel after coal, 6,443.6 TWh; gas is plentiful and much cleaner than coal; power stations are relatively cheap, although the market price of gas is subject to wide fluctuations, causing variable electricity prices to the consumer.

Hydro-Electricity third (4,288.6 TWh), especially with the production from the Three Gorges Dam in China coming into greater use. Unfortunately, most of the world's natural major (and minor) waterfalls have already been harnessed, and it would be necessary to construct an artificial dam such as 'The Three Gorges' in China with substantial environmental damage. Hydro-generated electricity also suffers from drought and other problems[18] such as inland tsunamis; one of the worst droughts was at the Itaipu Dam[19] in Brazil / Paraguay in 2021, when thousands of people were left without electricity for many months.

Nuclear generation 2,632.0 TWh in 2022. It is available to all countries prepared to agree to IAEA (International Atomic Energy Authority) regulations. Currently, the world's most popular type of reactor is the PWR (Pressurized Water Reactor), which uses 3% - 5% enriched uranium fuel which, when loaded, can operate continuously for about 18 months on full load, after which one-third of the fuel is replaced, necessitating a short refuelling outage lasting a few days. The spent fuel, which still contains 95% usable fuel, is held in a pond to cool and can be removed and stored on-site indefinitely in dry casks after several years—the higher the enrichment (costing more), the greater the time between refuelling intervals.

The Cassini-Huygens spacecraft was powered for almost 20 years by nuclear energy from an RTG (Radioisotope Thermoelectric Generator). MMRTGs (Multi-Mission RTGs) are also used for rover probes on Mars. Their electrical output is about 110 W, and they operate reliably in a hostile environment for about 1.5 Mars years (3 Earth years). The maximum enrichment for commercial reactors permitted by international law (on Earth) is 20%. There is a small amount of waste from nuclear reactors, as defined by the World Nuclear Association as follows: "*There are three types of nuclear waste, classified according to their radioactivity: low-, intermediate-, and high-level. The vast majority of the waste (90% of total volume) comprises only lightly contaminated items, such as tools and work clothing, and only 1% of the total radioactivity. By contrast, high-level waste – mostly comprising used nuclear (sometimes referred to as spent) fuel designated as waste from the nuclear reactions – accounts for just 3% of the total volume of waste, but contains 95% of the total radioactivity.*"

Oil produced 994.2 TWh of electricity in 2022. However, oil is declining in popularity in favour of gas; not surprisingly, Saudi Arabia uses the most oil, although it is interested in building future nuclear stations.

Wind produced 2,098.46 TWh of electricity in 2022. There are a lot of problems with wind power; firstly, it is unreliable because the force of the wind is intermittent and cannot be used for loads

which require a steady and continuous supply, such as aluminium smelters and electric arc furnaces. It also varies since it gusts and veers. Wind power stations (so-called 'farms') must be sited where there is sufficient commercially available wind at all times, requiring expensive additional transmission lines (+ pylons) for remote locations. They are 'land-hungry' and are often spread out and occupy areas of exceptional natural beauty or wilderness, thus frequently industrialising virgin countryside. They are not environmentally friendly and kill wildlife. When the wind is not blowing, they must be supported by standby power such as diesel generators, gas turbines, spinning reserve or batteries. They generally suffer from high maintenance costs, especially those located offshore. Their capacity factor is only about 30-35% compared to nuclear, which can achieve better than 99%, so when one studies statistics from previous years, the electrical output from a large capacity of installed wind turbines is frequently less than a smaller capacity of nuclear power. At the end of 2022, almost 900 GW of installed global wind energy capacity and 394 GW of nuclear, yet nuclear generated more electricity. Wind suffers from other defects, which I shall not list here, but it remains popular with environmentalists and politicians with little understanding of science and engineering.

Solar electricity produced 1,310.0 TWh in 2022. Solar electricity generation relies on the very crude method of shining the sun's rays onto mirrors and directing the energy to produce steam in a boiler. The ancient Greeks knew this process of creating high temperatures.

Archimedes called it "burning grass". The similarity ends there since the tracking of the sun throughout the day is highly sophisticated and utilises the most modern technologies. Also, the heat transfer fluids are chosen with utmost care to achieve the required temperatures and pressures. Energy is stored in various salts to retain as much heat as possible after sunset. Its intermittency is more predictable than wind and, together with accurate weather forecasts, could become an acceptable form of power. I suspect it does suffer from low energy density. Unfortunately, I don't know if I have any figures. The main disadvantage of concentrated solar power is that it frequently occupies prime agricultural land, which seems to me to be completely unnecessary as the land is needed for food production and takes food away from hungry mouths when other power sources could be utilised.

A Northern Cape of South Africa scheme uses solar power and batteries[21]. Whilst impressive with a solar capacity of 540 MW and a battery capacity of 225 MW, it is worth noting that the plant occupies 879 hectares (2,172 acres) of land and is 10km north to south (6,2 miles) of several 1,000 MW nuclear plants. Alternatively, 3,906 MW coal plants could be located in this area of land. The world needs to be more significant in order to house all the power that would be required from such resources. Of course, if they were located in the desert or other land deemed to be unusable, that might be a different proposition, but the cost would increase significantly because of the infrastructure required.

Biofuels produced 675.1 TWh of electricity in 2022. Drax Power Station was conceived in 1962 by the then CEGB as England's largest coal power station with a total capacity of 3,960 MW (net 3,906 MW) from 6 x 660 MW generating units. It was completed in 1986. In 2010, under the Government Renewables Obligation Scheme, it was decided to convert four of the units to biomass fuel using wood chips mainly obtained by felling trees in forests in North America with a capacity of 4 x 660 MW, a total of 2.6 GW; the remaining coal units were a closed in 2021.

Author's Comment: the logic of destroying forests, which are high carbon dioxide absorbers, turning them into wood chips to be burned and returning the CO_2 to the atmosphere in a power plant 3,000 miles away eludes me.

Other Renewables: Geothermal (hot springs) Wave, Tidal, etc.: according to REN21 *"The possible role and contribution of geothermal energy to the mitigation of climate change: In 2019, 13,900MW of geothermal power was available worldwide. An additional 28 gigawatts provided heat for district heating, space heating, spas, industrial processes, desalination, and agricultural applications as of 2010."*

Geothermal energy is available in about 25 - 30 countries, the largest being the USA. The largest tidal power station, with a 254 MW capacity, is in South Korea. Research using EU funding is progressing on the Isle of Orkney, Scotland, to develop a 4 MW tidal power station. Wave power projects in Portugal and the Isle of Islay in Scotland have both been shut down.

Water Vapour (H_2O)

Carbon dioxide cannot produce strong winds, rain or other precipitation. Therefore, it cannot be responsible for flooding or other effects attributable to climate change—however, water vapour can.

We can thank water vapour and other greenhouse gases mainly for keeping us relatively warm at an average surface temperature of 15˚C[22] (288.15˚K) instead of the uncomfortable—20˚C (254.15˚K) that it would be without the greenhouse

effect. The greenhouse effect keeps the Earth at approximately 35˚C warmer than it otherwise would be and keeps oceans ice-free. This is generally known as the 'Goldilocks Effect'—not too hot, not too cold, just right!

NASA "Space Place" says: *"Earth's atmosphere is similar to a jacket for our planet. It surrounds our planet, keeps us warm, gives us oxygen to breathe, and is where our weather happens. Earth's atmosphere has six layers: the troposphere, the stratosphere, the mesosphere, the thermosphere, the ionosphere, and the exosphere."* Each serves a particular function.

Water vapour is unlike any other atmosphere gas because it is condensible and, therefore, variable. Compared to carbon dioxide, which may be considered relatively inactive, it is volatile and active. It can change quickly within 24 hours, which carbon dioxide or other greenhouse gases cannot. It can act like an amplifier so that as the heat from the Sun intensifies, more water evaporates from sources on Earth, and the greenhouse effect increases. This continues until the air is saturated with maximum humidity; however, as the temperature rises, so does the saturation level. This cannot continue indefinitely, as the primary heat source is removed when the Sun sets. Also, as the water vapour moves higher beyond the stratosphere, it cools to form clouds, which will reduce the Sun's heat.

The infrared heat in the atmosphere will gradually decrease over time but will be retained for some time after the sun sets. It is worth remembering that 'what goes up must come down', so water vapour from evaporation is precipitated as rain, etc. Whilst the average water inventory may stay largely constant over a long period of time since the average amount of water lost through evaporation is equal to that gained by precipitation, in a short period of time, there can be some very volatile weather due to the rapid movement of water vapour.

Water vapour determines the weather and climatic conditions. In the air, it forms clouds and causes precipitation such as rain, hail, mist, snow, frost, ice, etc.; condensation also occurs in dew and cold surfaces, especially in winter as the temperature falls. It is an essential component of the water cycle. Water vapour is the prime mover that converts the sun's energy into wind. The water vapour content in the atmosphere is not constant but is highly changeable.

When the sun beats down, water evaporates from surfaces, ponds, lakes, the sea, and vegetation, which are then taken into the atmosphere, increasing the temperature.v Eventually, the water will come down somewhere in the form of precipitation. That could explain the conditions in August 2023 when high temperatures along coastal areas of Southern Europe will have sucked up large amounts of water from the warm Mediterranean Sea, only for it to be dumped in September in North Africa.

Something similar occurs each year in the Caribbean, where warm water ascends from the Gulf of Mexico and develops into hurricanes, which land on the United States' southeast coast, creating havoc. The regions with the least atmospheric water vapour are the Arctic regions, and the areas with the most are the tropics. Water vapour gives rise to convection currents, which form clouds and mist in the stratosphere, and, of course, this can cause air currents or winds as the water vapour rises.

"The latent heat release in atmospheric convection is directly responsible for powering destructive storms such as tropical cyclones and thunderstorms." A typical summer day in Johannesburg in the 1960s used to start with a cloudless sky; as the day progressed and the sun got hotter, wisps of cloud would begin to appear and grow throughout the day; at about 16:30 just as people were getting ready to leave work there would be a mighty downpour, and mists would rise from the hot ground. Frequently, there were thunderstorms and extensive lightning. There is no doubt that water plays an overarching role in weather and climate change, but we've always known that.

The climate and the part played by water vapour are highly complex and require extensive investigation and research. There are no simple solutions. Therefore, only a realistic study of the climate can be valid by analysing the enormous and complicated-effect of water vapour. The IPCC does not list water vapour as a greenhouse gas even though it is the most critical GHG because human activity does not affect it.

Furthermore, it is like the elusive 'genie' and can be almost negligible in some areas but predominate in others. It can be 100 times more prevalent than carbon dioxide, and its effect is more significant than all the other GHGs combined.

CONCLUSION

The effect of the atmosphere on the climate has been the subject of investigation since 1824 (200 years). However, at this stage, there seems to be no specific information other than vague predictions of what may happen if humankind continues to burn fossil fuels. So far, the proposed solutions of replacing fossil fuels, especially coal, with wind and solar energy have been totally ineffective. wn

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Women in datacentres must be prioritised

As the African datacentre sector emerges as an important global player gender diversity must undoubtedly also keep pace with this growth. Unfortunately, current estimates are not promising; a recent report by the Uptime Institute states that three-quarters of datacentre operators employ 10% or less women.

By Faith Waithaka
Cloud and Service Provider
Segment Sales Lead: Anglophone Africa
Schneider Electric

Similarly, a study by the International Energy Agency (IEA) reveals that women make up a mere 16% of the traditional energy sector's workforce, again highlighting a substantial gender gap. Moreover, women in the sector face a pay disparity of 20% compared to their male counterparts.

The reality is achieving sustainability goals and staying ahead of digitalisation curve, require a diverse and innovative workforce. Diversity, equity, and inclusion are not just ethical imperatives; it represents a strategic business imperative that drives creativity and foster innovation.

At this important juncture, industry leaders from across the continent must come together to pave the way for increased female representation in the datacentre sector.

The recent establishment of the African Women Business Energy Network (AWBEN) by the African Energy Chamber is an important step in the right direction. The chamber aims to foster a supportive community for women in the energy and datacentre industry. This initiative recognises that as the energy sector expands, so does the imperative for more women to participate.

AWBEN's key initiatives include inciting collaboration among African women in the energy industry, hosting mentorship programmes and empowering women to take ownership of their personal and professional development, offering coaching and sponsorship opportunities for girls in STEM, creating avenues to encourage more African women-participation and leadership roles in the energy industry.

ADDRESSING CULTURAL, SOCIAL AND SKILLS CHALLENGES

One of the challenges hindering female participation in the datacentre industry is the influence of cultural and social norms. Here, the industry must come together to not only attract women to the sector but to also break barriers that may discourage them from pursuing roles.

By dismantling these historic challenges, we can create an environment where women feel empowered to contribute meaningfully to the data centre industry. One of the areas where there is a need for change, is women in leadership. Young women thinking about their career options may be deterred from entering an industry where there are few women leaders. This needs to change.

Furthermore, to secure the future of sustainable datacentres in Africa, the industry must invest in both inspiring and retaining the next generation of skilled professionals. This begins with encouraging young talent, especially girls, to pursue STEM subjects from an early age.

Supporting initiatives such as Girls in Data and Woman in Data and establishing mentorship programmes are crucial steps in a more equally represented datacentre industry.

At Schneider Electric, we continue to prioritise programmes that uplift women such as 'How Women Rise' and 'Still, I Rise.' This year we also launched a women's forum across Anglophone Africa, aptly named the Schneider Electric Ladies Forum (SELF) that aims to promote the fostering of 'self' in terms of wellbeing, development, and empowerment.

Globally, we have also been recognised by Bloomberg Gender-Equality Index (GEI) for our efforts to increase gender equity through an inclusive and caring environment. wn

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Becoming involved in a Student Chapter and participating in meetings can teach a student member valuable business skills. SAIEE offers mentorship, coaching and vacation work.

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Our Purpose

To enhance the practice of electrical engineering in South Africa and the stature of our members through knowledge, networking, influence, education and communication.

Contact Us

SAIEE House, 18A Gill Street, Observatory, JHB

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www.saiee.org.za

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

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

MEMBERSHIP UPGRADE DISCOUNT STRUCTURE

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09/04/2024	An Introduction to Artificial Intelligence for Professionals
10/04/2024	Incident Investigation and Management (Root Cause Analysis)
16/04/2024	ORHVS - Operating Regulations for HV/MV Systems
18/04/2024	SAIEE Women in Engineering AGM
23/04/2024	Power Systems Protection
23/04/2024	Substation Design & Equipment Selection
24/04/2024	Nuclear Chapter presents: SMRs - Review of status of Gas-cooled Reactor Projects

MAY 2024

07/05/2024	Hack Lab
08/05/2024	SANS 10142-1 Edition 3
15/05/2024	Fundamentals of Financial Evaluation for Projects
15/05/2024	ECSA Road to Registration webinar
16/05/2024	Writing Good Technical Specification
18/05/2024	Biomedical Chapter webinar
20/05/2024	Cable Jointing, Termination and Testing
21/05/2024	An Intro to Artificial Intelligence for Professionals
22/05/2024	Planning Feasibility Studies in IR 4.0: An Engineer's Perspective
28/05/2024	Technical Report Writing

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SAIEE Academy Online Training

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