



**CENTRE FOR RENEWABLE &  
SUSTAINABLE ENERGY STUDIES**



**Stellenbosch**

UNIVERSITY  
IYUNIVESITHI  
UNIVERSITEIT

**CRSES  
ANNUAL REPORT  
2022**



**science & innovation**  
Department:  
Science and Innovation  
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# FOREWORD

*The year 2022 saw an acceleration in terms of the CRSES's work. We have had a number of breakthroughs in various key performance areas, as captured in this annual report. I will highlight only a few.*

In our ongoing training effort, we had eight interns, predominantly from technical vocational education and training (TVET) colleges, and some based at a water-energy-food (WEF) nexus project in the Vhembe district in Limpopo. One of the key outcomes of the training was knowledge transfer between CRSES engineers and TVET college graduates.

In addition, I am happy to report that we have managed to exceed all annual targets set in our 2018–2023 strategic development plan. The plan defines the Centre's areas of business, namely solar energy research, wind energy research, bioenergy, as well as power system studies, setting targets linked to the key performance indicators for the five-year period. One of my initial tasks upon joining the CRSES in 2017 was the development of said plan, involving consultations with the Faculty of Engineering and key funders such as the national Department of Science and Innovation (DSI) as well as Eskom. It was also informed by various legislative prescripts to align the CRSES's work with national priorities.

Since then, our work has continued to attract the attention of stakeholders in the energy sector and the general public and has grown in impact. Apart from succeeding in research and development initiatives, we also excel in implementing community initiatives such as the Masia Village WEF nexus project, which enabled us to deploy various technologies emanating from our work. Having attracted national government's attention, our media laboratory project continues to be implemented in rural schools nationwide. Our deployment of hydrogen fuel cells across South Africa allowed the country to develop membrane electrode assemblies (MEAs) under the Hydrogen South Africa (HySA) project. These MEAs are now the key element of the hydrogen valley described in government's Hydrogen Society Roadmap. The MEAs will form part of the production and conversion of green hydrogen using renewable energy. Hyplat, a spin-off company from the University of Cape Town, is collaborating with Bambili Energy to commercialise the MEAs and has secured more than 100 customers from across the globe.

Moreover, the Centre continues to produce sought-after graduates, cutting-edge research and insightful articles in leading journals. Some of the intellectual property we have created is currently being taken to market. Importantly also, as the CRSES's activities have expanded, our cashflow has increased proportionally.

A bittersweet moment in the reporting year was the loss of some staff members who took up opportunities elsewhere. These included Dr Ndamulelo Mararakanye, Ms Linda Joka and Ms Nawaal Jacobs. I, too, will be taking up the position as head of the DSI's Energy Secretariat in the South African National Energy Development Institute (SANEDI). It has been a privilege to lead the transdisciplinary and diverse team of the CRSES for the past six years.

**Prof Sampson Mamphweli**  
Director: Centre for Renewable and Sustainable Energy Studies



# BUILDING HUMAN CAPITAL

CRSES contributes to Human Capital Development through several capacity building pathways including internships, academic programmes, training as well as continued professional development (CPD). The aim is to provide highly skilled scientists, engineers and academics, as well as further capacitate professionals already in industry.

## 2022 CRSES interns

### Lugisani Kharidzha *(Intern: May 2022 - Oct 2023)*

I hold a bachelor's degree in Social Work from UNISA, a certificate in Project Management from Tshiredo Academy (NQF level 4), and a certificate in Agricultural Plant Production from Muselelwa Trading and Projects (NQF level 4).

My duties as a CRSES intern includes organising meeting venues, taking minutes, liaising with stakeholders, project planning, reporting community issues, welcoming visitors, and ordering office supplies. I have also had the privilege to attend business training workshops by the National Youth Development Agency (NYDA) and the Agricultural Research Council (ARC).



### Hulisani Makungo *(Intern: Apr 2022 - Dec 2024)*

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 NYDA.



### Hulisani Mulaudzi *(Intern: Apr 2022 - Dec 2024)*

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

My daily tasks as a CRSES intern includes 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 NDYA'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 the 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.



### Aluwani Tshishonga *(Intern: Jan 2022 - Dec 2024)*

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 *(Intern: Jan 2022 - Dec 2024)*

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 on-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 *(Intern: Jan 2022 - Dec 2024)*

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 attained several skills and look forward to learning more about renewable energy.



## Shumani Kone *(Intern: Jan 2022 - Dec 2023)*

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 lottaWatt (an energy monitoring device), and had the opportunity to draft the PVsyst design and install lottaWatt for a project that the Centre is working on. I also acquired soft skills such as professional communication.

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

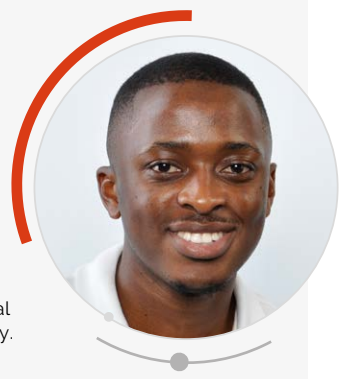


## Ntando Mncube *(Intern: Sept 2022 - Aug 2023)*

My internship so far has enabled me to engage in constructive inquiry, including evaluating the economic and technical feasibility of renewable-energy projects, analysing trends, forecasting the renewable-energy sector, and assessing policy and regulatory issues.

I have been working more on the commercialisation side. This involves transforming renewable-energy technologies and products into viable commercial products and services that can compete with conventional energy sources such as fossil fuels. The intention is for businesses and consumers to be able to invest in renewable energy in a way that is financially sustainable and attractive.

I am not only learning valuable lessons and gaining experience for the future, but I am also building strong analytical skills and expanding my knowledge of the technical, economic and policy aspects of the renewable-energy industry.



## *2022 CRSES postdoctoral fellow*

### **Dr Jafaru Egjeya** *(Post Doctoral Fellow)*

Cities across the globe are experiencing the impact of climate change, rapid population growth, increasing consumerism and urbanisation. This has placed severe strain on already limited water, energy, and food supplies. If we understand the trade-offs and synergies of water, energy, and food (WEF) use in each region or city, we can implement policies to ensure the sustainable use of these resources. As a postdoctoral research fellow with the African Research Universities Alliance (ARUA) Centre of Excellence in Energy situated in the CRSES, I aim to develop models to understand the WEF nexus.

Moreover, since the start of my fellowship in 2021, I have participated in several workshops both at and outside Stellenbosch University. Key workshops I attended in 2022 included the meeting of African early-career researchers at the University of Pretoria, and the early-career researcher workshop hosted by the University of KwaZulu-Natal. At both these events, I gained insights into best practices for early-career researchers to succeed. Also in 2022, I was selected as one of the top 20 postdoctoral fellows at Stellenbosch University to receive an award in recognition of my contribution to the University's research ethos. In addition, I received an Erasmus+ mobility grant to undertake a week-long all-expenses-paid trip to the University of Maribor, Slovenia, to present some of my research.

I thank the CRSES and my host, Prof Neill Goosen, for their support, and hope to continue delivering quality research outputs in 2023.



## *Farewell to key role players*

### **Dr Ndamulelo Mararakanye joins CSIR**

Dr Ndamulelo Mararakanye's time with the CRSES came to an end in November 2022 after six years. He has accepted a position at the Council for Scientific and Industrial Research (CSIR). He holds a PhD (Electrical Engineering) obtained from Stellenbosch University in 2022. His career began at Eskom in 2014. Two years later, he was appointed research engineer at the CRSES, and was promoted to senior research engineer in 2019.

During his time at the CRSES, he contributed to various projects, including:

- a feasibility study on the potential of rooftop photovoltaic systems in the Western Cape;
- a study on the impact of integrating intermittent renewable energy into the Namibian grid;
- a feasibility study of battery storage at the V&A Waterfront shopping centre;
- determining the optimal siting of wind and solar photovoltaic plants in South Africa;
- developing a curriculum for power systems planning and operations training courses in South Africa; and
- offering technical advisory services regarding small-scale embedded generation.

Dr Mararakanye received a number of awards during his time with the CRSES. These include being named RECORD RERE Young Researcher of the Year (2017), receiving the Best Paper award at the POWER-GEN & DistribuTECH Africa conference (2018), and scooping the Best Student Presentation award at the Eskom Power Plant Engineering Institute (EPPEI) student workshop and the Best Presenter award at Gen X Theatre Africa (both in 2019).



## Awards and prizes

### CRSES awards:

The CRSES's prize for **best final-year project** in Renewable Energy Studies in Stellenbosch University's Department of Mechanical and Mechatronic Engineering went to Zinhle Dlamini. Zinhle's project, "Design and simulation of shell-and-tubes heat exchanger for sCO<sub>2</sub> Brayton recompression cycle", scored 75%. It was completed under the supervision of Mr Carl Tshamala.

Matthew Keyser won the prize for **best postgraduate project** in Renewable Energy, having achieved 79% for the project entitled "Techno-economic assessment of an industrial-scale solar thermal heat system using compound parabolic collectors". The supervisor was Prof Craig McGregor.

### Research excellence awards:

(<https://www.sun.ac.za/english/Lists/news/DispForm.aspx?ID=9447>)

Prof Eugene Cloete, chair of the CRSES Steering Committee from 2012 until 2022, was recently honoured with the **Outstanding Postdoctoral Mentor award**. The awards are presented by nomination to honour hosts of postdoctoral fellows for their excellence in leadership, commitment to postdoctoral researcher development, and efforts to advance future research.

Dr Jafaru Egieya, a postdoctoral fellow with the ARUA Centre of Excellence in Energy, was selected for a **Stellenbosch University Deputy Vice-Chancellor's Top 20 Postdoctoral Research Fellows award**. The award recognises postdoctoral fellows who have contributed to research, scholarship and society through publications, grants awarded, participation in supervision and teaching, and engagement with the community, government, and industry.

The **Eugene Cloete Outstanding Postdoctoral Mentor award** was bestowed on CRSES associate director Prof Bernard Bekker of Electrical and Electronic Engineering. This special award introduced by Prof Eugene Cloete is presented by nomination to honour hosts of postdoctoral fellows for their excellence in leadership, commitment to postdoctoral researcher development, and efforts to advance future research.

### Project award:

Chemical Engineering's Prof Neill Goosen, director of the ARUA Centre of Excellence in Energy, received a **Wilhelm Frank Trust funding award** in collaboration with the Department of Materials Science and Engineering at the University of Ghana. The funding will go towards a project that will examine the production and improvement of photocatalysts that are able to harvest sunlight for the direct renewable production of hydrogen from water.

## CRSES Graduates

**Dr Ndamulelo Mararakanye** graduated with a PhD (Electrical Engineering) from Stellenbosch University in December 2022 (pictured below left). In his dissertation, he provided a framework for understanding variable renewable-energy integration issues based on the available renewable resources, penetration level and grid characteristics of a region. His study further proposed an approach for improving the accuracy of aggregated point and probabilistic forecasts derived from decentralised point forecasts by incorporating some of the common spatial and temporal correlations, including those caused by large-scale atmospheric circulations. Finally, it proposed modelling approaches to improve our understanding of extreme wind power forecast errors and conditional wind power forecast error distribution.

Also in December 2022, **Mr Rudzani Netshivumbe** graduated with his master's in Chemical Engineering from Stellenbosch University. His study focused on the production of methane from the fish sludge that originates from a recirculating aquaculture system. His research evaluated the effects of three waste mixtures on biogas yield and methane production in an anaerobic co-digestion process.



Dr Ndamulelo Mararakanye

## 2022 Graduates

The students listed below graduated during the year under review.

Name	Programme
Fenner, CC	MEng
Shidhika, FMT	MEng
Netshivumbe, R	MEng
Baziruwaha, J	MEng
Mupazviriho, MK	MEng
Martin, A	MEng
Coetzee, M	MEng
Van der Merwe, A	MEng
Ludick, L	MEng
Dickson, D	MEng
Vumbugwa, M	PhD
Tolessa, AM	PhD
Mararakanye, N	PhD
Labuschagne, C	PhD
Ockhuis, D	PhD

## Administrative and Financial Officer

CRSES extends its congratulations to its valued Administrative and Financial Officer on the remarkable achievement of completing her Master of Philosophy (MPhil) in Labour Law.

This accomplishment demonstrates dedication, hard work, and a profound commitment to academic excellence. Her success not only brings pride to CRSES but also serves as an inspiration to colleagues. As you continue to excel in your professional journey, we look forward to witnessing the valuable insights and contributions you will bring to CRSES. Elmien Lovell completed her MPhil in Labour Law at the University of the Western Cape in August 2022.

She has been with Stellenbosch University for 17 years.



## SARChI NRF Chair in Power Systems Simulation

CRSES's Associate Director, Prof Bernard Bekker, has been awarded the SARChI NRF Chair in Power Systems Simulation. According to Prof Bekker, this chair aligns with the existing research within the Electrical and Electronic department's Power Systems Research Group, which aims to characterise variability in the power system and understand its impacts in support of power system planning and operations.

"The Chair will focus on improving methodologies and input assumptions for simulating various aspects of current and future electrical power systems. The Chair's vision is to optimally leverage SU's existing ecosystem of renewable energy and power system simulation expertise and industry and academic relationships towards developing and strengthening a national competency in power system simulation within South Africa," he says.



## Bursary support for students

Altogether 19 students (five PhD, twelve MEng and two MSc) received bursaries in 2022. Of these, 14 (four PhD, nine MEng and one MSc) completed their studies at the end of the 2022 academic year, with the remaining five still continuing. The names of the bursary recipients follow below:

Surname	Name	Degree
Baziruwaha	Jean	MEng
Coetzee	Mark	MEng
Coetzer	Kurt	PhD
Dickson	Dian	MEng
Egberink	Ross	MEng
Hassan	Elzubeir	MEng
Kuyler	Judy	MEng
Labuschagne	Casper	PhD
Ludick	Luwan	MEng
Mafu	Portia	MEng
Martin	Andrew	MEng
Mushenya	John	PhD
Ndzonda	Siyabonga	MSc
Ockhuis	Dillan	PhD
Roodt	Roelof	MSc
Shidhika	Fennie	MEng
Snyman	Liam	MEng
Van der Merwe	Andrie	MEng
Westraadt	Edward James	PhD

*This central receiver solar power plant is situated in the Northern Cape*





*Khi Solar One -15MW CSP (Concentrated Solar Power) Plant*

# BUILDING HUMAN CAPITAL *continued*

## **STERG technical tour**

From 11 to 15 September 2022, staff, guests, and postgraduate students of the Solar Thermal Energy Research Group (STERG) embarked on the first technical tour since 2019 in collaboration with the CRSES. The aim was twofold: to give students access to concentrating solar power (CSP) plants in the Northern Cape (*pictured below left*), and to host a symposium where Stellenbosch University's research was presented to the CSP community on their home turf. A group of 22 master's and PhD students undertook the tour, accompanied by professors, academic staff, and guests.

The delegation visited the Redstone construction site, which, once complete, will comprise a 100 MW tower plant with 12 hours of molten-salt storage. Visits to an operational tower plant (Khi Solar One) and a parabolic trough plant (Karoshoek Solar One) presented the students with first-hand insight into the construction, commissioning, and operation of CSPs. The students had the rare opportunity to engage with the plant operators and engineers.

At the symposium on the last day of the tour, STERG master's students Nicolaas van Jaarsveld, Jandré Hanekom and Howard Piwang presented their research. Keynote speaker Nandu Bhula, chief executive of ACWA Power's Redstone solar thermal power plant, elaborated on progress and challenges with the Redstone CSP.

The tour was an overall success and continues to foster good ties with the CSP industry. Thanks to our hosts at Khi, Redstone and Karoshoek for making time for our group and answering our eager questions.



*A visit to the 50 MW Khi Solar One CSP*

## **Eskom initiatives**

### **The EPPEI Initiative**

The Eskom Power Plant Engineering Institute (EPPEI) was established in 2012 as an industry-academia collaboration platform to build human engineering capacity, firstly within Eskom, but also in the broader South African power industry. For the next 10 years CRSES hosted the EPPEI Specialisation Centre for Renewable Energy, and from 2017 the Eskom chair in Power System Simulation.

The second phase of the EPPEI contract with Stellenbosch University terminated at the end of 2021. While negotiations for a new phase was still in progress in 2022, collaboration between Eskom and Stellenbosch University continued, including through the hosting of a student workshop.

### **Ninth EPPEI student workshop**

The ninth EPPEI student workshop took place at the Eskom Academy of Learning in Midrand, Gauteng, in November 2022.

The workshop was introduced in recognition of the fact that the country's power industry stands to gain significantly from close collaboration between industry and universities. Many research projects and postgraduate studies focus on Eskom-specific technical challenges.

With Covid restrictions lifted, the 2022 workshop returned to an in-person format. The event attracted students from all EPPEI specialisation centres based at participating universities and universities of technology. They were able to present their work to their peers, associated academics, colleagues from Eskom, and technology suppliers. Two panel discussions were also included in the agenda, resulting in lively discussions on current issues.



*Prof Bernard Bekker (far right) chairs a panel discussion on South Africa's future electricity market, with panellists Keith Bowen (middle, chief economist at Eskom) and Dr Graeme Chown (left, specialist at Chown Associates).*

## Capacity building in green hydrogen project engineering

### Identifying the need

Green hydrogen (hydrogen generated from low-carbon sources such as renewable energy) is likely to play a part in the broader societal energy transition through the so-called power-to-X principle. This entails a conversion process utilising electrical power to generate hydrogen, typically during periods when fluctuating variable renewable energy (VRE) generation exceeds load, storing energy as green hydrogen, and reconvert it into end-use forms of energy through various pathways. As a carbon-free energy carrier, green hydrogen has significant potential to reduce greenhouse gas emissions.

In addition, the Presidency regards green hydrogen as a major strategic investment opportunity. According to Creamer Media's Energy Roundup report for July 2021, it is estimated that the country could produce more than 3,8 million tons of green hydrogen a year by 2050, which, in turn, could create around 370 000 direct and indirect jobs.

Clearly, therefore, significant growth is likely in green hydrogen-based projects supported by government. Add to this the developing international markets for hydrogen, and it is safe to conclude that the potential exists to create a thriving hydrogen industry in South Africa, with associated carbon reduction impacts and local economic and job growth.

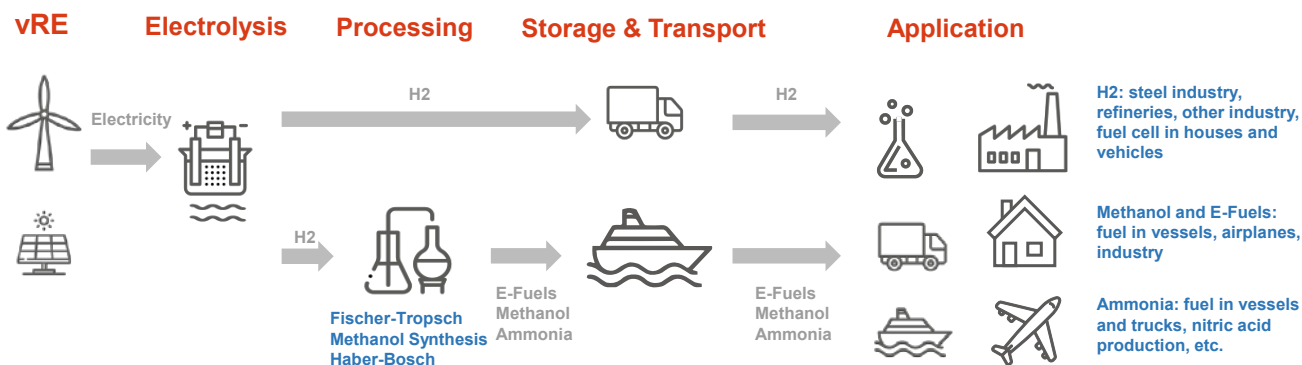
Current hydrogen activities in South Africa are mostly aligned with the Hydrogen South Africa (HySA) programme. Resorting under the Department of Science and Innovation (DSI), HySA has a strong research and awareness-building focus, but currently lacks targeted training and capacity-building initiatives outside the research domain. While some specialist capacity has been established at HySA-aligned academic institutions, current South African engineering degree programmes, both undergraduate and postgraduate, are generally not focused on training future engineering capacity in the hydrogen sector.

Against this backdrop, a need has been identified to build hydrogen project engineering capacity in the broader South African engineering industry, with a specific focus on green hydrogen. 'Hydrogen project engineering' can be defined as the activity of designing, funding and successfully implementing fit-for-purpose projects based on hydrogen, focused on the complete application cycle of hydrogen projects, including production, distribution, storage, and end use.

Building hydrogen project engineering capacity will open doors to jobs in numerous industries, whether as a design engineer, development engineer, project manager, production manager, or in research. The capacity building aims to reach a wide audience and should be focused on the implementation of full projects rather than specialist subcomponent-focused activities (as illustrated in the Diagram reference: GIZ 2021, below).

### Basic ideas for the concept

- no training on **electrolyser / fuel cell design** or **membrane technology**
- rather **project engineering / technical planning and design** of a green hydrogen/PtX production chain under consideration of **economic aspects**



# BUILDING HUMAN CAPITAL continued

## Proceeding with GIZ assistance

CRSES received a grant from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), enabling us to proceed with the green hydrogen project engineering capacity-building project in 2022.

One of the primary deliverables of this project was to put together three postgraduate and CPD course modules:

- "Hydrogen in the energy system", which offers a systemic view of energy systems with a specific focus on hydrogen;
- "Green hydrogen technology", which examines the available and developing technologies used for green hydrogen production, distribution, storage, and end use; and
- "Green hydrogen project engineering", which is focused on the principles of designing, funding and successfully implementing fit-for-purpose projects based on green hydrogen.

The first two of these three courses were successfully developed and presented towards the end of 2022, with the third course planned early in 2023.

In addition, CRSES hosted a one-day seminar **"Getting ready for the shift"** for students and supervisors in October. CRSES associate director Prof Craig McGregor chaired the seminar, and Mahandra Rooplall from the Industrial Development Corporation gave the opening address. The closing presentation was delivered by Prof Karin Wolff, senior adviser for Teaching and Learning in Stellenbosch University's Faculty of Engineering. Individual students delivered presentations and received feedback on their respective projects.

Also, as part of the capacity-building initiative, master's bursaries were awarded to encourage the establishment of South African research competency in green hydrogen project engineering relevant for the local context. The criteria were a BEng degree (either completed in 2021 or earlier) and registration as full-time students in 2022. More than ten bursaries were eventually awarded.

### Full outline of the module offering in 2022:

Full module name	Total	Academic Students	Eskom CPD* certificate attendees	Municipality and industry CPD* certificate attendees
Advanced Photo-voltaic Systems	42	30	0	12
Bioenergy	24	20	0	4
Distribution Customer Concepts	36	14	21	1
Distribution Network Planning & Operations	60	0	14	46
Energy Storage Systems	41	21	1	19
Green Hydrogen Technology	18	2	12	4
Hydro and Ocean Energy	12	12	0	0
Hydrogen in the Energy System	11	0	9	2
Long-term Power System Planning	43	20	20	3
Overview of the Power Plant Industry	19	16	2	1
Power System Analysis	43	0	42	1
Power System Data Analytics	34	13	18	3
Power System Flexible Operations	74	7	43	24
Power System Operations	60	14	46	0
Renewable Energy Systems	21	17	0	4
Smart-grid Communications	16	14	0	2
Solar Thermal Energy Systems	14	14	0	0
Wind Energy Systems	24	20	0	4
<b>Total attendees**</b>	<b>592</b>	<b>234</b>	<b>228</b>	<b>130</b>

\*Continuing professional development.

\*\*Students were able to attend more than one module

## SDEDH roundtable and CHIETA skills conference

As part of the national initiative to create a clean, affordable, and sustainable energy future for South Africa, the DSI launched the Hydrogen Society Roadmap (HSRM) in February 2022. Science Diplomacy for Economic Development through Hydrogen (SDEDH) is a DSI initiative that directly supports both the HSRM and the Hydrogen Commercialisation Strategy for South Africa (HCSSA) through a series of local and international roundtables and follow-up activities.

The CRSES, Impact Hydrogen and the Durban University of Technology jointly arranged the first SDEDH roundtable, which took place in hybrid format in December 2022. Themed "Hydrogen as a lever for social justice", the workshop aimed to:

- identify new spin-off projects to build the first tangible parts of the hydrogen value chain (involving small and medium-sized enterprises and multinationals);

- establish the conditions for creating all the prerequisites for the hydrogen value chain, including training, employment strategies, policy frameworks, and (international) partnerships;
- identify where South Africa can incorporate the United Nations' sustainable development goals into the hydrogen value chain;
- determine how South Africa can develop its domestic hydrogen market while becoming a preferred supplier to global markets; and
- leverage financing and investment as well as concrete collaborations to accelerate a socially just transition to a green hydrogen economy.

The roundtable aptly coincided with the Chemical Industries Education and Training Authority (CHIETA) Pan-African Hydrogen Skills Conference.

For more on the inaugural SDEDH roundtable and the CHIETA event, see <https://sd4ed-hydrogen.co.za/resources/>.



Minister of Higher Education, Science and Innovation Blade Nzimande



Prof S Mamphweli (CRSES) in discussion with colleagues during a break



A panel discussion at the CHIETA Pan-African Hydrogen Skills Conference

# BUILDING HUMAN CAPITAL *continued*

## *Solar thermal training courses under the SOLTRAIN banner*

SOLTRAIN (Southern African Solar Thermal Training and Demonstration Initiative) is a regional capacity-building initiative that focuses on increasing the uptake of solar thermal systems in the Southern African Development Community. The aim is to support target countries in changing from a largely fossil-energy supply system to a sustainable supply structure based on renewable energy in general, and solar thermal energy in particular.

Under the SOLTRAIN banner, the CRSES partnered with the AEE-Institute for Sustainable Technologies (AEE INTEC) to host three courses in July 2022.

The specialised course on medium temperature solar process heat, intended for professionals, attracted approximately 50 trainees. Some 35 participants enrolled for the second offering, a training course for quality inspectors of solar water heating systems.

The third and final training course on solar thermal systems was aimed at artisans. Modules were aimed at staff from both private and public companies in the electricity, social housing, health, and defence sectors. The objective was to equip artisans with the skills to carry out simple audits, design solar thermal systems, prepare calls for tenders, and assist in the evaluation of tenders. The course, which had 35 participants, focused on simple systems (low and high-pressure thermosyphon as well as pumped systems) that could support the solar thermal mass roll-out programmes.



*Participants of the specialised course on medium temperature solar process heat*



*Participants of the training course for Artisans on Solar Thermal Systems*



*Solar thermal systems course for artisans*

## Renewable Energy Postgraduate Symposium 2022

The annual Renewable Energy Postgraduate Symposium (REPS) offers postgraduate students in the renewable-energy field a platform to present their work to their peers, mentors, and supervisors in a welcoming environment.

The CRSES collaborated with the DSI Solar Thermal Spoke based at the University of Pretoria (UP) to host the twelfth edition of the event at UP on 31 October and 1 November 2022 (*see group photo right*).

Following a message on the importance of renewable energy from DSI's Somila Xosa, Prof Alta van der Merwe from UP delivered a keynote address, sharing tips on presenting research in front of an audience. Prof Karin Wolff, senior adviser for Teaching and Learning in Stellenbosch University's Faculty of Engineering, also made a presentation on a systems approach to the Engineering postgraduate research journey.

Student research presentations centred on the topics of:

- solar thermal energy systems;
- solar photovoltaic energy systems;
- wind energy systems;
- hydrogen, hydro and ocean energy;
- renewable-energy resource assessment;
- demand-side and energy storage applications;
- power systems planning and operations; and
- bioenergy (thermochemical, biological, chemical and physical conversion systems).

A total of 21 research papers were presented on the first day of the symposium. Go to <https://www.crses.sun.ac.za/events/annual-symposiums/> for more on the presentations.

The second day comprised a technical visit to UP's Engineering building to view a solar dish installation (*see picture on the right*).



Attendees at the Renewable Energy Postgraduate Symposium



Viewing a solar dish installation

## 'Start your own business' training and pitching session

The CRSES's entrepreneurship development programme, hosted in Masia village, Limpopo, is aimed at creating a conducive environment for young entrepreneurs to access relevant entrepreneurial skills, knowledge, values, and attitudes to start their own businesses.

The two-part programme offered both training and an opportunity for participants to pitch their ideas. The five-day training guided aspiring entrepreneurs on how to develop a profitable business plan, assess their readiness to start a business, reinforce their business ideas, and draft a marketing plan. Other topics included managing staff, financial planning, and the types and sources of startup capital. This was followed by a one-day pitching session, where participants were able to present their business ideas. CRSES director Prof Sampson Mamphweli closed proceedings by handing over certificates of completion to the participants.



Attendees at the Masia Traditional Authority

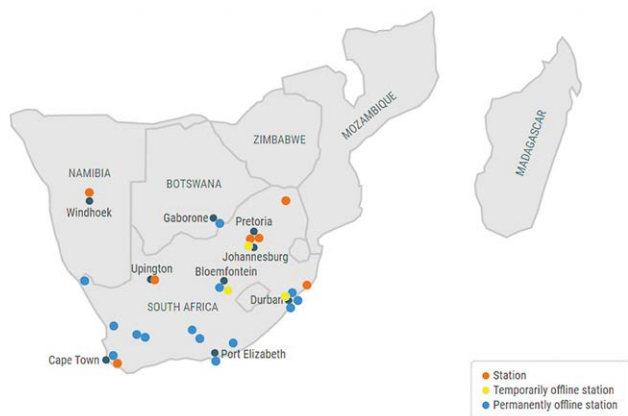
# RENEWABLE ENERGY RESEARCH AND MARKET TRANSFORMATION PROJECTS

*CRSES aims to facilitate the transformation of the energy sector by moving away from fossil fuel-based energies to renewable energy-based systems.*

## Southern African Universities Radiometric Network (SAURAN)

The Southern African Universities Radiometric Network (SAURAN) was initiated by the CRSES and the Group for Solar Energy Thermodynamics (GSET) at the University of KwaZulu-Natal in 2014. SAURAN aims to make high-resolution, ground-based solar radiometric data available from stations across Southern Africa (see map below), including South Africa, Namibia and Botswana. Obtained using state-of-the-art Kipp & Zonen radiometers, data is available in minute, hourly and daily time-averaged intervals and is available at no cost through the website <https://sauran.ac.za/>.

In 2022, a number of initiatives were set in motion to improve the



quality of data available on the network. Firstly, the **network was downscaled** to only ten stations. This enabled us to assign more time and money to each active station, allowing them to run more consistently and record higher-quality data.

Secondly, the **quality assessment of data** was addressed. Ground data is recorded and uploaded to the web application as raw data, which is in line with similar free weather data resources worldwide. From there, the researcher is responsible for assessing data quality and doing gap-filling. To help researchers' quality-assess the data they use, the SAURAN website was updated with accessible quality checking information. An online tool was also created that automatically performs some preliminary quality checking calculations and provides users with graphs based on the SAURAN data they enter. The tool is accompanied with a detailed document

that explains quality assessments, how the tool works, and how to perform quality checks manually (see screenshot of tool and guide below). To further improve accessibility, a link to these resources was placed directly beneath the download buttons for each station.

Over the months ahead, the download frequency of these

### SAURAN: Data quality checking program v1.4

This program is designed to perform data quality checks and formatting on weather datasets (csv files) downloaded from the SAURAN website (<https://sauran.ac.za/>).

For more information on the quality checking of data, please consult the document that came with this program. Please note that this quality checking is performed on minute or hourly resolution data and **not on daily averaged data**. Also note that larger minute-averaged files may take a while to upload. It is recommended that Google Chrome is used as the web browser when running this tool.

This code was written in Python, and is available below. If you would like to report bugs, problems with the program or require more information, please contact Don Fitzgerald at [don@sun.ac.za](mailto:don@sun.ac.za).

**Disclaimer: Use this program at your own risk. The CRSES takes no responsibility for incorrect results generated by this tool.**

- Click the play button, wait for it to finish and then move onto the next cell.
- Hit play and upload a weather file from the SAURAN website (\*.csv).
- Hit play to process the data and download the output file.

**NOTE: If you would like to run this program again, click the play button of the second cell and upload another file.**

resources will be compared to publications using SAURAN data to monitor whether quality assessment behaviour improves over time.

The third initiative to streamline SAURAN was a **study to establish a baseline for researchers' data quality assessment behaviour**. Titled "Open access data quality assessment behaviours and a boomerang effect investigation using the SAURAN data network", the study looked at all publications that had used SAURAN data since 2015. It is currently under internal review and should be published by late 2023.

A fourth and final intervention in 2022 was **the payroll incentive**. By adding station maintenance staff to the payroll in order to receive a small monthly fee, the initiative aimed to increase these staff's efficacy in cleaning, aligning and otherwise attending to the weather stations. Previously, this was offered as a free service from those working nearby the stations. Preliminary results point to a significant increase in their responsiveness, which helps improve data quality.

Since funding for SAURAN remains a challenge, the future of the online application is subject to some level of uncertainty.



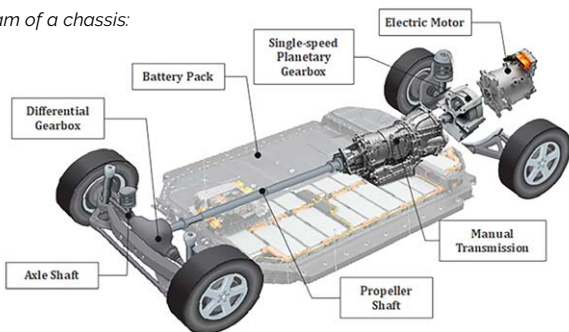
## Electric minibus research

CRSES is collaborating with the Electric Mobility Group in Stellenbosch University's Faculty of Engineering on various projects relating to electric vehicles and infrastructure. A major component of this work has been to plan for the eventual electrification of minibus taxis.

Since there are no electric minibus taxis in the country, a three-step approach was taken. Firstly, simulation tools were used with data captured in situ, ranging from origin-destination data to high-frequency tracking data. However, the existing simulation tools did not adequately represent minibus-taxi mobility. To remedy this, the team adapted the simulation virtualisation to the unique driving styles and drive-cycles of minibus taxis.

The two remaining steps are to obtain actual electric vehicles to which the simulation results could be validated, and to use the vehicles and the research findings to raise awareness among taxi drivers and owners. Two vehicles have been selected. The first is a brand-new minibus taxi imported with partners MiX Telematics, GoMetro, HSW, and ACDC (pictured below). The vehicle should reach South African shores by July 2023. The second vehicle is a retrofit (see artist's rendition below right) that saw the CRSES team and partners Rham Equipment and Golden Arrow convert a regular petrol (internal combustion) taxi to one with electric propulsion. The retrofitted vehicle should be in Stellenbosch ready for testing in June 2023. For more information, keep an eye on <http://ev.sun.ac.za>.

Diagram of a chassis:



The Electric Mobility Group is driving eco-friendly transportation solutions to foster a sustainable and innovative future.



A brand-new minibus taxi imported with partners MiX Telematics, GoMetro, HSW, and ACDC

# RENEWABLE ENERGY RESEARCH AND MARKET TRANSFORMATION PROJECTS continued

## ABSA sustainability reports

ABSA contracted the CRSES to help generate two reports, one on the status of electric vehicles (EVs) in South Africa, and the other on what a sustainable home means in our local context.

### Electric vehicles report

This report covered the state of EV technology worldwide compared to internal combustion engines (ICEs). Battery technologies were compared to weigh up the benefits and help explain manufacturers' choice of technology or combinations thereof. For instance, the figure below contains a performance metric comparison of popular lithium-ion (Li-ion) cathode chemistries. The higher the metric (further away from the centre), the better the benefit. (The LCO technology, for example, appears to be the lowest in cost.)

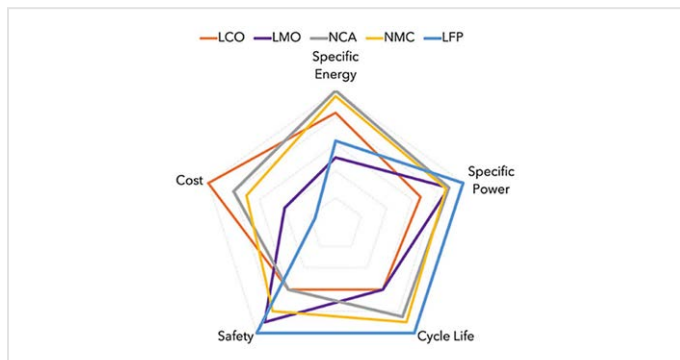


Image 1: Comparison of the main performance metrics of popular Li-ion cathode chemistries [2], [3]

\*LTO – lithium titanate (Li<sub>2</sub>TiO<sub>3</sub>); LFP – lithium iron phosphate (LiFePO<sub>4</sub>); LMO – lithium manganese oxide (LiMn<sub>2</sub>O<sub>4</sub>); NMC – lithium nickel manganese cobalt oxide (LiNiMnCoO<sub>2</sub>); LCO – lithium cobalt oxide (LiCoO<sub>2</sub>); NCA – lithium nickel cobalt aluminium oxide (LiNiCoAlO<sub>2</sub>)

The report went on to present an analysis of the market and current trends in the EV industry, both worldwide and in South Africa. The figure below shows the units sold in South Africa between 2016 and 2021, split into battery electric vehicles (BEVs), hybrid EVs (HEVs) and plug-in hybrid EVs (PHEVs).

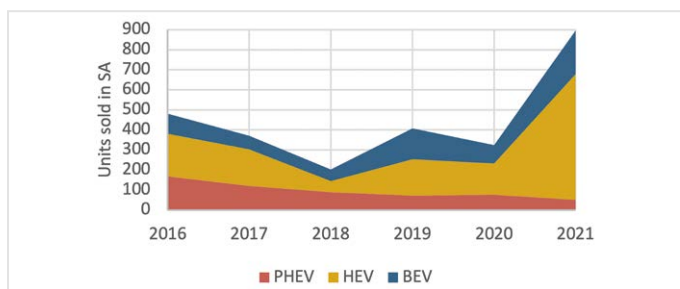


Image 2: SA market by electric vehicle fuel type - 2016 to 2021 [15]

Next, various EV manufacturers' perspective was discussed, including their plans for the future. Financial considerations are extremely important for the uptake of EVs in South Africa. This was detailed, touching on the depreciation of various EV models compared to their ICE equivalents. Sustainability was also considered by investigating what happens to retired EV batteries in the circular economy. The typical life cycle of a battery is illustrated in the figure below.

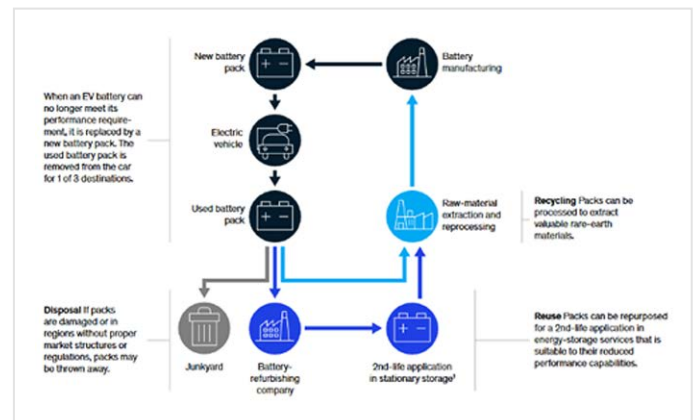


Image 3: Electric-vehicle (EV) battery life cycle (simplified) [34]

Finally, charging stations in South Africa were investigated in terms of both the current state and future projections. Even though EV sales in South Africa are still low, the growth has been significant. Charging innovations and research are progressing strongly, along with expanding charging infrastructure. Both have the potential to accelerate the uptake of EVs. Internationally, the depreciation of EVs appears to be similar to that of ICE vehicles but can vary significantly between models. This will require further research.

### Report on sustainable homes

This report started by defining what a sustainable home means to homeowners. The goal of creating sustainable homes is to improve residents' quality of life, while also cutting down on resource use (including, but not limited to, energy, water, and materials).

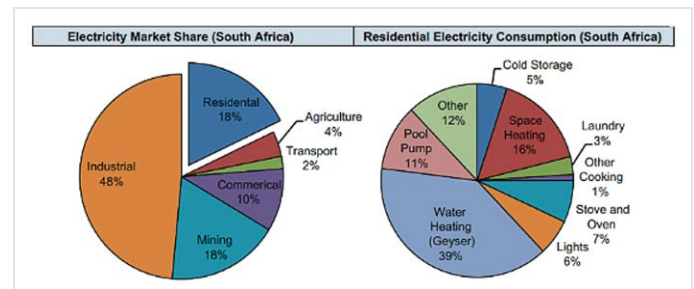


Image 4: Electricity market share and residential electricity consumption [9]

As the following chart illustrates, the residential sector is a noteworthy contributor to greenhouse gas emissions.

Therefore, to address environmental concerns, it is imperative to advance the cause of sustainability. The following infographic illustrates the different levels of house sustainability:

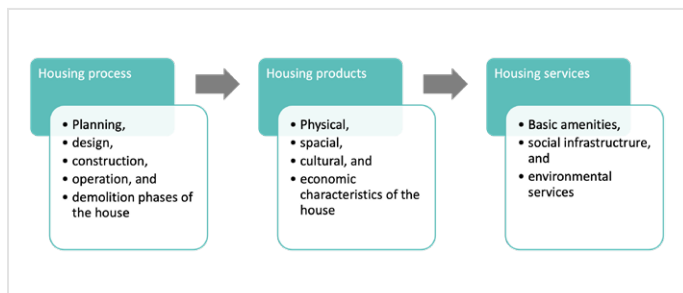


Image 5: Levels of Housing Sustainability [3]

## Masia Village WEF nexus project

### 20 kW photovoltaic cell solar system installed

Masia Village in Limpopo is the site of a DSI-funded project relating to the water-energy-food (WEF) nexus. The Masia Resource Centre in the village provides an ideal opportunity for the deployment of renewable and sustainable energy technologies, including a solar installation.

In October 2022, the CRSES fitted the centre with 36 solar panels with a 20 kW battery for storage. Each panel produces 550 W at peak, delivering a combined total of 19,8 kW (battery, inverters and bypass box pictured below). The solar system powers the centre and the borehole, which supplies water for use in the buildings and for irrigation of the nursery.



The report also touched on the difference between a sustainable and a smart home. While a sustainable home need not incorporate digital technologies, 'smart homes' are those that have been fitted with computerised or controllable technologies such as appliances, lighting, and climate control.

Sustainable interventions such as energy audits, LED light replacements, upgrades to old appliances, insulation and many more were discussed in detail, as well as the use of the cost of conserved energy (CCE) to assess whether a sustainable intervention is worth the capital expenditure. The CCE compares the annualised cost of conservation to the annual energy saved. Finally, the report also covered aspects such as tax incentives, regulations, standards, and certifications for sustainable interventions in South Africa.

### Fuel cell installation

A 5kW PS-5 fuel cell system has also been deployed at the Masia community centre (pictured below). The system is not yet producing power, as there is currently no electrolyser to produce hydrogen.



### Training in photovoltaic cells

Prior to the solar installation, the CRSES provided the villagers with training on solar technology. The aim was to introduce younger members of the community to renewable energy, and to photovoltaics in particular. The two-day training was conducted by CRSES junior engineer Simnikiwe Gulwa and was attended by TVET college graduates, university graduates and matriculants from Masia and surrounding villages.

### Borehole installed and nurseries being established

The Agricultural Research Council (ARC) portion of the project, comprising the establishment of fruit tree and vegetable nurseries as well as water supply to the building and for irrigation, commenced in October 2022. A new borehole was successfully installed, and the first water was supplied to the building in November. The construction of nursery infrastructure also started in November and should be completed by mid-March 2023. The nursery infrastructure consists of two 20 x 20 m nurseries (one for tree crops and the other for vegetable seedlings), a 12 x 15 m potting structure, an incubation chamber, and two storage spaces.

# AWARENESS AND OUTREACH

## *Second Media Lab to be launched*

In 2021, the CRSES launched the first Media Lab at Mugoidwa Secondary School in Limpopo's Vhembe district in partnership with the DSI and the South African National Energy Development Institute (SANEDI).

At the end of 2022, we were pleased to introduce the second one at Moloke Primary School in Apel, Limpopo (*see pictures below*). Like the first one, the second Media Lab aims to provide the school's learners with important computer literacy and learning opportunities to help them continue on to tertiary studies in the future. Technical installation is complete, and the final touches are being applied for the launch event in March 2023.



*Interior of the Media Lab*

*Media labs provide learners with important computer literacy and learning opportunities.*



*The Media Lab at Moloke Primary School in Apel, Limpopo*

## Atlantis training with the CULTIVA Group

In 2020, the Covid-19 pandemic brought the school outreach programme to an abrupt end. Therefore, the CRSES was pleased to return to youth engagement in 2022, providing renewable-energy training for the youth in Atlantis (pictured below). The training was presented in response to a request by the CULTIVA Group and was aimed at school-leavers and others contemplating tertiary studies.

Sixteen participants joined the two-week programme in August 2022. Areas covered included solar, wind, bio, hydro and geothermal energy. The theory sessions were supplemented with visits to the Gouda 132 MW wind farm, Solar MD (battery storage) and the Hopefield 5 MW solar photovoltaic farm.



Renewable-energy training for the youth in Atlantis

## Field visits to rural farming areas

As part of the Masia Village WEF nexus project, five CRSES interns, two project researchers and four postgraduate students from the University of Venda undertook a series of visits to the farming areas around the village. A total of 27 farming families were visited in the period August to November 2022.

The aim was to engage with the farmers in order to understand their farming practices and the challenges they encounter, from access to farming inputs, and disease and pest control, to postharvest losses, market access, and value addition to produce. The team also took this opportunity to introduce the WEF nexus project to the farmers, sharing information on the establishment of the nursery facility, the farm products processing facility, and the farm produce market centre development.

The engagement process was approved and supported by the traditional leaders through the Masia Royal Council.



Interaction with the farmers at Masia Village

# INTERNATIONAL COOPERATION

## Sixth SOLTRAIN conference

The sixth SOLTRAIN conference took place in early December 2022 in Somerset West, Cape Town. The event attracted approximately 120 attendees from the six SOLTRAIN partner countries of Namibia, Botswana, Zimbabwe, South Africa, Lesotho, and Mozambique (*picture of delegates below*). International experts from the International Energy Agency's Solar Heating and Cooling programme also attended.



Stellenbosch University's Engineering dean Prof Wikus van Niekerk and Austrian ambassador Romana Königsbrun opened the conference. South Africa was represented by CRSES delegates Dr Richmore Kaseke, Karin Kritzing, Linda Joka, Simnikiwe Gulwa, Lavhelesani Maluleke, Sedzani Ratsibi and Fhatuwani Mulaudzi, along with delegates from SANEDI.

SOLTRAIN receives financial assistance from the Austrian Development Cooperation and is implemented by AEE INTEC. Since inception in 2009, the initiative has trained some 5 000 experts in the field of solar thermal systems through more than 200 training courses. Theory-based training is conducted in collaboration with universities, energy institutes and training centres, while the practical training is presented in cooperation with vocational schools and solar technology companies. Altogether 27 students of solar thermal energy have been supported with bursaries.

The knowledge acquired from SOLTRAIN has been applied to 671 demonstration plants with a total installed solar collector area of 7 330 m<sup>2</sup> and a capacity of 5,1 MW<sub>th</sub>. The plants extend from small thermosiphon systems to larger solar plants for hospitals, children's homes, and hotels. SOLTRAIN has also delivered the first solar district heating network in sub-Saharan Africa, numerous solar plants for industrial process heat, as well as solar plants in combination with heat pumps and a photovoltaic thermal system. Every year, these solar thermal systems save 3,33 GWh of electricity and avoid nearly 2 000 tons of CO<sub>2</sub> emissions.

## World Association of Industrial and Technological Research Organisations (WAITRO) summit

WAITRO (<https://waitro.org/>) hosted its biennial conference in Somerset West in mid-November 2022 (<https://www.waitrosummit.org/>). Stellenbosch University was the official local host for the event, which brought together key research and innovation stakeholders from around the world.

The summit theme was inspired by sustainable development goal (SDG) 17, "Partnerships for the goals". The event, which returned to face-to-face mode following the virtual summit held in 2020, provided opportunities for networking, learning, and initiating new collaborations to achieve the SDGs. It was also a space to celebrate and recognise the positive impact of researchers and innovators from WAITRO member organisations.

As the WAITRO secretariat is hosted by Fraunhofer, the Fraunhofer Innovation Platform for the Water-Energy-Food Nexus at Stellenbosch University (FIP-WEF@SU) assisted with administration and logistics. FIP-WEF@SU also sponsored photography for the summit as well as Stellenbosch University award-winning wine for the gala dinner. The CRSES's Karin Kritzing and Engineering dean Prof Wikus van Niekerk served on both the local and international organising committees and represented FIP-WEF@SU at this event.



The CRSES team and Prof Wikus van Niekerk (second from left) at the WAITRO summit.

## FIP-WEF@SUN

The Fraunhofer Innovation Platform for the Water-Energy-Food Nexus at Stellenbosch University (FIP-WEF@SUN) had a successful 2022, filled with notable developments and achievements. Prof Andre Burger from Stellenbosch University's Department of Chemical Engineering led FIP-WEF@SUN for the first three quarters of the year, with Prof Oliver Damm from Industrial Engineering taking over the reins for the last quarter. Karin Kritzinger from the CRSES continued to lead the Energy team with strong input from colleagues at the Faculty of Engineering.

The Energy team helped draft six large collaborative proposals with various Fraunhofer institutes and other partners. One of these, "INSPIRED-APV: International cooperation and support through the development of agrivoltaics", has been accepted and will commence in 2023. Another proposal, "LEAP-RE SSG RemPop: Sustainable smart grids for remote populations", proceeded to the second round of full proposals and is set to be submitted in January 2023.

Moreover, Prof Reimund Neugebauer, the president of the Fraunhofer-Gesellschaft (pictured below), delivered the Prof Dimitri Dimitrov memorial lecture at the International Conference on Competitive Manufacturing. Stellenbosch University's Department of Industrial Engineering organised this event, which took place in Stellenbosch in March 2022.



Prof Reimund Neugebauer

## International Sustainable Energy Conference (ISEC)

Representing the CRSES at ISEC in Graz, Austria, in April 2022 were director Prof Sampson Mamphweli, senior research engineer Dr Richmore Kaseke, junior engineer Lavhelesani Maluleke, and marketing and communications manager Linda Joka.

The conference, organised by AEE INTEC and the United Nations Industrial Development Organisation (UNIDO), saw 350 experts from 40 countries present solutions for integrated urban and industrial energy systems using renewable heating and cooling systems. The seven high-level keynote addresses, 80 presentations and approximately 100 poster contributions all centred on initiatives for the implementation of the agreement on global warming and the phase-out of fossil energy supply reached at the United Nations Climate Change Conference in Paris in December 2015.

As a result of the war in Ukraine and the enormous dependence on fossil fuels that this has highlighted, delegates agreed on the urgency of an accelerated transformation of the global energy system towards greater energy efficiency and more renewables. With heating and cooling accounting for around half of Europe's total energy demand, this poses enormous challenges for society. However, researchers and industry representatives' presentations also illustrated that many opportunities still remain to contribute to this change – not only in Europe, but worldwide. The focus must be on energy-efficiency measures, the rapid decarbonisation of industry, the conversion of district heating systems to renewable energy sources, and the use of storage technologies.



Delegates at the International Sustainable Energy Conference (ISEC) 2022

# INTERNATIONAL COOPERATION continued

## Power Systems Computation Conference (PSCC)

Prof Bernard Bekker and PhD candidate Ndamulelo Mararakanye, CRSES associate director and senior engineer respectively, were among the delegates at the twelfth edition of the PSCC held in Porto, Portugal, at the end of June 2022. More than 200 papers were presented, with the emphasis on modelling and simulation for understanding a system of components, plants, the interactions between them, their collective behaviour, and methods to inform decision-making in power systems. As such, the event presented our two delegates with the opportunity to network and exchange ideas with world-renowned researchers in the field of power systems.



A major topic touched on at the PSCC was power systems optimisation under uncertainty. Discussions aimed to provide an overview of existing methods and applications for the modelling and optimisation of power systems problems affected by uncertainty.

Another theme covered at the event was the challenges and opportunities that emerge from the millions of controllable devices that are deployed across power transmission and distribution systems. The key message was that the move to power systems that are dominated by converter-interfaced resources poses both a threat and presents an opportunity: On the one hand, new dynamic phenomena and types of instability arise, necessitating advanced simulation tools. On the other, it allows for a massive decentralised and direct response to any disturbance. The secret is to tap into the flexibility potential of the millions of controllable devices to ensure the safe operation of power systems.

## International Conference on Electricity Distribution (CIRED) workshop on e-mobility and power distribution systems

In early June 2022, the CRSES's Prof Bernard Bekker, Lewis Waswa and Josh Dippenaar (pictured alongside) attended the CIRED workshop on e-mobility and power distribution systems in Porto, Portugal.



The workshop focused on the integration of electric mobility into power distribution systems. Discussions covered three main areas, namely:

- the planning and operation of power distribution systems to accommodate electric vehicles and e-mobility systems;
- the selection of equipment and components as well as the formulation of standards for the development of e-mobility integration; and
- the regulatory and business models associated with e-mobility.

The event enabled the CRSES delegation to share their current research with the audience, to network, and to compare the CRSES's research efforts with what other researchers and institutions are doing.

## African Research Universities Alliance (ARUA)

The ARUA network has partnered with the Grand Challenges Research Fund (GCRF), which has made available an award to each ARUA centre of excellence (CoE) to build African researchers' capacity. Part of the United Kingdom's official development assistance, the GCRF supports the SDGs by maximising the impact of research and innovation to improve lives and opportunities in the global south.

As a result, the ARUA CoE in Energy, which is based at Stellenbosch University, has embarked on a programme of activities to afford young African researchers the opportunity to enhance their research skills through both structured courses and 'learning while doing' alongside seasoned African academics. A specific aim of the capacity-building project is to strengthen capacity for multidisciplinary research, which employs renewable energy as an enabler for safe, affordable, and equitable basic service delivery and for strengthening the African food and agricultural system.

The project made steady progress in 2022. The CoE has been very active in terms of engaging external parties and stakeholders, hosting its first on-site capacity-building workshop in Stellenbosch.



The workshop was attended by representatives from Addis Ababa University (Ethiopia), Makerere University (Uganda), Strathmore University (Kenya), Stellenbosch University, the University of Cape Town, the University of KwaZulu-Natal (South Africa), the University of Dar es Salaam (Tanzania) and the University of Rwanda. This enabled the CoE to make good headway towards establishing a core team of researchers from these institutions. The workshop also introduced several postgraduate students to system dynamics modelling, provided some support in managing their studies, and trained both early-career researchers and seasoned academics in grant writing.

Moreover, the CoE continued to train postgraduate students. A particular highlight was the graduation of master's candidate Rudzani Netshivumbe, whose research explored anaerobic co-digestion as an alternative method to stabilise organic waste before disposal. Another two master's candidates have been admitted, whose work will form part of the WEF nexus project.

The CoE also played host to two Carnegie Foundation postdoctoral fellows, Dr Benjamin Agyei-Tuffour from the University of Ghana and Dr Newaye Medhin from Addis Ababa University. Both fellows made significant progress with their work while at Stellenbosch University, delivering multiple publications.

Looking ahead, the CoE is particularly looking forward to working on a project that will contribute to research on photocatalysis for hydrogen production. The work will be sponsored by the Wilhelm Frank Trust.

During the workshop the ARUA Centre of Excellence in Energy made good progress towards establishing a core of researchers with participants from the Addis Ababa University, Makerere University, Strathmore University, Stellenbosch University,

University of Cape Town, University of Dar es Salaam, University of KwaZulu-Natal and University of Rwanda in attendance. The workshop also introduced several postgraduate students to system dynamics modelling, provided some support on managing their studies and trained both early career researchers and seasoned academics alike on grant writing.

## SUSTAINABLE DEVELOPMENT GOALS



*The GCRF supports the Sustainable Development Goals to impact the global south*



ARUA CoE 2022 on-site workshop at STIAS

## Conference Proceedings

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### 2022

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Mustafa, J., Alqaed, S. & Sharifpur, M., 2022. 'Evaluation of energy efficiency, visualised energy, and production of environmental pollutants of a solar flat-plate collector containing hybrid nanofluid'. *Sustainable Energy Technologies and Assessments* 53 (2022) 102399 <https://doi.org/10.1016/j.seta.2022.102399>

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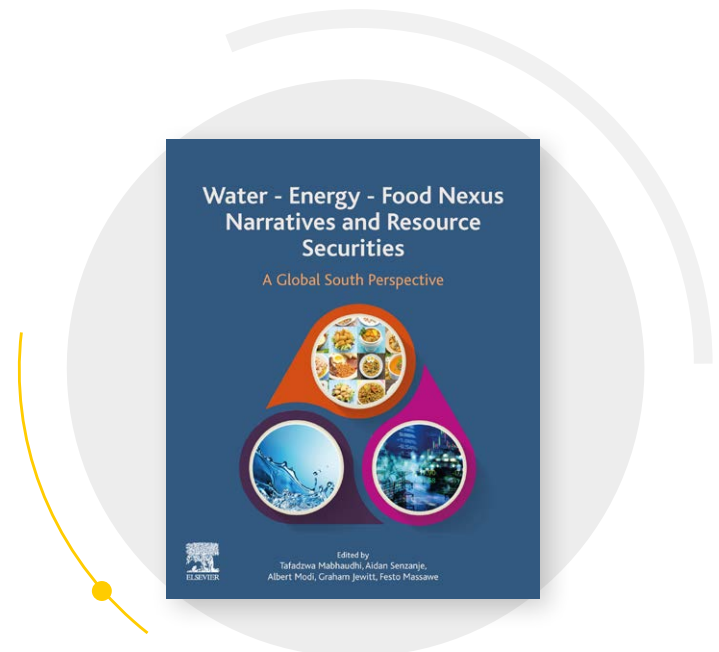
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## Chapters in Books

2022

Egieya, J., Görgens, J.F. & Goosen, N.J., 2022. 'Some quantitative WEF nexus analysis approaches and their data requirements., in: Mabhaudhi, T. (ed.)'. *Water-Energy-Food Nexus Narratives and Resource Securities* eBook ISBN: 9780323918374





*Soltrain: Training course for quality inspectors of solar water heating systems*

# STAFF



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Director



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Associate Director



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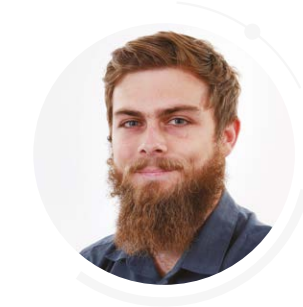
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Senior Engineer



**Ndamulelo Mararakanye**  
Senior Engineer



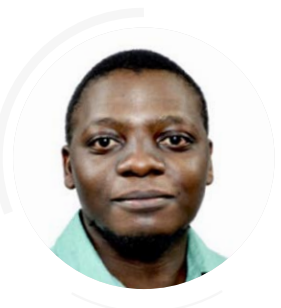
**Dr Justice Chihota**  
Senior Engineer



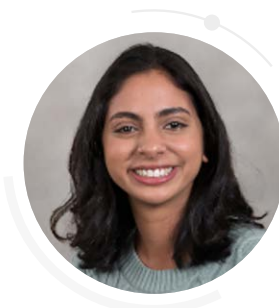
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Junior Engineer



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Administrative Officer



**Shumani Kone**

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**Godwin Mukondeleli**

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**Tondani Mulaudzi**

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**Aluwani Tshishonga**

Intern



**Hulisani Mulaudzi**

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**Hulisani Makungo**

Intern



**Lugisani Kharidzha**

Intern



**Ntando Mncube**

Intern

# STATEMENT OF INCOME AND EXPENDITURE

Until December 2022

For the period ending :	31/12/2022	31/12/2021
<b>TOTAL INCOME</b>	<b>(33 606 014,15)</b>	<b>(73 459 412,55)</b>
CONFERENCE/CONGRESS (NO VAT)	(279 424,04)	-
CONTRACT RESEARCH (TAXABLE)	-	(2 195 981,38)
DONATION: SPECIAL PURPOSES	-	(25 050,00)
INCOME FOREIGN EXEMPT	(65 034,67)	(886 323,33)
INCOME: BURSARY	(25 551 997,42)	(25 397 464,13)
INCOME: FOREIGN_ZERO RATE	(2 811 767,96)	(9 647 625,91)
INCOME: SUNDRY TAXABLE	(82 500,00)	(325 361,52)
INTEREST RECEIVE: INTERNAL ALL	(1 425 016,48)	(749 867,28)
PROFIT: EXCHANGE RATE FOREIGN	(3 295,48)	(76 506,24)
SALES: HANDBOOKS & MANUALS	(1 742 979,55)	(416 527,00)
SALES: TO INTERNAL ORG UNITS	(384 998,55)	(54 123,90)
SHORT COURSE INTERDEPARTMENTAL	(717 000,00)	(115 520,00)
SHORT COURSES	(540 000,00)	(118 240,00)
SHORT COURSES STUDENTS	(2 000,00)	-
SUNDRY INCOME: NON TAXABLE	-	(33 450 821,86)
<b>TOTAL EXPENDITURE</b>	<b>34 115 380,03</b>	<b>37 583 272,71</b>
"CURRENT EXPENDITURE ADVERTISEMENTS: GENERAL"	26 875,00	54 825,00
AFFILIATION & REGISTRATION EXPENDITURE	763 864,13	248 841,32
AUDIOVISUAL EXPENDITURE	23 589,60	-
AUDIT FEES: EXTERNAL	54 450,29	64 818,00
BANK COSTS	249,90	-
BURSARY POST GRADUATE	2 407 967,46	4 038 599,60
BURSARY UNDERGRADUATE	-	120 000,00
CELL PHONE AIRTIME	3 140,17	156,14
CELL PHONE RENT	3 940,35	5 335,45
CHEMICALS	105,42	-
CLEANING COSTS - EXTERNAL FIRM	36 908,88	47 230,98
CLEANING MATERIALS	3 813,76	169,34
CLOTHING: OTHER	34 090,84	-
CLOTHING: PROTECTIVE	423,69	-
COMPUTER MATERIALS	16 283,85	168 235,30
CONSULTATION FEES	249 988,17	1 056 558,00
CONSUMABLE MATERIALS	18 428,37	73 128,65
COPY AND PRINTING	89 965,02	22 514,69
COPYRIGHT	3 200,00	-
COURSES	25 066,94	42 225,87
ELECTRONIC COMPONENTS	97 834,43	696,41
ENTERTAINMENT: GENERAL	148 112,49	128 691,98
FOREIGN EXCHANGE LOSS	770,73	76 745,41
FUEL, OIL, LUBRICANTS	40 828,03	21 007,73
GENERAL OFFICE COSTS	14 423,33	11 490,08
GENERAL RESEARCH COSTS	1 630 260,87	-
GENERAL VEHICLE EXPENDITURE	1 238,59	-
GIFTS	1 374,79	2 149,90
ICRR (INDIRECT COST)	(4 254 085,98)	8 524 672,11
INS, LICENSES & 3RD PARTY	-	353,71
INTEREST PAID: INTERNAL APPORTIONMENT	5 125,53	1 021,42



For the period ending :	31/12/2022	31/12/2021
INTEREST: CREDITORS	-	18,75
INTERNET NETWORK EMAIL LEVY	94 388,47	116 409,11
KKW NON-CAPITALISED	-	14 581,09
LINEN	205,65	-
MAINTENANCE OF APPARATUS	-	600,00
MEDICAL EXPENSES	1 650,00	16 353,01
NON-CAPITALISED BOOKS	-	1 109,40
PHOTOGRAPHIC EXPENDITURE	17 978,12	53 400,00
POSTAGE AND COURIER SERVICES	17 688,66	5 342,73
PRIZES AND MEDALS	6 997,00	5 500,00
PROMOTION MATERIAL	13 867,50	-
REFRESHMENTS: NON ACADEMIC	112 034,43	57 964,84
RELOCATION COST: NEW APPOINTMENTS	6 650,00	-
RENT OF EQUIPMENT GENERAL	-	77 640,00
RESEARCH PUBLICATIONS	134 870,40	126 944,84
RESERCH CONTRACT CONDUIT PAYMENTS	5 314 782,61	6 548 786,94
SECURITY SERVICES	-	244,02
SERVICES	9 040 625,14	2 496 705,42
SMALLER FURNITURE AND EQUIPMENT	10 575,95	204 429,01
SOFTWARE	134 164,21	55 133,19
STATIONERY	28 674,56	27 382,51
SUBSCRIPTION & MEMBERSHIP FEES	21 883,74	257 468,39
SUBSCRIPTION BOOKS & MAGAZINES	-	14 950,00
TELEPHONE: CALLS	5 559,28	3 619,92
TELEPHONE: RENT	25 120,96	27 498,30
TOTAL REMUNERATION	13 644 438,97	10 799 311,43
TRANSLATION AND EDITING	55 377,00	-
TRAVEL: ACCOMMODATION VISUM PA	563 320,74	258 991,67
TRAVEL: FOREIGN TRAVEL SUBSISTENCE	540 913,16	207 210,96
TRAVEL:DAILY ALLOWANCE AIR CAR	583 782,71	296 737,44
TYRES	3 056,93	-
US - MUN ELECTRICITY	-	200,00
WORKSHOPS	1 316 848,44	316 191,19
<b>ASSET TRANSACTIONS</b>		
ASSET SCRAPPING/TRANSFERS	(86 380,23)	-
DEPRECIATION	369 727,79	373 579,09
INCOME: INTERNAL ASSETS	(283 347,56)	(373 579,09)
PROFIT/LOSS: ASSETS	135,00	-
ASSET ADJUSTMENTS	(135,00)	-
ASSET PURCHASES	971 690,75	883 081,46
<b>OPERATING (SURPLUS) / SHORTFALL FOR PERIOD</b>	<b>509 365,88</b>	<b>(35 876 139,84)</b>
<b>FUNDS TRANSFERS</b>	<b>10 905 172,20</b>	<b>2 827 897,06</b>
TRANSFERS FROM	29 876 153,74	20 023 743,40
TRANSFERS TO	(18 970 981,54)	(17 195 846,34)
<b>NET LOSS/(SURPLUS) FOR THE YEAR</b>	<b>11 414 538,08</b>	<b>(33 048 242,78)</b>
<b>Plus: ACCUM (FUNDS) / SHORTFALL ON 01/01/2022</b>	<b>(49 714 957,17)</b>	<b>(16 666 714,39)</b>
<b>ACCUM (FUNDS) / SHORTFALL ON 31/12/2022</b>	<b>(38 300 419,09)</b>	<b>(49 714 957,17)</b>

# FINANCIAL POSITION OF THE CENTRE

*The CRSES has three main sources of income: a core grant from the DSI, annual funding from Eskom, and revenue from research projects and short courses offered.*

The annual grant from the DSI is intended to support the appointment of three senior academics at Stellenbosch University, provide bursaries for postgraduate students, and contribute to the running expenses of the CRSES and funding for the renewable-energy spokes. In 2022, a total of R25 551 997,42 was paid to the Centre. This includes R8 424 000,00 earmarked for the various spokes, namely the Solar Thermal Spokes at Stellenbosch University and the University of Pretoria, the Wind Spokes at Stellenbosch University and the University of Cape Town, and the Photovoltaic Spokes at the University of Fort Hare and Nelson Mandela University. Altogether R13 644 438,97 was spent on the salaries of the chair, senior academic staff, and administrative staff, and R2 407 967,46 was paid out in postgraduate bursaries.

Eskom's contribution on the EPPEI programme for 2022 was R1 346 258,92. An amount of R324 999,00 was spent on bursaries for postgraduate students, and R962 185,66 on salaries for the chair, programme manager, other academic staff, and an administrative staff member.

The remainder of the CRSES's income for 2022 came from a number of private and public entities for contract research projects as well as from short and in-house training courses.

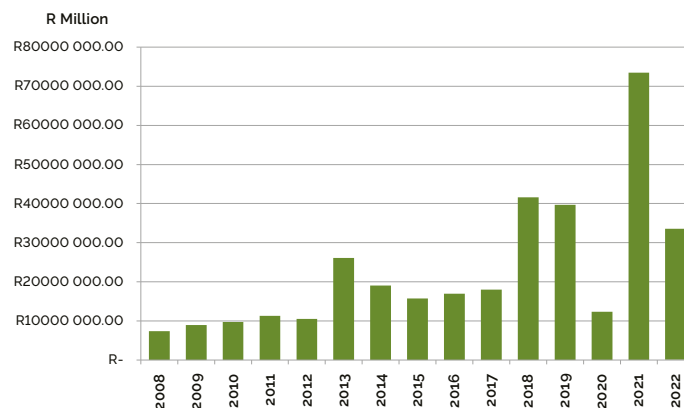
The comprehensive income statement for all cost centres, including Eskom EPPEI and project funds, is included on the previous two pages. The Centre's overall income up until December 2022 was R33 606 014,15, while the total actual funding available at the end of December 2022 was R38 300 419,09 (see the table below).

The CRSES has shown sustained growth in income since 2018. Ending 2022 with over R30 million in reserves, the Centre maintained a favourable financial position throughout the reporting year. However, as it is anticipated that the current financial constraints within Eskom will have an impact on the CRSES's future income, it is important that the Centre further diversifies its current revenue streams.

## Funds available at CRSES

	<b>31 Dec 2021</b> (12 months) (R)	<b>31 Dec 2020</b> (12 months) (R)
Total Income to Date	R73 459 412,55	R33 606 014,15
Total Expenditure to Date	R37 583 272,71	R34 115 380,03
Total Transfers	R2 827 897,06	R10 905 172,20
Total Equipment Acquisitions	R883 081,46	R971 690,75
Total Post-graduate bursaries	R4 038 599,60	R2 407 967,46
Total Remuneration	R10 799 311,43	R13 644 438,97
Nett Surplus for period	R33 048 242,78	R11 414 538,08
Accumulated funds from previous year	R16 666 714,36	R49 714 957,17
<b>Funds available 31 December 2022</b>	<b>R49 714 957,17</b>	<b>R38 300 419,09</b>

## Annual income of the Centre



# CONTACT DETAILS

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 [twitter.com/crses\\_us](https://twitter.com/crses_us)

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**Copy:** CRSES staff members,  
Division of Research Development

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**Reports:** ABSA Electric Vehicles Supplementary Report. Image 1-3  
ABSA Sustainable Homes Supplementary Report. Image 4-5

**Design and layout:** Nudge Studio



