CENTRE FOR RENEWABLE & SUSTAINABLE ENERGY STUDIES

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

CRSES ANNUAL REPORT 2021

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

Eskom

CONTENTS

FOREWORD

In the 2021 financial year, we continued to adjust to realities imposed by COVID-19, gradually moving away from a virtual-only environment to a hybrid one combining face-to-face and on-line engagements simultaneously.

Hybrid engagements allowed us to accommodate students, colleagues, collaborators, and clients who are geographically dispersed, while at the same time maintaining the much-needed human contact. We were able to host our now called Southern African Sustainable Energy Conference (SASEC) with most delegates attending in person, and few on-line. The new hybrid reality has also enabled CRSES to take on projects in more remote settings.

Our team expanded with new staff members joining us and these include Dr. Jafaru Egieya who is a Postdoctoral Research Fellow for the ARUA CoE, Mr. Daniel De Waal who is a Project Engineer, Mrs. Jainy Thomas who is a Project Manager, Mrs. Tshilidzi Ligege who is an Assistant Project Manager, and Ms Nawaal Jacobs as Marketing, Short Courses and Post Graduate Applications Administrative Officer. In addition, Ms. Pfano Tshikumbana, Ms. Akhona Shiyani and Mr. Joshua Magoro joined us as Project Interns. All these new colleagues settled well into their new roles, ensuring that CRSES continues to excel.

We are keenly aware that Variable Renewable Energy (VRE) is disrupting the traditional South African Power System, with fossil-based generation likely to decrease significantly. It is therefore important to capacitate regulators, managers, operators, and planners with regards to the planning and operation of the changing power system. Through the EPPEI SC-RE we secured the GIZ funding to both develop and present courses that are relevant to the changing electricity landscape. This is in line with our Human Capacity Development goals. This report gives more information about the possible academic paths.

Complimenting these efforts is our research relevant to the continued uptake of renewable energy. We collaborated with the Centre For Sustainability Transitions (CST) as well as the department of Electrical and Electronic Engineering (E&E) on an important study to determine the optimal location for renewable energy projects, focussing on grid support, network infrastructure requirements as well as opportunities for socio-economic development. The study is funded by the European Climate Foundation (ECF) and provides useful insights for both technological and policy related advancement. Noting that a focus on power generation alone will not suffice in advancing the Sustainable Development Goals, we also undertook a research study into e-mobility with the aim to determine pathways that effectively address the multi-faceted energy transition underway.

We continued our outreach and advocacy efforts including a state-of-the-art off-grid media laboratory launched by the Deputy Minister Honourable Buti Manamela at Mogoidwa Secondary School in Vhembe District, as well as the Water-Energy-Food Nexus project whose commencement was hosted by the Deputy Minister at Masia village, also in the Vhembe District Municipality, Limpopo Province. Through funding received from the Department of Science and Innovation (DSI), both projects enabled us to bring tangible renewable energy-based services to communities in underserved areas. Our research footprint into the said Water-Energy-Food Nexus continues to expand through ARUA and FIP WEF@SU, our platforms which enable collaborations with international institutions for cross sector sustainable solutions. The SOLTRAIN project, another international collaboration, is in phase four and continues to make inroads relevant to the use of clean energy in the heating and cooling sector.

CRSES continues to grow financially due to the various projects that we are engaged in. We look forward to new frontiers, as the renewable energy landscape augments. Our focus going forward is more on technology commercialization and localization with the aim to support economic growth and job creation. We appreciate the work done by our researchers at Stellenbosch University, engineers, support staff and various national and international collaborators. We are also grateful at the financial support that we receive from our main funders, the National Department of Science and Innovation and Eskom.

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.

Jamie van Wyk *(Intern)*

My WWF internship at the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University, commenced in April 2021 and ended in March 2022. I had completed my postgraduate diploma under the CRSES , just the year before, which is where I discovered my passion lied specifically in bioenergy -which was one of my modules. My interest in this field was further expanded by the opportunities that this internship gave me in collaboration with the Bioenergy Research Group at the Department of Process Engineering.

Most of my internship work was in the Bioenergy lab where I was trained on using substrates such as animal waste and food waste, to produce biogas through anaerobic digestion. The lab specifically has a focus on operating an Automated Methane Potential Test System to obtain Biomethane Potential results-which I was able to gain experience on and assist people with. Additionally, I was given responsibilities regarding lab experimental work and overseeing of the pilot-scale digesters.

Despite the on-going, COVID-19 pandemic impacting much of my experiences in comparison to previous interns, I remain extremely grateful for this WWF-SA internship experience as it not only helped me grow professionally but, as an individual too. I am thankful for my journey at the CRSES and the Process Engineering Department , as it gave me the confidence in furthering my studies in the bioenergy field and most importantly, a chance to network with leading researchers in the renewable energy sector.

Joshua Magoro *(Intern)*

My internship at CRSES in Stellenbosch University started in February 2021 and ended in February 2022. Upon completion, I obtained my National Diploma in Electrical Engineering from Cape Peninsula University of Technology (CPUT). The internship provided me with workplace experience, and demonstrated first-hand how the academic knowledge gained from studying is applied in the renewable energy sector.

At the Centre I was given training on several Renewable Energy Software packages, including PVsyst, HomerEnergy, HomerGrid and AutoCAD electrical, and was given the opportunity to participate in some design projects.

I participated in different kinds of projects including pre-feasibility studies for rooftop solar PV installations, as well as the Department of Science and Innovations' project for the Deployments of Hydrogen based and Renewable Energy Technologies across different parts of the country. I have also learned soft skills such professional communication and will forever be grateful to the CRSES for the opportunity afforded to me.

Akhona Shiyani *(Intern)*

My internship with the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University commenced in 1 February 2021 and ended 30 December 2021. The completion of my internship ensured that I would obtain my National Diploma in Electrical Engineering from Cape Peninsula University of Cape Town (CPUT).

During my tenure at CRSES I attended two courses namely : Introduction to Solar Energy and Advanced Photovoltaic systems. The courses sparked my interest in the renewable energy sector, improved my knowledge of sustainable energy in general and solar energy in particular. In addition to formal academic courses, I was given an individual training on renewable energy simulation software including PVSyst, Homer Pro and I was afforded the opportunity to complete several designs for pre-feasibility studies projects commissioned by Stellenbosch Municipality.

I attended technical conferences relevant to renewable energy Development of Harmonised dissemination conference (DAMOC) which focussed on Smart grid technologies as well as the Southern African Sustainable Energy Conference (SASEC) which was more broadly inclusive of all types of sustainable energies as well as Power System engineering. I got to see research dissemination first hand, and had the opportunity to engage with people from different renewable energy fields.

Mark Reuter *(Intern)*

I began my internship at the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University in August 2020. After more than a year as an intern at the Centre, I can safely say I learned more than I could have possibly expected. My most meaningful work started midway through 2021, where I worked in a team tasked with developing and deploying an energy monitoring system. Developing the system, which was later deployed at Mugoidwa Secondary School in Limpopo, allowed me to "get my hands dirty" with some practical engineering work and actually see the benefits and contribution of our work.

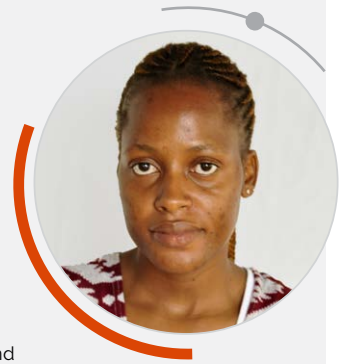
On a more academic note, I am very grateful to have attended one of the short courses offered by CRSES related to renewable energy namely Integrated Supply Side Technologies. The course was expertly delivered and assisted greatly to my holistic understanding of the integration of renewable energy with traditional technologies in South Africa. Furthermore, 2021 saw the continuation of my masters in electrical engineering focused on thermal unit commitment with high share of VRE generation using data-driven optimisation methods. This work was done under the supervision of Dr Bernard Bekker and Mr Ndamulelo Mararakanye, who were both very understanding and supportive as I (at times) struggled to jungle the responsibilities of the internship as well as my studies. As I approach the final few months of my internship, I am thankful for all I have learned and the amazing people I have gotten to know.

Ria Xavier *(Intern)*

My internship at the Centre for Renewable and Sustainable Energy Studies (CRSES) began in April 2020 and ended in March 2021. During this period I attended a short course on Energy Storage Systems hosted by Dr. Bekker and presented by Prof Bladergroen, and multiple writing workshops hosted by Stellenbosch University. I learned a lot during these courses and workshops, and felt more confident in my writing skills. The Energy Storage Systems short course sparked my interest in energy storage as it was highly informative and well presented.

I was given the opportunity to write up a conference paper on smart inverter technology and restrictive grid regulations in South Africa, under the supervision of Dr. Bekker, Associate Director of CRSES and Dr. Chihota, Post-Doctoral Fellow. Both have given me valuable insight and guidance on approaching research as well as on my writing. I was also extremely fortunate to have presented my conference paper at three events namely the Power Systems Research Group (PSRG) seminar, the Renewable Energy Postgraduate Symposium (REPS) and at the EPPEI Student Workshop. These conferences gave me a chance to present my research and receive valuable feedback from audience members regarding my work. My confidence in my work and presenting skills has increased due to the experience from attending these conferences; I had to defend my work and interact with other senior engineering researchers. I am very grateful for this opportunity given to me by the CRSES as I have learnt invaluable lessons and grown both professionally and personally.

Pfano Tshikumbana *(Intern)*



My internship with the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University began in July 2021 and would end in June 2022. Because my tenure as intern began during the lockdown caused by the Covid-19 pandemic, I had to make significant adjustments in the work environment. I was stationed on site at the Water-Food-Energy Nexus project at Masia Village, in Limpopo and would engage virtually with colleagues at Stellenbosch University.

My training included stakeholder management and engagement, which was important for the success of the project. Stakeholders relevant to the Masia Village project included Senior Academics and Researchers, Government Officials, Traditional Authorities, experts in Advocacy and Business training as well as members of the community. The engagements included significant event planning for workshops, meetings and launch events. Under the mentorship of Mrs. Sedzani Ratsibi, my skills in both stakeholder management and engagement as well as event planning and execution improved greatly.

A particular highlight during my internship was being given the opportunity to assist a post graduate student with data compilation for her research. The opportunity gave me invaluable insight into fieldwork for research as well as methods relevant to data collection and compilation. I am grateful to CRSES for the freedom and guidance I was afforded during my internship, enabling me to achieve my goals. I attained both personal and professional growth which have put me in good stead towards advancing my career.

Conducting experiments at the Process Engineering Department

BUILDING HUMAN CAPITAL continued

Dr. Jafaru Egieya *(Post Doctoral Fellow)*

With lockdown regulations still in place, my first few weeks at CRSES required significant adjustment, however, my internship mentor as well as my colleagues were all extremely supportive, making the internship a truly invaluable experience.

With the global population set to increase by 25 % (9.9 billion), surging climate change, and rising urbanization, there will be increased strain on the limited water, energy, and food available today. Hence, assessing the tradeoffs, interlinkages, and synergies of the water-energy-food (WEF) nexus is paramount to meeting the needs of people today without having an undue effect on future generations. This premise forms the fulcrum of my research work as a postdoctoral fellow with the African Research Universities Alliance (ARUA) Centre of Excellence in Energy (CoE). I joined the Center in April 2021 as a postdoctoral fellow after working for a couple of years modeling the workforce requirements of alternative energy generation in a developing country.

However, since I joined the Center, I have also engaged in workshops and training programs bordering on the implementation of WEF nexus studies in the City of Cape Town which has broadened my mind on the subject. For instance, I attended a two-day virtual training workshop on waste management and bioenergy which provided examples of bioenergy generating projects operational in Africa. Moreover, the training provided a platform to network with like-minded colleagues.

Hence, the support received from the Centre and most especially my host Prof. Neill Goosen has been overwhelming so far. I am optimistic about my research output in 2022.

Dr. Amaris Dalton *(Post Doctoral Fellow)*

The largescale proliferation of variable renewable energy (VRE), particularly wind and solar PV, into electricity networks poses several challenges both from a short-term operating perspective and from a long-term planning perspective. These challenges, in large part, stem from the viability of wind and solar resources across timescales. Variability of wind and solar resources is in turn driven the weather and climate.

My primary research focus is on the field of energy meteorology which seeks to investigate the wind and solar resources, particularly resource variability, from the perspective of the underlying causative mechanisms, notably large-scale atmospheric circulation patterns. More specifically myself, along with several masters students working under my co-supervision, are pursuing the following research aims: (1) the improvement of wind power forecasts by the inclusion of exogenous atmospheric variables as predictors using machine learning; (2) understanding changes in VRE resources stemming from the probable effects of climate change; (3) quantifying the relation between specific classified weather systems and VRE variability; (4) the representation VRE in probabilistic power flow studies; and (5) investigating the skill of wind power curves in representing wind power variability.

CRSES, and particularly my host Dr Bernard Bekker, has provided me with wonderful support, resources and opportunities to pursue my research aims and to develop as a scientist and academic. I have also been fortunate enough to have been awarded the Research, Innovation and Postgraduate Studies Postdoctoral Fellow Top Twenty Award: 2021, by Stellenbosch University.

Dr. Justice Chihota *(Post Doctoral Fellow)*

The energy industry's progression to low-carbon technologies (LCTs) is accelerating, with numerous transitions to green technology emerging. In power systems, at the distribution network level, numerous consumer-based LCTs such as solar photovoltaic installations, energy storage systems, and electric mobility (e-mobility) are increasingly being adopted and connected to the grid.

To maximize their utilization and benefits, distribution network operators (DNOs) must carefully manage and control LCT penetration (and usage patterns), based on a comprehensive technical understanding of the network's loadability and hosting capacity constraints.

My research aims to advance distribution network planning principles, methods, and tools for the successful integration of LCTs, including the design of the relevant transition pathways. As part of our research efforts in 2021, we (in collaboration with ETH Zurich, Switzerland) undertook a study exploring transition pathways to e-mobility in South African communities based on the intersection of technical, economic, and environmental factors. Our current and future research efforts will focus on similar transition pathways to LCTs, especially looking at the planning and coordination of energy systems at the community or consumer level, using a bottom-up approach.

The Centre's support continues to be a vehicle for the advancement of my research and career, and the facilitation of my contributions in the renewable energy space. For this, I am grateful to the directors, Prof. Mamphweli and Dr. Bekker, for their exceptional leadership and support.

2021 Graduates

The students listed below graduated during the year under review.

Name	Programme
March 2021	
Mr P Bothma	MEng (Structured)
Mr J Dippenaar	Masters
Mr MH Kiessling	MEng (Research)
Mr AD Liebenberg	MEng (Research)
Ms DH Lyners	Masters
Mr TJ Manatsa	MEng (Structured)
Mr T McKechnie	MEng (Research)
Mr V Van der Merwe	MEng (Structured)
Ms K Von Schoultz	MSc
Mr EJ Westraadt	MSc
Mr A Dalton	PhD
Mr TO Meyer	PhD
Mr RM Dix-Peek	PhD
Mr M Vumbugwa	PhD
December 2021	
Mr CD Botha	PhD
Mr OI Olumbamiwa	PhD
Mr WJ Farmer	PhD
Ms C Lewis	PhD
Mr FS Marincowitz	PhD

Awards

Post-doctoral research fellows have a significant contribution to academic performance at Stellenbosch University. In its vision to become a leading research university in Africa, SU invests in developing researchers who produce impactful research in the country, the continent and the rest of the world. Prof Eugene Cloete, the Deputy Vice Chancellor : Research, Innovation and Postgraduate studies launched the Post Doc Fellow Award in 2017 to honour the top performing post-doctoral research fellows at the University. The post docs are measured on their academic track record in terms of publication numbers, conference presentations, and other academic outputs such as grants and fund raising, academic service with regard to teaching and student supervision, peer-reviewing in the academic community, as well as community service.

In 2021, two CRSES researchers were among the awarded top 20 post docs being Dr Justice Chihota and Dr Amaris Dalton. Dr Chihota's research aims to advance distribution network planning principles, methods, and tools for the successful integration of low-carbon technologies, including the design of the relevant transition pathways. Dr Dalton's research focus is on the field of energy meteorology which seeks to investigate the wind and solar resources, particularly resource variability, from the perspective of the underlying causative mechanisms, notably large-scale atmospheric circulation patterns.

Eskom Power Plant Engineering Institute Collaborations

The following local Universities of Technology or previously disadvantaged universities have been officially collaborated with in 2021 under the EPPEI programme:

Name of partner institution	Co-operation Topic	Specialisation Centre Lead	Partner Lead
CPUT	7 students working on Eskom-approved EPPEI research topics	Dr Bernard Bekker	Carl Kriger
CUT	SAURAN station calibration	Dr Bernard Bekker	Herman Vermaak
MUT	SAURAN station calibration	Dr Bernard Bekker	Ewa Zawilska
NMU	2 students working on Eskom-approved EPPEI research topics	Dr Bernard Bekker	Peter Freere
TUT	4 students working on Eskom-approved EPPEI research topics	Dr Bernard Bekker	Josiah Munda
UniVen	SAURAN station calibration	Dr Bernard Bekker	Sophie Maluadzi
UniZulu	SAURAN station calibration	Dr Bernard Bekker	Brian Rawlins

The following international institutions have been officially collaborated with in 2021 under the EPPEI programme

Name of partner institution	Co-operation Topic	Specialisation Centre Lead	Partner Lead
Danish Technical University	Impact of weather systems on wind turbine generation	Dr Bernard Bekker	Dr Matti Koivisto
Sandia Labs	Modelling of thermal power stations	Dr Bernard Bekker	Dr Paul Gauche
MIT	Domestic Load Research	Dr Bernard Bekker	Dr Robert Stoner

Implementation of the EPPEI / GIZ power system planning and operations capacity building programme

Variable renewable energy (VRE) will increase significantly in the future South Africa Power System. Planned wind and solar PV generation represent around a third of total installed capacity by 2030.In the same future traditional carbon based generation like coal is likely to significantly decrease. Given these changes, planners, operators, managers, and regulators will need to be capacitated in the planning and operation of this changing system. EPPEI responded to this need by developing a programme to build power system planning and operation capacity within the South African industry and government, specifically acknowledging a future power system with significantly increased amounts of VRE generation.

EPPEI SC-RE secured R8 million of GIZ funding to develop and present a series of subsidised continuing professional development (CPD) and post-graduate (PG) diploma courses to Eskom and municipalities, targeting 350 attendees by June 2023.

The programme offers short learning courses closely aligned to real-world industry applications, integrated into existing EPPEI training offerings to ensure sustainability. Below is an overview of the courses offered, and where they are presented. By the end of 2021 three courses had been piloted successfully: Power System Analysis at WITS, Power System Flexible Operations at UCT, and Power System Operations at SU.

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

For more info please visit: **www.crses.sun.ac.za/short-courses/**

Capacity building learning paths

The capacity building offers two learning paths:

Continued Professional Development (CPD) AND **Academic**

It is **structured around three- to five-day learning modules** closely aligned to real-world industry applications, to cater for the varied requirements of the intended capacity building audience.The modules are designed in such a way that **candidates can obtain a variety of qualifications while attending the same contact session**, with the differentiation between qualifications determined through the additional assessments, assignments and projects.

Continued Professional Development (CPD)

SAIEE endorsed Planning and Operations **Manager** Certificate

YES

5 Certificates of **Attendance?** *

Certificate of **Attendance** and CPD points

YES

Attended all classes?

NO

Enrol for Certificate of **Attendance**

SAIEE endorsed Planning and Operations **Engineer** Certificate

YES

5 Certificates of **Competence ?** *

Certificate of **Competence** and CPD points

YES

Passed?

Enrol for Certificate of **Competence**

* Certificates for at least **one overview, one technology** and **three planning and operations** modules would need to have been received.

Academic

Post-Graduate Diploma in Engineering

YES

120 Credits?

15 Academic credits at NQF8

YES

Passed?

Enrol for **Diploma** module

Register for **Post-Graduate Diploma**

Structured Masters Degree in Engineering

YES

120 Credits + **research project**?

15 Academic credits at NQF9

YES

Passed?

Enrol for **Masters** module

Register for **Structured Masters**

Recognition of Prior Learning process **

Which qualification do I require?

** The Recognition of Prior Learning process allows candidates to submit a **portfolio of evidence** (which can include completed CPD certificate courses) to motivate for academic credits to be awarded.

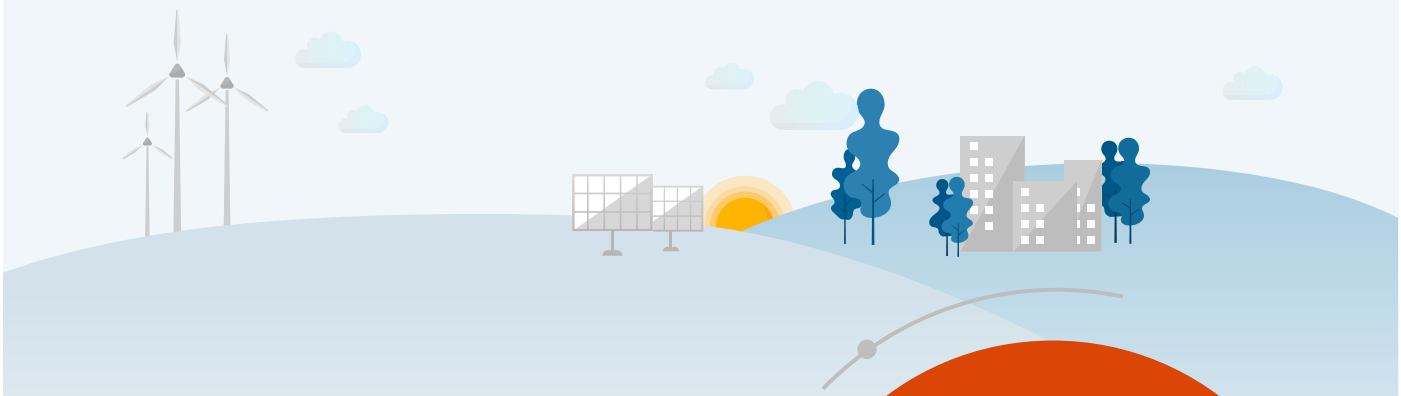
Academic programmes

Post-Graduate Diploma

- in **Mechanical** Engineering
  - Power Plant Engineering (UCT) — READ MORE
  - Renewable & Sustainable Energy (SU) — READ MORE
- in **Electrical** Engineering
  - Smart Grid Technology (SU) — READ MORE
  - Power System Planning & Operations (SU) — READ MORE

Structured Masters

- in **Mechanical** Engineering
  - Renewable & Sustainable Energy (SU) — READ MORE
- in **Electrical** Engineering
  - Smart Grid Technology (SU) — READ MORE
  - Power System Planning & Operations (SU) — READ MORE



"Variable renewable energy (VRE) will increase significantly in the future South Africa power system."

Short Course attendance in 2021

Module	Presenters	Total	Coursework	Research	Staff	Executives
Renewable Energy Systems	Mr Carl Tshamala	25	25	0	2	1
Renewable Energy Policy*	Ms M Davis	5	5	1	2	2
Thermal Energy Systems	Prof T Harms	Not presented				
Smart Grid Communication	Prof. Riaan Wolhuter	16	16	0	0	1
Introduction to Solar Energy	Prof T Harms, Dr Johan Strauss, Riaan Meyer	Not presented				
Advanced Photovoltaic Systems	Dr Arnold Rix & Dr B Bekker	11	6		1	3
Renewable Energy Finance*	Dr Jako Volschenk	1	1	0	0	0
Wind Energy	Mr Gareth Erfort	19	19	0	0	1
Integrated Supply Side Technology	Dr B Bekker & Mr S Chown	22	22	0	0	2
Integrated Demand Side Technology	Prof. Hendrick Johannes Vermeulen	22	22	0	0	0
Energy Storage	Dr B Bekker/ Prof Bladergroen	23	23	0	0	0
Bioenergy	Prof J Gorgens	8	8	0	0	2
Hydro & Ocean Energy	Prof T von Backstrom & Dr J Joubert	7	7	0	0	0
Power System Operation	Dr Gream Chown/ Dr B Bekker			0	0	22
Long term power system Planning	Michael Barry/ Dr Jarred White			0	0	6
Total students trained 2021		**159**	154	1	5	38

Designing the Curriculum for Power System Planning and Operations

SOLTRAIN IV

SOLTRAIN started in 2009 and is currently in its fourth phase of cooperation with partner institutions in Botswana, Lesotho, Mozambique, Namibia, South Africa, Zimbabwe and SADC Centre for Renewable Energy and Energy Efficiency (SACREEE).

SOLTRAIN's Support Scheme for Postgraduate Students

SOLTRAIN's Student Project Support Scheme supports masters or PhD theses dedicated to the topic of solar thermal energy. The scheme provides financial support for students in order to encourage them to work in the field of solar thermal, to build up capacity and to promote the opportunities that solar thermal energy offer with regard to various applications and sectors, with the overall aim to reduce the use of fossil fuels for a sustainable future.

During the course of SOLTRAIN's third and fourth phases, three bursary calls have been put out, attracting a total of 40 applications. From these, 15 projects have been approved which contribute to the overall aims of the SOLTRAIN project which include promoting the use of solar thermal energy in the SADC region to reduce greenhouse gas emissions and to foster the change from fossil fuels to the use of renewable energies.

Applications were received from students from all of the SOLTRAIN partner countries, and the SOLTRAIN steering committee took pleasure in being able to award four students from South Africa and Zimbabwe, two each from Lesotho, Botswana and Namibia and one student from Mozambique, meaning that all SOLTRAIN partner countries were represented. The gender breakdown of the applicants amounted to five female and ten male students.

TRAINING

One of the major focus areas of the SOLTRAIN initiative is increasing technical skills by carrying out a number of training courses targeted at different levels and stakeholder groups in the value chain of solar thermal technology.

Training in co-operation with Vocational Training Centres.

SOLTRAIN offers training modules for the staff of Vocational Training Centres (VTCs). The main focus is on practical training, installation and quality control (manufacturing, quality of imported products, installation, and maintenance). The courses focus on simple systems (low and high-pressure thermosyphon systems), that could support the solar thermal mass roll out programs.

CRSES hosted training courses in co-operation with VTCs on 25 – 26 and 31 March 2021. Fourteen (14) participants attended the training.

Specialised Courses for Professionals

In order to design and install high quality solar thermal systems for apartment buildings, hotels, hospitals, industrial applications etc, specialised courses for a restricted number of experts were organised. Due to the pandemic, the first course took place on January 19 and 21 in the form of webinars. The focus was on pumped medium scale solar systems for apartment buildings, hospitals and hotels, as well as Photovoltaic -Thermal (PVT) collectors that combine the production of both types of solar energy – solar heat and solar electricity – simultaneously in 1 collector. 70 participants attended the online course.

The second specialised course was held in Stellenbosch on 8 & 9 November 2021 and had a focus on Solar Cooling for the Sunbelt regions. The course was held in cooperation with the IES Solar Heating and cooling programme. It was hosted by CRSES and AEE INTEC. 48 participants attended the course.

Dissemination Courses

SOLTRAIN project partners are obliged to organise dissemination courses which are carried out by experts trained by AEE INTEC in the Train the Trainer courses. Two types of courses are conducted.

- Technical dissemination courses
- Non-technical courses in order to convince stakeholders from social housing companies, lodges, other multipliers, financial institutions as well as from companies dealing with industrial process heat.

The first dissemination course for the South African partner took place on 1 and 2 December 2020, hosted by SANEDI and CRSES in Limpopo, with 28 participants. The second took place on 10 & 11 June 2021 in Stellenbosch with 13 participants. The third took place on 26 and 27 August in Stellenbosch with 10 participants.

Dual training programme for artisans

A strong demand for "hands-on training" was articulated by almost all project partners who were involved in SOLTRAIN Phase III. There is also a demand for skilled solar thermal installers within the solar thermal companies. In order to combine these demands, a "dual training program for artisans", consisting of two theoretical and hands-on courses, in combination with an internship at a solar thermal company, is offered in Phase IV.

The theoretical and hands-on courses are carried out under the leadership of AEE INTEC in co-operation with Vocational Training Centres. The practical training is carried out by the solar thermal companies who provide the internship. Only solar thermal companies who attended training courses in previous phases of SOLTRAIN and who also already successfully installed demonstration systems, qualify for this activity. The internship at a company was originally planned for 3 to 4 months. However, after discussions at the kick-off meeting, it was decided to offer the internship for a maximum of 6 months if the host company agrees to co-finance for this period. The cost for the internship is shared between SOLTRAIN and the solar thermal companies who apply for this dual training program.

The table below lists the South African participants in the Dual Training programme:

			Duration of Training	
Applicant	Apprentice	Gender	Start Date	End Date
Holms & Friends	Jobe Nkanyiso Thuthukani Mthethw	M	Feb 2021	July 2021
Sonnekraft	Solomon Resenga Khoza	M	April 2021	Sept 2021

Delegates attending SOLTRAIN Specialised course in Stellenbosch

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.

Optimal siting of Variable Renewable Energy in South Africa

Stellenbosch University is conducting a study to determine the optimal location for Renewable energy projects. The study focuses on 3 areas:

- **Grid support**
  This area of study focusses on the impacts of a high penetration of variable renewable energy generation on grid operations. It is of interest to consider whether the future renewable energy fleet can be deployed such that the demand profile is optimally supported despite the influences of weather and climatic conditions on power generation.
- **Network infrastructure requirements**
  The bulk of the generation, i.e. coal-fired stations, are located in the North East of South Africa, mainly the Mpumalanga province. This is also, therefore, where the grid capacity is the most well-developed and robust. However, if at least 27 GW of renewable energy is to be constructed in the next 10 years, the bulk of that will have to be built in the regions with the best wind and solar PV resources, namely the Southern and Central regions of the country. Prioritising new VRE sites near existing network infrastructure can lead to sub-optimal value from these plants compared to adopting an integrated bulk process to align network expansion plans and optimal future VRE sites.
- **Opportunities for Socio Economic Development**
  South Africa has one of the most sophisticated systems for ensuring that local economies benefit from investments in renewables and local manufacturing benefits from local content rules. To build a renewable energy plant, regulations prescribe that a percentage of turnover and profits must be spent within the local area. The other part of the story is the impact on manufacturing and services businesses who will benefit from local content requirements (LCR) and servicing contracts (transport, repairs & maintenance, etc). Optimally siting VRE projects can maximise the socio economic benefits derived from these projects, additionally so if an integrated bulk perspective to VRE siting is adopted.

The study is funded by the European Climate Foundation (ECF), and is a collaboration between Centre for Renewable and Sustainable Energy Studies (CRSES), Centre for Sustainable Transitions (CST) and Department of Electrical and Electronic Engineering (E and E).

Three peer reveiwed jouranl articles from the study have already been published, as well as a media article in The Daily Maverick.

The stakeholders that have been engaged include ESKOM, CSIR, the IPP office, DMRE, and NERSA.

The outcome of the study directly supports South Africa's Just Energy Transition away from fossil fuel generation to clean energy sources.

Greek Islands Solar Thermal Project

District solar cooling project for Chalki Island

This study conducted a pre-feasibility analysis of implementing a centralised district solar thermal (ST) cooling system on the island of Chalki in Greece. The system is aimed at providing cooling for a medical centre, school, City Hall and 20 residential homes. The estimated cooling demand was developed by considering seasonal variation, annual temperature fluctuation, tourism, and day types such as holidays. A solar cooling system design was proposed and developed in simulation to indicate proof of concept and perform a base-case financial model.

To further investigate the feasibility, literature and case studies were reviewed, comparing photovoltaic (PV) with ST systems for heating and cooling. In large single-building applications, these two technologies are competitive, however when optimized, it was found that PV generally outperforms ST systems. Design guide principals also validate the theory that the system will most likely not be feasible in this application, especially when compared to PV coupled with vapor compression chilling (VCC) as an alternative.

A base-case financial model was run for the system, revealing a high levelised cost of energy, which further indicates that this project is techno-economically unattractive. The main factors indicative of an infeasible application include:

- The heat losses in long pipe runs with distribution to many different buildings
- Large parasitic power required
- Stagnation of the system for extended periods
- Low utilisation and base load due to climate fluctuation
- Inefficient fossil fuel back-up (no waste heat re-use or biogas available)

It was concluded that further engineering design and optimization for the centralised ST cooling system considered in this study would most likely not yield fruitful insights.

District solar heating project for Symi Island

This study investigates the pre-feasibility of a SF system to be implemented on the island of Symi in Greece. The system is to provide domestic hot water to the residence in the main town of Symi, which has a permanent population of 2440 residence with a fluctuation in tourism of approximately 450 persons. The report provides an energy demand model, based on literature and case studies, and then details a techno-economic design to investigate its viability.

It was concluded that a system which is large-scale, centralised, and distributes hot water through a district network is the most suitable for this application. This system was developed in simulation through Polysun software and consists of 850 flat plate collectors, two 160 kl hot water storage tanks and a 150kW heat pump as back-up. The SF of the system was optimized through simulation by considering the levalised cost of heat (LCOH) as the appropriate optimization indicator. An SF of 66% was determined to be optimal for this application. Stagnation was investigated and it was determined that it would be completely avoided during summer months.

Initial financial modelling showed promising results with an LCOH of € 0.15/kWh, which is attractive when compared to the traditional cost of electricity in Greece (€ 0.17/kWh). An additional worst-case financial model was done considering the current large increase of electricity prices in Europe and the system still showed attractive economic indicators.

The results indicate that the proposed SF system may be a feasible option for the island's domestic hot water requirement. It is suggested that this system be investigated further in more detailed feasibility studies, which would further help decision making regarding its implementation.

Backup battery system at Stellenbosch University Museum

The Centre for Renewable and Sustainable Energy Studies (CRSES) and the Stellenbosch University Museum is currently working together on a renewable energy-based project whose objective is to bring awareness to the public with regards to renewable and sustainable energy and to assist in mitigating the effect of load shedding for the Stellenbosch University Museum.

The project is executed in two phases with the first phase having been completed. The first phase entailed the implementation of several energy efficiency initiatives and the electrical rewiring of sections of the building to supply the essential loads from a backup battery energy storage system. The second phase will involve the installation of a solar photovoltaic system for public awareness concerning the benefits of renewable energy. This installation is also targeted at reducing energy costs for the museum.

CRSES performed a short study on the battery storage capacity needs to supply the essential loads during load shedding for 2 hours. In 2020, the maximum demand for the museum was 48.2 kVA and backing up the entire museum would be unwise. Therefore, essential loads were backed up (3 kVA), which includes emergency lights, the security system, the computers, and the network equipment. To achieve this, a Solar MD Lithium-ion (LiPO4) battery storage system with a capacity of 8.2 kWh and a 5 kVA MLT inverter were installed at the Stellenbosch University Museum. The inverter and battery are South African brands and are assembled locally. The role of CRSES was to oversee the process of procurement and installation of the project and report any risks and hindrances until signoff.

Bongani Mgijima, the director from the Stellenbosch University Museum added that the installed backup battery system has been a dream come true for them at the Museum because they no longer have to close during load shedding. Lastly, they look forward to "going green" by relying more on solar energy.

Eskom delegation visits CRSES and Department of Electrical and Electronic Engineering

RENEWABLE ENERGY RESEARCH AND MARKET TRANSFORMATION PROJECTS continued

Masia Village Water-energy-Food Nexus Project.

The Department of Science and Innovation promotes the creation of enabling environments for community projects that have relevance to the Water-Energy-Food nexus. The Masia Multi-purpose centre, in Masia village has provided an opportunity for such an enabling environment. The village is situated in the Vhembe district Municipality of the Limpopo Province.

The primary objectives of the Masia Village project are:

- To promote locally developed Intellectual Property (IP) relevant to the Water-energy-Food nexus
- To enable the market success of the IP and other Renewable and Sustainable Energy technologies
- To support youth entrepreneurs

The infrastructure projects planned for deployment at Masia village include:

- A hydroponics tunnel for high quality produce and efficient water usage
- A fruit tree nursery to support emerging small farmers
- An Agro-processing facility
- A borehole for water provision

The projects will be powered through:

- A 20 kW solar PV system
- A 1kW CPV system
- A 5 kW Hydrogen Fuel System with an on-site electrolyser

The project partners and their roles are listed below:

Partner	Role
Department of Science and Innovation (DSI)	Funding and Project support
Agriculture research council (ARC)	Research, deployment of agriculture infrastructure and training
DSI's renewable and Sustainable Energy Hub at Stellenbosch University (CRSES)	Research, Co-ordination stakeholder engagement
Masia traditional authority	Implementation site and project support
Bambili Advisory	H2 fuel cell installation and training
Nelson Mandela University (NMU)	Deployment of CPV system
South African National Development Institute (SANEDI)	DSI energy Secretariat
National Youth Development Agency (NYDA)	Youth Business Development
University of Venda (UniVen)	Stakeholder engagement

Deputy Minister Honourable Bhuti Manamela at the commencement of the Masia Village project

Delegates meeting with Traditional Authority at a Masia Village Project planning session

The role of Electric transportation in advancing SDGs.

In 2020, CRSES in partnership with ETH Zurich (Switzerland) received a 1-year research grant from the Swiss Tropical and Public Health Institute (TPI) under the Leading House Africa Seed Funding to conduct research contributing to the advancement of sustainable development goals in the global south. The collaboration between the research centers in this endeavor emanated from the research principals' (Drs Bekker and Chokani, at CRSES and ETH, respectively) mutual interests related to the ongoing energy transition and the role of electric transportation in advancing sustainable development goals (SDGs). Transitioning from existing mobility paradigms to electric mobility (e-mobility) can significantly reduce carbon emissions and contribute toward the advancements of clean energy (SDG7) and climate action (SDG13).

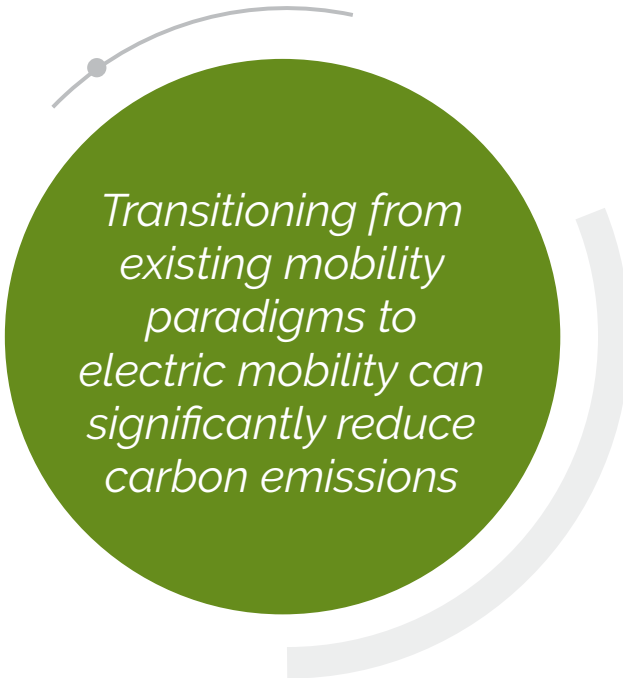
A successful energy transition requires careful planning guided by robust simulation frameworks to identify transition pathways that are optimized for technical, environmental, social, and economic factors. E-mobility transition simulation frameworks must address a multi-dimensional problem that is made even more complex by uncertainties in these associated factors. In this regard, the development of high-fidelity simulation methods – with a rigorous characterization of the relevant inputs, accurate simulation of impacts, and appropriate interpretation of outputs – is critical for enabling successful transition pathways to e-mobility.

The expertise in advanced energy modeling and simulation at both ETH and CRSES allowed the formation of a formidable team that would develop and apply state-of-the-art methodologies for e-mobility pathway simulations of high fidelity and resolution. LEC at ETH equipped the team with agent-based modeling and simulation expertise that enable detailed population and mobility studies, translating into vehicle mobility and energy requirements indicators. Then, CRSES advances the skillset with risk-based grid impact assessment studies that inform the limits of existing networks to host e-mobility and the requirements for upgrades and reinforcement.

The combination of high fidelity tools was applied to a case study focusing on the transition to electric minibus taxis (eMBTs) in Thohoyandou, a small town in the Limpopo province. Though typically of low adoption potential for private electric vehicles, Thohoyandou met the grant's socio-demographic focus and also is relevant in the case of e-mobility transition in the public transportation sector. Furthermore, the viability and feasibility studies for e-mobility in such areas enable and facilitate pathways for just energy transitions.

As part of the research activities, a review was conducted to study various transition pathways in other countries and contexts of high e-mobility penetration, including the methodologies and tools applied to inform the relevant planning, regulation, and operation of such technologies. Then, local studies investigating population and mobility characteristics were conducted, also with the employment of local human resource capital in Thohoyandou. The collected data, consolidated with past census and survey data, provided a good basis for the development of reliable and practical input models for the transition studies. The research results have great significance from environmental, technical, and financial perspectives. The research results provide both quantitative and qualitative indicators of the impact of increased penetration of e-mobility on reduced CO2 and particulate matter emissions, and the potential use of solar PV for charging e-vehicles. From a technical perspective, barriers, such as inadequacy of existing networks, will be identified, and measures, network reinforcement, and upgrading, to overcome these barriers will be assessed. From a financial perspective, amongst others, the affordability of e-mobility options, e.g., scooters, EVs, and eMBTs, and the required support mechanisms such as subsidies to facilitate the purchase of such e-vehicles, and the required capital investments for upgraded or new infrastructure to support the charging of e-vehicles, can be quantified from the outputs. In the context of the perspectives discussed above, optimized roadmaps for a successful transition to e-mobility can be developed.

CRSES has developed high-fidelity, state-of-the-art tools for simulating e-mobility scenarios and their corresponding impacts on existing electric networks, allowing for the formulation of optimized transition pathways to e-mobility and other energy transition studies at local, regional, and national scales. With this expertise, CRSES is involved in various research activities investigating the pathways for the adoption of public eMBTs in different Metropolitan areas.



RENEWABLE ENERGY RESEARCH AND MARKET TRANSFORMATION PROJECTS continued

SOLTRAIN Sector Workshops

Private and public companies, like electricity companies as well as the health and defence sector have either a huge heating or colling demand in the buildings they are responsible for or might have interest in solar thermal systems from the demand side management point of view (electricity companies). It is the aim of SOLTRAIN to inform these institutions about the possibilities of using solar energy for heating and cooling. A series of information workshops for different sectors were carried out in order to promote the installation of demonstration systems. CRSES hosted the following sector workshops:

- Public sector workshop. Attended by the Western Cape Government, and Green Economy Reference Group with 58 participants – held on 5 March 2020
- Health Sector workshop- held on 13 March 2020 with 9 participants
- Housing Sector workshop held on 28 April with 14 participants.

SOLTRAIN Demonstration Systems

SADC member states have excellent solar irradiation with more than 2,000 kWh/m^2 annual radiation and estimates from the International Energy Agency (IEA) suggest that solar thermal systems could meet about 70 –80% of the regions low-temperature heating and cooling demand. SOLTRAIN is designed to support and contribute towards the implementation of energy policies of the target countries that enhance the use of solar thermal systems. Energy poverty negatively affects the circumstances of large numbers of people in general, and particularly in the SADC member states. There are close links between energy supply and practically all aspects of sustainable development, such as access to water, agricultural and industrial productivity, health care, education, job creation, environmental pollution and climate change. The focus of SOLTRAIN is to contribute towards reducing energy poverty by improving access to sustainable energy technologies, specifically solar thermal solutions, and thus directly contributing to the realisation of SDG 7 and indirectly to SDG 1, SDG 12 and SDG 13.

The support of the installation of demonstration systems in so called "Flag-ship districts" is continuing in SOLTRAIN IV. These "Flagship Districts" were established in all six partner countries in the previous phases of the project after consultation with policy, local authorities, training and research institutions, industry and NGOs. The aim of "Flagship Districts" is to have several systems for different applications at different eligible institutions installed relatively close together (small region). This also helps to increase the visibility and impact of the SOLTRAIN demonstration systems.

The demonstration initiative is intended to motivate all institutions, direct project partners as well as local authorities, the solar thermal companies that were trained, to propose institutions for the installation of solar thermal systems. In the call for applications for demonstration systems, a special focus is on institutions that support women (e.g. girl's schools, maternity clinics, shelters for battered women) and marginalised groups (e.g. children and youth, in vulnerable situations, persons with disabilities, internally displaced persons, refugees and migrants). Social institutions, hospitals, clinics, communities as well as small enterprises that are located within the "flag ship district" are also able to directly apply for co-funded demonstration systems. The subsidy from SOLTRAIN is limited to a maximum of 50% of the overall system price for the beneficiary. In addition, monitoring equipment is provided for a limited number of systems. The monitoring devices are fully funded by SOLTRAIN.

23 plants were erected on apartment buildings in Melville Place, Cape Town in SOLTRAIN IV.

SOLTRAIN Solar Roadmap Implementation

SOLTRAIN aims to encourage the accelerated installation of solar thermal systems in the partner countries. This is done through the preparation and implementation of policy workshops that support responsible government ministries or their departments with the development of concrete political measures aimed at implementing solar thermal roadmaps developed.

The workshops hosted by CRSES were held on 3 February 2020 and 17 November2020. Participants numbered 14 and 10 respectively. There was good collaboration with policy makers and the local solar thermal industry. Attendees included representatives from the Western Cape Government's Departments of Human Settlements and Health as well as representatives from the City of Cape Town Metropolitan Municipality and the South African Renewable Energy Business Incubator (SAREBI)

Demonstration system at a housing development in Cape Town

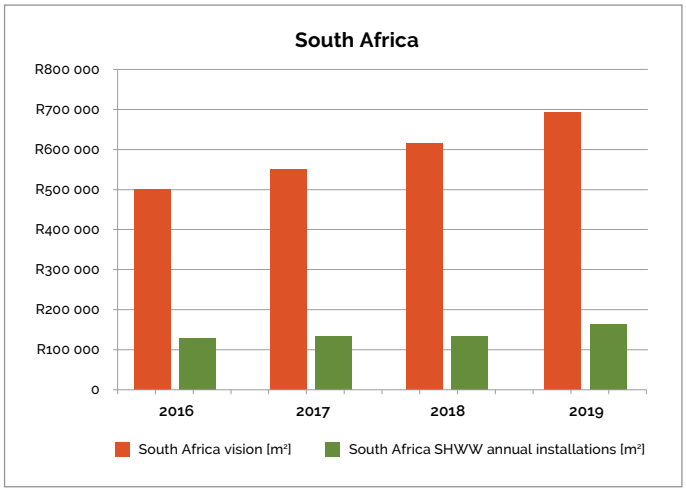
Monitoring

Progress on the implementation of the Solar Thermal Roadmaps is done on a continuous basis. This involves the collection of data relevant to installed solar thermal capacity, the CO^2 reduction of the installed system, as well as electricity savings. The contribution to the COP21 agreement and SDG 7 are documented.

For the South African partners, the 2030 targets in the solar thermal roadmap are as follows:

Country	South Africa
Target collector area per inhabitant in 2030 [m^2/Inhabitant]	0.5
Target collector area in 2030 [m^2]	30 million
Installed collector area at the end of 2019 [m^2]	2,333,306

The below graph gives a comparison of the annual collector installations according to the developed solar thermal visions 2030 (orange) and the actual installed collector area in green.



(Source: IEA SHC Heat Worldwide ed. 2021)

The below table gives the collector area, capacity, calculated number of systems, solar yield and CO2 reduction as reported. In the IEA SHC Solar Heat Worldwide report, edition 2021. For calculating the electricity savings an efficiency of the electrical heating element of 90% has been assumed.

Country	Total collector area [m^2]	Total Capacity [MW_{th}]	Calculated number of systems	Solar Yield [GWh/a]	Electricity Savings [GWh/a]	CO2 Reduction [tCO^2/a]
South Africa	2.332,975	1,633	662,283	1,802	1,982	612,845

The below table outlines the installed SOLTRAIN systems (phases I to IV)

South Africa	No. of systems	Total collector area [m^2]	Total Capacity [kW_{th}]	Solar yield [MWh/a]	Electricity Savings [MWh/a]	Avoided Electricity Cost [ZAR]	CO2 Reduction [tCO^2/a]
Phases I - IV	131	3,375	2.363	2,410.0	2,650.9	6,779,788	836
Commissioned under phase IV as of 31/12/2021	9	51	36	36.2	39.838	101.885	13

Approved solar thermal demonstration systems in South Africa in Phase IV by December 2021

Beneficiary	Institution	Collector area [m^2]	Number of systems
e-Junction	Mass housing project	249	1
Interchange Foundation - Pilote House	Single family home for old age people	2	1
St John Baptist Convent - System 2	Social Institution	32.48	1
Mariendahl Farm Residences	Housing Project	16.24	7
H. Hertzog	Individual home; early adopter	14.4	1
Russelstone & Holms	Housing Project	91.08	1

AWARENESS AND OUTREACH

SASEC

Stellenbosch University hosted the now called Southern African Sustainable Energy Conference (SASDE), which took place from 17 – 19 November at Lanzerac Wine Estate, Stellenbosch, South Africa and was chaired by Dr Arnold Rix. The conference was presented face to face, with strict COVID 19 protocols adhered to. This was a welcome change after months of virtual conferences.

The 2021 conference was the 7th SASEC, which previously had a focus on solar energy. The conference has now been broadened to include other sustainable technologies, with academic papers being presented in the following categories:

- solar thermal energy
- solar PV
- wind Energy
- hydrogen
- hydro and ocean energy
- renewable energy resource assessment
- demand side and energy storage applications
- power systems planning and operations
- bioenergy

The peer review process was rigorous, and the research presented was of high quality. In total 46 papers were presented from various institutions.

The Deputy Director General of the Department of Science and Innovation, Dr Mmboneni Muofhe gave the opening address. The keynote speakers were from industry and presented practical experience as to what is necessary towards a sustainable Southern Africa.

Ms Isabel Fick, the General Manager System Operator at Eskom, and Jan Jourie Fourie the General Manager: Sub-Sahara, Africa, at Scatec ASA gave riveting insights into the daily realities of the energy sector in South Africa.

SASEC is now the Southern African Sustainable Energy Conference with a broader focus on renewable energy techonologies

Delegates at SASEC 2021

Prof Mamphweli presenting a biodigester at the SASEC 2021 technical tour

Media Lab Launched at Mugoidwa School in Vhembe District

Stellenbosch University, through the Centre for Renewable and Sustainable Energy studies, has embarked on a journey to bring about sustainability and renewable energy to rural schools in innovative ways. This was done in partnership with the Department of Science and Innovation (DSI) and South African National Energy Development Institute (SANEDI). A project was showcased by implementing a Media Lab at Mugoidwa secondary school in the Vhembe district, Venda, Limpopo, that is off grid and has no financial burden to the school with regards to their electricity bills and may even reduce their bill in the future.

Why even do such a project? It is key to bridge the knowledge gap between communities that have easy access to the collective knowledge of society through the internet and those who don't have access to such knowledge yet. As the saying goes: knowledge is power. By bridging the gap, one can enable access to knowledge which in turn can enable learning on different levels. This could then assist people to make informed life decisions and provide new opportunities which may significantly improve lives, which might not have been possible before.

The implemented Media Lab consists of Chromebooks, which are specifically designed for harsh environments. They are considered drop resistant, inherently immune to software viruses without needing antivirus software, and include Google Educational Suite as an online resource for extending their curriculum. Also included in the Media Lab is a Clevertouch SMART whiteboard, as interactive learning has shown to provide a more effective learning experience. This is all powered by a 2.2 kW peak photovoltaic (PV) system from locally manufactured ARTsolar modeules, together with 8.2 kWh's of lithium-ion battery storage from SolarMD. Inverters and commissioning were provided by MLT, who are especially known for their dedication to local manufacturing. All the data can be viewed remotely and is also displayed on a local screen to show how much money the system is saving the school to increase community awareness and buy-in.

The Media Lab's sustainability is enhanced by upcycling used 2 x 12 m containers, seamlessly joined together to create a single learning environment. Bioclimatic design principles were considered in the design by looking at the sun path, creating a large overhang on the northern façade, window boxes that work as light shelves, well insulated roof and walls, and roof angle optimisation for increased PV yield. With respect to security, there is an alarm system that triggers using tripwires, various infrared sensors, CCTV cameras that can be viewed remotely, LED lights on the inside, polycarbonate burglar bars, and a reinforced security gate. The learning environment is enhanced by the ergonomically designed desks and chairs as well as creative artwork on the exterior of the media lab to facilitate a fun and exciting learning environment.

CRSES is working along with various stakeholders to implement more successful projects like this, not only to improve the level of education of learners at schools, but also to improve the access to knowledge for communities along with renewable energy awareness of South Africans.

Interior of Media Lab at Mugoidwa School

The Media Lab at Mugoidwa School

INTERNATIONAL COOPERATION

Damoc

The DAMOC Project (www.damoc.eu) is a collaborative EU Erasmus+ funded initiative aimed at capacity building in Smart Grid Technology. This dissemination conference is aimed at sharing the outcomes of the DAMOC Project with a broad stakeholder audience, including those from academia, government, agencies and industry, identified within the broad spectrum of energy / smart grid sector stakeholders. The DAMOC consortium consists of three universities in South Africa (Stellenbosch University, Cape Peninsula University of Technology and University of Pretoria), two universities from Tanzania (Nelson Mandela African Institution of Science and Technology and University of Dar es Salaam) and three European Universities (Technical University Dresden, Karlstad University and University degli Studi Guglielmo Marconi). The one-day information-sharing event will be held on 25 March 2020 and will be hosted by Stellenbosch University at the Centre for Renewable and Sustainable Energy Studies (CRSES).

On 09 June 2021 a dissemination conference was held showcasing the culmination of 3 years of development work carried out by the DAMOC consortium in the field of Smart Grid Education. The objectives of the conference were as follows:

- To showcase the DAMOC Project, its successes and identified challenges in the **development of human capacity** for the diffusion of SMART Grid Technology in the African context.
- Bring together all stakeholders in the South African and Tanzanian Smart Grid sector for promotion of networks and partnerships towards **human capital development**.
- Provide a catalyst for the future sustainability of Smart Grid **education** cooperation in Africa.

Dr Bernard Bekker, Associate Director at CRSES and ESKOM Chair in Power System simulation served as the Chair of the conference. Prof Nawaaz Mahomed gave an overview of the Damoc project. Delegates from CPUT, SU, UP, NMAIST, UDSM, KU, USGM, and TUD gave presentations.

Two keynote speakers addressed the conference.

Martin Adolph from Switzerland who is the Programme Coordinator and Study Group Advisor with ITU (the United Nations' specialised agency for information and communications technologies gave a presentation on the International Standards in support of digital transformation. Martin's work facilitates the development of international standards in the field of performance quality of service (QoS) and quality of experience (QoE) for the full spectrum of terminals, networks, services and applications ranging from speech over fixed circuit based networks to multimedia applications over networks that are mobile and packet based. Martin is also responsible for standardisation work in the field of distributed ledger technology for ITU. Martin holds degrees in Computer Science from TU Dresden and in Engineering from École Centrale Paris.

Prof Germano Lambert-Torres is from Brazil, and is the Director of R&D at PS solutions, Itajubá, and Chair of the Scientific Technical Council at Gnarus Institute, Brazil. He also serves as a consultant for many power industries in South America, with more than 150 R&D projects. He is a member of several committees in the Brazilian Government and regulatory agencies, such as the National Electric Energy Agency and the National Petroleum Agency. He has taught numerous IEEE and IFAC courses in the US, Europe, and Asia. He served as the Chair of the International Conference on Intelligent System Applications (ISAP) in 1999 and 2009. He is a Fellow of IEEE ,and received recognition awards in 2006 and 2007 from the IEEE Power and Energy Society.

ARUA

The ARUA network has partnered with the Grand Challenges Research Fund (GCRF), and each ARUA Centre of Excellence (CoE) received an award to build the research capacity of African researchers. The fund supports research to address challenges faced by countries in the Global South. The fund is part of the UK's official development assistance (ODA), and addresses the United Nations Sustainable Development Goals, by maximising the impact of research and innovation to improve lives and opportunity in the Global South.

The ARUA CoE in Energy, based at Stellenbosch University, has set out a program of activities where young African researchers will be engaged and afforded the opportunity to enhance their research skills and capabilities, firstly through some of the structured courses designed and presented by the African Centre for Scholarship at Stellenbosch University, and secondly by giving opportunity for 'learning-while-doing', where young researchers will 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.

Capacity Building project

The Capacity Building Project of the ARUA CoE in Energy aims to strengthen research capacity in the critical field of energy, and particularly in multi-disciplinary approaches that employ renewable energy as an enabler for the safe, affordable, and equitable provision of basic services, and for the strengthening of the African food and agricultural system.

The ARUA CoE in Energy Capacity Building Project is making steady progress and had a successful if challenging year during 2021. The CoE has been very active in terms of engaging outside parties and stakeholders and has strengthened its collaboration with African and non-African universities. The CoE is making good progress toward establishing a core of participating researchers, despite the Covid pandemic hampering progress due to difficulties in cross-border travel, and we managed to train several postgraduate students.

By remaining flexible and adaptable, it is anticipated that the CoE in Energy will continue to move the research agenda forward, and achieve the aims of the Capacity Building Project. It is

anticipated that the CoE in Energy will accelerate its activities and output going into the next year. A particular highlight of the year was the graduation of PhD candidate Amsalu Tolessa Mossissa, whose work formed part of the EcoAfrica research project.

The EcoAfrica Project

The EcoAfrica project is funded under the African Union Research Grant, and aims to enhance agricultural output on smallholder farms by employing agro-ecological techniques. EcoAfrica is an integrated research project that was conducted in a collaborative, multidisciplinary manner and at a multiscale level, with researchers from South Africa, Mozambique, Madagascar, France, Portugal and Belgium participating. The role of ARUA CoE in Energy was to investigate what contribution anaerobic digestion technology can make toward diversification of farming activities and ensuring access to renewable energy at smallholder level, through integrated on-farm biomass resource management.

Amsalu's research showed that the incorporation of anaerobic digestion technology is financially feasible at smallholder level. Furthermore, when the wider impacts of anaerobic digestion is considered on the household and farming system, the various co-benefits that can be realised make the technology particularly attractive. During the project, Amsalu collaborated with Stellenbosch University and Madagascan researchers, and thus far he has published 3 scientific papers from his work. The work contributed significant new knowledge on the potential benefits of integrating anaerobic digestion technology into smallholder farming systems, and can hopefully contribute toward implementation of this technology within wider South African society.

FIP-WEF@SU

The Fraunhofer Innovation Platform for the Water-Energy-Food Nexus at Stellenbosch University (FIP-WEF@SU) was established in 2020 by Stellenbosch University and the Fraunhofer-Gesellschaft. The aim of this long-term cooperation is to jointly develop needs-based technological and cross-sectoral solutions for water, energy and food security.

Through the FIP-WEF@SU, SU's Faculties of Engineering, Science and AgriSciences, under the auspices of the SU Water Institute (SUWI) and the Centre for Renewable and Sustainable Energy Studies (CRSES) collaborate with the SysWasser and Energy Alliances of Fraunhofer to share resources and co-develop project proposals.

After all the Covid-related travel restrictions, Stellenbosch University colleagues were able to visit Germany in October 2021. The focus of this visit was on energy-related cooperation and collaboration. Stellenbosch University was represented by Prof Andre Burger, the director of the FIP-WEF@SU and a professor at the department of Process Engineering, prof Oliver Damm, Fraunhofer Senior Advisor: South Africa and professor at the department of Industrial Engineering, Prof. Wikus van Niekerk, Fraunhofer Senior Advisor: South Africa and the Dean of Engineering, and Karin Kritzinger, Business Development and Networks Manager of the FIP-WEF@SU. The team visited the Fraunhofer Institute for Solar Energy Systems ISE, the Fraunhofer Institute for Systems and Innovation Research ISI, the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB, the Fraunhofer Institute for Energy Economics and Energy System Technology IEE, the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT, as well as the Fraunhofer Gesellschaft head office in Munich.

Visit: www.fip.sun.ac.za

A Stellenbosch University delegation visiting the Fraunhofer-Gesellschaft in Germany

SOLTRAIN

SOLTRAIN is a regional initiative on capacity building & demonstration of solar thermal systems in the SADC region. The aim of SOLTRAIN is to support the target countries in changing from a largely fossil energy supply system to a sustainable supply structure based on renewable energy in general, and on solar thermal in particular.

The initiative is funded by the Austrian Development Agency (ADA). CRSES in one of two South African Partner Institutions, the other being the South African National Energy Development Institute (SANEDI). The AEE-Institute for Sustainable Technologies (AEE–Intec) is the Austrian implementing agent and conducts the overall management of the project. Participating countries include: South Africa, Lesotho, Mozambique, Namibia, Mozambique, Botswana and Zimbabwe.

5th SOLTRAIN Conference

After a break of two years due to the pandemic, the 5th SOLTRAIN Conference took place on November 25, 2021, at the Holiday Inn in Harare Zimbabwe. The conference was delivered in a hybrid format and was well attended by 90 representatives from Southern Africa, including the host nation Zimbabwe, South Africa, Lesotho, Namibia, and Mozambique as well Austria. Twenty delegates attended virtually. The conference was opened by Birgit Weyss, from the Austrian Development Agency and the keynote address was delivered by Honourable Zhemu Soda, MP, Minister – Ministry of Energy and Power Development (MoEPD), Zimbabwe.

The Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University, as well as the South African National Energy Development Institute (SANEDI) comprised the South African SOLTRAIN partners. Don Fitzgerald from CRSES and Karen Surridge and Khothatso Mulaudzi from SANEDI attended virtually. Dr. Richmore Kaseke, Karin Kritzinger and Linda Joka from CRSES attended in person. The South African delegation also included industry partners Doran Schoeman from E3 Energy, Dave Liddell from Solarex Energy SA, Henning Holm from Holms and Friends and Wally Weber from Blackdot Energy.

A key theme of the conference is to no longer conceptualise Solar Thermal as niche, but rather as a technology with great potential. This was particularly evident in the address by Werner Weiss from AEE INTEC in Austria, who gave an overview of the now 11 years of training, policy support and demonstration. He emphasised the importance of government support to be able to fast track implementation to significant levels, as the private sector alone is unable to implement fast enough. Speakers showcased success stories from the demonstrations in their respective countries, and in some cases (e.g. Namibia), the policy changes being effected pertinent to renewable energy in general and solar thermal technology in particular. Best practice ideas were shared around common issues such as the certification of trained installers, general quality control relevant to installations and Public Private partnerships. the conference offered the opportunity the further development of ideas, thereby ensuring the continuation of the programme's collaborative successes.

Innovative solar thermal systems were presented where Don Fitzgerald a researcher from CRSES presented the PV2Heat system and Andola Tsiu from Lesotho presented PVT, a new possibility to generate heat and electricity from one system. Dave Liddell From Solarex Energy SA (Pty) Ltd, in South Africa, also gave a presentation on Solar and heat pump systems.

Several pathways were presented for the mobilisation of funding for Solar Thermal implementation, both from the European Union as well from local development funding institutions.

Delegates attending SOLTRAIN Conference in Harare, Zimbwabwe.

PV site visit at Mariendahl farm

PUBLICATIONS

Conference Proceedings

2021

Ahia, C.C., Meyer, E.L., Tile, N,. 2021, 'Growth and Structural Characterization of GaSb/GaAs Quantum Dots: Prospective application in Photovoltaic Cells'. *38th European Photovoltaic Solar Energy Conference and Exhibition* EU PVSEC. <DOI: 10.4229/EUPVSEC2021- 3BV.2.38

Bhugwandin, K, Carmichael, T, & van der Hoven, C, 2021 'Ambidexterity, dynamic capabilities, and disruptive innovation in regulated electricity markets', *6th Business and Entrepreneurial Economics Conference*, Plitvice Lakes, Croatia, 27-28 May 2021.

Bongers, L, Mararakanye, N, & Bekker, B, 2021 'Operating Reserve Dimensioning Methodologies for Renewable Energy Aligned Power Systems', *56th International Universities Power Engineering Conference (UPEC)*, Middlesbrough, United Kingdom, 31 August – 3 September 2021.

Ekuru, M, Popoola, O, Ramokone, A, & Awelewa, AK, 2021 'Development of a Smart Power Consumption Monitoring Device for Household Load Activities' *2021 International Conference on Electrical, Computer and Energy Technologies (ICECET)*, Cape Town, South Africa, 9-10 December 2021, pp. 1-7, <DOI: 10.1109/ICECET52533.2021.9698529>.

Farmer, WJ, & Rix, AJ, 2021 'Analysing the power system frequency dynamics subject to continuous spatial-temporal fluctuations', *4th Asia Conference on Energy and Electrical Engineering (ACEEE)*, Bangkok, Thailand, 12-14 March 2021, pp. 24-28, <DOI: 10.1109/ACEEE51855.2021.9575143>.

Farmer, WJ, & Rix, AJ, 2021 'Mapping the spatial perturbations seen by the power system network due to intermittent renewable energy sources', *2021 Southern African Sustainable Energy Conference (SASEC)*, Stellenbosch, South Africa, 17-19 November 2021.

Joubert, M, Dalton, A, & Bekker, B, 2021 'A Categorisation Wind Power Forecasting Methodologies, Highlighting Emerging Short-Term Forecasting Methods', *2021 International Conference on Electrical, Computer and Energy Technologies (ICECET)*, 9-10 December 2021, Cape Town, South Africa, pp. 1-6, <DOI: 10.1109/ICECET52533.2021.9698533>

Kritzinger, K, & Scholtz, L, 2021 'Building understanding: Informed decision-making for SSEG integration', *2021 Southern African Sustainable Energy Conference (SASEC)*, Stellenbosch, South Africa, 17-19 November 2021.

Labuschagne, C.J.J., Kamper, M.J., 'Coordinate descent method to minimize cogging torque in small-scale wind generators', *2021 Southern African Sustainable Energy Conference (SASEC)*, Stellenbosch, South Africa, 17-19 November 2021.

Mabhula, M, and Kamper M.J. 2021, 'Transient fault parameters of DC-excited vernier reluctance synchronous condenser' IEEE. International joint conference on Optimisation of Electrical and Electronic Equipment – AEGEAN Conference on Electrical Machines and Power Electronics (OPTIMACCEMP). September 2 – 3.

Meyer, T.O., van der Spuy, S.J., Meyer C.J., Corsini, A., 2021. 'Optimisation of Tip Appandage for the Control of Tip Leakage Vortices in Axial Flow Fans' *ASME Turbo Expo*, June 7 – 11. Virtual, GT2021 – 59465.

Mouton, DA, Mararakanye, N, & Bekker, B, 2021 'Assessment of Methods to Measure Power System Flexibility: A Review', *56th International Universities Power Engineering Conference (UPEC)*, Middlesbrough, United Kingdom, 31 August – 3 September 2021.

Ncube, P.D.N., Meyer, E.L., Shibeshi, Z.S., 2021. 'Development of an Automated Real-Time Diagnostic System for O&M of Large Scale Photovoltaic Arrays Operating under Outdoor Conditions' *38th European Photovoltaic Solar Energy Conference and Exhibition EU PVSEC*. September 6 – 10.

Ockhuis, D.K., Kamper, M.J., 2021. 'Static-FE harmonic analysis of PM slip couplers' IEEE. International joint conference on Optimisation of Electrical and Electronic Equipment – AEGEAN Conference on Electrical Machines and Power Electronics (OPTIMACCEMP). September 2 – 3.

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Tolessa, A., Goosen, N.J., Louw, T.M., 2021. Simulation of anaerobic digestion of agricultural substrates using Aaerobic Digestion Model No.1. *Southern African Sustainable Energy Conference (SASEC)* 2021. 17 – 19 November 2021, Stellenbosch, South Africa. https://sasec.org.za/documents/SASEC_2021_Conference_Proceedings.pdf

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Xavier, R, Chihota, MJ, & Bekker, B, 2021'The Value of Smart Inverter Control in Distribution Energy Management Systems and Virtual Power Plants, and Opportunities for South Africa', *56th International Universities Power Engineering Conference (UPEC)*, Middlesbrough, United Kingdom, 31 August – 3 September 2021.

Xavier, R, Bekker, B, & Chihota, MJ, 2021 'Smart Inverters in LV networks: A Review of International Codes and Standards, and Opportunities for South Africa', *2021 Southern African Universities Power Engineering Conference/Robotics and Mechatronics/Pattern Recognition Association of South Africa (SAUPEC/RobMech)*

Journal Publications

2021

Adjogri, S.J. and Meyer, E.L., 2021. Chalcogenide Perovskites and Perovskite-Based Chalcohalide as Photoabsorbers: A Study of Their Properties, and Potential Photovoltaic Applications. *Materials*, 14(24), p.7857, <DOI:103390/ma142487857>.

Ahia, C.C., Tile, N., Meyer, E.L., Olivier, E.J. and Botha, J.R., 2021. Morphological and geometric phase analysis of GaSb/GaAs quantum dots grown at atmospheric pressure using MOVPE. *Journal of Materials Science: Materials in Electronics*, 32(22), pp.27097-27106.

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Dalton, A, Bekker, B, & Koivisto, MJ, 2021 'Simulation and detection of wind power ramps and identification of their causative atmospheric circulation patterns', *Electric Power Systems Research Journal*, p. 106936, March 2021, <DOI: 10.1016/j.epsr.2020.106936>.

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du Plessis, J. and Owen, M., 2021. A single-stage hybrid (dry/wet) dephlegmator for application in air-cooled steam condensers: Performance analysis and implications. *Thermal Science and Engineering Progress*, 26, p.101108, DOI:10.1016/j.tsep.2021.101108>

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Meyer, T.O., van Der Spuy, S.J., Meyer, C.J. and Corsini, A., 2021. Design of a Tip Appendage for the Control of Tip Leakage Vortices in Axial Flow Fans. *Journal of Turbomachinery*, 143(7), DOI:10.1115/1.4050359>

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Rohani, S., Went, J., Duvenhage, D.F., Gerards, R., Wittwer, C. and Fluri, T., 2021. Optimization of water management plans for CSP plants through simulation of water consumption and cost of treatment based on operational data. *Solar Energy*, 223, pp.278-292, <DOI:10.1016/j.solener.2021.05.044>

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Waswa, L, Bekker, B, & Chihota, MJ, 2021 'A Probabilistic Estimation of PV Capacity in Distribution Networks from Aggregated Net-load Data', *IEEE Access*, October 2021, <DOI: 10.1109/ACCESS.2021.3119467>.

Hon. Deputy Minister Manamela with delegates from DSI, CRSES and Community leaders at the launch of the Media Lab.

STAFF

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Director

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Associate Director and Eskom Chair in Power System Simulation

Prof. Neill Goosen

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Project Manager and Senior Engineer

Ndamulelo Mararakanye

Senior Engineer

Dr Justice Chihota

Senior Engineer

Dr Carmen Lewis

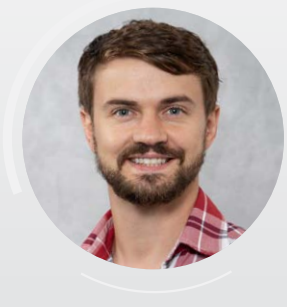
EPPEI Administrator

Dr Jafaru Egieya

Postdoctoral Fellow

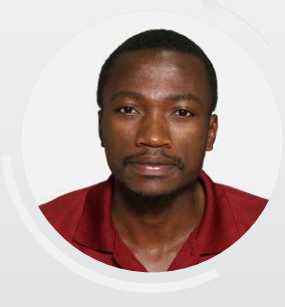
Donald Fitzgerald

Engineer



Oan De Waal

Engineer



Lewis Waswa

Engineer

Simnikiwe Gulwa

Junior Engineer

Sandelize Heydenrycht

Receptionist and Administrative Assistant

Linda Joka

Marketing and Communications Manager

Sedzani Ratsibi

Project Commercialisation Manager

Jainy Thomas

Project Manager

Elmien Lovell

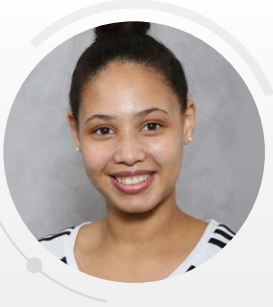
Administrative and Financial Officer

Nawaal Jacobs

Marketing, Short Courses and Postgraduate Applications Administrator

Tshilidzi Ligege

Assistant Project Administrative Officer



Jamie Van Wyk

Intern

Joshua Magoro

Intern

Akhona Shiyane

Intern

Mark Reuter

Intern

Ria Xavier

Intern

Pfano Tshikumbana

Intern

STATEMENT OF INCOME AND EXPENDITURE

Until December 2021

For the period ending :	31/12/2021	31/12/2020
TOTAL INCOME	**(73 459 412.55)**	**(12 360 145.32)**
CONFERENCE/CONGRESS	-	(17 764.00)
CONTRACT RESEARCH (TAXABLE)	(2 195 981.38)	(200 000.00)
DONATION: SPECIAL PURPOSES	(25 050.00)	-
INCOME FOREIGN EXEMPT	(886 323.33)	(1 079 341.87)
INCOME: BURSARY	(25 397 464.13)	-
INCOME: FOREIGN_ZERO RATE	(9 647 625.91)	(2 642 819.79)
INCOME: SUNDRY TAXABLE	(325 361.52)	(128 662.71)
INTEREST RECEIVE: INTERNAL ALL	(749 867.28)	(831 100.93)
PROFIT/LOSS: EXCHANGE RATE DEB	-	(7 128.39)
PROFIT: EXCHANGE RATE FOREIGN	(76 506.24)	(3 145.81)
SALES: HANDBOOKS & MANUALS	(416 527.00)	-
SALES: TO INTERNAL ORG UNITS	(54 123.90)	(252 261.19)
SHORT COURSE INTERDEPARTMENTAL	(115 520.00)	-
SHORT COURSES	(118 240.00)	(273 315.00)
SUNDRY INCOME: NON TAXABLE	(33 450 821.86)	(6 924 605.63)
TOTAL EXPENDITURE	**25 421 813.21**	**22 094 979.47**
"CURRENT EXPENDITURE ADVERTISEMENTS: GENERAL"	54 825.00	24 725.00
AFFILIATION & REGISTRATION EXP	248 841.32	207 791.81
AUDIT FEES: EXTERNAL	64 818.00	44 212.50
BURSARY POST GRADUATE	4 038 599.60	4 706 631.00
BURSARY UNDERGRADUATE	120 000.00	30 000.00
CELL PHONE AIRTIME	156.14	1.74
CELL PHONE RENT	5 335.45	3 948.07
CLEANING COSTS - EXTERNAL FIRM	47 230.98	35 743.61
CLEANING MATERIALS	169.34	3 045.12
COMPUTER MATERIALS	168 235.30	5 877.15
CONSULTATION FEES	1 056 558.00	1 018 932.62
CONSUMABLE MATERIALS	73 128.65	5 312.63
COPY AND PRINTING	22 514.69	32 805.29
COURSES	42 225.87	-
ELECTRONIC COMPONENTS	696.41	6 363.62
ENTERTAINMENT: GENERAL	128 691.98	21 597.86
FOREIGN EXCHANGE LOSS	76 745.41	121 482.93
FUEL, OIL, LUBRICANTS	21 007.73	2 089.66
GENERAL OFFICE COSTS	11 490.08	2 999.00
GENERAL VEHICLE EXPENDITURE	-	135.00
GIFTS	2 149.90	980.00
ICRR (INDIRECT COST)	8 524 672.11	1 111 439.17
INS, LICENSES & 3RD PARTY	353.71	1 308.34
INTEREST PAID: INTERNAL APPOR	1 021.42	80.07
INTEREST: CREDITORS	18.75	-
INTERNET NETWORK EMAIL LEVY	116 409.11	62 332.60

For the period ending :	31/12/2021	31/12/2020
KKW NON-CAPITALISED	14 581.09	-
LIQOUR AND SOFT DRINKS	-	1 082.48
MAINTENANCE OF APPARATUS	600.00	24 562.53
MEDICAL EXPENSES	16 353.01	-
NON-CAPITALISED BOOKS	1 109.40	-
PHOTOGRAPHIC EXPENDITURE	53 400.00	100.00
POSTAGE AND COURIER SERVICES	5 342.73	20 829.56
PRIZES AND MEDALS	5 500.00	-
PROMOTION MATERIAL	-	1 315.89
REFRESHMENTS: NON ACADEMIC	57 964.84	18 515.07
RENT OF EQUIPMENT GENERAL	77 640.00	14 584.52
RENT OF ROOMS	-	16 699.05
RESEARCH PUBLICATIONS	126 944.84	-
RESERCH CONTRACT CONDUIT PAYME	6 548 786.94	5 655 799.15
SECURITY SERVICES	244.02	-
SERVICES	2 496 705.42	1 403 133.69
SMALLER FURNITURE AND EQUIPMEN	204 429.01	102 378.74
SOFTWARE	55 133.19	147 647.87
STATIONERY	27 382.51	20 656.87
SUBSCRIPTION & MEMBERSHIP FEES	257 468.39	21 363.13
SUBSCRIPTION BOOKS & MAGAZINES	14 950.00	-
TELEPHONE: CALLS	3 619.92	4 682.76
TELEPHONE: RENT	27 498.30	26 620.23
TOTAL REMUNERATION	10 799 311.43	9 781 334.11
TRAVEL: ACCOMMODATION VISUM PA	258 991.67	132 451.45
TRAVEL: FOREIGN TRAVEL SUBSIST	207 210.96	176 325.45
TRAVEL:DAILY ALLOWANCE AIR CAR	296 737.44	124 947.38
US - MUN ELECTRICITY	200.00	-
WORKSHOPS	316 191.19	84 078.75
ASSET TRANSACTIONS PROFIT/LOSS: ASSETS	-	(680.00)
ASSET PURCHASES	883 081.46	193 549.74
OPERATING LOSS/(SURPLUS) FOR THE YEAR	**(35 876 139.84)**	**13 061 667.89**
FUNDS TRANSFERS	**2 827 897.06**	**1 553 931.48**
TRANSFERS FROM	20 023 743.40	11 391 535.46
TRANSFERS TO	(17 195 846.34)	(9 837 603.98)
NET LOSS/(SURPLUS) FOR THE YEAR	**(33 048 242.78)**	**14 615 599.37**
Plus: ACCUM FUNDS AT THE BEGINNG OF THE YEAR	**(16 666 714.39)**	**(31 282 313.76)**
ACCUM FUNDS AT THE END OF THE YEAR	**(49 714 957.17)**	**(16 666 714.39)**

Reinet Uys: Director Financial Services

1/3/2022

Date

FINANCIAL POSITION OF THE CENTRE

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

CRSES received 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 the running expenses of the CRSES as well as funding for the renewable energy spokes. In 2021 a total amount of R20 781 464.13 was paid to the CRSES. This includes a total of R 8 424 000.00 earmarked for the various spokes, i.e. Solar Thermal Spoke at Stellenbosch University and University of Pretoria, the Wind Spokes at Stellenbosch University and University of Cape Town, the Photovoltaic Spokes at Univeristy of Fort Hare and Nelson Mandela University. An amount of R10 799 311.43 was spent on salaries of the Director, senior academic staff and administrative staff. R4 038 599.60 was paid out as postgraduate bursaries.

The contribution of Eskom on the EPPEI programme for 2021 was R4 437 782.51. An amount of R1 327 967.60 was spent on bursaries for postgraduate students and R1 905 167.00 was spent on salaries for the Chair, Programme manager, other academic and administrative staff.

The remainder of the income comes 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 of CRSES for all cost points, including Eskom EPPEI and project funds, is included on page 22 and 23. The overall income of the Centre until December 2021 was R73 459 412.55. This is due to the late payment of the DSI Funding for the 2020 financial year of R19 377 464.13 that was only received in the beginning of 2021 and the funding of the current financial year of R20 781 464.13. Also received in 2021 is an additional amount of R16 261 000.00 for the Masia Village, PV Marketplace App and Eastern Cape school projects.

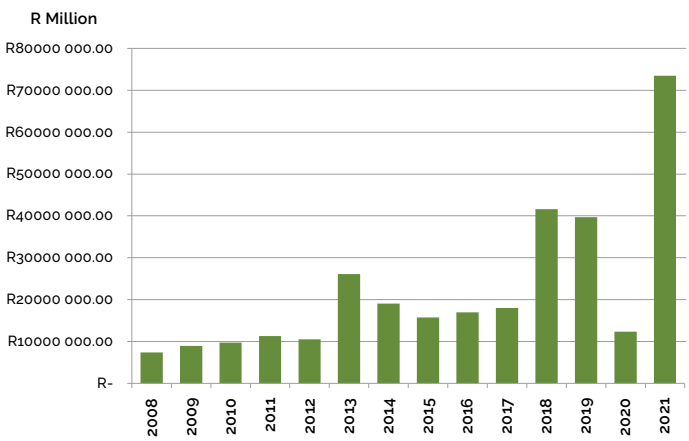
CRSES showed sustained growth in income from 2008 to 2011. In 2012, the income decreased slightly, mainly due to the decision of the DSI to transfer the Renewable Energy Bursary Programme from the Centre to the NRF. In 2013, the income of the Centre more than doubled, predominantly due to the large projects completed for Eskom and GIZ. This growth was not sustainable, as reflected in the reduced income in 2014 and 2015. This trend has reversed and income to the Centre increased in 2016 and 2017. With more than R40 million in reserves, the Centre is in a favourable financial position for 2021.

It is however anticipated that the current financial constraints within Eskom will negatively affect the future income of the Centre and it is therefore important that the Centre further diversifies current income streams.

Funds available at CRSES

	31 Dec 2020 (12 months) (R)	**31 Dec 2021** (12 months) (R)
Total Income to Date	R12 360 145.32	R73 459 412.55
Total Expenditure to Date	R25 421 813.21	R37 583 272.71
Total Transfers	R1 553 931.48	R2 827 897.06
Total Equipment Acquisitions	R193 549.74	R883 081.46
Total Post-graduate bursaries	R4 706 631.00	R4 038 599.60
Total Remuneration	R9 781 334.11	R10 799 311.43
Nett Surplus for period	R14 615 599.37	R33 048 242.78
Accumulated funds from previous year	R31 282 313.76	R16 666 714.36
Funds available 31 December	**R 16 666 714.39**	**R49 714 957.17**

Annual income of the Centre



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