CENTRE FOR RENEWABLE &
SUSTAINABLE ENERGY STUDIES

2019

CRSES ANNUAL REPORT

UNIVERSITEIT iYUNIVESITHI STELLENBOSCH UNIVERSITY 100 1918·2018

science & technology Department: Science and Technology REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation

Eskom

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FOREWORD

2019 was an exciting year for renewable energy in South Africa, most notably with the release of the Integrated Resource Plan (IRP) by the Department of Energy (DoE) in October. IRP 2019 outlines the country's plan for the procurement of generation capacity up to 2030. Significant generation capacity has been allocated to renewable energy, importantly 6000 MW of new Solar PV capacity and 14,000 MW of new Wind Power capacity to be procured. This is positive news for us at the CRSES as it signifies a far more de-carbonised future for electricity generation in South Africa.

Work at CRSES was equally exciting and we had a busy year. We welcomed new members to our team. Ms Linda Joka joined our Marketing and Communications department. Mr Simnikiwe Gulwa was promoted from being an Intern to a Research Engineer. We also welcomed Dr Justice Chihota as a Research Fellow, who later received his PhD in December. We would like to congratulate Dr Justice Chihota on his achievement, and wish him well in his future endeavours.

The year 2019 was the second year of our 5-year strategic plan (2018 – 2022) and we made significant progress in relation to the targets set out in the strategic plan. Regarding Human Capital Development targets, we trained two interns and continued our work with two postdoctoral fellows and we made significant progress in relation to our targets. Two of our PhD candidates attended a summer school in Denmark, gaining valuable skills in the field of data science applied to power systems studies. With regards to student outputs we had fourteen students graduating with their Masters and PhDs. We also funded fifteen Stellenbosch University students from the DSI's Energy Research Programme, and a further nine students received funding from the Eskom EPPEI Power Systems Studies Programme. Additional funding from the Eskom EPPEI programme was also allocated to UCT, NMU, CPUT, CUT, and TUT Students for bursaries and research running costs.

In terms of knowledge creation and transfer, we had good attendance for our renewable energy short courses from industry participants and we also delivered individualised training on various renewable energy software. In addition, we delivered a "train the trainer" course on all technical aspects of solar thermal systems for twenty people from local solar thermal technologies installation companies.

We continued our awareness and advocacy efforts. Through the Schools' programme we trained one hundred and eighty-three (183) learners and 18 educators. Researchers, staff members and students also attended various conferences nationally and internationally, some presenting their cutting-edge research articles. CRSES also hosted the Renewable Energy Post-Graduate Symposium, (REPS) and collaborated with the University of Fort Hare to host the Southern African Solar Energy Conference (SASEC). Both the latter conferences were extremely successful, and SASEC had significant international presence with very good articles presented by invited guests and delegates including students.

CRSES continued to perform well financially, with significant revenue growth recorded for two consecutive years.

I would like to take this opportunity to express our utmost gratitude to our Management Committee, Advisory Board, partners, funders, collaborators, students and staff both within CRSES, at the Faculty of Engineering and Stellenbosch University in general. I believe that our achievements are as a result of collective efforts.

Prof Sampson Mamphweli

BUILDING HUMAN CAPITAL

Human Capital Development is at the heart of the strategic focus areas of the South African government, particularly in scarce skills areas such as renewable and sustainable energy, and power systems research. The Centre for Renewable and Sustainable Energy Studies is well positioned to assist the national government in developing people in these areas of specialisation and strives to produce highly skilled scientists, engineers and academics who will be able to compete successfully in the global knowledge economy. This is achieved mainly through the training of interns, Masters and PhD candidates, interns and Postdoctoral Fellows.

Practical support is provided in terms of project supervision, financial assistance, practical tasks and mentoring, and training in soft skills. While interns are mostly South African, the Centre does extend intern opportunities to foreign interns/exchange students as well. During 2019 these included:

- Stephen Lee from MIT, USA
- Nametso Moumakwa from BUST, Botswana
- Katharina Bär from Technical University of Inglostadt, Germany
- Adelia Chikombo a PhD candidate at Stellenbosch University funded through the AIR project as part of capacity building for Eduardo Mondlane University in Mozambique.

Intern:

Mbulelo Mabhoko

My internship with the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University commenced in April 2019 and ended in March 2020. Completion of the internship ensured that I would obtain my National Diploma in Electrical Engineering from Cape Peninsula University of Technology (CPUT).

During my tenure as an intern I attended two renewable energy courses: Introduction to Solar Energy as well as Advanced Photovaoltaic (PV) systems. Both courses greatly improved my knowledge of renewable energy in general and solar energy in particular.

At CRSES my focus was to analyse Small-Scale Embedded Generation (SSEG: rooftop PV) grid tied systems in South African municipalities, specifically tariff structures, regulations and policies as well technical issues encountered on the grid due to SSEG systems. I was given individual training on several renewable energy simulation software packages including PVSyst, Homer Energy and Homer Grid and was afforded the opportunity to complete several design projects. I also participated in building a small demonstration wind turbine. I believe that this knowledge will definitely give me an edge in a professional environment.

My internship at CRSES culminated in co-authoring a paper titled *Comparing long term versus Simulated PV System performance: A Review and Case Study.* The particular case study was a 22.5kWp PV system instaqlled on a rooftop at Stellenbosch University. I presented the paper at the Southern African Solar Energy Conference (SASEC 2019) hosted by the University of Fort Hare at Mpekweni Beach Resort in the Eastern Cape. This was a personal highlight.

The CRSES experience was far beyond my expectations and I am eternally greatful to colleagues, mentors and in particular, my supervisor. I was given excellent advise on professional etiquette and how to carry myself in life in general, and I believe I have grown tremendously as a result.

Intern:

Thabang Mosaka

My Internship at the Centre for Renewable and Sustainable Energy Studies (CRSES) began in April 2019 and ended in March 2020. During this period I attended two short courses on renewable energy namely: Renewable Energy Policy as well as Sustainable Development. The courses have sparked my interest in the renewable energy sector, particularly policy development.

I was afforded the opportunity to write a literature review on renewable energy policies in different countries under the supervision of a senior research engineer, Mr Ndamulelo Mararakanye and the Associate Director of CRSES, Dr Bernard Bekker. Both gave me considerable guidance on how to approach research topics and write in a manner that is logical and effective. This has given me invaluable preparation for future research writing.

My day to day functions included working with the Bio-refinery research group at the department of Process Engineering. I was trained on using different substrates such as seaweed, paper sludge, food waste, etc to produce biogas for heating under anaerobic digestion. I was also trained on operating an Automated Methane Potential Test System as well as a Compact Gas Chromatography. I was later given the responsibility to train Masters Students on how to operate the two systems. Through this experience I learned how to interact with people at different professional levels, from senior academics to students.

I am very grateful to CRSES for the opportunity given to me as I have grown both professionally and also as a person.

Research Fellow:

Justice Chihota

My involvement with CRSES started in 2018 when I was privileged to receive a bursary for the final period of my PhD studies. Upon submission of my PhD in March 2019, I joined the Centre as a Research Engineer focussing on power system planning considering renewable energy integration.

Power systems are experiencing an increased uptake of distributed energy resources (DERs) such as photovoltaic (PV), wind power, battery energy storage systems (BESS) and electric vehicles (EVs). While several benefits can be derived from DER penetration, several technical issues may result. For these issues, the severity depends on the conditions and level of penetration. Understanding the technical impacts of DERs is critical for power system planning; the definition of limits for penetration is required for uptake regulation on existing networks, and then, for new electrification systems, the uptake of DERs demands new planning principles such that the sizing and selection of network equipment (e.g. conductors and transformers) considers scenarios of DER uptake. While doing this, the uncertainty associated with the power system – the stochasticity of the load demand, and the uncertainty of the location and capacity of DERs – must be considered. My research addresses these issues through the development of stochastic-probabilistic approaches for load flow analysis and DER impact assessment studies. The relevant technical tools are necessary for optimal planning; avoiding the under-utilization of DER capabilities and ensuring system reliability through risk-based planning.

CRSES has afforded me a strategic platform to conduct my research on renewable energy integration. The centre is an appropriate hub for my research for several reasons: Firstly, the focus on renewable and sustainable energy means that the workplace is endowed with specialists in the subject, which exposes me to a strong resource of knowledge relevant to my research. The expose facilitates career development, by expanding my knowledge in some of the key areas that support my core research. Secondly, working with Dr Bernard Bekker (as my host) is strategic as he is the chair of the Renewable Energy Research division of Eskom's power plant engineering institute (EPPEI). This opportunity allows the alignment of our research with industry needs, ensures practical outcomes, and favours industry collaborations. Lastly, CRSES – through its diverse project portfolios, forums and other technical events – has linked me to a rich network of researchers, experts and key industry players in the renewable energy sector. This has proven to be beneficial for the advancement of my work.

As further development of the ongoing research, I intend to delve into the autonomous control of inverters for active regulation of power injections (from PV, wind, and BESS) and charging (EVs and BESS), as well as the management of ancillary services from the inverter systems. This work forms the scope of my anticipated role as a post-doctoral fellow in the 2020-2021 calendar year.

Post Doctoral Fellow:

Dr. Fumni Faloye

Bioenergy continues to show great potential as a renewable alternative to fossil fuel with tremendous growth potential when properly annexed. My research is focused on the development of production technologies for anaerobic digestion of organic wastes for biogas production.

I have been actively involved in research focusing on strategies for enhancing anaerobic digestion while exploring the new potential for biogas technology application in the household, agricultural, and industrial sectors. Results from these research engagements have yielded positive outputs such as the potential for an integrated anaerobic digestion technology and agro-industrial system to harness the benefit of a circular bio-economy.

My roles also include developing research capacity by providing support to postgraduate students who are also funded by the CRSES on projects that bridge the knowledge gaps in the development of viable bioenergy system and unlocking the potential for biogas production as a source of renewable energy in South Africa.

The support from the Centre has been enormous not only by funding my research but also by providing mentorship and guidance that has helped to broaden my research expertise.

Intern visiting Sauran measuring station

BUILDING HUMAN CAPITAL continued

2019 Graduates

The students listed below graduated during the year under review. Where available, their theses and dissertations can be found at www.crses.sun.ac.za/research-completed.php.

Name	Initial	Programme	Supervisor/Bursary
April 2019			
Ms Kell-Blair	K	MEng (Research)	Supervisor/Bursary
Ms Strydom	A	MPhil	Supervisor/Bursary
Mr Farmer	W	MEng (Research)	Supervisor/Bursary
Mr Naude	H	MEng (Research)	Supervisor/Bursary
Mr Steyn	A	MEng (Research)	Supervisor/Bursary
Ms Kanhukamwe	F	MEng (Research)	EPPEI
Mr Soni	M	MEng	EPPEI
Mr Shuda	E	MEng (Research)	Scatec
Mr Coetzer	K	MEng (Research)	Scatec
Dr Mokomela	T	PhD	Supervisor/Bursary
Dr Pitot de la Baujardiere	JFP	PhD	Supervisor
Mr Koegelenberg	DJ	MEng (Structured)	Supervisor
Mr Oluwusi	OI	MEng (Structured)	Supervisor
Mr Piessou	C	MEng (Structured)	Supervisor
Mr Taljaard	PD	MEng (Structured)	Supervisor
Mr Basson	EJJ	MEng (Research)	Supervisor
Mr Erasmus	SJ	MEng (Research)	Supervisor
Mr Fourie	DM	MEng (Research)	Supervisor
Mr Grobbelaar	D	MEng (Research)	Supervisor
Mr Joubert	H	MEng (Research)	Supervisor
Mr Schommarz	TM	MEng (Research)	Supervisor

Name	Initial	Programme	Supervisor/Bursary
December 2019			
Dr Bradby	L	PhD	Bursary
Dr Groch	M	PhD	Supervisor/Bursary
Dr Erfort	G	PhD	Supervisor
Mr Kehinde	A	MEng (Research)	Supervisor/Bursary
Mr Bekker	G	MEng (Research)	Supervisor/Bursary
Mr Ollier	NN	MEng (Structured)	Supervisor
Mr Lubbe	JF	MEng (Research)	Supervisor

The Students below graduated with a Postgraduate Diploma in Engineering: **Renewable Energy**

Name	Initial
April 2019	
Mr Shahonya	IN
Ms Mohlotsane	TV
December 2019	
Mr Addison	MP
Ms Nigrini	V
Mr Nullah	P
Ms Tshuma	P

Graduated bursary students

	2006-2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	**Total**
MPhil/MEng/MFor	19	3	6	0	5	2	2	2	8	2	**49**
MSc/MScEng/MCom/MEng (Research)	26	8	10	4	16	15	6	12	7	9	**113**
PhD	4	0	3	2	4	2	1	3	4	3	**26**
Total	**49**	**11**	**19**	**6**	**25**	**19**	**9**	**17**	**19**	**14**	**188**

Awards

EPPEI Student Workshop

The 6th Eskom Power Plant Engineering Institute (EPPEI) Student Workshop was held at the Eskom Academy of Learning (EAL) in Midrand from 21-22 August 2019. The workshop was themed: *Creating business agility through EPPEI research and innovation – supporting Eskom in a world of rapidly changing power utility operating and business models.* During the workshop, more than 25 EPPEI sponsored students presented their research on variety of topics, including: emissions and drought, power plant condition monitoring, cooling systems, asset management, materials and renewable energy.

CRSES, being the home of EPPEI Specialisation Centre in Renewable Energy, was well represented in the workshop.

Ndamulelo Mararakanye, a research engineer from CRSES, gave a presentation on *investigating renewable energy curtailment as a flexibility resource in the future South African grid.* Courtney Rhoda, an MEng student in Electrical and Electronic Engineering Department, gave a presentation on *impact assessment of electric vehicles on low voltage distribution network.* Dr. Justice Chihota, a postdoctoral fellow from CRSES, gave a presentation on *transform for probabilistic voltage computation on distribution feeders with distributed generation.*

In their respective sessions, Ndamulelo Mararakanye and Courtney Rhoda won the award for the Best Student Presentation.

CRSES-Supported PhD students Bring 4IR expertise home.

Data science is becoming important in the operation and planning of electric power systems across the world. Driven by the development of information and communication technology, an information layer is now added to the conventional transmission and distribution networks for data collection, storage and analysis.

Stellenbosch University increased its knowledge and network in the field of data science applied to power systems through two PhD students that attended a summer school on this topic at the Technical University of Denmark (DTU), situated in Copenhagen, Denmark. Ndamulelo Mararakanye and Amaris Dalton, both funded by the CRSES, attended the DTU summer school during June 2019. The school focused on data-driven analytics and optimization for energy systems, and brought together academics and industry professionals from around the world. During the intensive 5-day course the attendees learnt about the latest developments and methods in this field, exchanged ideas and built professional networks.

Activities such as this are central to CRSES's mandate, to produce highly skilled scientists, engineers and academics in the field of renewable energy who will be able to compete successfully in the global knowledge economy and support the 4th industrial revolution.

Students in training

TRAINING

Continuous learning structured in a flexible manner is key to staying abreast of today's fast changing engineering landscape. CRSES acknowledged this fact back in 2013 already, when the Centre was instrumental in launching the Renewable and Sustainable Energy post-graduate programmes within mechanical and mechatronic engineering department. The offering has been broadened to include programmes in Electrical and Electronic Engineering as well as the School of Public Leadership.

A wide variety of stand-alone block modules can be attended towards Continuing Professional Development (CPD) points allowing members of industry to increase their knowledge of specific subjects without the time commitment required for enrolling in a post-graduate programme.

Short course attendance in 2019

Module	Total	Coursework	Research	Staff	Executives
Renewable Energy Systems	41	39		1	1
Renewable Energy Policy*	57	52	1	2	2
Thermal Energy Systems	13	12			1
Introduction to Solar Energy	17	15			2
Advanced Photovoltaic Systems	11	6		1	4
Renewable Energy Finance*	63	61		0	2
Wind Energy	10	10			
Integrated Supply Side Technology	27	21			6
Energy Storage	34	25			9
Bioenergy	16	15			1
Hydro & Ocean Energy	6	6			
Total students trained 2019	**295**	**262**	**1**	**4**	**28**

* These courses are not technology focussed and are presented by the School of Public Leadership in the Faculty of Economic and Management Sciences.

Renewable Energy Software Training

CRSES offers training and support on renewable energy software. This support is structured flexibly rather than offered as a fixed term short course. The training is suitable for, but not limited to – installers, engineers, technicians, architects and researchers.

During the period under review, individualised training was conducted for the following renewable energy software:

- **PVSyst –** This software allows for the solar simulation of Photovoltaic (PV systems in order to investigate the feasibility of projects, establish performance predictions of systems and to optimise installations or additions to installations.
- **PolySun –** This software supports the modelling and simulation of small to large scale solar thermal systems for residential, commercial and industrial applications.
- **Power Factory (DigSilent) –** This is a power analysis software application for use in analysing generation, transmission, distribution and industrial systems.
- **Homer Pro –** This is a software application for optimising microgrid design in all sectors.

Workshops and Lectures Presented in 2019

SOLTRAIN Train the Trainer Course - 23 – 25 September 2019

The 'Train the Trainer' Course was hosted by the Centre for Renewable and Sustainable Energy Studies and AEE-Intec as part of the Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN). The course was presented at the Stellenbosch Institute for Advanced Study (STIAS) from 23 to 25 September 2019 and was attended by 20 people from local solar thermal installation companies in the region. Mr Rudi Moschik from AEE-Intec and Mr Angelo Buckley from CRSES presented the course. The material covered all technical aspects of solar thermal systems for small- to large-scale applications and provided attendees with the necessary skills for effectively designing and sizing system for practical applications. This training course was the first of three to be hosted by the CRSES during Phase 4 of the SOLTRAIN project, running from 1 July 2019 to 31 December 2022.

Brulpadda – A Game Changer?

On 6 March 2019 Mr Steve Clark, a PhD student in the Mechanical Engineering department presented a lecture on a gas field discovery in South Africa. Mr Clark is a member of the Solar Thermal Research Group (STERG) and presented the lecture in collaboration with CRSES. Mr Clark has extensive experience in gas development business, having had assignments in USA, Europe, South America, Asia and Africa. His analysis went behind the headlines that the Brulpadda gas field has generated, providing a review of the discovery and its development. The lecture included the description of prospect, the probable size of the field, the likely development options and how the gas field fits into the energy mix in the country. Students and academics from Stellenbosch University, University of Cape Town, Cape Penninsula University of Technology, other institutions as well as members of industry and the public were invited to attend the lecture.

SOLTRAIN Train the Trainer Course participants

RENEWABLE ENERGY RESEARCH AND MARKET TRANSFORMATION PROJECTS

CRSES aims to facilitate the transformation of the energy sector in South Africa and other African Markets by moving away from fossil-based energies to exploring the viability of installing renewable energy systems.

V&A Waterfront Wharf – Battery Storage Feasibility Study

The Centre for Renewable and Sustainable Energy Studies (CRSES) was contracted by V&A Waterfront Holdings to conduct a battery storage feasibility study for the V&A Wharf during 2019. The study built on the results of the PV feasibility study which was done during 2015 for the same building. The client's interest in the use of solar PV and battery storage solutions is to not only to contribute to their energy mandate but also provide means of "smart" energy usage in buildings with high electricity demand throughout the day.

The study investigated the use of an optimal battery storage capacity for energy arbitrage and peak shaving which would provide the client with the maximum financial benefit over its operational lifespan. This research study was successfully completed with promising results for the client and is expected to be implemented in coming years.

Potential PV penetration in the Western Cape

The Centre completed a study on the potential PV penetration in the Western Cape. A workshop sharing the outcome of the study with various interested parties from the Western Cape Government, City of Cape Town, Green Cape, and Eskom.

The purpose of the study was to determine the potential impact from disaggregated solar photovoltaic (PV) electricity generation on the municipal and Eskom distribution (Dx) and transmission (Tx) networks in the Western Cape for Eskom. The overall aim of this research is to stimulate investment in private and public PV installations by supporting informed decision-making by both the private and the public sectors.

This study will integrate and consolidate existing research for implementation of PV and build on this base. The study has three focus areas:

1. **PV Implementation**
   The disaggregated PV implementation will determine how much PV can be implemented seamlessly in likely uptake areas before congestion will occur. It will highlight network capacity and indicate an achievable role out plan at a granular level.
2. **Impact on network design**
   The impact of high penetration will indicate network strengthening design needs, in order to integrate all the identified PV. This will be compared with current proposed strengthening to determine projections in terms of future capital to integrate the PV.
3. **Emerging technology research**
   Research into the implementation of new storage technologies, including optimal size and siting, will be identified. The emerging technologies' ability to perform voltage control , load shifting and mitigation and intermittence will be evaluated.

Within the above focus areas, the key issues of security of supply, impact of cloud-cover, rapid voltage change, QOS, and others will be taken into consideration. The appropriate potential volumes of PV and storage can be derived from the cities' spatial planning and utilities development plans.

Future Electricity Generation At Local Level

This three-year project, funded by the Nedbank Green Trust, is a collaborative effort between WWF-SA and CRSES. The project assists local governments with the development of policies and models that facilitate the integration of decentralised renewable energy without depleting municipal revenue.

An agent-based decision making tool to support policy makers dealing with residential rooftop PV is under development. The tool will measure how, and to what extent, individual choices pertaining to the installations of residential rooftop PV are both influences by the state of the system and influences the state of the system in turn. The tool was demonstrated to, and discussed with, the Municipalities of Mossel Bay, George, Nelson Mandela Bay and Buffalo City, who all provided valuable feedback and inputs.

Three academic papers were delivered in 2019 and an accessible briefing paper that disseminates some of the initial findings of the project to a wider audience.

WWF Energy briefing paper: *Residential investment in rooftop solar PV. What does it hold for the future?* This briefing note provides a snapshot of the issues with household rooftop PV installations as well as action points to work towards environmentally friendly, socially just and financially sound electricity system for municipalities. It is published on the CRSES and the WWF-SA websites.

The Association of Municipal Electricity Utilities 27th technical convention (AMEU) 2019 (13-16 October, Cape Town): *Understanding solar photovoltaic investment decisions in the residential sector in South Africa: A technical analysis?* This paper discusses the unique South African municipal environment in the context of household rooftop PV installations and explains the investment decision-making process from the household perspective. Through System Dynamics Modelling it maps out the South African local energy transition, based on a household rooftop PV investment survey, conducted by WWF-SA and Stellenbosch University in 2018. The paper is available on the CRSES website.

Solar World Congress 2019 (4-7 November, Santiago, Chile): *Consumption Patterns in the Residential Electricity Market; a Decision Making Tool.* This paper introduces the agent-based decision making tool that has been developed to support policy makers dealing with residential rooftop PV. The paper was accepted for publication in the conference proceedings.

Southern African Solar Energy Conference (SASEC) 2019 (25-27 November, East London): *Integration of solar energy into the grid: technical or social challenge? Building a collective vision.* In this paper, the financial implications of household rooftop PV installations is analysed, pointing to a strong financial incentive for households to flaunt the law by not registering their systems. The paper concludes that there is a need for a common understanding of both the opportunities and limitations presented by rooftop PV.

CRSES launches improved SAURAN website

The Southern African Universities Radiometric Network (SAURAN) program, in an initiative of The Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University and the Group for Solar Energy Thermodynamics (GSET) at The University of KwaZulu – Natal.

SAURAN makes high-resolution, ground based solar radiometric data available from 23 weather stations located across the Southern African Region including South Africa, Namibia and Botswana. Most of the stations provide direct normal irradiance (DNI), global horizontal irradiance (GHI) and diffuse horizontal irradiance (DHI) at 1-minute, hourly and daily time averaged intervals. Measurement data may be downloaded free of charge from the SAURAN website, subject to the conditions of use outlined on the site. The availability of free data encourages and enables research in the field of renewable energy as well as other meteorological related fields.

An updated website has been launched, with improved features including:

- A renewable energy simulator that models the contribution of various renewable technologies at multiple locations in Southern Africa.
- Information for the end user relevant to quality checking data, which is imperative when conducting research.
- The current status of the station the end user may wish to download data from.
- The earliest and latest dates of available data per station.

For further information, visit the website at sauran.ac.za.

AWARENESS AND OUTREACH

The Centre's Schools Programme

At CRSES we realise that it is imperative to raise children's awareness of climate change and renewable energy. As such the Centre has developed a set of materials for teachers, in line with South Africa's Curriculum and Assessment Policy Statement (CAPS).

The material developed enhances the renewable energy sections in the curriculum of the following subjects:

- Geography for grades 10 – 12
- Natural Science for grades 7 – 9
- Mathematics for grades 7 – 9
- Physical Science for grades 10 – 12

During 2019, the following schools received training:

School name	Number of learners	Number of teachers	Grade
Good hope primary school	26	1	7
Hidayatul Islam primary school	27	1	5
Khayamandi primary school	48	2	6
A.F Louw primary school	44	2	7
Private Academy	18	1	6
Hidayatul Islam primary School	20	1	7
Vhembe district: Limpopo	None	10	10 & 11

The table below summarises the number of educators and learners that have been trained since inception.

Year	Schools	Educators	Learners
2008	3	3	
2009	18	27	
2010	119	117	
2011	72	110	
2012	30	40	
2013	99	103	
2014	277	376	230
2015	73	167	963
2016	88	146	70
2017	20	52	546
2018	88	149	961
2019	15	18	183
Total	**878**	**1,306**	**2,878**

Delegates and Speakers at SASEC 2019

REPS – Renewable Energy Post Graduate Symposium

The keynote speakers at the Renewable Energy Postgraduate Symposium (REPS) held at Stellenbosch University on 17 and 18 July emphasized the need for relevant, perhaps even bankable research. *"Academic research needs to come out of the lab and onto commercial spaces,"* said Mr. Cebo Silinga as he presented instruments from the Technology Innovation Agency (TIA) designed to accomplish just that. Mr. De Wet from Innovus, expanded on this sentiment, inviting students to use this Stellenbosch University based institution to apply for patents and *"take their research to the market"*. Interactions with the audience in their sessions highlighted the need to find a balance between commercializing tech-research versus publishing in academic journals.

Ms Kubeshni Bughwadin from Eskom gave a macro view suggesting that Renewable Energy was a key driver of the Fourth Industrial Revolution. The ensuing robust engagements with her presentation brought to the fore an underlying concern by students as to the readiness of the African continent for the pace and nature of change. *"We need to decide whether we are leaders of quick followers"* was the challenge Ms Bughwadin left for the students to mull over.

Scatec's Abri Stegmann allowed the students to peek into the future, and see a different set of challenges they may face after their studies. He presented *"The design and construction of utility scale PV plants"* in which he gave actual examples of having to build under difficult locations and environments. These include swamp land, desserts, thick jungle, monsoon areas, regions with heavy snowfall and sub-zero temperatures as well as remote areas with a weak grid.

The 10th REPS hosted by the Centre for Renewable and Sustainable Energy Studies (CRSES) and held simultaneously with the 6th annual STERG Symposium was thus in full swing. The symposium is a CRSES annual event in which post graduate students conducting their research in the renewable energy fields are afforded the opportunity to present their research to their peers. This provides them with a less intimidating environment in which they freely share their research.

Students who presented came from various universities including Stellenbosch University, University of the Free State, University of Cape Town, Vaal University of Technology, University of Pretoria, University of Fort Hare and University of Zululand.

Delegates and Speakers of REPS 2019

SASEC - Southern African Solar Energy Conference

The 6th Southern African Solar Energy Conference (SASEC) 2019 was held from 25 – 27 November at Mpekweni Beach Resort in the Eastern Cape. The conference yet again provided an excellent platform for researchers, developers and students to share and discuss developments pertinent to Solar Energy.

The conference was hosted by the University of Fort Hare in collaboration with the Centre for Renewable and Sustainable Energy studies (CRSES) at Stellenbosch University.

In his introductory address as the chair of the conference, Professor Golden Makaka from the University of Fort Hare, highlighted the increased importance of solar energy globally.

In his opening address, Mr Mmboneni Muofhe, Deputy Director General of Technology Innovation at the Department of Science and Innovation (DSI), emphasised the importance of energy in all South African government strategies.

The conference technical programme was compiled under the auspices of an international advisory and review committee of solar energy and power systems experts. A total of 43 technical papers were selected for presentations after a rigorous peer review process.

Three keynote addresses were delivered by experts in their field.

In his keynote address, Dr Ben Kroposki, the Centre Director of Power Systems Engineering at the National Renewable Energy Laboratory (NREL) in the USA, focussed on the integration of high levels of photovoltaics (PV) into existing power systems.

Dr Paul Gauché, the Manager of Concentrating Solar Power (CSP) Technologies at Sandia National Laboratories, USA, spoke about current research and development pertinent to cost reduction, autonomy and seasonal storage of CSP in his keynote address.

In his keynote address, Mr Riaan Meyer, the Managing Director of GeoSUN Africa, a spin-off company of CRSES at Stellenbosch University, focused on new trends in solar resource assessment.

On the last day of the conference, delegates had the opportunity to visit the ILB Helios PV manufacturing plant and the Science and Technology Park at the East London Industrial Development Zone, hosted by the Eastern Cape Department of Economic Development, Environmental Affairs and Tourism.

> *"Academic research needs to come out of the lab and onto commercial spaces."*

RENEWABLE ENERGY ADVOCACY, CONFERENCES AND SYMPOSIA

Powertech Africa 2019

The 3rd Annual PowerTech Africa conference was held at the Mövenpick Hotel and Residences, Nairobi, Kenya on 31st of January and 1st of February 2019.

The focus of the conference was on identifying the potential of renewable energy sources in the Sub-Saharan Regions – Wind, Solar, Tidal Wave, Geothermal, and Gas. The conference also discussed – assessment, implementation and integration of renewable energy sources, smart grid/off-grid solutions and overcoming financial and infrastructural challenges with focus on development in the Sub-Saharan region.

Prof. Sampson Mamphweli, Director of CRSES was an invited speaker. His presentation was titled *"Potential Renewable Energy Solutions for the East African market, lessons from South Africa"*. The presentation focussed on renewable energy solutions with practical references to what has been done in South Africa. Prof. Mamphweli also announced book that he is editing. He is invited potential chapter contributors to make submissions.

STERG students with Paul Gauché, PhD from Sandia Labs at Solar PACES

India – South Africa Bilateral Workshop on Renewable Energy

On 22 – 23 March 2019, 15 experts from various parts of India and 10 experts from South Africa participated in a renewable energy workshop, under the India/South Africa programme of Cooperation in Science and Technology. The workshop, which took place at The Indian Institute of technology (IIT), Delhi was coordinated by Prof Sukumar Mishra from India (IIT Delhi) and Prof Sampson Mamphweli, Director: CRSES from South Africa. Mr Sanjeev Varshney, Head: International Bilateral Cooperation gave an overall perspective of India-South Africa R&D collaboration and expectation from the workshop.

Dr. Sanjay Bajpai, Head, Technology Missions Division (energy, water and all other) gave a glimpse of Indian research and development programmes on renewable energy.

The experts identified several a`reas of collaboration in renewable energy. The National Research Foundation (NRF) of South Africa will issue a call for proposals with a focus on the agreed areas of collaboration. The NRF will also provide funding for the successful proposals.

EMC Europe

The EMC Europe 2019 Conference tool place from 2 – 6 September 2019 in Barcelona Spain. Mr. Kurt Coetzer, a post graduate student was was co-sponsored by CRSES to attend this conference where he presented a paper titled: "Investigating Lightning Induced Currents in Photovoltaic Modules." "I found the conference to be highly elevant to my research topic as it had sessions relationg to computational electromagnetic simulation methods, the computational modelling of lightning, electromagnetic compatibility problems associated with power systems, lightning-based real-world experimentation, time-domain EMC measurements, and transient EMI" said Mr Coetzer. "In addition to the many interesting workshops and presentations which were directly applicable to my research, the conference also offered networking opportunities within the EMC community."

In total , over 700 participants from 44 countries were in attendance. The conference included interactive sessions, such as the three-part workshop chaired by Andy Plumer from Lighting Technologies, Inc.

Solar PACES

The 26th annual Solar PACES conference took place from 01 to 04 October 2019 in Daegu, South Korea. Ziyauddin Panchbhaya presented a paper he co-authored with Jaap Hoffmann titled: *"Design Process and Optimization of Helically Twisted Tapes as a Suitable Insert for Heat Transfer Enhancement in Solar Receiver Tubes."* Panchbhaya gave an oral presentation on 03 October in the category of Heat Transfer Fluids.

Dewalt Erasmus had a poster presentation at Solar Paces. "Energy storage appears to be the most valuable benefit of CSP" he commented about the presentations he saw at the conference. Erasmus met key authors in his research area, including the inventor of the Tulip receiver and CTO from AORA Solar, the inventor of the radial and axial impinging jet based receivers from KTH, Sweden, Reiner Buck from the DLR, as well as Paul Gauche and Clifford Ho from Sandia Labs, USA.

AMEU

The 27th Association of Municipal Electricity Utilities (AMEU) technical convention was held at the CTICC in Cape Town form 13 – 16 October 2019. The theme of the convention was "the 4IR, Building the Power Utility of the Future today. The central question was what must utilities do to safeguard their relevance in the electricity market?

Karin Kritizinger and Nikkie Korsten, two researchers at CRSES as well as Louise Scholtz from WWF – SA presented a paper titled: "Understanding Solar Photovoltaic investment decisions in the residential sector in South Africa: A technical Analysis". The paper introduces System Dynamics Modelling techniques as an approach to develop a better understanding of the complexity and the interconnectedness of many factors that influence the decision making of actors, ranging from the household's motivation to invest to local government's responses to the increased investment in residential rooftop PV. The paper argues that these parties have common goals and 'wants' but have conflicting ideas on how local renewable energy should be implemented. Critical to address this impasse, would be to open up dialogue between household PV owners and municipalities.

This research is part of an ongoing project that looks into the existing electricity distribution systems at municipal level and how to implement local renewable energy in a financially viable, technically stable and safe manner. The research is a collaboration between CRSES and WWF – SA, funded by the Nedbank Green Trust.

Hessequa Sustainable Energy Workshop

Hessequa Municipality and Stellenbosch University organised a Sustainable Energy Workshop in a joint effort to establish a sustainable energy plan for the next 30 years for the municipality. The workshop was facilitated by Elaine Fouche, a PhD student from Stellenbosch University. The workshop was held at the Town Hall in Riversdale on 10 and 11 July.

Ndamulelo Mararakanye and Nikkie Korsten, attended the workshop as researchers from CRSES at Stellenbosch University. Mararakanye presented on the progress and prospects of renewable energy internationally as well as for South Africa. Korsten presented on the challenges municipalities in South Africa currently face in the light of increased private investments in rooftop photovoltaic (PV) within their jurisdictional borders. An analyses of consumer investment decision making towards rooftop photovoltaics (PV) was discussed to inform policy making in facilitating the integration of decentralised renewable energy.

This workshop aligned well with CRSES's mission to assist the public and private sector in renewable and sustainable energy challenges and solutions.

RENEWABLE ENERGY ADVOCACY, CONFERENCES AND SYMPOSIA continued

Technical tour

A technical tour with students from the Solar Thermal Research Group (STERG) as well as two staff members from CRSES took place from 8 – 12 July. CRSES was one of the sponsors for the tour. A total of 23 people travelled for 4 days visiting renewable energy plants as far afield as Upington. The plants included Xina Solar one, a 100 MW parabolic trough CSP plant, Khi Solar one, a 50 MW solar power tower CSP plant, a Scatec PV plant under construction, as well as Bokpoort CSP, a 50 MW parabolic trough CSP plant.

Solar Thermal Research Group members and CRSES staff on technical Tour

National Science Week

The National Science Week took place 29 July to 3 August. This is an annual celebration of science, engineering and technology, attracting thousands of learners and members of the public to workshops, science shows and lectures, which are held at universities, schools, science centres and public facilities countrywide led by the Department of Science and technology. CRSES collaborated with The Prof Mamphweli Foundation and hosted a number of activities in Vuwani, Limpopo.

Other Conferences attended were as follows:

Name of Conference	Date and Place	Attendees
SAPA Limpopo Provincial Conference	19 – 20 September, White, River South Africa	Prof S Mamphweli
Brics Youth Energy Agency	14 – 16 August 2019, Windhoek, Namibia	Prof S Mamphweli
Africa Power Week	9 – 13 September 2019, Johannesburg, South Africa	Prof S Mamphweli, Nikkie Korsten
CIGRE Southern Africa	1 – 5 October Johannesburg, South Africa	Dr. B Bekker and Ndamulelo Mararakanye
ISES Solar World Congress 2019	3 – 8 November, Santiago, Chile	Karin Kritzinger and Angelo Buckley
Engineering Open Day	23 February	All CRSES staff

Delegations visiting CRSES

- **The Deputy Minister for the environment of the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety, Ms Rita Schwarzelühr-Sutter and her colleagues visited the Centre on 11 February 2019.**

- **The Austrian Ambassador to South Africa visited CRSES on 26 February 2019, to discuss the Soltrain project.**

- **The Director General of the Department of Science and Innovation (DSI) visits CRSES:**

  Dr Phil Mjwarha, Director General (DG) at the DSI, visited CRSES on October 9. The DG was at the Centre to find out on progress made on two specific ERP projects, the Helio 100 as well as the Solar Turtle, a spin off company of the CRSES. The DG was accompanied by the Deputy Director General (DDG), Mr Mboneni Muofhe, Chief Director: Hydrogen and Dr. Rebecca Maserumule, Director: Transport Fuels Mr Somila Xosa, Deputy Director: Transport Fuels Ms Tumi Mailula as well as an intern Ms Maketele Monyemangene. After presentations to update the delegation on the status of the projects, a site visit was conducted at the Mariendahl farm, situated 12 km from the university. The Helio 100 project is situated on the said farm.

caption needed.

DSI delegation visits CRSES

INTERNATIONAL COOPERATION

At CRSES we believe that in order to succeed in our field, we need collaborations. The Centre, therefore, collaborates with research universities and other institutes nationwide, on the African continent and at international level.

AIR

The Academic Initiative for Renewables (AIR) is a three-year initiative aimed at the development of undergraduate and postgraduate programmes in renewable energy at participating African universities. Funded by DAAD, the project consortium is led by Technische Hochschule Ingolstadt (Germany) and includes NMU, University of Malawi, University of Zimbabwe, University of Zambia, Eduardo Mondlane University (Mozambique), Botswana International University of Science and Technology, and Stellenbosch University, represented by CRSES. The project also provides exchange opportunities for students to attend block courses or conduct short-term projects at partner institutions.

The consortium meets twice a year, with workshops scheduled at each of the participating universities. The most recent workshop was held in Stellenbosch from 16-20 April 2018. Besides engaging in the curriculum design and development activities, members had the opportunity to visit the Palmiet Hydropower Plant, the SA Renewable Energy Technology Centre, and a sustainable community project in Belhar. The next meeting was held at the University of Zambia in Lusaka during October 2018.

NICHE Programme

Innovative ways to transfer technology and know-how, developing skills and expertise for gas, renewable energy and management in Mozambique

This programme is run together with Eduardo Mondlane University in Mozambique and the University of Groningen in the Netherlands. The expected outcome of the project is the academic and organisational capacity to develop, implement and maintain a comprehensive education programme in the field of gas and renewable energy, delivering graduates and applied research results that respond to the demands of the labour market and human needs. As part of the programme's PhD training, CRSES supervises 1 PhD student, Miss A Chicombo, from Eduardo Mondlane University, Mozambique. The project runs until May 2019.

ARUA

The ARUA is pursuing its goal of enhancing research and graduate training in member universities through a number of channels, including the setting up of Centres of Excellence (CoEs) to be hosted by member universities. A CoE is defined as "a team, a shared facility or an entity that provides leadership, best practices, research, support and/or training for a focus area."

The **ARUA CoE: Energy** is hosted by Stellenbosch University with Professor Johan Gorgens (Process Engineering, SU) and Professor Sampson Mamphweli (Director: CRSES) serving as co-directors. The aim is to bring together world-class researchers from member universities to undertake collaborative research in Energy, and is therefore an assembly point for good and committed researchers and students seeking to do cutting-edge work, with a specific focus on achieving socio-economic development in the African context.

The ARUA CoE Energy has prioritized the integration of Renewable and Sustainable Energy (RSE) into systems that address the food, nutrition and water supply challenges of Africa. Whereas energy, water and food are often described as stumbling blocks in socio-economic development, the CoE: Energy considers such integration of technologies to offer opportunities for socio-economic advancement through the associated self-sufficiency. Such integration of RSE into water and food supply systems is expected to enable sustainable intensification of agriculture, improved postharvest processing and preservation of foods, and the supply of water, as these are critically dependent on energy availability.

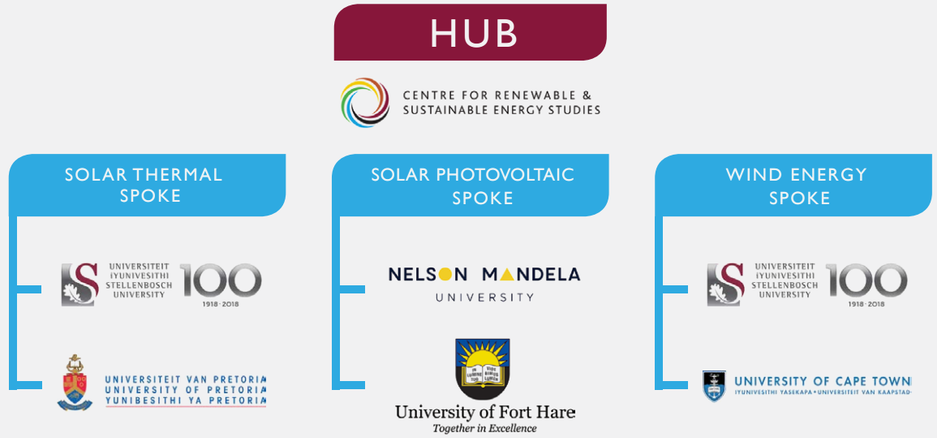
DAMOC

Funded under the Erasmus+ Key Action 2 (Capacity Building in Higher Education), the Centre, together with Technische Universität Dresden, initiated a cooperation project on the Development of a Harmonized Modular Curriculum for the Smart Grid (DAMOC). Together with two other European university partners in Sweden and Italy, and three other African university partners, two of whom are based in Tanzania, the project aims to develop education programmes on smart grid technology. Under this initiative, CRSES successfully developed a Masters programme in Smart Grid Technology, housed in the Department of Electrical and Electronic Engineering

"The aim is to bring together world-class researchers from member universities to undertake collaborative research in Energy"

ENERGY RESEARCH PROGRAMME

The Energy Research Programme (ERP) is a programme of the Department of Science and Innovation , which seeks to develop renewable energy research capacity and expertise within the national system of innovation using a hub and spokes model constituted as follows:



Great Potential for Wind

– Professor from Stellenbosch University visits Wind Institute

Prof. Kamper was impressed by the campus and the university. He was particularly pleased about the openness of the university for new ideas and concepts in the cooperation with African partners, which is the unique characteristic of the university. In his lecture he stated that hitherto the main emphasis in energy resourcing was first and foremost on fossil-based resources, but now studies distinctly showed the necessity of using wind energy in a mix of renewable energies.

Prof. Kamper is head of wind energy research at the Stellenbosch University in South Africa, and focuses his research primarily on alternative wind energy drive train technologies. His research unit forms part of the Energy Research Programme (ERP) of the Department of Science and Innovation (DSI).

The contact with Stellenbosch University stems from the PEESA-Project (Programme on Energy Efficiency in Southern Africa) of the Flensburg University. The aim of the PEESA-Project is to increase the number of highly qualified experts in the field of regenerative energies and to raise the standard of university education in Southern Africa.

"The co-operation with such a renowned university as Stellenbosch in one of our core-topics is an affirmation of our work once again. We are pleased that we could engage Maarten Kamper as a proven wind energy expert for our lecture series, and we are planning to extend the cooperation with Stellenbosch University", said Torsten Faber, Head of the WETI.

South Africa's Energy Research Program (ERP) Researcher, who leads a research spoke on wind energy technology, Prof. Maarten Kamper visited the Flensburg University of Applied Sciences. In the framework of the Wind Energy Technology Institute (WETI) lecture series, Prof. Kamper delivered a lecture on the need for wind energy and the specific research currently being conducted on this technology in South Africa with particular reference to the research supported by the National Department of Science and Innovation (DSI) under the ERP.

Wind experts: (from left): Prof. Dr.-Ing. David Schlipf (WETI), Prof. Dr. Clemens Jauch (WETI), Prof. Maarten J. Kamper (Stellenbosch University) and Prof. Dr.-Ing. Torsten Faber (Institute Director WETI)

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Articles in peer-reviewed journals

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Elaine Fouche, Alan Brent. Journey towards Renewable Energy for Sustainable Development at the Local Government Level: The Case of Hessequa Municipality in South Africa Sustainability, 11(3:755) February 2019

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Benjamin Batinge, Josephine Kaviti Musango, Alan C Brent. Perpetuating energy poverty: Assessing roadmaps for universal energy access in unmet African electricity markets. *Energy Research & Social Science,* 55:1-13. 2019

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Mararakanye N, Bekker B. Renewable energy integration impacts within the context of generator type, penetration level and grid characteristics. *Renewable and Sustainable Energy Reviews* 2019; **108**:441-451.

Conference proceedings

2019

Daniel F, Rix AJ, *"Optimising the Design of a Hybrid Power Supply Using a Genetic Algorithm".* 2019 IEEE 27th Southern African Universities Power Engineering Conference, Bloemfontein, South Africa, IEEE 2019: 269-274

Coetzer KM, Wiid PG, AJ Rix AJ, *"The MOV as a Possible Protection Measure for Bypass Diodes in Solar PV Modules'.* 7th International Conference on Clean Electrical Power (ICCEP 2019), Otranto, Italy, 2-4 July, 2019

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Erasmus DJ, Lubkoll M, Graig KJ, TW von Backström, *"Capability of a Novel Impingement Heat Transfer Device for Application in Future Solar Thermal Receivers"*. Solar Paces 2019, Daegu, South Korea, 14 October 2019.

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Popular media and Policy Briefs and Technical Reports

The Centre completed the following reports in 2019

ABSA Renewable Energy Short Reports 2019
http://crses.sun.ac.za/files/research/publications/technical-reports/Renewable%20energy%20short%20reports.pdf

Solar Water Heating Technologies, A Buckley, February 2019.
http://crses.sun.ac.za/files/research/publications/popular-media-and-policy-brief/Solar%20Thermal%20Policy%20Brief_Rev2.pdf

Solar Heat Worldwide Report Edition 2019. The solar heat worldwide report edition 2019 has been officially launched. This report provides global market development and trends for 2018 as well as detailed market figures for 2017.

It highlights the significant impact that solar heating and cooling (SHC) technologies have on the reduction of greenhouse gas emissions. A total of 480 GWth (686 million square meters) of SHC systems were in operation worldwide in 2018, saving 43 million tons of oil equivalent and avoiding 138 million tons of C02 emissions. SHC is a global business that employed about 672 000 in 2017, with an annual turnover of about USD 16.9 billion.

The report was compiled by Werner Weiss and Monika Spörk-Dür from AEE - Institute for Sustainable Technologies in Austria for the International Energy Agency SHC Programme, supported by the Austrian Ministry for Transport, Innovation and Technology. The Centre for Renewable and Sustainable Energy Studies (CRSES) collated the statistics for South Africa under the auspices of the SOLTRAIN project. Please let us know if you would like to contribute to future editions. Suggestions for improvements are also always welcome.

The full report can be accessed at http://www.crses.sun.ac.za/files/research/publications/technical-reports/SHWW_ed2019.pdf

FINANCIAL POSITION OF THE CENTRE

CRSES has three main sources of income:

- An annual core grant from the **Department of Science and Innovation**
- As the Specialisation Centre in renewable energy technology for the Eskom Power Plant Engineering Institute, the Centre hosts the Eskom Chair in Power System Simulation and receives annual funding from **Eskom**
- The remainder of the income comes from a number of **private and public entities** for contract research projects, and from short courses and in-house training courses

The annual grant from the DSI is mainly used to support the appointment of three senior academics at Stellenbosch University, provide bursaries for postgraduate students, and contribute to the running expenses of the Centre and the renewable energy spokes. In 2019, the DSI grant amounted to R25,958 million of which R4, 98 million was used for the appointment of staff.

The contribution of the DSI is supplemented with other funds from the Centre so that in total R12.96 million was spent on the various academic and research activities of the Centre. An amount of R2.277 million was spent on bursaries for post graduate students.

The contribution from Eskom for 2019 was R6,236 million. An amount of R1,254 million was spent on bursaries for postgraduate students and R2,345 million was spent on salaries for the Chair as well as other academic and administrative staff.

Historically, the Centre showed sustained growth in income from 2007 to 2011. In 2012 the income decreased slightly, mainly due to the decision of the DST 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. Due to the growth driven by projects in 2013, the growth itself was not sustained as reflected in the reduced income in 2014 and 2015. This trend has subsequently reversed and income to the Centre has been on an upward trend in 2017, 2018 and a slight decrease in 2019.

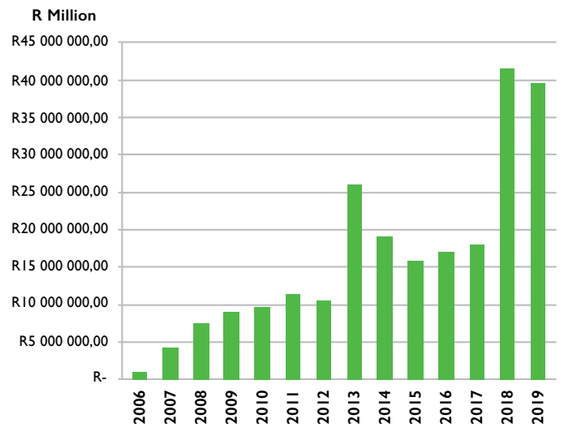
"With more than R30 million in reserves, the Centre is in a favourable financial position for 2019."

Table 19:

Funds available at CRSES

	31 Dec 2019 (12 months)	**31 Dec 2018** (12 months)
Total income for the year	R 39 661 089,30	R 41 965 810
Total expenditure for the year	-R 22 094 979,47	-R 20 114 116
Expenses	-R 22 049 743,88	-R 20 020 926
Equipment	-R 45 235,59	-R 93 190
Total net transfers from Centre cost points	-R 841 561,89	-R 8 600 992
Funds available 1 January	R 22 372 616,00	R 9 121 914
Net surplus. Shortfall for period	R 9 084 547,00	R 13 250 702
Subtotal	R 31 457 164,00	R 22 372 616
Balance sheet items	-R 1 073 317,00	-R 4 761 637
Funds available 31 December	**R 30 383 847,00**	**R 18 207 094**

Annual income of the Centre



STATEMENT OF INCOME AND EXPENDITURE

Until December 2019

For the period ending :	31/12/2019	31/12/2018
TOTAL INCOME	**-28 993 548.91**	**-24 156 388.67**
CONTRACT RESEARCH (TAXABLE)	0.00	-23 884 347.83
INCOME: BURSARY	-2 355 000.00	0.00
INCOME: DST	-25 958 698.45	0.00
INCOME: SUNDRY TAXABLE	-208 985.22	0.00
INTEREST RECEIVE: INTERNAL ALL	-433 254.89	-265 612.84
PROFIT: EXCHANGE RATE FOREIGN	0.00	-28.00
SALES: TO INTERNAL ORG UNITS	-14 000.00	-6 400.00
SUNDRY INCOME: NON TAXABLE	-23 610.35	0.00
TOTAL EXPENDITURE	**12 960 609.86**	**10 319 252.40**
CURRENT EXPENDITURE		
ADVERTISEMENTS: GENERAL	70 950.00	39 686.50
AFFILIATION & REGISTRATION EXP	72 643.20	37 142.81
AUDIT FEES: EXTERNAL	16 125.00	0.00
BURSARY POST GRADUATE	2 277 641.66	935 000.00
BURSARY UNDERGRADUATE	60 000.00	0.00
CELL PHONE AIRTIME	1 470.51	1 315.52
CELL PHONE RENT	1 583.53	335.79
CLEANING COSTS - EXTERNAL FIRM	33 628.85	28 207.65
COMPUTER MATERIALS	0.00	2 244.86
CONSULTATION FEES	64 817.74	102 071.15
CONSUMABLE MATERIALS	0.00	144.95
COPY AND PRINTING	39 560.26	4 787.23
ENTERTAINMENT: GENERAL	22 726.58	35 224.80
FUEL, OIL, LUBRICANTS	620.55	0.00
GENERAL OFFICE COSTS	379.08	0.00
GIFTS	0.00	526.68
INS, LICENSES & 3RD PARTY	47 275.95	265.00
INTERNET NETWORK EMAIL LEVY	13 243.68	13 881.91
LEVY: ICRR (INDIRECT COST)	1 346 519.11	2 104 347.83
POSTAGE AND COURIER SERVICES	68.63	247.97
PRIZES AND MEDALS	2 500.00	5 500.00
REFRESHMENTS: NON ACADEMIC	36 097.18	3 986.80
RENT OF EQUIPMENT GENERAL	1 335.69	0.00
RENT OF ROOMS	49 053.80	0.00
RESERCH CONTRACTCONDUIT PAYME	3 170 500.00	1 911 750.00
SERVICES	62 865.00	89 740.20
SMALLER FURNITUREAND EQUIPMEN	0.00	369.80
STATIONERY	5 777.37	8 149.23
SUBSCRIPTION & MEMBERSHIP FEES	11 509.24	7 490.00
TELEPHONE: CALLS	7 236.23	5 444.94
TELEPHONE: RENT	11 810.83	12 058.81
TOTAL REMUNERATION	4 987 636.32	4 508 491.67
TRANSLATION AND EDITING	21 655.00	0.00
TRAVEL: ACCOMMODATION VISUM PA	73 886.43	68 996.06
TRAVEL: FOREIGN TRAVEL SUBSIST	58 611.82	64 268.91
TRAVEL:DAILY ALLOWANCE AIR CAR	168 463.46	104 735.17
WORKSHOPS	189 250.00	219 245.00

For the period ending :	31/12/2019	31/12/2018
ASSET TRANSACTIONS		
ASSET SCRAPPING/TRANSFERS	1 107 325.51	-3 874.79
DEPRECIATION	217 271.71	30 001.15
INCOME: INTERNAL ASSETS	-1 324 597.22	-26 126.36
PROFIT/LOSS: ASSETS	-586.96	0.00
ASSET PURCHASES	33 754.12	3 595.16
OPERATING (SURPLUS) / SHORTFALL FOR PERIOD	**-16 032 939.05**	**-13 837 136.27**
FUNDS TRANSFERS	**4 974 102.72**	**2 340 217.11**
TRANSFERS FROM	15 560 515.58	7 734 791.00
TRANSFERS TO	-10 586 412.86	-5 394 573.89
NET (SURPLUS) / SHORTFALL FOR THE PERIOD	**-11 058 836.33**	**-11 496 919.16**
Plus: ACCUM (FUNDS) / SHORTFALL ON 01/01/2019	**-12 248 925.98**	**-752 006.82**
ACCUM (FUNDS) / SHORTFALL ON 31/12/2019	**-23 307 762.31**	**-12 248 925.98**
Min: BALANCE SHEET ITEMS	**355 000.00**	**0.00**
DEBTORS CONTROL ACCOUNT	355 000.00	0.00
FUNDS AVAILABLE ON 31/12/2019	**-22 952 762.31**	**-12 248 925.98**

Issued by

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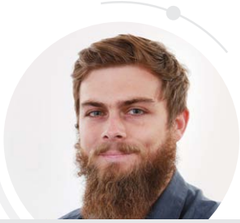

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