

CRSES ANNUAL REPORT 2024



CENTRE FOR RENEWABLE &
SUSTAINABLE ENERGY STUDIES



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FOREWORD

I am honoured to introduce the CRSES 2024 Annual Report as the Director of the Centre for Renewable and Sustainable Energy Studies at Stellenbosch University. I officially joined CRSES on 1 October 2023, bringing with me over 25 years of experience in environmental engineering and research leadership.

Over the past year, our team has grown stronger and more dynamic. We welcomed seven new staff members, including one intern, who joined seven other interns whose contracts concluded at the end of 2024. This expansion signifies a strong injection of talent and renewed dedication to the Centre's mission of advancing research, innovation and scholarship in renewable and sustainable energy in South Africa, Africa and globally.

At the same time, we said goodbye to three valued colleagues: Dr Richmore Kaseke, Inge Rae Scholtz and Tshilidzi Ligege, who have pursued new opportunities outside our centre. We thank them for their contributions and wish them well in their new endeavours.

We started the year with a "bang", hosting the finalists of the Milken-Motsepe prize in Green Energy in Africa; and concluded with the successful organisation of the Southern Africa Sustainable Energy Conference, SASEC 2024, which attracted more than 200 delegates from all over the world. For the first time, the proceedings of the SASEC 2024 conference will be published by Springer, a leading scientific publisher.

CRSES continued to flourish across its core focus areas, "Technology Development & Commercialisation", "Training and Awareness", "Advisory Services", and "Contract Research", each representing our integrated ecosystem model.

With the introduction in 2024 of the **NEXT (National Energy and Power to X Trajectories)** portfolio, led by the NRF SARCHI Chair in Power Systems Simulation, Prof. Bernard Bekker and Chief Engineer Monique le Roux, the CRSES now articulates in five expert portfolios addressing every aspect of the energy transition – from technology development and commercialisation in solar and wind energy within the **Department of Science, Technology and Innovation (DSTI) Renewable Energy Hub and Spokes Programme**, to green hydrogen research within the SU-strategic **Hydrogen Engineering Platform**, to the WEF Nexus in Africa within the **ARUA Centre of Excellence (CoE) in Energy**, and finally to skills/ professional development within the **Short Courses/ Postgrad Modules** portfolio.

Collectively, these portfolios support CRSES in delivering impactful innovation, forming skilled professionals, engaging with the public, and advancing contract research and academic inquiry. We are especially proud to highlight some remarkable individual and team achievements during 2024. Prof Craig McGregor, Head of the Solar Thermal Energy Research Group (STERG), received the Outstanding Postdoctoral Mentor Award at the Research and Innovation Excellence Awards gala held at the Stellenbosch Institute for Advanced Study (STIAS). This award recognises Prof McGregor's exceptional mentorship, dedication to nurturing early-career researchers, and inspiring leadership that pushes the boundaries of solar thermal energy research.

Our young researchers continue to excel on regional and international stages. CRSES Junior Research Engineer Liam Snyman earned both the **Best Oral Presentation** and **Best Paper** awards at the Southern Africa Sustainable Energy Conference (SASEC) 2024, in collaboration with his co-authors, Prof. Bernard Bekker and Monique Le Roux. His technical analysis of South Africa's loadshedding dynamics and practical recommendations highlight the Centre's role in addressing critical energy challenges with accuracy and relevance.

Aligned with our commitment to human capital development, CRSES has also strengthened strategic industry collaborations. The secondment of CRSES intern Shumani Kone to Revive Electrical Transformers provided him with invaluable hands-on manufacturing experience, exemplifying CRSES's role in empowering TVET graduates and bridging academia-industry gaps.

Furthermore, we celebrate the academic growth within our team. Our Marketing and Communications Officer, Fhatuwani Mulaudzi, and our Commercialisation Officer, Sedzani Ratsibi, successfully completed their Postgraduate Diploma in Marketing and in Sustainable Development, respectively, at Stellenbosch University while balancing full-time responsibilities. This is testament to the culture of lifelong learning and professional development fostered at CRSES.

I am inspired by the resilience, passion and dedication demonstrated across our team. Despite inevitable transitions, our expanding portfolios of researchers, support staff and interns position us to deliver even greater value in renewable energy research, education and outreach.

As we reflect on the year's achievements, we renew our commitment to shaping a clean-energy future for Africa. We will continue to build on our strengths in training, innovation and strategic partnerships.

A special thank you to every member of the CRSES community, including staff, students, collaborators and our partners, for your continued passion, dedication and support.

I look forward to progressing our Centre's vision and impact in the years ahead.

Prof. Cristina Trois,
Director, CRSES
Stellenbosch University



MISSION & CORE ACTIVITIES

Our Mission

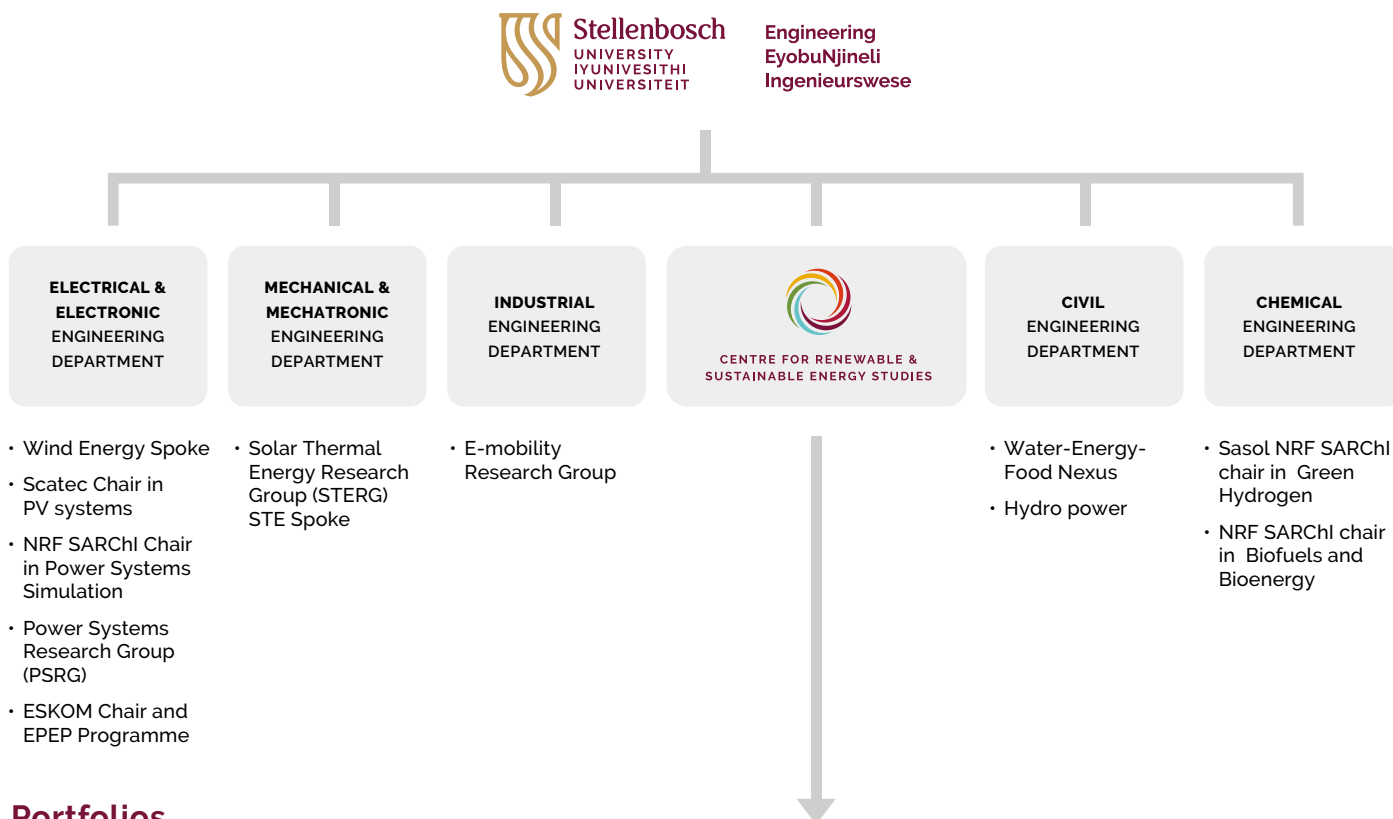
*The Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University **advances a sustainable future** through **world-class** renewable and sustainable energy research, advisory services, awareness campaigns and training programmes.*

Our Core Activities



THE CRSES ECOSYSTEM & PORTFOLIOS

The CRSES Ecosystem



Portfolios



For over 15 years, the DSTI-funded Hub and Spoke programme has trained hundreds of postgraduate students and published many research papers on renewable energy. It also gives hands-on experience through solar and wind energy projects. The programme connects several South African institutions, with one main hub managing the funding and activities, and partner spokes focusing on specific research areas in solar and wind energy.

CRSES NEXT leads advanced research in modelling and optimising energy systems, with a focus on national and regional energy and grid planning. It tackles the challenges of integrating variable renewable energy (VRE), inverter-based resources (IBR), and distributed energy resources (DER) like rooftop solar, electric vehicles and battery storage, which require major changes in how energy systems are planned and managed.

This research supports the development of green hydrogen systems at Stellenbosch University through the Hydrogen Engineering Research Platform (H2P). With South Africa's strong renewable resources and green hydrogen ambitions, H2P aims to close key knowledge gaps in hydrogen system engineering for large-scale clean hydrogen production. The initiative plans to build a modern, multidisciplinary hydrogen lab at SU's Faculty of Engineering, focusing on three main areas: electrolyser technology, clean hydrogen combustion, and biogas upgrading using hydrogen.

The African Research Universities Alliance (ARUA) is an Africa-wide research network that aims to strengthen research on the continent and improve postgraduate training. Stellenbosch University is proud to contribute to this effort by hosting the Centre of Excellence (CoE) in Energy and building a network of excellent African researchers around the common theme of energy.

The CRSES offers modules from its acclaimed postgraduate degrees as short courses to the public and private sector. These modules are registered with the Engineering Council of South Africa (ECSA) as short courses that qualify for Continuous Professional Development (CPD) points. Attendees can earn four CPD points for each of the four courses offered.

OUR TEAM



Prof Cristina Trois
Director



Prof Bernard Bekker
Associate Director and Eskom
Chair in Power System Simulation



Prof Craig McGregor
Associate Director



Dr Ritchie Kaseke
Project Manager and
Senior Engineer



Monique le Roux
Chief Engineer



Warrick Pierce
Principal Engineer



Dr Justice Chihota
Senior Engineer



Christina Auret
Senior Engineer



Donald Fitzgerald
Research Engineer



Storm Morison
Junior Research Engineer



Liam Snyman
Junior Engineer



Johannes de Bruyn
Junior Engineer



Simnikiwe Gulwa
Junior Engineer



Lavhelesani Maluleke
Junior Engineer



Sedzani Ratsibi
Commercialisation Manager



Yumna Parker
Centre Manager, ARUA



Elmien Lovell
Administrative and
Financial Officer



Sandelize Heydenrycht
Receptionist and
Administrative Assistant



Keziah Maher
Short-courses
Administrator



Inge-Rae Scholtz
Marketing, Communications
and Events Coordinator



Fhatuwani Mulaudzi
Assistant
Marketing Officer



Tshilidzi Ligege
Assistant Project
Administrative Officer



Dr Francois Rozon
Postdoctoral
Research Fellow



Dr Andrea Dell'Orto
Postdoctoral
Research Fellow



Dr John Edison Sempira
Postdoctoral
Research Fellow



Shumani Kone
Intern



Godwin Mukondeleli
Intern



Tondani Mulaudzi
Intern



Aluwani Tshishonga
Intern



Hulisani Makungo
Intern



Hulisani Mulaudzi
Intern



Sydwel Tenza
Intern

PROJECTS: PORTFOLIO ACTIVITIES

OUTREACH & AWARENESS

CRSES hosts the live Milken-Motsepe Green Energy Prize demonstrations at Stellenbosch University.

With four teams on-site and one team in Nigeria, the event showcased groundbreaking innovations in green energy. The demonstrations, held on 19 and 20 February 2024, in front of the Engineering Faculty Building at Stellenbosch University, were a resounding success.

The Milken-Motsepe Prize in Green Energy incentivises entrepreneurs who have ideas for solutions to advance progress toward UN Sustainable Development Goal (SDG) 7: Ensuring access to affordable, reliable, sustainable and modern energy for all.

The Milken-Motsepe Prize in Green Energy aims to reward innovators who expand access to reliable, affordable, and sustainable electricity in Africa. Energy access is a key driver for

economic growth and shared prosperity. **The prize offered \$2 million in prizes and additional benefits**, including a \$1 million grand prize for the winning team and \$1 million in additional prize money. Participating teams also received access to networking, training, and other resources.

In May 2024, the judges awarded the \$1 million grand prize and a runner-up prize of \$250 000 at the 2024 Milken Institute Global Conference.

Afrak, an initiative based in the UK and Malawi, was awarded the \$1 million grand prize for its innovative system involving solar microgrids to power custom-designed tractors for deep-bed farming.

OMNIVAT, a South Africa-based company, was awarded the \$250 000 runner-up prize for its containerised electricity generation and storage system for remote communities.

Credit: The Milken-Motsepe Prize for winners' photos and information.



From left: Emily Musil (Milken Institute), Dr. Precious Moloi-Motsepe (Motsepe Foundation), Prof. Cristina Trois (CRSES)

CRSES exhibits at the Africa Energy Indaba Conference

The Centre for Renewable and Sustainable Energy Studies (CRSES) took part in the Africa Energy Indaba Conference from 5 to 7 March 2024. As exhibitors, the Centre had the chance to showcase its work and projects to people from across Africa and beyond, including energy experts, policymakers, researchers, and others working in the field.

Our team shared the work done by the CRSES in renewable and sustainable energy, and team spoke about its research, projects and efforts to help more people use clean energy, improve energy efficiency, and solve energy-access problems. The Centre's booth showed new technologies, successful projects and practical ideas in sustainable energy.

CRSES teamed up with SOLTRAIN for a joint booth that was busy throughout the event. Inge-Rae Scholtz, Lavhelesani Maluleke, Simnikiwe Gulwa, and Dr Francois Rozon helped run the stall, while Monique le Roux led a live discussion. The Centre displayed equipment for solar thermal energy systems, which helped start interesting conversations. New videos created just for the event were also showcased.

Many visitors signed up for future SOLTRAIN training and events. There was also strong interest in the Centre's short courses on renewable energy, especially those that count toward professional development.

The Centre representatives met with other organisations, exchanged ideas, and explored ways to work together. More women in energy were also added to the SOLTRAIN Gender and Diversity database to support inclusion in the sector.

The Africa Energy Indaba is one of the biggest energy events in recent times, with over 120 exhibitors.

Our involvement gave us great exposure in the energy sector.



CRSES stall at the Africa Energy Indaba ^

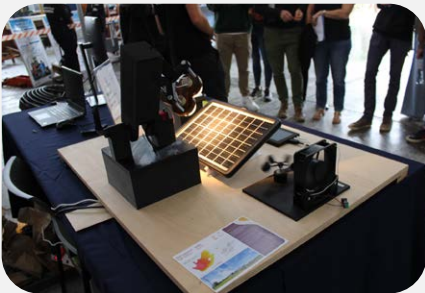
“Communicating our work **demonstrates impact, builds credibility, and supports progress** toward a sustainable energy future.”

CRSES participates in Open Day 2024

We had an incredible time showcasing our amazing work to parents, learners and students at this year's Stellenbosch University Open Day, which took place on Saturday, 20 April 2024! Teaming up with our esteemed research partners at STERG, we stood out with our innovative stall inside the Mechanical and Mechatronic Structures Laboratory.

From fascinating demos to engaging talks, we shared our passion for renewable energy with all who visited us. And guess what? In addition to that, we introduced our brand-new Demonstration Unit on Renewable Energy and showcased it for the public to see.

The event was a success, with high attendance by staff members, parents, learners and students.



CRSES's Chief Engineer, Monique le Roux, delivers a presentation on South Africa's current electricity crisis

The Chief Engineer of CRSES, Monique le Roux, delivered a presentation on South Africa's current electricity crisis at the ICSC Energy Transition workshop in Cape Town.

The presentation included the impact and outlook of load shedding, and also addressed energy policy in South Africa and how it should be approached to determine the optimal electricity capacity expansion plan for the country. The workshop ran from 24 to 25 April 2024 at the Cape Town International Convention Centre.



CRSES and Cultiver team up to launch the BRECCS

CRSES and Cultiver teamed up to launch the BRECCS (Building Renewable Energy Conscious Communities) programme, which is aimed at fostering awareness of renewable energy in marginalised communities while empowering unemployed youth

through training and job opportunities in renewable energy.

An intensive training session was held at the Atlantis Special Economic Zone (SEZ), where 25 passionate youths delved into the world of renewable energy, from solar to wind, hydro and bioenergy, and gained valuable insights and skills for a sustainable future.

CRSES and Cultiver Hosts 2nd BRECCS

CRSES, in partnership with the [Cultiver Group](#), conducted the second Building Renewable Energy Conscious Communities programme (BRECCS) in 2024. The programme aimed to raise awareness of renewable energy (RE) among members of marginalised communities and to empower unemployed youth through training, exposure and short-term employment opportunities in renewable energy. The training took place in Kayamandi township in Stellenbosch, where 22 youths were trained during from 15 to 19 July 2024.

The programme covered an introduction to renewable energy, including solar, wind, hydro and bioenergy. On 5 August 2024, each participant received a certificate of attendance, and three of the top performers were named as BRECCS champions and were rewarded with a cash prize.

The Centre was represented by Dr Richmore Kaseke and Simnikiwe Gulwa.



Dr Richmore Kaseke and Simnikiwe Gulwa of CRSES at the BRECCS ^

Development of South African energy statistics for public dissemination

In 2024, the Centre for Renewable and Sustainable Energy Studies (CRSES) launched an energy data visualisation project to improve public understanding of South Africa's power system. Initially focused on statistics, the project shifted to a geospatial view of the country's electricity sector, highlighting challenges like constrained generation and the role of renewable energy. The revised dataset, set for release in early 2025, will feature interactive maps and insights to inform energy policy, investments and public awareness.

Key findings about South Africa's power system include:

- 35% of electricity consumption is concentrated in major cities.
- Coal-based generation is in Mpumalanga, nuclear in the Western Cape and hydro in specific regions.
- Gas generation is limited due to underdeveloped infrastructure.

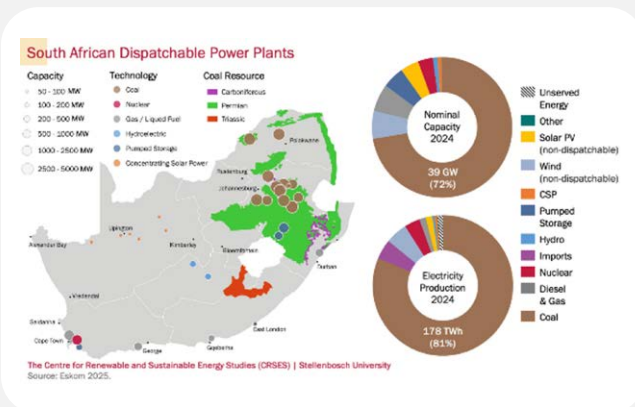
South Africa has faced declining electricity consumption since 1990, despite stable peak demand. This is due to energy efficiency, increasing tariffs, and limited new power plants, resulting in loadshedding since 2008. There is a need for diverse generation sources and better system flexibility.

Renewable energy, especially wind and solar PV, is growing, but still small in total energy production. The integration of renewable energy faces challenges like transmission constraints, lack of flexibility, and variability in wind and solar output.

The project will be finalised in 2025, providing interactive tools and detailed maps. Key next steps include data verification, publication on CRSES's website, quarterly updates, and raising awareness about the project. The goal is to offer actionable insights to policymakers, researchers and the public, supporting South Africa's transition to a sustainable energy future.

As South Africa continues its **energy transition**, CRSES remains committed to **delivering high-quality data and analysis** to inform decision-making and drive a **sustainable energy future**.

Read more at: www.crses.sun.ac.za/sa-energy-stats/



A visual presentation of the Energy Statistics ^

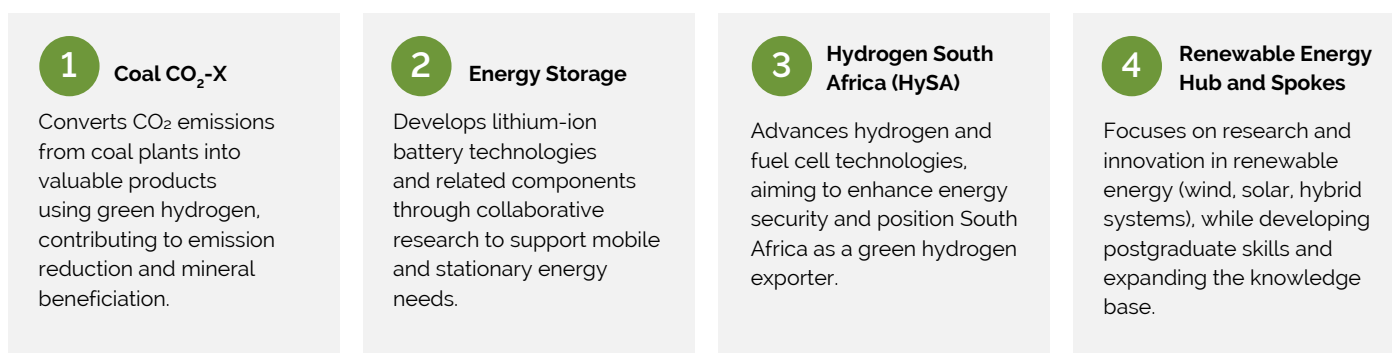
HUB & SPOKES ACTIVITIES

Executive Summary

The Department of Science and Innovation (DSI), through its Hydrogen and Energy (H&E) Chief Directorate, contributes to five strategic goals in the 2019 White Paper on Science, Technology and Innovation (STI), including innovation for a capable state and human capital development.

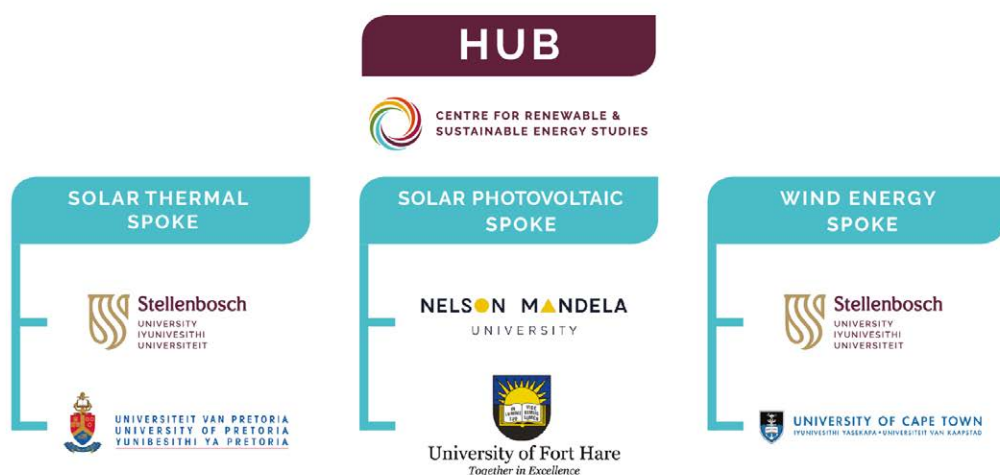
In 2020/2021, the DSI established the Energy Secretariat to oversee the implementation, monitoring, and evaluation of energy-related innovation policies and manage four key Research, Development and Innovation (RDI) Flagship Programmes. The Secretariat's role includes supporting large-scale clean energy deployments, coordinating training for TVET (technical and vocational education and training colleges) and UoT (university of technology) graduates, and aligning efforts with national strategies like the Hydrogen Society Roadmap.

Current RDI Flagship Programmes:



Responsive Coordinated and Efficient National System of Innovation

The **Renewable Energy Hub and Spokes Programme**, coordinated by the **Centre for Renewable and Sustainable Energy Studies** at Stellenbosch University, aligns with STI priorities by promoting renewable energy research, human capital development, policy support and awareness. The **Hub** oversees and coordinates specialised research carried out at various **Spokes** hosted by partner universities.



Spokes and their Focus Areas

Current innovation activities within the Hub and Spokes Programme are described below:

SU Wind Spoke:

Small-scale wind generator specially designed for off-grid battery charging. The technology can also be used to support rural mini-grids.

TRL 6



SU Wind Spoke:

Linear dry gravity storage small-scale prototype for grid stabilisation in RE penetration areas. Here shown are the first tests conducted, at this stage horizontally.

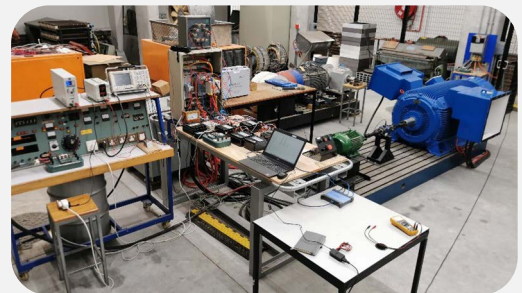
TRL 4



SU Wind Spoke:

Synchronous condenser technology for grid stabilisation in RE penetration areas.

TRL 4



UCT Wind Spoke:

Microgrid test rig to support groundbreaking research development and innovation around grid integration of renewables.

TRL4



NMU Solar PV Spoke:

Concentrator photovoltaic (CPV) technology promises higher PV generation efficiencies and yields than conventional PV modules.

TRL 5



UP Solar Thermal Spoke:

The Solar Dish Brayton Cycle technology is an innovation capable of generating electrical energy as well providing surplus heat for various domestic, commercial and industrial applications.

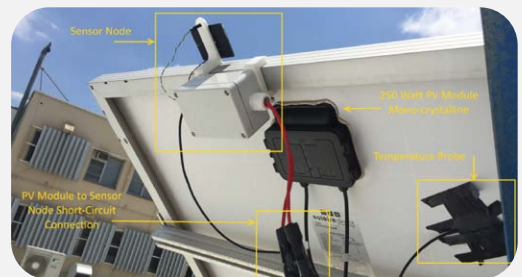
TRL 6



Hub:

The PV Health-Monitoring System has the potential to reduce operating and maintenance cost for large IPPs by offering real-time PV health monitoring and fault detection.

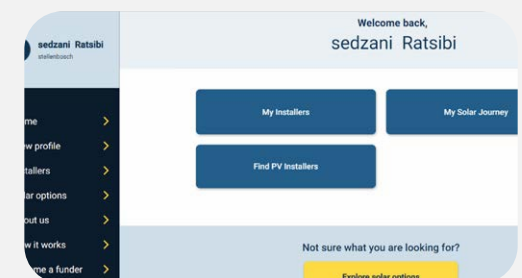
TRL4



Hub:

The PV Marketplace is an innovative platform designed to streamline the adoption of renewable energy solutions by connecting stakeholders such as schools, funders and service providers.

TRL 5



Hub:

Media and Science Laboratories offer numerous opportunities for responding to STI priorities especially in areas of:

- Smart communities
- Internet of things
- Coding and robotics
- Future-proof education and skills

TRL 7



Deployment of Solar Dish Brayton Cycle Turbine at Masia Village

Work towards the deployment of the Solar Dish Brayton Cycle Turbine system at the Masia Resource Centre by the University of Pretoria's Solar Thermal Spoke progressed steadily in early 2025. After completing Phase A and B testing on the rooftop of Engineering Building 2 at the University of Pretoria, the team prepared to enter Phase C, focused on testing the system's potential to melt metals such as aluminium, generate electricity, and deliver general heat applications like hot water and steam. Phase C testing was scheduled for the second half of February 2025 in Masia Village. Alongside testing, good progress had been made on the in-house manufacturing of key components, including the vacuum-membrane reflectors and the system's heat exchanger.

By 12 March 2025, the system was fully deployed at the Masia Multipurpose Resource Centre in Limpopo. This marked the beginning of a community-centred demonstration period during which the team showcased the full functionality of the mobile solar-dish gas-turbine hybrid. The technology integrates a reflective dish with a Brayton cycle micro-gas turbine and was designed to produce both electricity and thermal energy, while also demonstrating the ability to melt metals, particularly aluminium and zinc, using waste heat.

What makes this system particularly innovative is its mobility and automated control. The dish folds into a compact "stow" position for safe transport or to be used in unfavourable weather conditions, while a smart control system automatically adjusts each mirror facet to maintain accurate solar focus. Both features were the subject of patent demonstrations during the deployment.

The live testing in Masia successfully achieved Technology Readiness Level 7 (TRL 7), demonstrating that the system is ready for real-world applications. Over a two-week period, the team engaged with local residents, answered questions, and monitored the system's performance in actual operating conditions.

The feedback from the community was overwhelmingly positive. While the energy generation capabilities were appreciated, it was the system's ability to melt aluminium cans that sparked the most interest. Community members immediately saw the potential for small-scale recycling, turning waste into usable aluminium billets or shapes that could support new income-generating activities. This unexpected but welcome feedback led the development team to plan further modifications to focus the system more directly on metal recycling in its next deployment.

Following the successful demonstration, the mobile system was returned to the University of Pretoria for reconfiguration. The goal is to optimise it specifically for aluminium recycling before sending it back to Masia for permanent use.

In addition to its technical success, the project has played an important role in human capital development. Students, junior engineers and technicians contributed to all stages of the system's design, assembly and field deployment, gaining hands-on experience in renewable energy applications. This work supports the broader national goal of growing expertise in solar thermal power generation and sustainable engineering.

As a country with some of the world's best solar resources, South Africa is well-positioned to lead in solar energy innovation. The Masia deployment shows how research-driven solutions can deliver real value, not just through technology, but through community engagement, skills development, and sustainable local impact.



Completed components of the Solar Dish Brayton Cycle Turbine system to be deployed at Masia Resource Centre. ^

Demonstration of the Solar Dish Brayton Cycle Turbine at Masia Village ^

Using Knowledge for Economic and Inclusive Development

PV Marketplace

Polymorph was appointed to assist with the development of components for the PV Marketplace, incorporating GreenX's schools funding business model. The marketplace now features innovative functionalities that enable funders and philanthropists to connect directly with schools, providing tailored support for renewable energy projects in their chosen institutions. By bridging the gap between schools and funders, the PV Marketplace has the potential to transform renewable energy adoption in the education sector, driving sustainability and fostering effective collaborations.

This initiative forms part of the PV Marketplace project to assess the viability of the Marketplace as a comprehensive platform for renewable energy solutions. The integration of schools and funders within the platform represents a strategic effort

to position the PV Marketplace as a catalyst for sustainable development, while creating a space for key stakeholders to engage effectively.

The pilot will further explore the scalability of the Marketplace and its potential to serve as a game-changing tool in renewable energy adoption, not only within schools, but also across broader educational and community-based initiatives.



New Marketplace logo ^

Increased Knowledge Generation

Synchronous Condenser Grid Compensator

Synchronous condensers (SCs) are grid-connected electrical machines designed to offer stability to the grid by providing reactive power and grid strength. The use of such technology becomes increasingly important with the greater penetration of renewables into the grid, accompanied by the loss of grid strength. Eskom is currently installing and planning the greater installation of a relatively large number of big SCs to stabilise the SA power grid.

The SU Wind Energy Spoke is proposing and currently investigating the use of so-called passive-rotor SCs. These SCs have the advantages of very low maintenance and huge inertia. In partnership with ACTOM, the Wind Spoke built the first prototype of the technology and tested it in the previous year. Laboratory tests (see photos) picked up vibration and noise problems. These issues were investigated this year and the results and conclusions are currently being prepared for a journal paper, as follows:

O.I. Olubamiwa, S. Botha, S.C. McIntyre, and M.J. Kamper, "Vibration investigation of a DC-VRM synchronous condenser prototype," IEEE Transactions on Energy Conversion.

Considering the many design options to reduce the vibration problem, the outcome of the study shows that the 12/10 DC-

VRM topology is not suitable for SC operations, mainly due to large, concentrated attraction forces between the stator and rotor components of the machine.

This result prompted the team to look at alternative passive rotor SC options. This led to the finding of a good alternative with substantial advantages compared to the DC-VRM. This technology has been disclosed to INNOVUS at the SU, which is currently looking into its patentability, and therefore no further information can be given in this report. In parallel, the team designed a small prototype SC of this technology that is currently under construction and which is planned to be tested in the laboratory in the 4th quarter of this financial year. If the tests are positive and the technology seems patentable, a provisional patent will be issued.



Synchronous condenser (the DC-VRM) being tested in the SU Wind-Energy-Spoke laboratory. ^

Komati Wind Turbine System

Stellenbosch University's Wind Spoke has successfully developed and deployed a small-scale wind-generation system designed to directly charge batteries with minimal need for additional conversion components. The system, rated at approximately 3.5 kW, offers a practical and efficient solution for hybrid and standalone applications. It is particularly well suited for households, farms and rural mini-grids, making it a strong candidate for advancing energy access in remote communities.

The generator at the heart of the system features concentrated winding coils and permanent magnets, resulting in high torque density and efficiency. It can operate with both fixed and variable DC supplies using an inverter, making it adaptable to different energy needs. Importantly, the entire unit has been designed and manufactured locally, supporting South Africa's goal of building self-reliant renewable energy capacity.

This technology was recently deployed at the Komati Power Station, where it has been integrated into Eskom's microgrid infrastructure. The Komati site, located near Middelburg in Mpumalanga province, serves as one of Eskom's national demonstration points for rural mini-grids. With an average wind speed suitable for small-scale generation, the site was an ideal choice for this installation.

The deployment process has been completed. All laboratory testing of the generator and turbine was finalised ahead of installation. A site inspection with Eskom engineers and the tower manufacturer, Sectional Pole, confirmed technical readiness, and tower construction proceeded following receipt of the necessary components. Environmental and safety documentation was compiled and approved, ensuring that the project met all compliance requirements. The microgrid itself was relocated to the visitor centre at the Komati Station, and the wind turbine is now fully installed and operational at its final location.

The Komati wind system is running as part of a fully functional containerised microgrid. Its components include inverters, combiner units and battery banks, which work together to deliver a consistent and reliable flow of clean energy. This setup provides a powerful demonstration of what is possible when academic research, industry partnerships and national utility strategies align.

With the successful completion of this project, Stellenbosch University and Eskom have shown how locally developed renewable energy technologies can be effectively deployed to support South Africa's transition to sustainable and inclusive energy systems.



Photos of wind generator (left), wind turbine, nacelle and tail (middle), and lab tests showing the SUNSynk, generator and connection box (right). ^

Dry Gravity Storage System

Energy storage plays a very important role with the increasing use of intermittent renewable energy sources. This research looks at a newly proposed dry gravity energy storage system. It consists of linear electrical machine systems that move iron masses up (charging energy) and down (discharging energy). The study shows that this technology is economical for primary responses to power networks. It can be used above-ground, or for example using deep mineshafts, as not many are in use in South Africa. Specific drive technologies are being investigated. A small-scale model was built to investigate the technology.

In the photos, a horizontal system is shown in the first tests. This system will finally be put up vertically to demonstrate part of the dry gravity energy storage technology.



Linear dry gravity storage system. ^

Brushless Doubly Fed Induction Generator (BDFIG)

The Brushless Doubly Fed Induction Generator (BDFIG) is a new kind of induction generator to solve the brushes-and-sliprings problem of the conventional DFIG wind generators. The BDFIG is thus brushless, although it needs a special cage rotor. The idea is to see whether the BDFIG can be used for wind

generator applications. The design of BDFIGs is challenging, as the power density of these generators is not as good as that of conventional DFIGs. Furthermore, the manufacturing of the special cage rotor is also not standard.

By way of a PhD study, a prototype generator was designed and built (see photos below left), and is currently undergoing tests in the laboratory.

Brushless Doubly Fed Reluctance Generator (BDFRG)

The Brushless Doubly Fed Reluctance Generator (BDFRG) is a further new kind of generator that uses a passive reluctance rotor (see photos to the right), which is easy to manufacture and therefore solves the more difficult problem of the manufacturing of the cage rotor of the BDFIG. The aim of the research is to evaluate this technology as applied to wind generators.

By means of a PhD study, a prototype BDFRG was designed and built (see photo to the right), which is currently undergoing tests in the laboratory (see photo of test setup). A complete comparison of both the BDFIG and BDFRG will be published in an ISI journal.



BDFRG rotor in manufacturing (left) and test machine (right). ^



BDFIG rotor (left) and stator (right). ^



Test set-up for both BDFIG and BDFRG. ^

Permanent Magnet Vernier Wind Generator

A new kind of electrical machine with higher power and torque density is the permanent magnet vernier machine (PMVM). Research on this forms part of a Master's and focuses on the suitability of this technology for wind generators for variable DC-grid wind farms. A prototype 4-kW generator was built and tested as part of a first study (see photo of the PMVG and test setup to the right). The results are currently being investigated.

What makes this generator unique is that it has a double three-phase stator with two converters so that if one of the two converters fails, 50% of the power can still be obtained with the healthy converter. This is in response to the relatively low reliability of converters found in wind generator systems.



Test setup of the PMVG (right). ^

Minister Blade Nzimande Hands over third Media Lab

The Minister of Higher Education, Science, Technology and Innovation, Dr Blade Nzimande, handed over the third media lab under one of his special projects aimed at future-proofing education and skills, one of the societal grand challenges identified in the Science, Technology and Innovation Decadal Plan. The project was done in collaboration with Sanedi.org and Stellenbosch University's Centre for Renewable and Sustainable Energy Studies.

The third Media Lab was handed over to Naledi Primary School in Ottosdal, North West province, on 29 April 2024. The Media Lab is powered by a solar photovoltaic system and represents a commitment to modern education and skills development in rural areas. This initiative aligns with the Science, Technology and Innovation Decadal Plan's goals of future-proofing education and providing clean energy solutions to underserved communities. The Lab will introduce learners and educators to technology-driven classrooms, preparing them for the future. The media lab has a seating capacity of 42.

This project was funded by the Department of Science and Innovation and was implemented by Stellenbosch University's

Centre for Renewable and Sustainable Energy Studies in collaboration with SANEDI. Other key partners include the Department of Higher Education and Training, the North West Provincial Government and Vuselela TVET College.

Dr Richmore Kaseke of the CRSES represented the Centre well at the launch.



Minister of Higher Education, Science, Technology and Innovation, Dr Blade Nzimande, with Naledi Primary School learners during the handover.



Naledi Primary School Media Lab

Science Lab and Water-Energy-Food Nexus Project Handover

On Friday, 5 April 2024, the Minister of Higher Education, Science and Innovation, Dr Blade Nzimande, handed over the Russell Bungeni Secondary School Science Lab and the Masia Village Water-Energy-Food Nexus Project. The successful event was supported by local leaders, including Chief Given Bungeni, Chief Thovhele vho-Masia, the Limpopo MEC for Education, Ms. Mavhungu Lerule-Ramakhanya, the Executive Mayor of Vhembe District Municipality, Cllr Freda Nkonda, and the Mayor of Makhado Local Municipality, Cllr Mahandana Dorcus Mboyi. This project was made possible through collaboration with the Department of Higher Education, Science and Innovation, SANEDI, Stellenbosch University, Bambili Energy, HySA Infrastructure, ARC.LNR, NYDA, and UNIVEN.



Science Lab

On Friday, 5 April 2024, the Department of Science, Technology and Innovation (DSI), in collaboration with Stellenbosch University's CRSES, Sanedi.org, and Chief Given Bungeni of the Traditional Authority, launched a state-of-the-art solar-powered Science Laboratory at Russell Bungeni High School in Hlanganani ka Bungeni.

This incredible initiative represents our collective commitment to fostering innovation, empowering youth, and embracing renewable energy solutions.

The fully equipped solar-powered science laboratory includes the latest technology, creating a dynamic space for hands-on exploration and discovery. The science lab will inspire generations of students to pursue their passions and make a positive impact on the world.

We would like to thank everyone who contributed to this project's success, from our partners and supporters to the dedicated educators and students. Together, we are building a brighter tomorrow fuelled by knowledge, innovation, and renewable energy.



Peter Mokaba Primary School Media Lab completed

Work towards the deployment of the Peter Mokaba Primary School Media Lab also progressed well and the installation was completed in May 2024. The handover of the lab was initially planned for 16 May 2024; however, due to unforeseen circumstances, the Ministry postponed the handover until further notice. The photos on the right show the Peter Mokaba Primary School Media Lab during the final stages of construction. This lab has the same seating capacity as the Naledi Primary School lab, which is 42.



Final construction stages of the Peter Mokaba Primary School Media Laboratory in May 2024. ^

Media/Science Lab commercialisation

During the course of March 2025, GreenX Engineering signed a non-exclusive licence agreement with Stellenbosch University for the commercialisation of Media and Science labs. A number of large South African companies have been approached to support the rollout of these media labs, which would need to be done in conjunction with education departments across South Africa.

The licensing was one of a handful of options explored, which included the following

- Licensing selected given the flexibility to recruit and select appropriate partners, while retaining oversight of the rollout and quality requirements
- The sale of the IP was an alternative commercialisation option, which would facilitate the exit of Stellenbosch University as a stakeholder, but this was rejected

- A third alternative was that Stellenbosch University would commercialise the Media Lab rollout, but this undertaking went beyond the scope of the University's core activities



Peter Mokaba Primary School Media Lab ^

Capacity building and imparting skills in support of a Just Energy Transition

Through the Train-the-Trainer Programme, which aims to build the capacity of TVET college lecturers in the renewable and sustainability space, the Hub supported four (4) of these lecturers to attend the Advanced Solar PV Systems and Green Hydrogen Project Engineering Courses, and nine (9) TVET college lecturers to attend the Bioenergy Short Course that

ran from 3 to 7 June 2024. In addition to the TVET college lecturers, five (5) TVET college graduates attached to the Masia Water-Energy-Food Nexus project were also supported to attend the same course. The aim was to equip the graduates with additional skills that can help them diversify the energy supply at Masia through converting organic waste from the food systems into useful energy. The table on the following pages gives the list of supported TVET lecturers and graduates and their affiliated institutions.

“

Capacity building and skills development are important in empowering people and ensuring that the Just Energy Transition is inclusive, fair, and sustainable.

”

Human Capital Development

The Human Capital Development programme currently supports twenty-nine (29) postgraduate students across different spokes and the hub. Details of the supported students are provided in Table A. A total of ten (10) TVET college students were trained. Details of the trained TVET students are provided in Table B. In addition, nine (9) technicians were supported, and the details are provided in Table C.

Number of postgraduate students (master's and doctoral) supported in the clean energy sector

No	Name	Surname	Institution	Programme	Year of 1st study	Degree	Course
1	Nikhil	Bejrajh	UCT	RSE Hub & Spokes	2023	PhD	Elec Eng
2	Caitlin	Cockcroft	UP	RSE Hub & Spokes	2024	MEng	Mech Eng
3	Roy	David	UCT	RSE Hub & Spokes	2023	MSc	Elec Eng
4	Lucky	Dube	SU	RSE Hub & Spokes	2023	PhD	Elec Eng
5	Matthew	Duckitt	SU	RSE Hub & Spokes	2023	MEng	Mech Eng
6	Don	Fitzgerald	SU	RSE Hub & Spokes	2024	PhD	Elec Eng
7	Ryno	Gerber	SU	RSE Hub & Spokes	2004	MEng	Elec Eng
8	Elizabeth	Hageman	NMU	RSE Hub & Spokes	2024	MSc	Physics
9	Shakir	Hartogh	SU	RSE Hub & Spokes	2004	MEng	Elec Eng
10	Evan	Humphries	UP	RSE Hub & Spokes	2024	MEng	Mech Eng
11	Mu-Een	Khan	SU	RSE Hub & Spokes	2023	MEng	Mech Eng
12	Conrad	Kloppers	SU	RSE Hub & Spokes/ Scatec	2023	MEng	Elec Eng
13	Tenzin	Koetsier	SU	RSE Hub & Spokes	2024	MEng	Mech Eng
14	Bethuel Karabo Sepena	Langa	UFH	PV Spokes	2024	MSc	Chemistry
15	Monique	le Roux	SU	RSE Hub & Spokes	2024	PhD	Elec Eng
16	Tristan	Le Roux	SU	RSE Hub & Spokes	2023	PhD	Mech Eng
17	Phemelo	Maile	UCT	RSE Hub & Spokes	2023	MEng	Elec Eng
18	Lavhelesani	Maluleke	SU	RSE Hub & Spokes	2023	MEng	Mech Eng
19	Storm	Morison	SU	RSE Hub & Spokes	2024	PhD	Elec Eng
20	Sinikiwe Abrosia	Mvokwe	UFH	PV Spokes	2024	MSc	Chemistry
21	Christa	Nsanzubuhoro	SU	RSE Hub & Spokes	2023	PhD	Mech Eng
22	Judhi	Rens	SU	RSE Hub & Spokes/ Scatec	2024	MEng	Elec Eng
23	Roelof	Roodt	NMU	RSE Hub & Spokes	2024	PhD	Physics
24	Jean	Schnaar-Campbell	SU	RSE Hub & Spokes	2023	MEng	Mech Eng
25	Sarath	Simon	SU	RSE Hub & Spokes	2023	MEng	Mech Eng
26	Jonathan	Swanepoel	UP	RSE Hub & Spokes	2024	PhD	Mech Eng
27	Schalk	van der Merwe	SU	RSE Hub & Spokes/ Scatec	2023	MEng	Elec Eng
28	Brendan	Willemse	SU	RSE Hub & Spokes/ Scatec	2024	MEng	Elec Eng
29	Joshua	Woods	SU	RSE Hub & Spokes/ Scatec	2023	MEng	Elec Eng

Number of unemployed TVET and University of Technology Students trained in the clean energy sector

No	Name	Surname	Programme	Institution
1	Given	Kone	RE Internship	SU
2	Hulisani	Makungo	RE Internship	SU
3	Ndishavhelafhi	Mukondeleli	RE Internship	SU
4	Tondani	Mulaudzi	RE Internship	SU
5	Hulisani	Mulaudzi	RE Internship	SU
6	Matthew	Sivewright	RE Internship	NMU
7	Uzair	Slarmie	RE Internship	UCT
8	Robert	Stevenson	RE Internship	NMU
9	Aluwani	Tshishonga	RE Internship	SU
10	Ntombizakhe	Xhego-Jimlongo	RE Internship	UCT

Number of artisans and technicians supported in the clean energy sector

No	Name	Surname	Programme	Institution
1	Llewellyn	Kordom	Solar Thermal	SU
2	Livhuwani	Maremeni	Solar Thermal	UP
3	Dipekeng	Marula	Solar Thermal	UP
4	Rafael	Mgcina	Solar Thermal	UP
5	Fidelcastra	Modise	Wind	SU
6	Zwivhuya	Muofhe	Solar Thermal	UP
7	Hoosain	Salie	Wind	UCT
8	Vincent	Schoeman	Solar PV	UFH
9	Sthembile	Skhosana	Solar Thermal	UP



SOLTRAIN+ 2024 ACTIVITIES

Southern African Solar Thermal Training and Demonstration Initiative

The SOLTRAIN initiative, established in 2009 and currently funded as SOLTRAIN+ by the Austrian Development Agency until 2026, is implemented by AEE INTEC in collaboration with nine country partners. Its goal is to support these countries in moving from reliance on fossil fuels to adopting renewable energy-based systems, with a particular focus on renewable heating and cooling (RHC) technologies and energy efficiency. The initiative focuses on capacity building through training programmes, awareness raising to inform the public about the benefits of RHC technologies, advancing research and development (R&D), and supporting policymakers in developing solar thermal roadmaps. In addition, SOLTRAIN offers co-funding for demonstration systems and promotes gender and diversity (G&D) initiatives to increase women's participation in the traditionally male-dominated energy sector. The Centre for Renewable and Sustainable Energy Studies (CRSES) is one of the country partners that facilitates all activities within the Western Cape region.

In 2024, the CRSES hosted three training courses, successfully equipping 61 experts in solar thermal systems, with women making up 23% of the participants. This led to presentations at two conferences and participation in an awareness-raising event that contributed significantly to enhancing the gender diversity network. Some of the participants were involved in two demonstration projects, which included the installation of integrated photovoltaic thermal (PVT) systems with heat

pumps at a social institution and a hospital. The participants also undertook an educational tour that showcased innovative renewable heating solutions. This tour not only highlighted cutting-edge technologies, but also played a crucial role in educational enrichment, professional development, and promoting sustainable energy solutions. Collaboration was established with the International Centre for Sustainability and Excellence (ICSE) in Eswatini to expand the utilisation of the SOLTRAIN initiative beyond its project timeline, with the aim to broaden the adoption of sustainable energy solutions across the continent, thereby enhancing regional expertise and capacity in renewable energy.

Summary of Activities for 2024

Activity Type	Total	Details
Training courses held	3	Focused on renewable heating and cooling (RHC)
Experts trained	61	Including 47 men and 14 women
Demonstration projects (in progress and approved)	2	PVT systems with heat pumps installations
Energy audit in progress	4	Targeting different energy-intensive sites
Technical tour conducted	1	Showcasing renewable heating solutions
Awareness raising events attended	1	—

Training Activities

Train-the-Trainer Course

The Centre for Renewable and Sustainable Energy Studies (CRSES) facilitated a two-day SOLTRAIN Train-the-Trainer course on 29 February and 1 March 2024, held at the Stellenbosch Institute for Advanced Study (STIAS), South Africa. The session, led by Rudolf Moschik from AEE-INTEC, focused on the dimensioning and design of medium- to large-scale pumped solar thermal systems. Attended by eight participants from universities, vocational colleges and solar thermal companies, the course aimed to enhance their technical skills. The participants expressed a strong interest in further training to expand their expertise.



Train-the-Trainer Workshop ^

Institutional and Commercial Building Thermal Energy System Workshop

The building sector is responsible for about one-third of global energy-related carbon emissions, largely due to electricity use in water heaters, cooling systems and other energy-intensive equipment. Decarbonising heating and cooling systems in buildings can significantly reduce emissions from fossil fuel consumption, promoting energy efficiency and sustainability. To address these challenges, CRSES and SOLTRAIN hosted a two-day workshop on Institutional and Commercial Building Thermal Energy Systems. The workshop aimed to discuss low-carbon thermal energy systems, focussing on solar and heat pump solutions for commercial and institutional buildings. Participants included industry experts, consultants and municipal representatives, all working together to explore practical solutions to reduce grid dependency, enhance energy security, and meet CO2 reduction targets.

The workshop featured sessions on thermal energy systems, cost-benefit analyses, and Cape Town's energy strategy for reducing carbon emissions by 2050. It also included discussions

on sustainable energy solutions, barriers to adopting solar thermal systems, and strategies for overcoming these challenges. The second day focused on heat pump design, thermal storage and energy audits, with case studies providing insights into system implementation and long-term operation. Participants expressed interest in collaborating on projects and furthering their knowledge in system design. The workshop successfully facilitated knowledge exchange and collaboration, contributing to a sustainable energy future in South Africa.



Figure 3: Institutional and Commercial Building Thermal Energy Systems ^

Training on Energy Audits and Solar Thermal System Design for Buildings

Energy audits and the design of renewable heating and cooling systems are crucial in today's evolving energy landscape. Energy audits identify inefficiencies and potential savings, helping to improve performance and reduce costs. The design of renewable systems enhances the provision of reliable, low-cost heating and cooling, reducing reliance on non-renewable energy sources. Experts skilled in these areas are vital for advancing sustainable energy solutions.

A SOLTRAIN+ training session on energy audits and solar thermal system design, held on 21 and 22 October 2024, aimed to improve industry professionals' skills. Around 30 participants, including engineers and consultants, attended, with discussions on data acquisition, case studies and system

design. Participants also applied their knowledge to conduct energy audits on case studies, some of which may become demonstration projects. The session's success is attributed to experts Rudolf Moschik and René Baumann from AEE INTEC.



Figure 4: Training on Energy Audits and Solar Thermal System Design ^

Technical Tour

Educational Tour on Renewable Heating Solutions: Insights and Innovations for the Building Sector

On 23 October 2024, an educational tour was conducted to showcase innovative renewable heating solutions at the Langebaan Windtown Hotel and Mediclinic. Hospitals and hotels require significant energy for water heating and compensating for thermal losses, typically rely on heat pumps and electric boilers. However, with rising electricity costs and the climate crisis, renewable energy solutions are becoming more competitive. The sites visited incorporated hybrid heating systems, combining photovoltaic thermal (PVT) technology with heat pumps. PVT panels generate both electricity and thermal energy, while the heat pump serves as a backup heating source. This system has the potential to offer a 100% renewable hot water solution.

The tour provided hands-on experience, bridging theoretical knowledge with real-world application, and helped professionals stay updated on alternative energy solutions, design practices, and regulatory compliance. Special thanks to Mark Epstein from Greenline Africa and Ryan Dearlove from Solarus South Africa for their guidance during the tour.



Figure 5: Educational Tour on Renewable Heating Solutions ^

Scientific Dissemination

ISEC – 3rd International Sustainability Energy Conference 2024

The ISEC conference, which was held in Graz, Austria on 10 and 11 April 2024, was a resounding success, drawing over 400 participants from 35 countries, and featuring 80 presentations and 100 posters. The event saw key contributions from ministers of Austria and Brazil, as well as government, industry, and research representatives.

Francois Rozon presented his PhD research on the adoption of renewable energy in industry, with a focus on the South African beverage sector. He introduced a three-stage framework for industrial decarbonisation, assessed energy consumption and CO₂ emissions in the South African beverage industry, and shared a decision tree to guide long-term decision-making. His presentation was well received, particularly alongside other discussions on decarbonisation solutions in Sub-Saharan Africa.

Johannes Koke, a visiting professor from Osnabrück University, presented a poster on techno-economic modelling of PV-driven high-temperature heat pump systems for beverage facilities. This research, a collaboration between Prof Craig McGregor, Dr

Rozon and Prof Koke, compared the coefficient of performance for different heat pump configurations and the levelised cost of heat versus solar thermal systems.

Stellenbosch University's active participation, representing STERG and the CRSES, highlighted their commitment to renewable energy and decarbonisation efforts. The contributions were well received, and the conference's success has set the stage for the next ISEC conference in April 2026, at which ongoing research and projects from Southern Africa will be showcased.



Figure 6: ISEC 3rd International Sustainability Energy Conference 2024 ^

Utilisation and Expansion of SOLTRAIN Beyond the Project Timeline

During the October training session, there was an opportunity to interact with delegates from Eswatini, which provided an excellent opportunity to discuss the expansion of the SOLTRAIN project to other African nations. This interaction led to the establishment of a promising collaboration with the

International Centre for Sustainability and Excellence (ICSE) in Eswatini. Together, a detailed proposal was drafted aimed at extending the reach and impact of SOLTRAIN beyond its current project timeline. This proposal has been submitted to SACREEE for further development and support. This step is part of a larger endeavour to integrate sustainable energy solutions across the continent, facilitating regional growth in renewable energy expertise and capacity.

Demonstration Projects

This section provides an overview of the demonstration projects in which the CRSES was involved.

Huis Ebenhaeser PVT and Heat Pump Project

Huis Ebenhaeser is an elderly care facility serving previously disadvantaged communities in and around Stellenbosch. The facility accommodates 120 residents, of which 80% are frail. To reduce operating costs and meet sustainability objectives, the facility has implemented a solar renewable system for domestic hot water. The system comprises photovoltaic thermal (PVT) panels that provide both a thermal output of 19.25 kWth and an electrical output of 4.9 kW. The system further includes a heat pump for backup and an energy-efficient distribution and circulation system to minimise thermal losses. The heat pump is already operational, and the installation of PVT collectors is scheduled for 2025, as the roof still needs refurbishment.



Mediclinic PVT and Heat Pump Project

Mediclinic Southern Africa manages a network of multidisciplinary acute-care private hospitals dedicated to delivering value through safe, high-quality care in a patient-centric environment. As part of its commitment to sustainability, Mediclinic Cape Gate has implemented an innovative renewable energy system. This system consists of photovoltaic thermal (PVT) panels that produce a total of 137 kWth of thermal energy and 38 kW of electrical power, complemented by a 124-kW heat pump. This integrated energy solution is designed to supply 100% renewable hot water to the 128-bed hospital. The installation of this system was completed in 2024, with operational commencement anticipated by December of the same year.



CBC (Cape Brewing Company)

Situated in Paarl, Western Cape, the Cape Brewing Company implemented a solar thermal system designed for process heat in 2015. The system features flat plate collectors that cover 120 m² and provide a thermal capacity of 84 kWth. Unfortunately, due to inadequate maintenance, the system's heat exchanger was damaged. Recently, the company sought assistance in finding a service provider to inspect and restore the system to optimal functionality. CRSES will install monitoring equipment to ensure continuous performance assessment and maintenance guidance.



Energy Audits

This section outlines the ongoing and planned energy audits across various sites and projects. The audits aim to assess, recommend and implement energy-efficient solutions to enhance sustainability and reduce operational costs. These audits are crucial for identifying potential areas for the integration of renewable energy technologies.



SUNZ-Thermal energy recommendations for SU roadmap

This study assesses hot water-heating solutions for three student residences at Stellenbosch University, aiming to evaluate various water-heating technologies. The study is currently in progress and was expected to conclude in the week of 20 January 2025.



City of Cape Town

The City of Cape Town is exploring the installation of demonstration systems at two key city-owned facilities with substantial energy needs. The goal is to enhance business continuity, increase renewable energy utilisation, and improve cost-effective service delivery. The CRSES is scheduled to conduct an energy audit in January 2025 to further this initiative.



Rotex Fabrics

Rotex Fabrics is considering a project that includes the integration of solar hot water systems, possibly targeting condensate return or hot water. In addition, a larger project is being contemplated that would involve deploying biomass at an industrial park to serve various businesses in the area, supplemented by solar thermal integration for high-temperature steam supply. CRSES will continue discussions with Rotex Fabrics to gather the necessary data for an energy audit analysis.



CCBA Devland / KWV

An initial part of the energy analysis for CCBA Devland was conducted in December 2024. Further analyses are planned for KWV and its neighbours in 2025, pending the availability of additional data.



Financial Overview

2023 Financial Audit

In accordance with the standard AEE-Intec reporting template, the 2023 financial overview was prepared by Dr Rozon, who had only recently joined the SOLTRAIN+ initiative. This required an excessive number of work hours, given that different programme managers had been involved over the previous twelve months. Nevertheless, the expenditure verification was performed by LDP Compliance in March 2023. This went well and no major findings were identified, with the only deviation being with respect to interest calculated but not paid over to the ADA.

A subsequent audit from Austrian Development Agency representative found minor issues to be rectified in the future, namely:

- Document contractors
- Ensure invoices are filed and dates accurate

SOLTRAIN Training/Technical tour: October 2024

Training sessions:

An educational training session was held on **21 and 22 October 2024**, during which energy experts gained valuable knowledge and insights into energy audits and solar thermal system design. The session began with a compelling discussion on the global impact of climate change and the essential role of solar thermal technologies in sustainable energy solutions. Participants then delved into detailed aspects of energy audits, including applicable standards, guidelines, the process of data acquisition, and the effective use of relevant tools and templates. Case studies were also analysed, providing a practical perspective on the audit process. The focus then shifted to the technical design and dimensioning aspects of mid-sized solar thermal

systems, covering topics such as the design of collector areas, storage tanks and collector hydraulics, and the use of relevant simulation software. To reinforce the learning process, each participant was encouraged to apply the knowledge gained by conducting energy audits on selected case studies. These audits are intended to serve as benchmarks, with some projects potentially evolving into demonstration projects supported by the **SOLTRAIN** funding initiative. The outcomes of these sessions are eagerly anticipated, and the ongoing collaborative efforts are focused on advancing sustainable solutions for a greener future. Special thanks go to **Rudolf Moschik** and **René Baumann** from **AEE INTEC**, for sharing their invaluable knowledge and expertise.

Technical Tour:

An informative and educational technical tour of the PVT installations at Langebaan Windtown Hotel and Mediclinic took place on 23 October 2024. This tour provided valuable insights that complemented the knowledge gained from the solar thermal design training session. A huge thanks to Mark Epstein from Greenline Africa and Ryan Dearlove from Solarus South Africa, for leading such an insightful tour! We look forward to our next visit and the opportunity to see the new projects that are under way.



STERG 2024 ACTIVITIES

STERG Technical Tour 2024

Credit: STERG Website

The Solar Thermal Energy Research Group (STERG) embarked on a technical tour to the Northern Cape from 15 to 20 July 2024. The goal was to give students hands-on experience of renewable energy plants, focusing on concentrating solar power (CSP). The group included 11 master's students, one PhD candidate, and several academic staff members, along with a lecturer from UCT's engineering faculty.

Visit to the Redstone CSP Construction Site

On 16 July, the group visited the construction site of the Redstone CSP plant. Once completed, this plant will provide electricity to over 200 000 households, with a capacity of 100 MWe. Redstone also features 12 hours of molten salt storage, allowing it to generate electricity even at night. This visit gave the students a unique behind-the-scenes look at the construction of CSP plants.

Exploring Operational Power Plants

On 17 July, the group visited two fully operational energy plants. The first stop was Ilanga CSP 1, a 100 MWe parabolic trough CSP plant that uses synthetic oil as a heat-transfer fluid and has 4.5 hours of molten salt storage. The second visit was to the Kenhardt Photovoltaic (PV) Plant, developed by Scatec. This massive plant has around one million PV panels and a capacity of 540 MWe. It also includes 225 MW of battery storage, which helps the plant provide power in the evenings.

STERG Annual Symposium in Upington

On the 18th of July, STERG hosted its annual symposium in Upington. This event provided a platform for the students to share their research and network with industry professionals. Presentations included research on CSP technologies and supercritical CO₂ cycles. The symposium was attended by both local and international researchers, and featured talks by several STERG members, including Dr Varun Singh, as well as lecturers like Colin du Sart and Themba Mokoena, who discussed the role of SANEDI in promoting solar power in South Africa.

The tour was a valuable experience for the STERG group, enhancing their knowledge of CSP technologies and fostering strong connections with the industry. Special thanks were given to the hosts at Redstone, Karoshhoek and Scatec, for their warm hospitality and willingness to share their expertise with the group. This tour continues to strengthen STERG's relationship with the growing CSP industry in South Africa.



STERG delegation on the way to Prieska ^



The 100MW Redstone concentrated solar thermal power (CSP) plant ^



Attendees at Ilanga CSP 1 ^



STERG delegation at Kenhardt PV ^

STERG well represented at SolarPACES 2024 in Rome

Article from: <https://sterg.sun.ac.za/sterg-well-represented-at-solarpaces-2024-in-rome/>

SolarPACES (Concentrating Solar Power, Thermal, and Chemical Energy Systems) is an international conference that aims to bring researchers together from across the world and focus on the development of concentrating solar power systems. It is widely considered as the annual global get-together of the CSP community.

A group of students and academic staff from the Solar Thermal Energy Research Group (STERG) attended the SolarPACES 2024 conference, which took place from in Rome, Italy from 7 to 11 October.

The group made a strong impact at the conference, with seven presentations in total – six poster presentations and one oral presentation, showcasing STERG's ongoing research to leading industry experts and fellow researchers in the field of concentrated solar power.

Beyond the formal presentations, the conference was an excellent platform for networking and relationship-building. The team engaged actively with international colleagues, laying the groundwork for future research collaborations.

Several exciting technologies and concepts were showcased at the conference, with a notable focus on hybrid CSP systems, energy-storage solutions, and decarbonisation strategies. There was significant interest in the use of ceramic materials in high-temperature storage, and the integration of hydrogen production within CSP systems. Discussions also covered hybrid systems combining CSP, PV and battery technologies to enhance flexibility and reliability in energy production.

After the conference, the STERG delegation took the opportunity to stay in Rome and explore the city. The group visited several tourist attractions, including the Colosseum, Spanish Steps, Trevi Fountain, Borghese Gardens and the Pantheon.

The students would like to thank STERG, for sponsoring the delegation's conference attendance at STERG's premier conference.



STERG delegation on the way to Rome ^



STERG delegation outside the Colosseum ^

HYDROGEN ENGINEERING PLATFORM

The Stellenbosch University Hydrogen Platform made good progress in 2024. The platform received an extra R4.9 million in funding, gained recognition from the Department of Science, Technology and Innovation (DSTI), and became part of a larger plan called FUTURA.

The platform built important partnerships with groups like HySA/Catalysis, Sasol and Fraunhofer, and worked with international organisations such as ARUA and the University of Osaka.

The Hydrogen Platform improved its research setup by creating new labs, including one for testing electrolysis and another for gas turbine combustion. The platform also worked on projects in areas like advanced manufacturing, biogas upgrading and combustion modelling.

However, it faced challenges with staffing, lab space, and delays in starting projects.

In 2025, the platform plans to hire more staff, grow partnerships and funding, increase visibility, and focus on research in electrolysis, biogas upgrading and hydrogen combustion. It plans to launch a website and hold a roadshow to promote its work.

Although the platform made progress in 2024, it still faced some challenges. With clear plans, it is on track for continued growth in green hydrogen research.



CRSES NEXT ACTIVITIES

NEXT (New/National Energy/Electricity and Power-to-X Transitions/Trajectories) focuses on power system simulation, including both the outward flow of electricity (power-to-X) and the inward flow, such as grids, dynamics and microgrids.

NEXT aims to enhance the quality of energy decisions in South Africa (SA) and potentially in the broader Africa, striving for global recognition of excellence in academically rigorous, modelling-based decision support for electricity-focused energy futures. The initiative does not cover non-simulation activities, like technology development, training, consulting or broader energy systems, nor does it focus on non-engineering areas such as job creation or social impact.

Projects

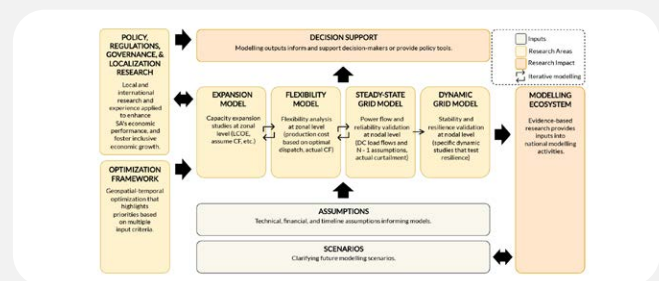
Power System and Renewable Energy Integration Modelling (ongoing)

Funder: Presidential Climate Commission

CRSES has been contracted by the Presidential Climate Commission, together with NEDLAC and the Danish Energy Agency, to provide comprehensive modelling services to answer key question relating to the long-term planning and grid integration of renewable energy sources in South Africa. The project addresses South Africa's grid capacity challenges that limit the integration of large-scale renewable energy projects and will be done by developing advanced models that incorporate energy generation and demand, together with transmission grid complexities and constraints. These models will guide infrastructure investments and policy decisions to support a sustainable and economically viable energy pathway for South Africa.

The project will produce three models that aid in decision-making regarding the technical and economic impacts of different power-generation mixes on grid expansion, as well as inform infrastructure investments and policy decisions:

- **Energy Systems Model (Including Capacity Expansion and Production Cost Model):** Optimises the selection and utilisation of power-generation technologies to meet electricity demand at the lowest cost.
- **Geospatial Renewable Energy Resource Model:** Identifies optimal locations for new renewable projects based on resource mapping, grid integration and socio-economic factors.
- **Transmission Grid Simulation Models:** Analyses both steady-state and dynamic grid performance to assess the technical feasibility of the proposed energy mixes.



Stellenbosch University Net Zero Energy Plan (ongoing)

Funder: Stellenbosch University, Facilities Management

Stellenbosch University, in response to the urgent need for decarbonisation, is developing a comprehensive Net Zero Energy Plan to address climate change through cleaner electricity generation. CRSES is collaborating with the University's Facilities Management to create a least-cost sustainable energy development pathway and answer some key research questions:

How can Stellenbosch University achieve net zero energy while minimising cost?

The plan aims to leverage South Africa's abundant wind and solar resources to support the University's decarbonisation goals and provide cost-effective energy solutions during loadshedding.

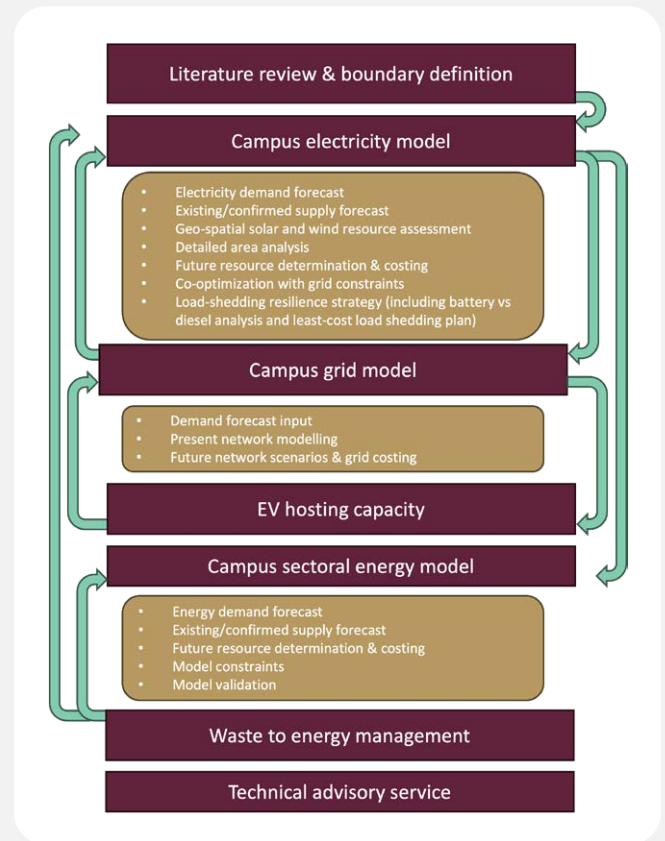
What tools will be required to make assessments for future decision-making?

This project will provide the University with robust planning tools and models to assess resource availability and analyse various decarbonisation scenarios through integrated electricity, campus grid and sectoral energy modelling.

What infrastructure changes are required for local grids to support EG and EV adoption and growth?

The study also evaluates the capacity of local grids to accommodate the growing adoption of embedded generation (EG) system and electric vehicles (EVs), identifying potential constraints and infrastructure needs to maximise the hosting capacity and ensure reliable grid integration.

The project will deliver three key models to aid Stellenbosch University in decision making: a Campus Electricity Model, a Campus Grid Model, and a Campus Sectoral Model, all aimed at positioning the University as a leader in energy transition.



SANEDI JET Research Project (ongoing)

Funder – SANEDI

The SANEDI JET Research Project aims to develop advanced grid planning solutions to assist South African municipalities to manage the integration of distributed energy resources (DERs), such as photovoltaic (PV) systems, electric vehicles (EVs), and battery energy storage systems (BESS). It addresses several key topics, including the potential grid impacts and corresponding mitigation solutions at both the local and system levels, the hosting capacity (HC) limits of existing infrastructure, data requirements for new planning and operational applications, and other risks related to the physical security of distribution systems. The project comprises two key components: a review of international DER planning best practices to extract key lessons for South Africa, and technical studies tailored to local needs.

The research answers critical research questions around the changing landscape of distributed network planning under increasing DER penetration. Some of these questions include:

What are the technical impacts of DERs on local municipality grids?

This project explores the scope and severity of the expected technical effects of DERs on local municipal grids, by identifying the penetration conditions at which these impacts are expected. It further investigates best practice mitigation solutions from around the world, particularly from leading countries in DER integration such as Australia, the USA and Germany.

What are the hosting capacity limits of the existing infrastructure in relation to DERs?

This project examines how hosting capacity is assessed, including relevant frameworks, models and data requirements

for comprehensive analysis. It identifies characteristic limits and typical bottlenecks for different types of feeders and analyses the sensitivity of hosting capacity to various parameters such as loading conditions, feeder length, branching, customer types and classes.

How can EG integration regulations optimise the integration and utilisation of DERs?

This project explores the progress and opportunities within current South African regulations to advance DER integration, particularly addressing the increase in interconnection requests. Recognising that a deemed-to-satisfy guideline is designed to limit the risk of technical issues, and that detailed studies are resource and time intensive, this research investigates how intermediate criteria can be developed to fast-track the interconnection process.



Western Cape EV Hosting Capacity Study (ongoing)

Funder: Western Cape Government

This project evaluates the technical feasibility of the region's grid infrastructure to support growing electric vehicle (EV) adoption, with a focus on electrifying public transport. Exploring future scenarios that combine different EV technologies, adoption rates, charger types and network designs, the study assesses the existing grid's capacity to accommodate projected EV demand. The project will analyse technical impacts on supply points, local distribution networks, and the provincial transmission system, prioritising regions with significant changes in mobility patterns. For networks facing capacity challenges, the study will identify technical, regulatory and strategic solutions to increase hosting capacity. Addressing mainly public mobility, the project aims to provide decision

makers with practical insights and actionable recommendations for a smooth and sustainable transition to electrified transport.



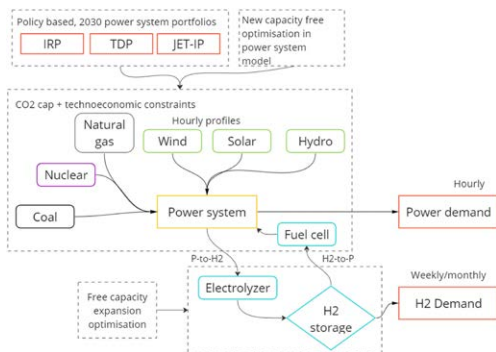
NECOM Embedded Generation Integration Project (completed, 2024)

Funder/Collaborators: NECTOM, CSIR

NECOM (the National Energy Crisis Committee) was established to address the energy crisis in South Africa through various interventions, including new generation capacity (mainly increased deployment of renewables at utility scale and embedded generation), improving plant performance and transmission strengthening, and demand management. These interventions aim to reduce and ultimately eliminate loadshedding, securing South Africa's energy future. Stellenbosch University, through CRSES, was tasked with specific research under Workstream 7, "Data Analytics and Research", specifically focussing on demand-side technology options. This CRSES-driven project brought together various research efforts from energy and grid experts at SU, supporting NECTOM in achieving its objectives and mission. The research questions included in this project are:

What are the prospects of grid-connected hydrogen production in SA by 2030?

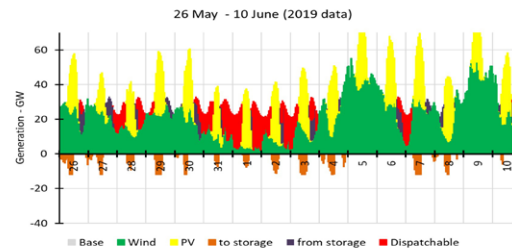
CRSES, in collaboration with the University of Groningen, recently published a journal article investigating the prospects of grid-connected green hydrogen production in predominately fossil fuel-based countries like South Africa. The paper specifically investigated the feasibility of meeting the Hydrogen Society Roadmap's goal of 500 kt green hydrogen production in South Africa by 2030.



What is the role of firm-dispatchable power in a variable generation power system?

Firm-dispatchable generation plays a critical role in balancing electricity grids that rely on variable renewable energy sources like wind and solar. Even with energy storage, enough firm capacity is needed to fully replace renewable generation during periods of average demand. The amount of energy provided by these plants depends on economic factors, but their installation is necessary.

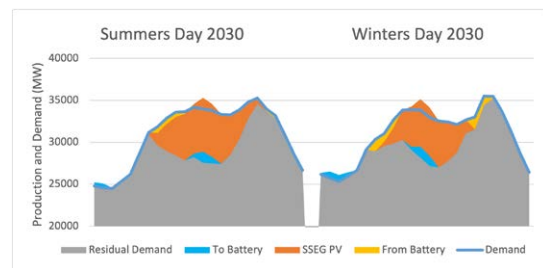
In South Africa, accelerating firm-dispatchable generation is key to addressing the country's energy challenges, including loadshedding. This can be achieved by repurposing old coal plants, using modular technologies, and promoting private



investment to build a more reliable, cost-effective and sustainable energy system.

What are the system-wide impacts of increasing embedded generation (EG) in the SA power system?

The rapid growth of behind-the-meter solar PV and battery installations in South Africa could lead to significant operational challenges, particularly with system balancing. To manage system flexibility and demand response effectively, detailed planning must incorporate flexibility requirements into iterative models. In addition, tariff structures should incentivise and optimise the use of embedded generation (EG) batteries to reduce the impact of solar PV on the grid. Updated regulations are urgently needed to ensure the visibility and control of EG systems.



What are the hosting capacity constraints for integrating embedded generation at the distribution level?

To increase hosting capacity for embedded generation (EG) at the distribution level, targeted policies and regulations are essential, especially for the commercial and industrial sectors. These sectors are well-suited for PV integration due to their larger loads, better compatibility and higher thermal capacity in medium-voltage (MV) networks. Prioritising EG system visibility and control, along with streamlining interconnection processes, will enhance grid management and accelerate EG integration.

Municipalities also need technical readiness and proactive planning to manage potential voltage regulation and congestion risks on distribution networks. Mitigation strategies must be implemented, ensuring that sufficient human and financial resources are available.

What are the hosting capacity constraints for integrating embedded generation at the system level?

The embedded generation (EG) targets in the draft IRP align with system hosting capacity estimates for high-risk scenarios,

highlighting grid challenges beyond the distribution level, such as reverse power flow and congestion, which could affect grid stability. Detailed technical studies are needed to assess the feasibility of the 2030 EG targets within hosting capacity limits and to identify necessary reinforcement strategies.

The growing role of distribution networks in power generation requires improved coordination between municipalities and the system operator, ensuring regular communication on EG and hosting capacity status for effective regulation and operational control.

What are the opportunities of demand-side management as a load-shedding solution?

Demand-side management (DSM) offers potential as a loadshedding solution, particularly through smart meter-based load limiting for non-self-rotating South African municipalities during NRS048-9-initiated loadshedding events. While traditional DSM methods used by self-rotating municipalities to lower loadshedding stages are not applicable, the project explored a novel concept of loadshedding immunity. This approach allows self-rotating municipalities to maintain

electricity during loadshedding events. Within this immunity framework, DSM initiatives could be used post-loadshedding to prevent exceeding the notified maximum demand. Although DSM cannot directly reduce the severity of loadshedding, it could still benefit non-self-rotating municipalities if implemented strategically. Further research is needed to develop a nationwide DSM framework and evaluate its costs and benefits for these municipalities.



Eskom Power Engineering Project (ongoing)

Funder - Eskom

The Eskom Power Engineering Project (EPEP) is a Research, Testing and Development NEC3 Professional Services Contract (PSC3) with Stellenbosch University to conduct operational, applied, fundamental, basic and futuristic research to solve Eskom technical challenges around renewables, power system planning and operations, and grid flexibility. The aim is to do this, by providing short-, medium- and long-term technical solutions. The project addresses the following key research questions:

How does increased DER penetration affect maintenance scheduling for transmission infrastructure?

Increased DER penetration can reduce available maintenance windows due to grid congestion, complicating scheduling for essential transmission infrastructure upkeep.

What strategies can optimise maintenance efficiency in a congested grid with high levels of distributed generation?

Optimising maintenance efficiency may require dynamic scheduling and advanced grid-monitoring tools to balance generation, load and maintenance needs amid growing distributed generation.

What are the implications of implementing annual curtailment measures for utility-scale solar PV and wind generation?

Annual curtailment measures for utility-scale PV and wind generation could help manage localised grid constraints, but need to be designed carefully to avoid excessive energy losses.

How can curtailment strategies alleviate thermal and voltage constraints while maintaining grid stability?

Curtailment strategies can alleviate thermal and voltage issues by limiting generation during peak congestion, thereby ensuring grid stability while maintaining energy flow.

What policies and practices can enhance grid reliability, resilience and sustainability in the light of DER integration?

Policies and practices focused on real-time grid monitoring, adaptive curtailment and advanced planning can enhance the grid's reliability, resilience and sustainability as DERs become more prevalent.



Defossilisation and Power-to-X Allocation Study for South Africa (ongoing)

Funders/Collaborators – Fraunhofer IEE

The PtX Allocation Study is a collaborative project between Fraunhofer IEE and CRSES aimed at developing an open-source, sector-coupled, multi-nodal energy system model for South Africa. This project aims to equip planners with a model-based analysis of Power-to-X (PtX) development pathways, linking long-term net-zero energy system scenarios with short-term policies. This high-resolution and high-fidelity model, PyPSA-RSA-Sec, is built upon the existing PyPSA-RSA electricity model. Through this model, a study is performed to identify cost-effective pathways for scaling PtX production to meet future domestic and export energy demands.

The analysis applied a scenario-based approach, developed with South African stakeholders, that explores different levels of renewable energy deployment, CO₂ policies, local PtX adoption, export potential, transmission constraints, and transport and industrial sector transformations. Three scenarios aligned with key national policies are studied: the Current Policy Path, the Resilient Net-Zero Path, and the Net-Zero + Early and High-

Export Path. These scenarios are aligned with South Africa's Just Energy Transition Investment Plan (JET-IP), the Green Hydrogen Commercialisation Strategy, and the Transmission Development Plan (TDP), incorporating data from global hydrogen trade studies and national infrastructure assessments. Promising pathways for renewable energy and PtX expansion are evaluated, providing insights into South Africa's long-term energy and decarbonisation strategy.



City of Cape Town PV Potential Study (completed, 2019)

Funder – Eskom

This project investigates the impact of increasing photovoltaic (PV) system installations on power networks in the Western Cape, South Africa. Acknowledging the global rise in PV penetration and associated concerns, the study analyses detailed grid models of representative networks to project the effects of high PV penetration. This report specifically identifies potential technical challenges, such as voltage rise, power flow congestion, and protection issues, which may arise under high PV-penetration scenarios. These identified issues informed the development of mitigation strategies in subsequent research efforts under the same project. The technical performance outputs of this work informed the estimation of necessary capital investment and increased operational and maintenance costs required to accommodate the projected PV growth.

The research included a literature review of technical issues and a technical component that assessed the hosting capacity

limits of low-voltage (LV) and medium-voltage (MV) networks, considering voltage level, conductor loading, and transformer loading in representative Western Cape networks. It also assessed the implications of the analysis for network operations and long-term planning.



Stellenbosch Biomass Power Station – Feasibility Study (completed, 2024)

CRSES, in collaboration with Stellenbosch University investigates the viability of establishing a biomass-to-energy (B2E) power station near Stellenbosch. The proposed project aims to produce dispatchable, renewable electricity by utilising local biomass resources, primarily alien and invasive trees (IAT) and other unwanted woody materials.

Stellenbosch is geographically well positioned to supply biofuel to this power station for the next 20 years and beyond. The study showed that the technology and expertise exist in the Western Cape to engineer, procure and commission biomass-to-energy power plants of world class standard and reliability. This will be able to generate power at a significantly lower levelised cost of electricity than its diesel-driven or PV solar-charged battery storage counterparts.

What are the potential benefits of an integrated approach to biomass power generation?

The study examined key aspects, such as biomass availability, environmental benefits, financial viability, and grid integration. It highlights the abundance of biomass in the region,

particularly from invasive species and agricultural waste, and the opportunity to use this resource for long-term, sustainable energy production.



PtX Training in Berlin

Storm Morison attended intensive two-week training on hydrogen and PtX at our office in Berlin, Germany. Throughout the programme, participants took part in training sessions prepared and facilitated by Agora Think Tanks' hydrogen experts. The goal of the programme was to strengthen participants' ability to assess the opportunities and risks associated with hydrogen and PtX technologies. The multidisciplinary sessions covered the primary aspects of hydrogen, including technological, political and economic perspectives, as well as the sustainability criteria needed to develop hydrogen economies.

Through a series of exercises, participants mapped the hydrogen policy context and relevant stakeholders in their respective countries and engaged in group discussions to identify key lessons learnt. The core of this exercise involved developing an independent policy recommendation that aligned with the participants' national and organisational contexts.

After completing the Hydrogen and PtX Training, participants were able to:

- Evaluate technological and economic landscapes and their associated policy implications

- Critically discuss sustainability aspects of transitioning towards renewable hydrogen economies
- Better understand the roles of relevant stakeholders driving national hydrogen debates



Attending the IEEE in Rome

The 24th International Conference on Environment and Electrical Engineering (IEEEIC24) serves as a global platform for sharing ideas and information on energy systems. It was held in a hybrid format from 17 to 20 June 2024 in Rome, Italy. The conference was combined with the 8th IEEE Industrial and Commercial Power System Conference Europe (I&CPS Europe).

CRSES's Prof. Bernard Bekker and Dr Chantelle Van Staden, in their roles as supervisors, accompanied several students to the conference to present their research, receive feedback from international peers, and network globally. The students who attended were Shaniel Lakhoo, Liesel Prinsloo, Francisca Daniel-Durand, Theunis Oosthuizen and Ryan Thompson.



PSRG Team Building: Kromrivier Beast Trail Running

In May 2024, the PSRG team had their team building at the Kromrivier Beast Trail. The team included running, with options for both 27 km and 42 km races. The goal of the team building was to help build a strong team spirit and a sense of community among the students.

By taking on this physical challenge together, the team aimed to work better as a group, support each other, and form closer connections. This experience allowed the students to bond and grow together, both personally and as a team. Through activities like this, PSRG hopes to create a supportive and connected community that extends beyond their studies.



PSRG Writing Workshop 2024: Skill Building and Academic Development

On 31 January 2024, the Power Systems Research Group hosted an all-day Writing Workshop from 08:30 to 16:00. The workshop was aimed at providing valuable insights and practical skills for students pursuing academic research.

The Writing Workshop was designed to support those in the field of power systems, offering an overview of the subject as well as critical advice on navigating postgraduate studies.

The first session focused on the power system itself, providing participants with a solid understanding of the field. The workshop explored the motivations and benefits of pursuing a Master's or PhD, including how to effectively navigate the path toward these advanced degrees.

The workshop was also dedicated to the practice of conducting a literature review. Participants learnt key techniques for reviewing existing research, synthesising information, and identifying gaps in knowledge. In addition, the workshop covered the important dos and don'ts of academic writing, providing practical tips to enhance writing skills and improve the quality of research papers.

Recognising the pressures that come with academic life, the workshop also touched on maintaining a healthy work-life balance. The session offered advice on managing the demands of research while ensuring personal well-being.

This PSRG Writing Workshop offers a comprehensive approach to academic growth, combining technical knowledge, writing skills and personal development. It is an excellent opportunity for students to gain valuable insights that help in their academic journey.

CRSES Researchers Present at SpliTech 2024

CRSES's Prof. Bernard Bekker and Dr Justice Chihota attended the SpliTech 2024 conference, where they presented their research. The conference took place in Split and Bol (Island of Brac), Croatia, from 25 to 28 June 2024. Their paper, titled **"Stochastic Analysis of Transformer Loading Due to Single-Phase Distributed Energy Resources"**, proposes a probabilistic method based on a disaggregate approach, assessing the loading of individual phases of the transformer. This allows for

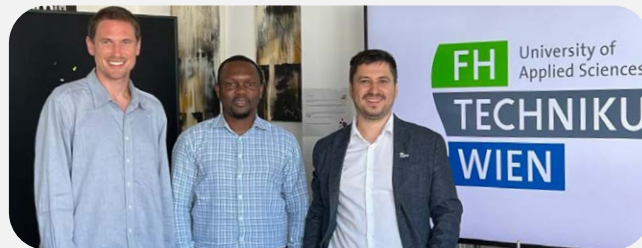
the accounting of the impacts of unbalanced allocation due to distributed energy resources (DER) planning uncertainties. Furthermore, the method addresses operational uncertainties related to both load and DERs through probabilistic characterisation. It uses a case study focused on solar photovoltaic (PV) penetration in low-voltage residential areas.

The participation by Prof. Bernard Bekker and Dr Justice Chihota in SpliTech 2024 shows how important research is in creating smarter and more sustainable energy systems.

CRSES's Dr Justice Chihota at CIRED 2024

CRSES senior engineer Dr Justice Chihota attended CIRED 2024 in Vienna, Austria, where he did a presentation titled "An analytic probabilistic hosting capacity assessment method for low voltage distribution networks".

The 2024 CIRED conference focused on increasing distribution network capacity. This was a two-day conference that took place from 19 to 20 June 2024.



From left to right: Dr David Fellner, Dr Justice Chihota and F.H.-Prof. Ing. Momir Tabakovic

CRSES Research Engineer, Storm Morison wraps up an incredible week in Nairobi!

Storm Marison is a research engineer at the Centre for Renewable Energy Studies.

She attended a training course called "Modeling the Integration of Hydropower into Modern Energy Systems for Africa", from 19 to 23 August 2024.

The course covered several important topics, including:

- PyPSA Modeling: Basic Python programming for analysing energy systems.
- Renewable Energy Integration: Methods for adding renewable energy sources to power grids.
- Hydrology Basics: How to use hydrological data in energy modelling.
- Renewable Energy Tools: Tools and techniques for modelling renewable energy.
- Pumped Storage Systems: Using pumped storage systems for energy and water supply.
- Practical Exercises: Applying theoretical models to real-life scenarios.

Morison thanked Carole Rosenlund from ICH for organising the course and welcoming everyone to Kenya. She also expressed her gratitude to Priyesh Gosai, Ekaterina Fedtova, Emmanuel and Fabrizio Finozzi for their excellent presentations and insights.

To finish her trip, Storm took on the challenge of climbing Mount Kenya. To her, the adventure highlighted how personal and professional growth can go hand in hand.

Storm's journey is a great example of combining learning with adventure and reaching new heights.



A summary of activities and achievements of the ARUA Centre of Excellence in Energy throughout 2024.

The African Research Universities Alliance (ARUA) and each ARUA Centre of Excellence (CoE) aim to build the research capacity of African researchers. The ARUA CoE in Energy, based at Stellenbosch University, engages young African researchers and has set out a programme of activities where they are afforded the opportunity to enhance their research skills and capabilities. This is done, firstly, through some of the structured courses designed and presented by the African Doctoral Academy at Stellenbosch University, and secondly, by being given an opportunity for 'learning-while-doing'. In this regard, young researchers participate in research projects and learn from seasoned African academics while doing so. Through this programme, the ARUA CoE in Energy hopes to contribute toward the development of some of the promising young African academics, strengthen the renewable energy research on the continent, and build lasting partnerships between African institutions.

The ARUA CoE in Energy continued to make steady progress and had a successful year during 2024. A particular highlight was having students from some of the CoE's spoke universities, namely Maasai Mara University, the University of Ghana, the University of Dar es Salaam, Addis Ababa University, Usmanu Danfodiyo University and the University of Ibadan, attend the Stellenbosch University Summer School Programme. The programme is aimed at delivering intensive research and methodology training to Master's and doctoral candidates, their supervisors, and researchers from diverse fields, supporting them in all stages of their doctoral journey.

In November, the CoE in Energy collaborated with the African Doctoral Academy at Stellenbosch University and the Centre for Renewable and Sustainable Energy Studies (CRSES) to deliver a

two-day workshop for postgraduate/Master's students, doctoral candidates and researchers in the energy sector as a pre-event to the Southern African Sustainable Energy Conference (SASEC) 2024. This two-day SASEC pre-conference workshop on Academic writing and publishing, and entrepreneurship and commercialisation in renewable energy, aimed to equip early

career researchers in our academic network with essential skills for academic success and transitioning research into market-ready solutions. The workshops were an initiative of the Department of Science and Innovation (DSI) Renewable Energy Hub and Spoke Programme at the Centre for Renewable and Sustainable Energy Studies (CRSES), in collaboration with the African Research Universities Alliance (ARUA) Centre of Excellence (CoE) in Energy and the African Doctoral Academy (ADA) at Stellenbosch University. The workshop was free to attend to those delegates already registered to attend the SASEC conference.

Lastly, the previous year saw the launch of the Africa-Europe Clusters of Research Excellence (CoRE) between ARUA and The Guild of European Research-Intensive Universities (The Guild). The CoE in Energy forms part of the Renewable Energy CoRE group, along with partners from the University of Ghana, Makerere University, the University of Ghent, the University of Oslo and the University of Groningen. The Renewable Energy CoRE group successfully hosted its second on-site meeting during the SASEC conference, which brought together a core group of researchers. Plans for the upcoming year were set in motion.

It is anticipated that the CoE in Energy will accelerate its activities and output going into the next year, especially with the ARUA-The Guild Renewable Energy Cluster of Research Excellence.

Pre-SASEC Workshop held at the Stellenbosch Institute of Advanced Study (STIAS) on 11 and 12 November 2024.

This was a collaboration between the Department of Science and Innovation (DSI) Renewable Energy Hub and Spoke Programme at the Centre for Renewable and Sustainable Energy Studies (CRSES), the African Research Universities Alliance (ARUA) Centre of Excellence in Energy, and the African Doctoral Academy (ADA) at Stellenbosch University.



CONFERENCES

CRSES Team Members attend TUM SEED Annual Symposium 2024 in Kenya

Two CRSES staff members had the opportunity to attend the SEED Symposium held at the Boma Hotel in Nairobi, Kenya. The symposium took place from 25 to 30 August 2024. The Symposium was hosted in collaboration with Jomo Kenyatta University of Agriculture and Technology (JKUAT), and it focused on sustainable energy solutions and entrepreneurship in the Global South. It provided a unique platform for experts, stakeholders and partner universities to engage in discussions, exchange knowledge and explore innovations within these critical sectors.

The symposium began with a focused discussion on entrepreneurship in the Global South, addressing the region's challenges and opportunities. Participants also had the chance to review and provide feedback on academic papers presented by PhD candidates. This session allowed attendees to engage deeply with the subject matter, setting the tone for the days that followed.

On the second day, participants travelled to the JKUAT campus, where they took part in a brainstorming session aimed at refining the SEED programme's focus for its second phase. One

of the key topics was funding, exploring new approaches to ensure the programme's sustainability and impact.

The symposium highlighted cutting-edge technologies and approaches to sustainable energy solutions tailored to the Global South. Key discussions revolved around practical energy applications that can address local challenges. One particularly notable discussion explored the concept of "living labs",

which are real-world environments where sustainable energy solutions can be tested and refined before scaling.

The event further showcased how entrepreneurship can serve as a catalyst for economic growth and job creation, particularly within the energy sector. Local, scalable solutions were emphasised, with a focus on addressing energy access challenges in ways that are contextually relevant and sustainable.

The staff members also attended the traditional attire-themed gala dinner, which provided a relaxed and enjoyable atmosphere for networking.

On the final day, the group travelled to Nairobi's "Silicon Savannah", a growing entrepreneurial ecosystem. Visits included:

- **E-Motorcycle Business:** Participants toured a workshop dedicated to e-motorcycle businesses, learning about how the company provides sustainable, battery-powered motorcycles. This visit showcased an innovative business model that integrates energy solutions with local transportation needs.
- **Local Restaurant Experience:** The group enjoyed a traditional Kenyan meal, Nyamachoma, at a local restaurant, offering participants a taste of Kenyan culture while fostering a sense of community.
- **Green Gas Stoves:** A visit to a site selling green gas stoves provided valuable insights into the innovative approach to clean cooking solutions. Participants observed a vending machine model where customers can refill gas containers, further promoting sustainable energy use.

For the CRSES staff members, the SEED Symposium proved to be an impactful event that offered valuable insights into sustainable energy solutions and entrepreneurship in the Global South. The event showcased the evolution of the SEED programme, highlighted innovative local business models such as e-motorcycle workshops and green gas stoves, and provided opportunities for networking and collaboration.

The symposium underscored the importance of community-driven initiatives and practical, scalable solutions to energy access. By bringing together a diverse range of experts and stakeholders, the event fostered new ideas and partnerships, which will contribute to the continued growth of sustainable energy and entrepreneurship in the region.



CRSES Team members participated in SANEDI 2nd Annual Conference

The SANEDI Conference 2024, held on October 23-24 at the Eskom Academy of Learning in Midrand, South Africa, brought together key stakeholders from government, industry, academia, and civil society to discuss strategies for achieving a balanced energy transition in the country. The theme, Balanced Energy Transition: for Energy Security, Affordability, and Inclusiveness, emphasised the importance of ensuring a sustainable energy future for South Africa that prioritizes energy security, affordability and inclusiveness.

A team from the Centre for Renewable and Sustainable Energy Studies (CRSES) attended the conference, including Prof. Cristina Trois, Dr Francois Rozon, Mr Simnikiwe Gulwa and Mrs Sedzani Ratsibi. Their participation in the event provided valuable insights into the evolving landscape of South Africa's energy transition and the role that academia plays in driving innovation and policy development in the sector.

The conference focused on three primary areas of discussion. The first was energy security, which addressed the need for a stable and reliable energy supply, while reducing the country's dependence on fossil fuels. Key discussions revolved around the role of renewable energy in diversifying South Africa's energy mix, as well as the importance of grid modernisation and infrastructure development to support energy resilience.

The second key focus was affordability, with a detailed examination of the financial challenges of transitioning to renewable energy. The discussions covered the cost implications of clean energy investments and the role of government incentives and subsidies to make renewable energy more accessible. The need for adaptive energy pricing structures was also highlighted as essential for supporting both consumers and investors.

Inclusiveness, the third focal point, centred on bridging the energy access gap in rural communities. Public-private partnerships were emphasised as a key vehicle for promoting inclusive energy policies, while workforce development and skills training for the renewable energy sector were seen as critical to ensuring equitable participation in the energy transition.

A networking session sponsored by GIZ concluded the first day of the conference, offering an opportunity for participants to engage with each other, exchange ideas, and establish potential collaborations. This session underscored the importance of partnerships in driving a balanced energy transition, reinforcing the shared commitment among all stakeholders to work toward a common goal.

On the second day, a notable event was the Women in Energy Breakfast session, hosted by the Deputy Minister of the Department of Science and Innovation, Ms Nomalungelo Gina. This session focused on the role of women in the energy transition and discussed gender inclusivity challenges in the

sector. Prof. Cristina Trois and Mrs Sedzani Ratsibi from CRSES attended the session, which featured a keynote address by the Deputy Minister emphasising the importance of empowering women in the energy industry, supporting career advancement opportunities, and fostering gender-equitable policies.

Among the key takeaways from the conference, the importance of balancing economic, social and environmental considerations in the energy transition was highlighted. Participants agreed that collaboration between government, the private sector and local communities was essential for achieving energy sustainability. Emerging technologies, such as hydrogen energy, battery storage and smart grids, were recognised as pivotal in shaping the future energy landscape. In addition, adaptive policy and regulatory frameworks were identified as key to supporting innovation and market growth.

The SANEDI Conference 2024 concluded with a gala dinner that featured an awards ceremony. During this event, the Hub and Spokes Programme was recognised for its significant contribution to SANEDI's mandate, particularly its impact on energy innovation and development. This recognition highlighted the ongoing efforts and collaborative initiatives in driving South Africa's energy future toward greater sustainability and inclusivity.

The SANEDI Conference 2024 underscored the need for a holistic and collaborative approach to South Africa's energy transition. The involvement of CRSES staff members Prof. Cristina Trois, Dr Francois Rozon, Mr Simnikiwe Gulwa and Mrs Sedzani Ratsibi highlighted the academic sector's critical role in driving the country's energy transformation. The discussions and insights from the event will be instrumental in shaping South Africa's energy policies and fostering innovation that will ensure a sustainable and inclusive energy future for all.



From the left: CRSES Dr Francois Rozon, Prof Cristina Trois, award-winning South African actress and filmmaker Florence Masebe, CRSES's Dr Richmore Kaseke, and Simnikiwe Gulwa

Southern African Sustainable Energy Conference (SASEC) 2024

From 13 to 15 November 2024, Stellenbosch University's Centre for Renewable and Sustainable Energy Studies (CRSES) hosted the Southern African Sustainable Energy Conference (SASEC) at the Lord Charles Hotel in Somerset West, Western Cape, South Africa. This key event served as a significant forum for researchers, engineers, industry leaders and policymakers to engage in discussions on the forefront of sustainable energy innovations, highlighting the essential role of research, development and innovation in advancing sustainable energy solutions.

The conference attracted over 100 groups of experts to explore and discuss essential topics related to sustainable energy. The conference schedule was packed with keynote presentations, panel discussions, a policy roundtable, and multiple sessions addressing topics from solar and wind technologies to bioenergy and the pathways to a Just Energy Transition. At the event, CRSES's Dr Francois Rozon, Don Fitzgerald, Storm Morison and Liam Snyman gave insightful presentations on renewable energy. Their presentations were well received and sparked a lively discussion among attendees about potential future initiatives.

In addition, Dr. Rozon chaired a session that explored the integration of wind and solar energy systems in industrial applications. Dr Rozon, accompanied by colleagues from

CRSES, visited Distel's waste-to-energy plant, which would benefit from solar thermal. This plant, managed by an external operator, is situated in Stellenbosch. The visit occurred on 12 November, just before the commencement of the conference. This engagement is part of ongoing efforts to collaborate with the industry on integrating renewable energy solutions into existing industrial operations, aiming to enhance sustainability and efficiency.

The conference is a DSTI, SANEDI, HUB, and Spoke programme initiative.



SU students and staff at SASEC 2024 day 1 ^



CRSES organising team and students at SASEC 2024 ^

An Overview of SASEC 2024

The **SASEC 2024 Conference** was held at the **Lord Charles Hotel** in Somerset West and made use of several key venues within the hotel:

- **The Somerset Suite** was used for the plenary sessions.
- **Somerset Rooms 1, 2, and 3** hosted the parallel sessions, each covering specific themes in sustainable energy.
- **Speaker Prep Room:** Lourensford.
- **Ballroom:** Used for the welcoming reception and the gala dinner.

The conference offered an engaging scientific programme, including **plenary sessions**, **panel discussions**, **presentations** and a **policy roundtable**. It provided a platform for researchers, engineers, industry practitioners and policymakers to share knowledge and discuss the latest advancements in the energy sector.

A total of 153 abstracts were initially received for SASEC 2024, with 152 abstracts accepted. To be included in the programme, all accepted abstract presenters had to submit a full paper or briefing note. Following the review process, 27 papers were withdrawn and 37 did not submit full papers or briefing notes, leaving 88 full papers/briefing notes for review. Of these, 73 were accepted for oral presentations, and 15 for poster sessions.

Delegates participated in over 120 presentations, covering key topics such as solar energy, wind energy, green hydrogen, bioenergy and sustainable energy policy. The conference also hosted four plenary focus sessions, one policy roundtable, and various thematic parallel sessions on topics like power systems, decarbonisation, and renewable energy resource assessment.



SASEC attendees at the plenary session ^



SASEC attendees in a session ^



SU, DSI and SANEDI Delegates on day 1 of SASEC at the plenary ^

SASEC 2024 Conference feedback

Attendees were overwhelmingly positive about the conference. Many emphasised the excellent networking opportunities and the chance to engage with international experts. The **panel on science diplomacy** and the **economic development of Southern Africa** sparked a lot of interest, as it provided a framework for linking energy research to broader socio-economic goals.

The **Pre-SASEC Workshops** and **SASEC 2024** were a success. The workshops provided early-career researchers with essential tools for academic writing and research commercialisation, while the conference brought together key stakeholders to discuss the future of sustainable energy in Southern Africa.

To improve future events, particularly in securing **industry involvement**, it is recommended to start the **outreach process earlier** and provide **customised engagement packages** for sponsors and exhibitors. These changes will help boost industry participation, ensure greater visibility for innovations, and enhance the overall impact of the conference. With continued collaboration and planning, SASEC will remain a vital event in advancing the sustainable energy agenda across the continent.

CRSES Researchers' SASEC Participation

Dr Francois Rozon, CRSES project manager, presented a paper on the *"Adoption of renewable energy solutions by South African beverage manufacturers"*.

His presentation was very well received and sparked a lively discussion among attendees about potential future initiatives. In addition, Dr Rozon chaired a session that explored the integration of wind and solar energy systems in industrial applications. Accompanied by colleagues from CRSES, he also visited Distel's waste-to-energy plant, which would benefit from solar thermal. This plant, managed by an external operator, is situated in Stellenbosch. The visit occurred on 12 November, just prior to the commencement of the SASEC Conference. This engagement is part of ongoing efforts to collaborate with industry on integrating renewable energy solutions into existing industrial operations, aiming to enhance sustainability and efficiency.

Donald Fitzgerald, CRSES Research Engineer, presented his briefing note titled *"Status quo of circular economy in South Africa's solar PV sectors and strategies for the future."*

Don's briefing note touches on the status quo in South Africa with regards to circular economy in solar photovoltaic (PV) sectors. The capacity of installed PV has increased exponentially from 1.7 GWp to 8.1 GWp in the last 8 years. Early projections of local waste generated by this rapid PV uptake estimate that there will be around 1 million tonnes of PV waste by 2050. The lack of comprehensive end-of-life (EoL) regulations and recycling infrastructure in South Africa, combined with challenges related to waste collection and transportation, highlights the need for strategic planning to address PV waste and promote a circular economy. This leads us to the proposed PhD research that aims to more accurately predict future PV waste streams in South Africa, reduce PV waste through placement and longevity optimization, and create an accessible tool to assist decision makers with these results.

Storm Morison, CRSES Research Engineer, presented a briefing note titled *"Introducing flexibility as a driver for bioenergy integration into South Africa's power system planning,"* which is related to her PhD research investigating the integration of bio-based flexible electricity generation in South Africa's long-term power system planning.

Liam Snyman, CRSES Junior Engineer, presented a paper titled, *"Understanding the 2024 reduction in South African loadshedding: A technical analysis"*.

This paper investigated the trend of reduced loadshedding by analysing contributing factors such as planned and unplanned maintenance and the effects on the fleet energy availability. The paper also looked at changes in national demand, the adoption of embedded solar photovoltaics (PV), and typical loadshedding mitigation methods employed by the national utility, such as the use of Open-Cycle Gas Turbines (OCGT) and new generation capacity.

The research forms part of the Centre's function to develop and share knowledge, particularly in the context of the South African energy system and its operation. The topic of discussion was considered relevant due to the interest in answering the question:

"Why has loadshedding ended, and how has the national utility achieved this turnaround?"



SASEC 2024: CRSES researchers' participation ^

BUILDING HUMAN CAPITAL

SHORT COURSES

Short Course Programme Report – 2024

In 2024, the Centre for Renewable and Sustainable Energy Studies (CRSES) successfully offered a total of **17 specialised short courses**, continuing the strong foundation laid in previous years. **Sixteen** of these were hosted by **Stellenbosch University (SU)** and **one** was presented in collaboration with our long-standing partner, the **University of Cape Town (UCT)**. These intensive five-day courses ran from **March through September 2024**, supporting skills development and capacity building in the renewable energy sector.

In addition to forming a key part of the curriculum for **structured Master's and Postgraduate Diploma students**, the short courses attracted a wide range of **industry professionals** and **government employees**, many of whom attended as part of their **Continuing Professional Development (CPD)**.

In 2024, **138 CPD participants** engaged with our modules – demonstrating the continued demand for high-quality, specialised training in the renewable energy space.

Thanks to continued support from the **Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)**, many municipal and state-owned enterprise (SOE) employees were able to attend on a subsidised basis. This funding remains essential to ensuring broad access to professional training and contributes meaningfully to national capacity-building goals.

CRSES remains committed to expanding the reach and impact of its short course programme. We are actively pursuing future grant opportunities to ensure that these valuable training opportunities remain **accessible** and **affordable**.



Prof Bernard Bekker presenting during one of our short courses ^

Short Courses 2024:

Overview		
Smart Grid Technology Overview	SU	Introduction to the key concepts of the Smart Grid, including information and communication technologies and their application and integration
Power System Analysis	WITS	The fundamentals, models and applications of power system load flow, short-circuit analysis, stability and control
Hydrogen in the Energy System	SU	A systemic view of energy systems with a specific focus on hydrogen
Technology		
Advanced Photovoltaic Systems	SU	Fundamentals, financial modelling, technical design, installation and maintenance of PV systems
Wind Energy	SU	Fundamentals, resource and feasibility modelling, technical design, project development and grid-integration of wind energy systems
Energy Storage Systems	SU	Fundamentals, applications, technologies, modelling and design, and economics of energy storage systems
Solar Thermal Energy Systems	SU	Fundamentals of solar thermal energy systems, specifically CSP, including concentrator principles and thermal storage applications
Smart Grid Communications	SU	Communications fundamentals, applications and technologies within the context of the power system
Bioenergy	SU	The practical and commercial application of various technologies for biomass conversion into bio-energy, ranging from bio-fuels to electricity
Hydro and Ocean Energy	SU	Ocean and hydro energy associated with the elevation or movement of water, including resources, conversion technologies and implementation
Renewable Energy Systems	SU	The scientific, engineering, resource and integration aspects of various types of renewable energy systems at the introductory level
Green Hydrogen Technology	SU	The available and developing technologies used for green hydrogen production, distribution, storage and end use
Integration		
Power System Data Analytics	SU	The data analytics life cycle applied to solve power system problems, with a special focus on demand and renewable energy short-term forecasting
Long-term Power System Planning	SU	The principles and techniques informing optimised long-term generation capacity planning, and transmission expansion planning
Distribution Customer Concepts	SU	Understanding the concepts inherent in the end use of electricity, including load modelling, pricing, technologies, and mini- and microgrids
Distribution Network Planning & Operations	NWU	Distribution network technical planning fundamentals, codes and regulations, and applications, and protection and technical operations
Power System Operations	SU	The fundamentals of power system operations in a future with high shares of VRE, and the processes and technologies that support such operations
Power System Flexible Operations	UCT	Operational power system flexibility optimisation where technical systems and electricity markets interact, and flexibly operating power plants
Green Hydrogen Project Engineering	SU	A course focused on the principles of designing, funding and successfully implementing fit-for-purpose projects based on green hydrogen

BURSARIES

Recipients of CRSES Staff Bursary recipients 2024

- | | |
|-----------------------------------|--|
| 1. Monique le Roux – PhD Elec Eng | 4. Lavhelesani Maluleke – MEng Mech Eng |
| 2. Don Fitzgerald – PhD Elec Eng | 5. Sedzani Ratsibi – PGDip Sustainable Development |
| 3. Storm Morison – PhD Elec Eng | 6. Fhatuwani Mulaudzi – PGDip Marketing |

INTERNS

Sydwell Tenza

I am an intern at the Centre for Renewable and Sustainable Energy Studies (CRSES), and I play an active role in supporting sustainable agriculture, renewable energy solutions, and community engagement initiatives. My journey at the Centre started in November 2024 and will end in September 2025. My responsibilities include enhancing the Centre's informational materials, coordinating various project programmes, conducting surveys and interviews to support research, and actively engaging with key stakeholders such as community members, industry professionals and the Centre's managers. I am also involved in organising and executing project activation programmes and exhibitions, and collecting valuable contact information to further strengthen the Centre's reach and impact.

In addition to my role at CRSES, I am currently pursuing an MSc in Sustainable Agriculture at Stellenbosch University (SU) and am honoured to be a 2024/25 Future17 Graduate. I hold a BSc in Agriculture: Pasture Science (cum laude) from the University of Fort Hare, and I am registered as a Candidate Natural Scientist. This internship allows me to bridge my academic background with real-world experience, and I am committed to developing my skills in both sustainable agriculture and renewable energy to contribute meaningfully to these fields.



Hulisani Makungo

I hold a diploma in Computer Science, a certificate in Electrical Engineering (NQF level 5), and trade as an electrician. I am currently studying Installation Rules at Trinity Further Education and Training College.

I am doing my internship under the Water-Energy-Food (WEF) nexus project at Masia Village in Vhembe, Limpopo. My duties include monitoring the solar system, nursery, seedling growth stages and landscaping. Through the internship, I have also attended training in business, management and funding modules through the National Youth Development Agency (NYDA).



Hulisani Mulaudzi

I have completed a certificate in Electrical Engineering (NQF level 5).

My daily tasks as a CRSES intern include monitoring the solar system, fault finding, and reporting on the progress of the project. At the Centre, we work in teams, which enables us to gain valuable skills from different well-trained and experienced researchers.

I have attended short courses in Solar Energy Basics and Awareness of Solar Systems. Through NYDA's assistance, I have also completed a module on how to start my own business. Highlights of my internship journey includes assisting with the installation of a 20 kWh solar system, as well as the wiring of a building. Another skill that I have acquired through the programme is how to construct a nursery, which is an ongoing project.



Shumani Kone

Completing my CRSES internship will enable me to obtain my national diploma in Electrical Engineering from Capricorn TVET College.

At the Centre, I have attended three courses, namely Introduction to Solar Energy, Solar Photovoltaic Installation, and Advanced Photovoltaic Systems. The courses have improved my knowledge of sustainable energy, and solar energy in particular. I have also received training in renewable-energy software, including PVsyst and IottaWatt (an energy-monitoring device), and had the opportunity to draft the PVsyst design and install IottaWatt for a project that the Centre is working on. I also acquired soft skills such as in professional communication.

I will forever be grateful for everything I have learnt and the amazing people I got to know.



Aluwani Tshishonga

I hold a certificate in Electrical Engineering (NQF level 5) from Vhembe TVET College and completed an introductory short course in Hydrogen Fuel Cell Systems presented by the University of Pretoria/Bambili Advisory.

My internship duties include taking part in all projects and drafting reports. I am also responsible for monitoring the renewable systems installed at the site.

At the CRSES, I have had an opportunity to attend Coursera's programmes in Renewable Energy and Solar Basics. I have also attended NYDA's course on how to start a business, as well as a course in Solar Awareness. I have been involved in the construction of a nursery and the installation of a photovoltaic cell system.



Tondani Mulaudzi

I have obtained a certificate in Electrical Engineering (NQF level 5) at Tshwane South College (TVET), a certificate in Project Management at Vhembe TVET College, and completed an introductory short course in Hydrogen Fuel Cell Systems presented by the University of Pretoria/Bambili Advisory.

As an intern at the CRSES, my responsibilities include monitoring and maintaining the renewable-energy technologies that have been installed at the site. The project I am working on is agriculture-based, but powered by renewable technologies.

On my internship journey, I have learnt how to maintain hydrogen fuel cells, install photovoltaic cell systems, wire homes and offices, write reports, do presentations, construct a nursery and irrigation system, cultivate vegetables and maintain fields.



Godwin Mukondeleli

I have been placed at the Masia Village WEF nexus project in Limpopo.

I hold a certificate in Electrical Engineering (NQF level 5) from Vhembe TVET college and have completed short courses in Hydrogen Fuel Cell Systems, Basic Firefighting, Basic Life Support, as well as First-Aid Procedure presented by the University of Pretoria.

My internship duties include monitoring the 20 kWh solar energy photovoltaic system, making sure that the battery is well maintained to meet the project's day-to-day water and electricity needs. I also assist the team with fault finding in the solar system, and maintenance as part of the agricultural section of the project.

Working in the CRSES environment and being exposed to renewable and sustainable energy has been eye-opening. In addition to working on the solar system, I have also been part of the wiring project (installation of indoor and outdoor lights), as well as a 5 kW hydrogen fuel cell project to back up the solar system.

My experience at the Centre has been very positive. I have obtained several skills and look forward to learning more about renewable energy.



POSTDOC FELLOWS

Dr Andrea Dell'Orto

South Africa's organic waste stream, which exceeds 30 million tonnes annually, represents both a pressing environmental challenge and a largely untapped reservoir of renewable energy. Currently, more than three-quarters of this organic waste is landfilled, contributing to rising greenhouse gas emissions, representing over 3.8% of the national carbon footprint, and accelerating landfill capacity shortages.

Since joining CRSES as a Research Engineer in 2024, my research at the Centre has been driven by the dual goal of mitigating climate impacts and unlocking the inherent energy potential of organic waste by developing and optimising waste-to-energy solutions, both focusing on the biological production of hydrogen and methane from food waste in South African municipalities, and advising the City of Cape Town on potential energy production avenues from the currently disposed municipal solid waste. This approach directly addresses the need for innovative, locally relevant solutions that valorise organic waste, reduce emissions, and contribute to a just energy transition.

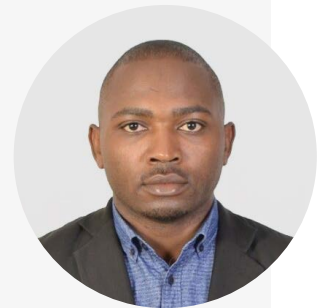
As Centre Manager for the ARUA Centre of Research Excellence in Renewable Energy, I facilitate intra-African collaborations and partnerships with European institutions to advance renewable energy research. This role has enabled strategic grant acquisitions and the design of cross-continental projects and North-South collaborations, spanning from Norway to South Africa. I am passionate about leveraging waste-to-energy options to address waste management challenges and enhance the sustainability of the energy sector. The support and guidance of my supervisors, Prof. Cristina Trois and Prof. Prathieka Naidoo, have been instrumental in my journey, and I look forward to continuing to contribute to the field of renewable energy through interdisciplinary research and collaboration.



Dr. John Edison Sempira

Dr John Sempira Edison earned his PhD from the University of Georgia, Athens USA in 2019, specialising in Bioprocess Engineering. He joined the Centre for Renewable and Sustainable Energy Studies (CRSES) as a postdoctoral research fellow on a one-year fellowship in 2024, supported by the Africa Research University Alliance (ARUA). His fellowship was extended with support from Stellenbosch University until the end of 2025. Dr Sempira's research focuses on the food-energy nexus, an area he has cultivated over eight years across academia and international consulting. John works directly with the CRSES's sub-unit, the Centre of Excellence for Energy (CoE), in collaboration with the Department of Chemical Engineering, particularly the Bioresource research group.

Currently, John is engaged with research work on organic waste valorisation, particularly the development of bioconversion pathways, and innovative resource recovery systems that can be scaled to commercial scale. He works with several organic materials, including food waste, paper sludge, furfural residues for biomethane, bioethanol and/or biohydrogen production. He also directly supports graduate students' research on similar concepts. With his background in design and human ergonomics, Dr Sempira also supports projects aimed at testing newly developed technologies directly with end-users. His work bridges the gap between lab-based innovation and real-world applicability. To John, the CRSES offers a platform to integrate his passion for sustainable food systems with the rapidly evolving field of renewable energy.



Dr Francois Rozon

Dr Rozon's research focus is on institutional and industrial thermal energy system conversion to be more efficient and greener. After spending over two decades in industry, Francois decided to return to academia and completed his PhD in 2024. He is now a Postdoctoral Research Fellow with the CRSES. In addition to leading the Austria-funded Soltrain initiative in the Western Cape, in collaboration with AEE-Intec, Dr Rozon leads the DSTI solar and wind technology research and development Hub and Spokes Flagship programme. His aim is to expand the collaboration between research universities and industry to increase the impact of renewable energy and open opportunities for greater adoption. Dr Rozon regularly speaks at local and international conferences to share his work and build awareness of the role industry should play in reducing carbon emissions.



ACHIEVEMENTS & AWARDS

Hub and Spoke Wins Top Award at 2nd Annual SANEDI Energy Conference!

The Hub and Spokes programme has achieved a significant milestone by winning the award for first position for the best-contributing project to SANEDI's mandate at the 2nd Annual SANEDI Energy Conference. This recognition highlights the hard work and dedication of everyone involved in the project.

The Hub and Spokes bring together researchers to focus on renewable and sustainable energy, and the RSE Hub team makes a more substantial impact by coordinating these efforts. The team supports researchers by helping turn innovative ideas into practical solutions. In doing so, they also provide valuable advice on energy policies and raise awareness about renewable energy.

Beyond research, the Hub and Spoke initiative organises workshops and conferences that facilitate knowledge sharing and networking.

The team also assists small and medium enterprises in their growth by demonstrating new technologies and offering educational programmes in renewable energy.

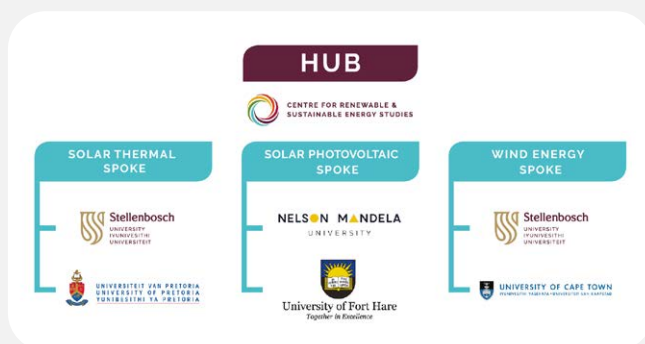
The Hub and Spoke initiative reports its activities to SANEDI and the Department of Science and Innovation (DSI) to ensure accountability and transparency in its operations.

Winning this award is a proud moment for the Hub and Spoke team, and also a motivation for the team to continue their important efforts in the energy space.

Congratulations to the entire Hub and Spoke team for this well-deserved recognition!



CRSES' engineer, Simnikiwe Gulwa ^



Hub & Spokes presentation ^

Prof Craig McGregor: Recipient of Outstanding Postdoctoral Mentor Award

Source: STERG Website

STERG would proudly like to acknowledge that Prof Craig McGregor, the director of the Solar Thermal Energy

Research Group (STERG), received an award for "Outstanding Postdoctoral Mentor" on 31 October 2024.

This award was presented at the Research and Innovation Excellence Awards gala dinner. These awards celebrate the achievements of the "crème de la crème" at Stellenbosch University (SU). The gala dinner was held at the Stellenbosch Institute for Advanced Study (STIAS), and the awards recognise "excellence across various categories, including postgraduate students, early career researchers, established researchers, women in research, newly A-rated researchers, and outstanding postgraduate supervisors".

According to Dr Varun Pratap Singh, currently doing a postdoc at STERG under the supervision of Prof McGregor, "Prof. McGregor is an exceptional mentor who fosters a dynamic research environment, encouraging innovation and critical thinking. His unwavering support, insightful guidance, and dedication to nurturing early-career researchers make him truly deserving of this award. Under his mentorship, I have gained invaluable research experience, expanded my scientific perspectives, and developed a deeper appreciation of solar thermal technologies. His leadership continues to inspire the STERG team to push boundaries and contribute meaningfully to the field."



Prof Craig McGregor ^

SASEC 2024 Best Oral Presentation and Best Paper Award

Stellenbosch University – Understanding the Reduction of Loadshedding Events: A Technical Analysis

Presented by: Liam Snyman

CRSES Junior Research Engineer, Liam Snyman, was honoured with two awards. He received the Best Oral Presentation Award and the Best paper Award at the Southern African Sustainable Energy Conference (SASEC) 2024 for his outstanding contribution, titled "Understanding the reduction of loadshedding events: A technical analysis".

In a presentation that was both insightful and accessible, Liam unpacked the complex dynamics behind South Africa's

loadshedding challenges. His analysis not only provided a clear technical breakdown of the factors contributing to power outages, but also proposed actionable strategies for their reduction.

Liam's work combined solid research with real-world solutions, making it relevant to both researchers and industry experts. His clear and practical presentation encouraged important discussions about sustainable energy and showed the value of using data to plan for South Africa's changing energy needs.



Liam Snyman ^

CRSES and Revive Electrical Transformers Collaboration for Empowering TVET Graduates

In alignment with the DSTI mandate for TVET graduates, the CRSES has initiated strategic collaborations to provide practical work experience. One such initiative involved the secondment of Shumani Kone, the CRSES intern, to Revive Electrical Transformers (RET) for an enriching eight-month tenure.

Shumani Kone's Journey with Revive Electrical Transformers

During his secondment, Shumani immersed himself in the comprehensive process of transformer manufacturing. He acquired hands-on experience in winding transformers, overseeing each stage from inception to the final product ready for customer delivery. Reflecting on his experience, Shumani expressed gratitude for the opportunity provided by the CRSES, stating, "Being hands-on during the manufacturing

the transformers was empowering and is a skill that will assist in acquiring a job elsewhere."

Shumani's dedication and the practical skills he developed did not go unnoticed. Upon completing his term with RET, he was offered a position as a Junior Technician, marking a significant milestone in his career and underscoring the success of the secondment initiative.

This collaboration between CRSES and industry leaders like Revive Electrical Transformers exemplifies the impactful pathways being created for TVET graduates, equipping them with essential skills and opportunities to thrive in their respective fields.



Shumani Kone ^

GRADUATIONS

CRSES Marketing and Communications Officer Completes PGDip

Fhatuwani Mulaudzi, who is responsible for marketing and communications at CRSES, successfully completed a Postgraduate Diploma in Marketing at Stellenbosch University. The course consisted of 12 modules and was completed over one year.

"In 2022, I joined the CRSES with a National Diploma and a BTech in Journalism. I joined the Centre as an Assistant Marketing and Communications Officer and had a desire to further my studies in this field to expand my knowledge. I presented my idea to our Director, Prof. Cristina Trois, who was supportive of it and

encouraged me to further my studies. She offered me a bursary to pursue a Postgraduate Diploma (PGDip) in Marketing at Stellenbosch University."

The journey was not easy, as it required balancing her work at the Centre with the demands of attending a full-time course. The programme required a physical presence, which made managing both responsibilities challenging but rewarding. Despite these challenges, Fhatuwani completed the course in a year and graduated in December 2024.



Fhatuwani Mulaudzi ^

Project Commercialisation Manager

CRSES Project Commercialisation Manager, Sedzani Ratsibi, graduated with a PGDip in Sustainable Development from the Centre for Sustainability Transitions and was fully funded by the CRSES.

"Studying for this degree was both intellectually stimulating and personally transformative. The CST offered a collaborative and practical learning environment that deepened my understanding of complex sustainability challenges. Engaging with themes like resilience, futures thinking and political

economy alongside diverse peers enriched my perspective. Practical tools such as scenario planning and system mapping have equipped me to apply sustainability thinking confidently in my work and strengthened my commitment to a just and sustainable future."



Sedzani Ratsibi ^

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STATEMENT OF INCOME AND EXPENDITURE

Until December 2024

For the period ending:	31/12/2024	31/12/2023
TOTAL INCOME	48 310 103.96	30 000 470.27
CONFERENCE/CONGRESS	334 501.69	0.00
CONTRACT RESEARCH	7 210 963.78	9 459 857.29
DONATION	0.00	400 000.00
INCOME: BURSARY	0.00	9 597 826.23
INCOME: FOREIGN	7 836 312.63	4 554 010.48
INCOME: SUNDRY	1 911 321.20	746 992.20
INCOME: DST	24 655 825.76	297 296.29
INTEREST RECEIVED	2 307 857.64	2 391 173.99
PROFIT: EXCHANGE RATE FOREIGN	0.00	18.70
SALE: MOVABLE ASSETS	(71 304.35)	71 304.35
SALES	300 000.00	955 806.69
SALES: TO INTERNAL ORG UNITS	1 613 773.79	129 370.30
SHORT COURSE INTERDEPARTMENTAL	1 329 851.82	1 088 500.00
SHORT COURSES	881 000.00	308 313.75
TOTAL EXPENDITURE	42 918 099.40	45 586 548.69
AFFILIATION & REGISTRATION	901 814.32	1 268 077.29
AUDIOVISUAL EXPENDITURE	0.00	17 804.00
AUDIT FEES: EXTERNAL	91 525.95	91 623.12
BURSARY POSTGRADUATE	2 519 158.22	1 182 093.88
BURSARY UNDERGRADUATE	409 676.30	0.00
CLEANING COSTS	0.00	17 756.67
CLEANING MATERIALS	0.00	8 365.75
CLOTHING: OTHER	0.00	6 628.30
CLOTHING: PROTECTIVE	0.00	776.87
COMPUTER MATERIALS	0.00	11 455.38
CONFERENCE/CONGRESS REFUND	0.00	44 000.00
CONSULTATION FEES	277 404.34	1 853 568.93
CONSUMABLE MATERIALS	56 070.72	33 262.01
COPY AND PRINTING	68 414.78	85 063.71
COURSES	0.00	66 725.00
CROCKERY	0.00	973.17
ENTERTAINMENT: GENERAL	409 268.20	2 869 385.61
FLOW-THROUGH FUNDS (SUB-CONTRACTS)	9 038 347.77	0.00
FOREIGN EXCHANGE LOSS	0.00	114 782.75
FUEL, OIL, LUBRICANTS	0.00	5 884.70
GENERAL OFFICE COSTS	3 343.31	2 625.19
GENERAL RESEARCH COSTS	0.00	1 404 000.00
GENERAL VEHICLE EXPENDITURE	3 552.44	0.00
GIFTS	4 961.50	1 752.36
ICRR (INDIRECT COST)	3 885 577.64	3 165 114.72
INSURANCE, LICENCES & 3RD PARTY	51 316.43	48 826.09
INSURANCE - OTHER	15 760.00	7 023.69
INTEREST PAID	39 234.99	107 017.89
INTERNET NETWORK EMAIL LEVY	171 212.75	142 185.48
SMALL ASSETS	20 428.46	12 098.38

For the period ending:	31/12/2024	31/12/2023
MAINTENANCE BUILDINGS-STELLENBOSCH	364 864.10	283 833.83
PACKING MATERIALS	529.96	0.00
POSTAGE AND COURIER SERVICES	109.84	19 939.58
PRIZES AND MEDALS	0.00	5 500.00
REFRESHMENTS: NON-ACADEMIC	0.00	28 676.61
RENT OF EQUIPMENT GENERAL	121 277.65	5 869.90
RENT OF ROOMS	8 662.50	54 450.00
RESEARCH MATERIALS	0.00	1 536 782.60
SECURITY SERVICES	25 714.56	3 299.33
SERVICES	5 527 465.34	15 180 520.40
SMALLER FURNITURE AND EQUIPMENT	6 036.79	484 131.36
SOFTWARE	394 631.89	483 347.37
STATIONERY	415.94	31 157.88
SUBSCRIPTION & MEMBERSHIP FEES	0.00	17 603.11
SUNDRY EXPENSES	60 955.14	37 644.23
TELEPHONE: CALLS	3 757.83	4 371.45
TELEPHONE: RENT	25 737.63	18 823.34
TOTAL REMUNERATION	15 043 936.43	10 641 729.24
TRANSLATION AND EDITING	0.00	9 070.00
TRAVEL: ACCOMMODATION VISA PA	3 617.16	519 182.86
TRAVEL: FOREIGN TRAVEL SUBSISTENCE	57 490.16	361 711.24
TRAVEL: DAILY ALLOWANCE AIR CAR	1 503 508.32	1 124 525.96
US - MUN ELECTRICITY	0.00	2 000.00
WORKSHOPS	705 927.52	755 752.55
ASSET TRANSACTIONS		
ASSET PURCHASES	1 096 392.52	1 407 754.91
Net operating income / (shortage) for the year	5 392 004.56	(15 586 078.42)
FUNDS TRANSFERS	(48 684.73)	1 659 582.21
TRANSFERS FROM	(5 145 795.91)	(10 733 363.11)
TRANSFERS TO	5 097 111.18	12 392 945.32
Net income / (shortage) for the year	5 343 319.83	(13 926 496.21)
Accumulated funds at the beginning of the year	24 373 922.88	38 300 419.09
Accumulated funds at the end of the year	29 717 242.71	24 373 922.88



4 April 2025

Prof Cristina Trois

Date

Director: Centre for
Renewable and Sustainable
Energy Studies

FINANCIAL POSITION OF THE CENTRE

The Centre has three main sources of income: a core grant from the Department of Science and Innovation, income from research projects and income from short courses offered by CRSES.

CRSES receives a core grant from the Department of Science and Innovation (DSI). The annual grant from the DSI is mainly to support the appointment of three senior academics at Stellenbosch University, provide bursaries for postgraduate students and contribute to funding for the renewable energy spokes. In 2024, a total of R24 655 825.76. was paid to the Centre. This includes a total of R8 604 000.00 earmarked for the various spokes, viz. the Solar Thermal Spoke at SU and UP, the Wind Spokes at SU and UCT, and the Photovoltaic Spokes at UFH and MNU. An amount of R15 043 936.43 was spent on the salaries of the chair, senior academic staff, engineers and administrative staff, while R2 519 158.22 was paid out as postgraduate bursaries and R409 676.30 was paid out for undergraduate bursaries.

The remainder of the income comes from several private and public entities for contract research projects, and from short and in-house training courses.

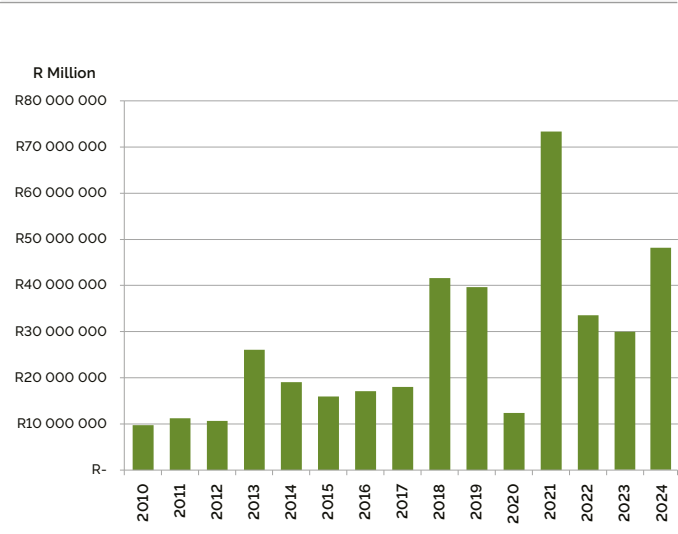
The comprehensive income statement of the Centre for all cost points, including project funds, is included on page 58 and 59. The overall income of the Centre until December 2024 was R48 310 103.96, an increase of R18 000 000.00 due to an increase in research contracts for the 2024 financial year and an increase in attendance of short courses. The total actual funding available at the end of December 2024 was R29 717 242.71, as can be seen in the table that follows.

The Centre has shown sustained growth in income since 2018. With more than R29 million in reserves, the Centre is in a favourable financial position for 2024. With the increase in income of R18 000 000.00, it shows that the Centre has diversified its current income streams.

Funds available at CRSES

	31 Dec 2023 (12 months) (R)	31 Dec 2024 (12 months) (R)
Total income to date	R30 000 470.27	R48 310 103.96
Total expenditure to date	R45 586 548.69	R42 918 099.40
Total transfers	R1 659 582.21	(R48 684.73)
Total equipment acquisitions	R1 407 754.91	R1 096 392.52
Total post-graduate bursaries	R1 182 093.88	R2 519 158.22
Total remuneration	R10 641 729.24	R15 043 936.43
Nett surplus for period	(R13 926 496.21)	R5 343 319.83
Accumulated funds from previous year	R38 300 419.09	R24 373 922.88
Funds available 31 December 2024	R24 373 922.88	R29 717 242.71

Annual income of the Centre



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This report is a reflection of the dedication, collaboration and expertise that each of you brings to the Centre every day.

We would also like to thank our funders and partners, whose ongoing support makes our work possible.

This report is more than just a summary of our year; it is testament to what we can achieve together.

Thank you for being part of the journey.



CRSES staff members in their Faculty of Engineering 80th birthday t-shirts ^



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