

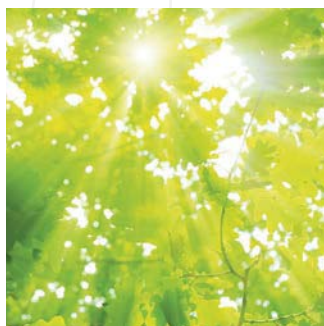
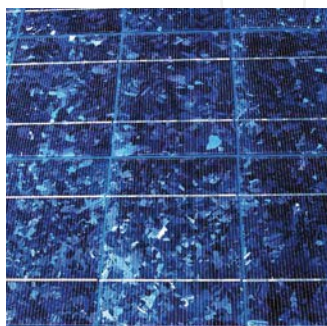


CENTRE FOR
RENEWABLE & SUSTAINABLE
ENERGY STUDIES

| CRSES ANNUAL REPORT 2014 |

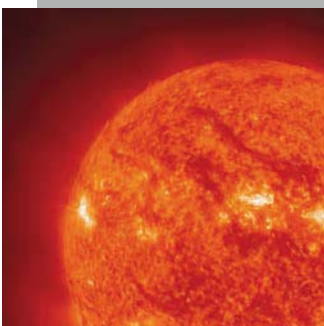
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SAVING OUR PLANET, LIFTING PEOPLE OUT OF
POVERTY, ADVANCING ECONOMIC GROWTH...
THESE ARE ONE AND THE SAME FIGHT. WE MUST
CONNECT THE DOTS BETWEEN CLIMATE CHANGE,
WATER SCARCITY, ENERGY SHORTAGES, GLOBAL
HEALTH, FOOD SECURITY AND WOMEN'S
EMPOWERMENT. SOLUTIONS TO ONE PROBLEM
MUST BE SOLUTIONS FOR ALL.

Ban Ki-moon



FOREWORD

The Centre for Renewable and Sustainable Energy Studies (The Centre) is a leading Southern African research and teaching institute in the field of renewable energy. The Centre is located in the Stellenbosch University's Faculty of Engineering, and acts as a central hub for renewable energy studies at the University. The research focus areas include solar, wind, geothermal, biomass, and ocean waves and currents as sources of energy. The scope of projects undertaken by the Centre ranges from feasibility studies for the implementation of renewable energy technologies, to highly technical studies on specific technologies. In this respect, innovation and building human capital is essential.

During the past seven years, more than 50 postgraduate degrees (master's and doctoral degrees) were conferred, including research students supervised by Centre staff and students completing coursework master's degrees. The research master's and doctoral degrees are available in various academic departments at SU as well as other universities, in particular the University of Cape Town, University of Pretoria, North

West University, University of KwaZulu-Natal, University of Fort Hare, and Nelson Mandela Metropolitan University. At least 15 postgraduate students were supported through NRF funds as well as reserve funds from the Centre in 2014.

The Centre hosts regular forum discussions and research lectures, with more than 400 delegates having attended these events. A school outreach project was initiated in 2008, reaching 7 520 learners by 2014.

A significant project recently undertaken by the Centre has been participating in the development of a solar technology roadmap for South Africa's Department of Science and Technology (DST). The outcome of this project is to inform the country of the national strategy pertaining to the research and development (R&D) of solar technology systems. It is expected that this R&D roadmap will augment the larger solar energy roadmap that is being developed, through collaboration between the DST and Department of Energy (DoE), with assistance from the International Energy Agency (IEA).

In another project, Prof Wikus van Niekerk, director of the Centre, prepared the first policy brief on Ocean Energy for the DST.

Highlights from 2014:

- 24 papers published in accredited journals and peer-reviewed conference proceedings
- 25 students graduated with master's and doctoral degrees
- two newly investigated technologies/devices introduced by inventors
- a coursework master's project developed into a promising solution for rural electrification, functioning as a micro-utility where consumers could recharge batteries during the day to supply power at night
- Prof van Niekerk received the South African National Energy Association (SANEA) Energy award for 2014 and Prof Alan Brent (associate director of the Centre) received the SANEA award for the best publication in 2014.

There was an increase in the expenditure of the Centre in 2014. This was mainly due to a number of large projects for Eskom, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the provincial government of KwaZulu-Natal being completed.

The Centre is well positioned to maintain, and in some cases expand, its activities and programmes in 2015 and beyond.

The main assets of the Centre remain the excellent staff, both those employed by the Centre as well as the academics and researchers associated with the Centre, the excellent facilities at Stellenbosch University, and the students at the different universities cooperating with the Centre.



Prof Eugene Cloete, Vice-Rector: Research and Innovation



INTRODUCTION

The Centre for Renewable and Sustainable Energy Studies (The Centre) at Stellenbosch University (SU) was established in 2007 as the national hub for postgraduate programmes in renewable and sustainable energy through a grant from the Department of Science and Technology (DST) and the then Department of Minerals and Energy. The initial funding contract was signed with the South African National Energy Research Institute on 8 August 2006. In 2013, this contract was renewed for another five-year period by the National Research Foundation.

In 2012, the Centre was also designated as the Specialisation Centre for Renewable Energy Technology, as part of the Eskom Power Plant Engineering Institute. In this programme, the Centre is one of eight specialisation centres responsible for research into existing and new technologies in Eskom to generate electricity, as well as to train masters and doctoral students, some of whom are full-time engineers working for Eskom. As part of this programme, SU established the Eskom Chair in Concentrating Solar Power in 2013.

The Centre at SU has a dual purpose: the training of scientists and engineers with the required technical expertise to unlock the country's renewable energy resources, and the implementation of appropriate technologies for the sustainable use of renewable energy.

Our academic programmes started in February 2007 with 30 students enrolled in the two coursework master's degrees (MEng Structured and MPhil) and various other research degrees at master's and doctoral level. In 2014, seven postgraduate modules were presented, starting with general modules on renewable energy technology, policy and finance, as well as specialised modules such as solar and bio-energy. Of the 15 students who received bursaries from the Centre in 2014, 13 graduated; nine with master's degrees and four with doctoral degrees.

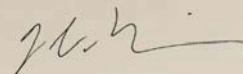
The Centre is involved in a variety of renewable energy research and specialist consulting projects. These range from feasibility studies and technology reviews of how solar, wave and wind energy can power different loads, to projects investigating the feasibility of large-scale concentrating solar power plants, including the measurement of the available solar resource.

The Centre was instrumental in establishing the Scatec Solar Chair in Photovoltaic Systems in 2014, housed in the Department of Electrical and Electronic Engineering. This position is funded by Scatec Solar, one of the successful independent power producers in the current renewable energy procurement programme of the Department of Energy.

This is the ninth annual report of the Centre and spans the period 1 January - 31 December 2014. It represents the eighth full academic year that the renewable energy postgraduate programme has been in place.

This report presents an overview of our activities as we look back on 2014 as a year of consolidation. We were able to meet and exceed the targets set for us by our various stakeholders because of strong, motivated students and hard-working, well-qualified staff. I express my sincere appreciation and gratitude to them because without motivated people, we will never achieve our objectives.

I look forward to an even more exciting 2015, and trust that you will find this report interesting and inspiring.



Prof Wikus van Niekerk, Director: Centre for Renewable and Sustainable Energy Studies



TIMELINE



2006

The South African National Energy Research Institute (SANERI), a division of the Central Energy Fund, awarded SU the responsibility as the country's hub for hosting the national postgraduate programme in renewable and sustainable energy studies. The initial funding contract was signed with SANERI on 8 August 2006.

2008

Expanding on the 'hub and spoke' model, three 'spokes' were established in partnership with four other universities: the wind energy spoke, solar photovoltaic spoke and solar thermal spoke.



2011

The Centre is designated as the Specialisation Centre in Renewable Energy Technology, as part of the Eskom Power Plant Engineering Institute (EPPEI)



2007

The new academic programmes started in February 2007, and the Centre for Renewable and Sustainable Energy Studies was established in the Faculty of Engineering at Stellenbosch University.



CENTRE FOR
RENEWABLE & SUSTAINABLE
ENERGY STUDIES

2009

Prof Alan Brent was appointed as associate director of the Centre from 1 September 2009.



45 students at seven different universities in South Africa were supported with bursaries from the Centre.

2010

The Solar Thermal Energy Research Group (STERG) was established at SU.



SOLAR THERMAL ENERGY
RESEARCH GROUP

2006 – 2014



2013

The Centre's funding contract from the Department of Science and Technology was renewed for another five-year period by the National Research Foundation.

SU established the Eskom Chair in Concentrating Solar Power as part of the EPPEI programme.



2013

The Lourensford Wine Estate approached the Centre to perform an on-site prefeasibility study for the installation of a ~1 MW PV project.



2012

The Knowledge Centre is opened, housing STERG and the Centre. The Knowledge Centre is sponsored by Sasol. GeoSUN Africa was launched as a spin-off company of the Centre.



| CRSES ANNUAL REPORT 2014 |

The SANE Energy Awards 2014 honoured three members of the Centre: Prof Wikus van Niekerk received the SANE Energy Award 2014 for his contribution to renewable energy in South Africa (particularly in the field of solar energy). Prof Alan Brent, together with Dr Marco Lotz from Nedbank, received an award for their publication *Carbon Footprinting Guide*, and postgraduate student Karel Malan received the SANEDI RECORD RERE Young Research Award 2014 for his work on SA's first heliostat control system capable of controlling thousands of heliostats.



2014

A collaborative effort between SU, The Centre, GeoSun Africa, GeoModel Solar and the German Government, through their agency the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, resulted in the publication of more accurate maps of Direct Normal Irradiation and Global Horizontal Irradiation data for South Africa.

BUILDING HUMAN CAPITAL

South Africa's renewable energy sector looks set to become an increasingly prominent feature of the local economic landscape providing many job opportunities for skilled individuals with postgraduate qualifications from Stellenbosch University.

The Centre is equipping a wide range of graduate specialists to make their mark in the fast-growing renewable energy sector:

Nicola Cencelli

"Much of my work involves helping organisations put together proposals for the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)," says Nicola Cencelli, an engineer at the consulting firm 3E in Cape Town.

Cencelli credits Stellenbosch University's academic programme saying that it is well-suited to students who want to pursue a career in renewable energy.

Completing her master's degree in wind turbine technology at SU in 2005, she advises power producers, construction firms and banks about establishing renewable energy plants in South Africa.

Dr Josephine Musango

While working as a resource economist at the CSIR, Josephine Musango began researching renewable energy in 2008. She specialises in the application of system-dynamics modelling in resource management.

"Renewable energy is an important part of government's drive to establish a green economy," says Musango who examined the sustainability of South Africa's renewable energy industry to earn her PhD in 2012.

Pierre van der Merwe

Pierre van der Merwe, a graduate of SU's Department of Mechanical Engineering, believes that the renewable energy industry has big potential for his employer Reutech Radar Systems and other local engineering groups.

The government's REIPPPP Programme has proved a boon to the local engineering and construction industry. Reutech Radar Systems, a division of defence contractor Reutech, is one of many local firms to benefit from the programme. The company secured a multi-million rand contract to design and manufacture 1 540 dual-axis solar trackers for the new Touws River CPV solar plant.

Durandt Groenewald

Independent contractor Durandt Groenewald has also moved successfully into the renewable energy business. Groenewald, a specialist drilling contractor in the mining and agricultural sectors, worked on the construction of the Kalkbult solar plant, near De Aar in 2013. A former officer in

the South African Air Force, Groenewald has also worked on the Lesedi PV solar plant near Kimberly and the Dreunberg PV solar facility outside Burgersdorp. He studied at SU's Military Science Faculty in the late nineties.

Jian Swiegers

Jian Swiegers joined the local office of USA corporation SunPower in 2012, and worked on the construction of the Herbert and Greefspan PV solar plants near Douglas in the Northern Cape. He is currently working on a new 84 MW solar project near Prieska.

He earned his MScEng in mechanical engineering at SU and has a long track record in the so-called green industry. "I enjoy the combination of green technology, engineering and commercial challenges. While studying at SU we were encouraged to innovate and develop a broad set of skills," says Swiegers.

Samantha Bartle

Samantha Bartle, project manager at Sunchem Biofuel Development South Africa (Sunchem SA), is working to widen the country's energy sources. She is overseeing trials to cultivate specialised tobacco plants for the production of biofuel for the aviation industry.

A mechanical engineering graduate, Bartle completed her master's degree in renewable and sustainable energy at SU earlier this year. "My focus was on the development of the biofuels industry in South Africa," she says. "The Solaris tobacco project aims not only to produce an alternative source of energy but also to encourage rural development."

Hannes Bester

Hannes Bester, who earned a BEng in electrical and electronic engineering at SU, enrolled in the University's part-time master's programme in renewable energy in 2010. "The course is very good. It provides a well-balanced overview of the sector and covers wind, solar, hydro and policy issues."

In 2011, Bester joined Sustainable Power Solutions, an engineering firm that builds, maintains and manages PV solar plants, and was appointed as manager at the Jeffreys Bay Wind Farm last year.

Graduated bursary students

	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
M Phil/ M Eng/ MFor	2	2	4	5	6	3	6	1	5	34
MSc/ MScEng/ MCom	2	2	5	9	8	8	10	10	16	70
PhD	1			2	1		3	3	4	14
Total	5	4	9	16	15	11	19	14	25	118

Right: Nicola Cencelli at Klipheuwel Wind Farm





COLLABORATION AND IMPACT

The Centre for Renewable and Sustainable Energy Studies offers various postgraduate degree programmes in renewable and sustainable energy studies including coursework and research master's degrees, as well as doctoral degrees. The Centre undertakes contract research and specialist consulting, and plays an active role in raising general awareness of renewable energy countrywide. In 2014, the Centre supported a number of other South African universities in the presentation of postgraduate courses in renewable energy, purchasing of equipment, accessing funding, and developing human resources in terms of staff and students.

Postgraduate programme in renewable and sustainable energy studies

The national Department of Science and Technology, through the National Research Foundation, contracted Stellenbosch University to host a postgraduate programme in renewable and sustainable energy studies. This programme is augmented by a number of other research groups, research chairs and activities at Stellenbosch and other universities. Since its inception in 2007, the programme has made a significant contribution to the development of human capital, knowledge generation and technology transfer in South Africa. The aim of the Centre is to roll out the academic programme, in full measure, to other institutions in South Africa and the region of the Southern African Development Community.

Specialisation Centre in Renewable Energy Technology

During 2012, Stellenbosch University signed a contract with Eskom, the national electricity utility company of South Africa, to become the Specialisation Centre in Renewable Energy Technology as part of the Eskom Power Plant Engineering Institute. Part of the obligation to implement this contract vests in the Centre; with the responsibility of furthering the development of the necessary capacity to grow and support the renewable energy sector in South Africa and on the African continent. The activities sponsored by Eskom focus on concentrating solar power and wind energy, and furthermore include the Eskom Chair in Concentrating Solar Power.

The SAURAN network

The Southern African Universities Radiometric Network (SAURAN) is an initiative of the Centre and the Group for Solar Energy Thermodynamics at the University of KwaZulu-Natal. SAURAN makes high-resolution, highly accurate, ground-based solar radiometric data available from stations located across the southern African region, including South Africa, Namibia, Botswana and Réunion Island.

Solar irradiation data is available at one-minute, hourly and daily time-averaged intervals, and includes direct normal irradiance (DNI), global horizontal irradiance (GHI), diffuse horizontal irradiance, air temperatures, wind speeds and ultra violet light measurements. GHI data is valuable for photovoltaic applications while DNI is important for solar water heating and concentrating solar power applications.



SAURAN makes high-resolution, highly accurate, ground-based solar radiometric data available from stations located across the southern African region, including South Africa, Namibia, Botswana and Réunion Island.

At the end of April 2015, there will be 15 stations included in the SAURAN database, with participation from Stellenbosch University, University of Pretoria, University of the Free State, Nelson Mandela Metropolitan University, Mangosuthu University, University of KwaZulu-Natal, University of Fort Hare, University of Venda, and internationally, the University of Réunion.

The SAURAN database can be accessed at www.sauran.net



Sinovuyo Poni at the University of Pretoria during a solar measurement station installation.

DEVELOPMENT OF TECHNOLOGY

One of the Centre's key objectives is to transfer appropriate, existing renewable energy technologies to the South African market. In addition, the Centre aims to develop new technology for Southern Africa and as export products for the rest of the world. These developments either focus on the primary research areas of Stellenbosch University, or on the most abundant renewable energy resources available in southern Africa. The Centre assists students with novel ideas on technology or social innovation to implement renewable energy in their projects, and has received numerous requests to evaluate newly developed technologies or patents over the years.

SolarTurtle

James van der Walt, a master's degree student, developed a promising solution for rural electrification. He came up with the concept of using a refurbished container with solar panels that houses a battery charging station, mainly to have a safe and secure storage facility for the equipment at night. The aptly-named SolarTurtle functions as a micro-utility where consumers can recharge batteries during the day to provide light or power to appliances such as television sets, at night. Van der Walt is currently supported by the Technology Innovation Agency, Stellenbosch University, the Department of Science and Technology and the South African National Energy Development Institute to commercialise the concept by developing a pilot plant that will be deployed in the Eastern Cape. The project was selected as one of the finalists in the

Western Cape's Better Living Challenge, and was exhibited at the BLC Showcase in October 2014. James also received the WWF-SA Climate Solver Award on 6 March 2014.

Heliol00

The Solar Thermal Energy Research Group at Stellenbosch University developed uniquely South African heliostat technology intended for small-scale concentrating solar power (CSP) stations. CSP stations are able to provide dispatchable, clean energy at utility scale, with socio-economic benefits and high localisation potential. In early 2014, the team won a grant from the Technology Innovation Agency to demonstrate the technology in a 100 kW pilot facility on the Mariendal experimental farm near Stellenbosch. The technology takes a simple and fresh approach to overcoming the challenges that are currently faced in heliostat fields.

The newly developed heliostat technology boasts:

- Design simplicity that allows for **infield assembly** and **job creation**
- **Smaller heliostats** that leverage economies of scale reaching production volumes similar to that of the automotive industry
- **Low cost design** that reduces the upfront capital cost required, which is currently the biggest barrier to market entry
- Integrated heliostat support systems that negate the need for any earth works or foundations and that have a **low impact** on the natural vegetation allowing for dual land use.



The submerged SWEC device

An international effort to utilise ocean energy had initially been driven by a spike in the oil price in the 1970s. With the sponsorship of the De Beers Chairman's Fund and Murray and Roberts, amongst others, Prof Deon Retief and his colleagues of the Department of Civil Engineering at SU began the development of a novel wave energy converter: the Stellenbosch Wave Energy Converter (SWEC). However, the oil prices had stabilised by 1989, and the SWEC was defined as technically viable but economically impractical. The proposed cost of electricity generated by SWEC was similar to nuclear power, but much more expensive than the very cheap coal-fired power which Eskom was producing at the time. The decision was therefore made at that time to halt further development of SWEC.

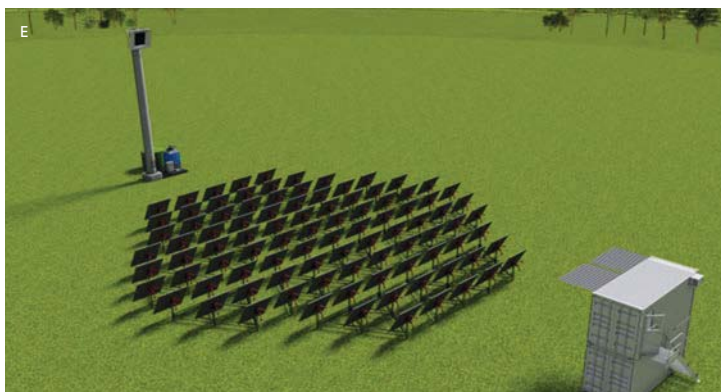
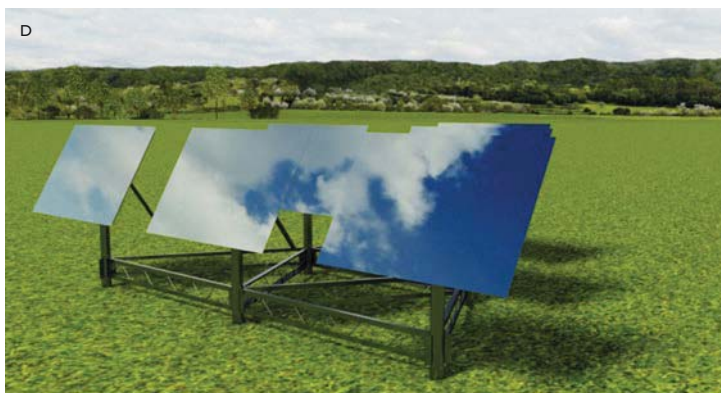
When the Centre was established in 2007, research on the SWEC was resumed. Current work focuses on understanding the hydrodynamics inside the chamber as well as the numerical simulation model of the air flow.

How it works:

The device is made up of two 160 m long submerged arms which are positioned in a V-like shape, fixed to the sea floor. The arms consists of a number of modules, each having a number of chambers acting as submerged oscillating water columns (OWCs). The turbine generator unit is vertically attached to the arms at the apex of the V.

As the crest of a wave moves overhead, water is forced into the submerged OWCs. This increases the pressure in the OWCs chamber and forces air into the high pressure duct. As the trough of a wave passes overhead, the pressure decreases again and air is sucked out of the low pressure duct. Each OWC is connected to the high pressure duct and low pressure duct through one way valves. The constant pressure differential between the two ducts induces an airflow which drives the turbine and in turn drives the generator. The SWEC has been designed to absorb only a portion of the wave passing overhead in order not to disrupt the natural motion of the waves to a large degree.

A and B: James van der Walt at the Solar Turtle; C: Thembakazi Mali (SANEDI) inside the Solar Turtle; D and E: Heliol100; F: Jason Fairhurst at the Stellenbosch University Wave Flume with a scale model of the SWEC



CONTRACT RESEARCH

The Centre acts as a point of entry into SU for all Renewable Energy (RE) research, doing resource assessments and conducting policy, regulatory and financial studies. These research contracts range from solar measurements and other renewable energy assessments, renewable energy feasibility studies (mostly desktop studies), development of RE roadmaps, advice on the national RE policy, regulatory, legal and institutional frameworks for the development of RE, as well as developing investment plans and financing options in the RE sector.

The Centre has completed a number of contract research projects for clients ranging from the private sector to decision makers at national, regional, and local level governments, municipalities and energy utilities.

Over the last eight years, the Centre has played a key role in organising stakeholder workshops, identifying technology and social development needs, and building national consensus on a variety of national projects. This is made possible by the extensive national and international network the Centre has with research organisations, technology developers and technology providers.

The Centre has played a key role in organising stakeholder workshops, identifying technology and social development needs, and building national consensus on a variety of national projects.

Some of our contract research projects:

South African-German Energy Programme – installation and monitoring of DNI solar stations and updating of the South African solar resource map

Client: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Until the commencement of this project, there was a general lack of measured, high-accuracy solar data in South Africa available in the public domain. In particular, there is a lack of direct normal irradiance (DNI) data used for concentrating solar power and concentrating photovoltaic systems. The rationale for this GIZ-funded project was to measure and release high-accuracy solar resource data into the public

domain, as well as to update the existing solar maps for South Africa.

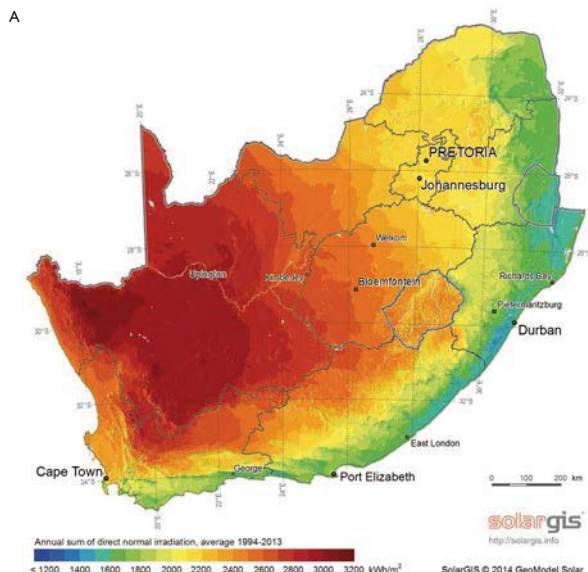
This project was funded by the German government, through their agency the GIZ, as part of the South African-German Energy Programme.

The scope of the project proposed to the GIZ included the installation of six solar measurement stations, which were measured and recorded over a period of at least 12 months. The locations of these stations were determined in collaboration with the Centre, GIZ and other stakeholders in order to find the areas where there are still gaps in ground measurements.

The project objectives were reached by following these steps:

- **Sites:** Six installation sites were established in consultation with the client and other interested parties. The selected sites were: Pretoria, Vryheid, Bloemfontein, Vanrhynsdorp, Graaff-Reinet and the Richtersveld.
- **Equipment and installation:** Stellenbosch University specified and procured six sets of measurement equipment and installed it at the selected locations.
- **Data:** A web portal was developed (www.sauran.net – Southern African Universities Radiometric Network), where these six sets of high-accuracy measured solar data were placed in the public domain, along with other available data sets. High-accuracy solar data forms the basis of a range of activities relating to and eventually resulting in solar developments.
- **Solar map:** The SolarGIS, DNI and GHI maps were updated with data sets of the GIZ stations as well as data from private clients where measurements taken over one year were available.

Status: This project was completed in November and updated solar maps of Southern Africa can be downloaded at <http://crses.sun.ac.za/research-publications-resources>.



Technical advice on large (1MW) PV installation

Client: Lourensford Wine Estate

The Centre was appointed as technical advisor to complete a prefeasibility study leading up to the development of a tender specification document that will be used in a formal tender process to procure a turnkey PV project of 1 MW or less. Services included:

- Consolidation of historical electrical energy usage data (time series format). Data was obtained and analysed.
- On-site investigation into available/existing infrastructure related to the development of 1 MW PV. Various PV project areas were identified, with recommendations given.
- Assessment of the available solar resource for the greater estate as well as smaller project areas (e.g. rooftops, vacant land areas).
- Investigation and cataloguing of secondary renewable resources on the estate deemed important to future development.
- Development of technical specifications and the tender process related to a large scale (500 kW) roof integrated PV system for a turnkey installation. The technical specifications formed part of the tender documentation and were used in a tender process for procurement purposes. Bid submissions are currently under review.
- Compilation of an analysis of the tenders received in a report.

The Centre formed part of the tender evaluation committee adjudicating the tenders.

Status: Completed

Conducting research on the green economy in KwaZulu-Natal

Client: KZN Government

The KwaZulu-Natal provincial government approached the Centre to conduct research on the green economy in KwaZulu-Natal. This contract research had several sub-sections, including the:

• **KwaZulu-Natal renewable energy development potential GIS study**

The development of a web-based GIS tool to identify potential project sites as the site relates to renewable energy technologies of 1 MW and greater installed capacity. The project investigated typical site selection criteria applied to renewable energy projects and collated these on a provincial scale for the KwaZulu-Natal province extent. All the map-able criteria were presented on a web-based GIS platform that informs potential developers on locating potential renewable energy projects. Data layers are not downloadable and the web-based utility is not a substitute for conducting EIAs or SEAs or any similar vehicle.

• **KwaZulu-Natal Sustainable Energy Investment Policy (SEIP)**

The Centre carried out scoping studies on the identified buildings, resulting in the development of prefeasibility studies with the aim of developing technical specifications for these, drawing up individual tender specification documents and advising on tender evaluations (if the project goes to tender).

Status: Ongoing

A: South African DNI Solar Map; B: Row of pyranometers at SU's solar measurement station Sonbesie.





AWARENESS AND OUTREACH

The Centre is mandated to increase the awareness of the contribution that renewable energy can make to reduce the environmental impact of our current carbon-intensive energy supply. The Centre strives to effectively communicate the importance of carbon decoupling in the energy industry and educate the public with regards to the potential risks of climate change if no action is taken. To this end, we have organised a number of public and academic lectures, forums and workshops and published on a variety of topics in the popular press.

School outreach programme

The Centre initiated a School Outreach Project in 2008. Therese Lambrechts, an experienced project manager with a passion for climate change and renewable energy, developed learning material on climate change and renewable energy, suitable for the subjects of natural science (Grade 9) and geography (Grades 10 and 11). Since 2008, the Learner Teacher Support Material has been implemented and disseminated in high schools in the Western Cape, Limpopo, Eastern Cape, KwaZulu-Natal, Free State and Northern Cape provinces. This has been achieved through teacher training workshops, using the existing school networks from the Department of Basic Education, the Wildlife and Environment Society of South Africa (WESSA) Eco-Schools programme and Science Centres. From 2008 to 2014, 634 schools were reached and 820 teachers were trained through these workshops.

During 2014, a total of 277 schools received a set of the Learner Teacher Support Material and 376 teachers were trained.

School Outreach Programme Outputs 2008 to 2014

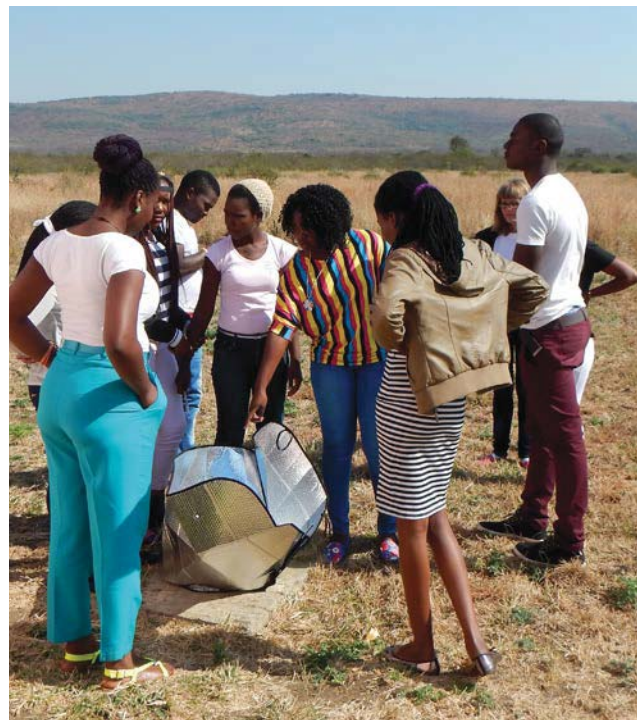
Outreach	2008	2009	2010	2011	2012	2013	2014
Total number of schools reached	3	18	119	72	30	99	277
Total number of educators reached	3	27	117	110	40	103	376
Total number of learners reached	0	540	2 340	2 200	120	2 010	7 520
Total number of students reached			376	257	25		25

It is evident that follow-up support is important to both support teachers with activities, assignments and assessments, and to determine the effective use of the resource materials in the classroom.

Funding still remains a challenge for the schools' programme as the resource is distributed to teachers without any cost to the schools or teachers.

www.crses.sun.ac.za/service-schools

Since 2008, the Learner Teacher Support Material has been implemented and disseminated in high schools in the Western Cape, Limpopo, Eastern Cape, KwaZulu-Natal, Free State and Northern Cape Provinces.



Training in Mozambique, July 2014

TRAINING

The Centre provides short courses and in-house training for companies to train their staff on the different technical, financial and policy aspects of renewable energy. Various modules are available from which to choose. Companies select a combination of appropriate modules for each training courses, with the duration and focus of each course determined by the company's areas of interest and time available.

The following modules were presented in 2014:

- Renewable Energy Systems
- Renewable Energy Policy
- Renewable Energy Finance
- Introduction to Solar Energy
- Advanced Photovoltaic Systems
- Bioenergy
- Wind Energy
- Thermal Energy Systems

Below are some examples of our workshops and our customised training courses presented to industry and other institutions during 2014:

Designing efficient and financially viable grid-tied photo-voltaic systems

This course was presented from 23-25 June 2014 at STIAS, Stellenbosch. The aim of the course was to provide the understanding and awareness of available technological tools for designing grid-tied PV systems within the South African solar resource, technical and legislative contexts. The underlying design criterion is to optimise the energy yield versus lifecycle costs of the PV system within the given resource, technical and legislative constraints, thereby optimising the financial viability of the system.

The course was attended by 16 people from industry and personnel from the South African Renewable Energy Technology Centre at the Cape Peninsula University of Technology. CRSES research engineer, Ulrich Terblanche, and postdoctoral researcher, Dr Sameer Hameer, also attended.

PVSYST training course

This course was presented from 28-31 July 2014 at Stellenbosch University, by Michel Villos, a PVSYST training instructor from PVSYST SA, Switzerland. Registration was limited to 18 people to optimise the learning experience with each student having access to a workstation and the software.

Delegates who attended came from industry, Eskom, the University of Johannesburg, and the National Electricity Company of Angola with Ulrich Terblanche and Imke Meyer from the Centre also in attendance.

Renewable energy training course

The Innovation Hub in Pretoria requested a five-day, in-house training course on renewable energy for ten interns of the Innovation Hub's Green and Sustainable Development Projects programme. This was presented from 10-17 July 2014 by staff from the Centre and the ten interns attended.

Renewable energy and energy efficiency: small-scale embedded generation information sharing workshop

On 25 November 2014, the Centre, in conjunction with the South African Local Government Association, presented an information sharing workshop to municipalities on renewable energy and energy efficiency: small-scale embedded generation. The workshop took place in Caledon. Sixty-five delegates from various municipalities, GIZ, the Centre, the Department of Environmental Affairs and Development of the Western Cape, NERSA, and the City of Cape Town attended.

The Centre provides short courses and in-house training for companies to train their staff on the different technical and policy aspects of renewable energy.

Renewable energy short learning programmes

Stellenbosch University, through the Centre, and Nelson Mandela Metropolitan University (NMMU) collaborated on the offering of short learning programmes (SLPs) in the field of renewable energy. Initially the SLPs are offered by utilising SU staff and the academic content of our current modules. NMMU hosted the following four short courses in Port Elizabeth in 2014, presented by Stellenbosch University lecturers:

- renewable energy technology
- wind energy
- photovoltaic systems
- renewable energy finance and policy

NMMU aims to develop the SLPs into a postgraduate offering, similar to the postgraduate programme at SU.



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PUBLICATIONS continued

Conferences and symposia

The Second Southern African Solar Energy Conference (SASEC2014) was held from 27-29 January 2014, hosted by Nelson Mandela Metropolitan University in Port Elizabeth.

The 4th Renewable Energy Postgraduate Student Symposium took place from 17-18 July 2014 in the Knowledge Centre building of the Faculty of Engineering. This symposium incorporated the Solar Thermal Energy Research Group (STERG) symposium on 17 July, which focused on solar thermal energy topics. The wind, ocean, bio-energy and solar photovoltaic (PV) technology platforms were the focus of the second day of the symposium.

The Centre also organised the first Eskom Power Plant Engineering Institute (EPPEI) – Student Conference at the ESKOM Academy of Learning, which took place from 5-6 May 2014 in Midrand, Johannesburg.

Cebo Silinga, a recent MEng graduate and research engineer at the Centre, attended the SolarPACES International Conference from 16-19 September in Beijing, China. Silinga together with the STERG group participated in the TASK I group, which focused on solar thermal electric systems. The work presented in the TASK I group dealt with South African perspectives on concentrating solar power (CSP) grid integration. Silinga's presentation at the conference covered the Renewable Energy Independent Power Producer Procurement Programme's (REIPPPP) two-tier tariff, with implications for a proposed virtual hybrid CSP peaking system.

The next SolarPACES conference will be held from 13-16 October 2015 in Cape Town.

Imke Meyer, a research engineer at the Centre, attended the INORE symposium (International Network on Offshore Renewable Energy) and the ICOE conference (International Conference on Ocean Energy) in November 2014. The ICOE took place in Halifax, Nova Scotia, Canada from 4-6 November 2014. The location of this conference was very significant as on the northern shores of Nova Scotia lies the Bay of Fundy which has the largest tidal range in the world. Meyer presented her work on resource characterisation of the Agulhas current, titled *Resource Assessment of the Agulhas Current for the Purpose of Marine Energy Extraction* authored by I. Meyer, J. Reinecke and J.L. Van Niekerk. A full paper on this work was published with the conference proceedings. This work tied in well with the tidal-centric theme of the conference with interest from oceanographers into the unique behaviour of this current. One of the main themes of the conference was site and resource characterisation, together with marine environmental concerns paired with the site development. Meyer had the privilege to view this resource and witness the extreme conditions, which need to be overcome to deploy devices in these swift moving tidal currents. At present, there is large momentum in this area to deploy tidal devices in the Minas Passage, held in the Bay of Fundy, with four test berths connected to sea cables ready to couple to the pilot devices which are to be deployed at site in 2015/2016.

A: Cebo Silingo at Stellenbosch University's solar roof laboratory; B: Imke Meyer at Stellenbosch University's towing tank used for ocean current research.



FINANCIAL POSITION OF THE CENTRE

The Centre has three main sources of income. It receives an annual core grant from the Department of Science and Technology (DST) through a contract with the National Research Foundation (NRF). As the Specialisation Centre in Renewable Energy Technology for the Eskom Power Plant Engineering Institute (EPPEI), the Centre receives an annual contribution that is shared between the Centre and the Solar Thermal Energy Research Group (STERG) at Stellenbosch University. The remainder of the income comes from a variety of private and public entities for contract research projects, and for short and in-house training courses.

The annual grant from the DST/NRF is mainly used to support the appointment of three senior academics at Stellenbosch University, bursaries for postgraduate students and a contribution to the running expenses of the Centre. In 2014, this grant came to R4,64 million, of which R3,7 million was used for the appointment of staff. The contribution of the DST/NRF is supplemented with other funds from the Centre so that in total R8,3 million was spent on the various academic and research activities of the Centre in 2014. An amount of R1,03 million was spent on bursaries for postgraduate students.

With more than R10 million in reserves, the Centre is in a favourable position to continue with its work in 2015.

The contribution from Eskom on the EPPEI programme for 2014 was R3,94 million, of which R1,96 million was available to the Centre. The remainder was transferred to the Department of Mechanical and Mechatronic Engineering to support the Eskom Chair in Concentrating Solar Power as well as STERG. An amount of R300 000 was spent on bursaries for postgraduate students.

The comprehensive income statement of the Centre for all the cost points, including the Eskom EPPEI and project funds is included on page 22 and 23. The overall income of the Centre in 2014 was R19 042 932 – down 27% from 2013, while the total expenditure increased to R17 307 740. The total available funds at the end of 2014 were R10 928 131 as can be seen in the table below. The decline in overall income can be ascribed to the unusual spike in 2013's earnings, from a large number of projects that the Centre conducted and completed for Eskom in 2013, and due to most of the GIZ project's funding being

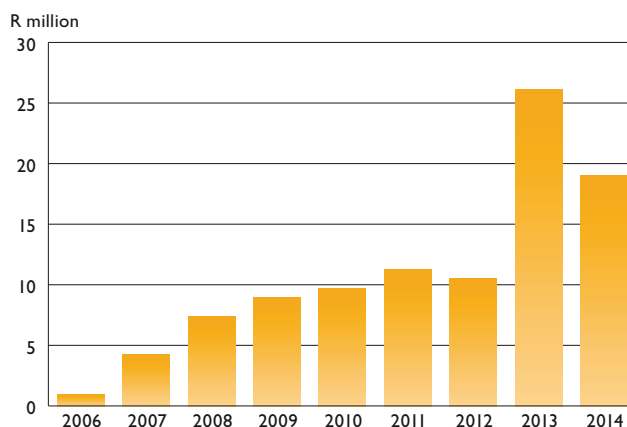
received in 2013. The Centre successfully reduced the overall reserves available at the end of 2013, and these funds were mostly applied to support the academic mission of the Centre.

The Centre showed sustained growth in income from 2007 up 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 for Eskom and GIZ as discussed. This growth was not sustainable as was reflected in the smaller income in 2014. With more than R10 million in reserves, the Centre is in a favourable position for 2015. 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 the Centre

	2014	2013
Total Income	R19 042 932	R26 068 607
Total Expenditure	-R17 307 740	-R15 685 151
Expenses	-R15 474 606	-R13 351 488
Equipment	-R1 833 134	-R2 333 663
Total Transfers	-R2 514 089	-R4 565 063
Nett Surplus/Shortfall for the period	-R778 897	R5 818 393
Funds available 1 January	R12 809 217	R6 990 824
Nett Surplus/Shortfall for the period	-R778 897	R5 818 393
Subtotal	R12 030 320	R12 809 217
Balance Sheet Items	-R1 102 189	-R1 505 610
Funds Available 31 December	R10 928 131	R11 303 607

Annual income of the Centre



STATEMENT INCOME AND EXPENDITURE – ALL COST POINTS IN THE CENTRE

FOR THE PERIOD ENDING:	31/12/2014	31/12/2013
TOTAL INCOME	19 042 931	26 068 607
Conference/congress (no vat)	185 681	6 459 684
Contract research (taxable)	3 085 663	3 810 448
Donation: special purposes	70 000	0
Income foreign exempt	16 297	22 759
Income: bursary	204 500	89 550
Income: foreign_zero rate	2 984 958	4 265 983
Income: NRF apportioned	4 640 720	6 397 000
Income: NRF thrip(zero rate)	1 122 851	1 166 667
Income: sundry taxable	1 437 618	3 450 291
Interest receive: internal all	690 119	387 240
Profit/loss: exchange rate deb	0	8 265
Profit: exchange rate foreign	2 943	1 914
Sales: to internal org units	37 209	8 800
Short courses	646 600	0
Sundry income: non taxable	3 917 770	0
TOTAL EXPENDITURE	-17 307 739	-15 685 151
CURRENT EXPENDITURE		
Advertisements: general	-110 697	-62 106
Advertisements: posts	0	-59 084
Affiliation & registration exp	-234 543	-167 265
Bank costs	-246	0
Bursary postgraduate	-2 232 339	-688 756
Bursary undergraduate	-66 480	-98 620
Cell phone airtime	-2 189	-2 840
Cell phone rent	-2 666	-3 318
Cleaning costs – external firm	-18 270	-5 940
Cleaning materials	0	-1 041
Clearance fee non-capital	-821	0
Clothing: other	-11 730	-3 193
Computer materials	-413 781	-1 001 006
Consultation fees	-3 901 854	-3 302 548
Consumable materials	-271 550	-113 473
Copy and printing	-217 412	-147 534
Courses	-800	-10 500
Electronic components	-11 084	-1 301
Entertainment: general	-128 437	-102 256
Fencing materials	-36 400	-100 842
Flowers and gifts	-3 762	-7 029
Foreign exchange loss	-18 049	-59 177
Fuel, oil, lubricants	-10 464	-1 132
General office costs	0	-181
General research costs	-50 000	0
General vehicle expenditure	-66 247	-67 755
Glass ware	-1 307	0
Handbooks and manuals	-3 262	-1 528
Ins, licenses & 3rd party	-2 409	-6 336
Interest paid: internal apportioning	-20 875	-6 153
Internet network email levy	-65 202	-34 337
IP transfer fee	-60 280	-41 594
Levy: ICRR (indirect cost)	-801 910	-1 377 795
Levy: space and facility	-18 113	-29 049
Maintenance of apparatus	-657	-1 300
Maintenance of computer	-1 126	0
Medical expenses	0	-12 032
Non-capitalised books	-9 325	-3 039
Postage and courier services	-6 620	-12 133
Prizes and medals	-2 500	-5 500

FOR THE PERIOD ENDING:	31/12/2014	31/12/2013
Refresher courses and seminars	0	-100
Refreshments: non academic	-12 254	-400
Rent of equipment general	-4 533	-28 039
Rent of rooms	-25 865	-9 715
Roads and parking expenditure	0	-371
SCW non-capitalised	-750	0
Services	-37 895	-16 630
Smaller furniture and equipment	-24 911	-24 603
Software	-127 747	-43 061
Sponsorship/donation out institutions	-200	-7 400
Stationery	-23 982	-34 223
Subscription & membership fees	-48 142	-23 780
Subscription books & magazines	-6 944	0
Sundry expenditure	0	-29 713
Sundry expenses	0	-21 492
Telephone installation costs	0	-750
Telephone: calls	-13 917	-26 914
Telephone: rent	-32 977	-33 235
Total remuneration	-4 949 561	-3 527 536
Translation and editing	-3 905	0
Transport cost	-4 444	0
Travel: accommodation visum parking	-248 461	-1 018 079
Travel: foreign travel subsistence	-416 102	-225 908
Travel: daily allowance air car	-489 316	-188 771
Workshops	-199 270	-553 050
ASSET TRANSACTIONS		
Asset scrapping/transfers	248 671	0
Depreciation	-852 841	-288 848
Income: internal assets	604 170	288 848
Asset adjustments	0	0
Asset purchases	-1 833 134	-2 333 663
OPERATING SURPLUS / SHORTFALL FOR PERIOD	1 735 191	10 383 456
FUNDS TRANSFERS	-2 514 088	-4 565 062
Transfers from	-10 249 804	-11 222 320
Transfers to	7 735 715	6 657 258
NET SURPLUS / SHORTFALL FOR THE PERIOD	-778 896	5 818 393
PLUS ACCUM FUNDS / SHORTFALL ON 01/01/2014	12 809 217	6 990 823
ACCUM FUNDS / SHORTFALL ON 31/12/2014	12 030 320	12 809 217
MINUS: BALANCE SHEET ITEMS	-1 102 189	-1 505 610
Creditor provision balancing	93 000	0
Debtors control account	-1 367 057	-2 281 617
ICRR control	141 064	231 554
Loan account bridging funds	0	0
Space and facility control acc	19 736	18 513
Sundry creditors	11 068	525 939
FUNDS AVAILABLE ON 31/12/2014	10 928 131	11 303 607



F Majiet
Director: Financial Services

STAFF

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CONTACT DETAILS

Sandy Heydenrycht
Email: crses@sun.ac.za
Tel: 021 808 4069
Fax: 021 883 8513

Postal address




Centre for Renewable and Sustainable Energy Studies
Stellenbosch University
Private Bag XI
Matieland
7602

Physical address

Centre for Renewable and Sustainable Energy Studies
4th Floor Knowledge Centre
Corner of Banghoek and Joubert Street
Stellenbosch
7600

GPS co-ordinates 33°55'44.60"S 18°51'51.47"E

www.crses.sun.ac.za

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 www.facebook.com/CRSES.Stellenbosch.University

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Photographs: Anton Jordaan

Design and layout: Jenny Frost Design

Printing: Hansa Print

Publishing coordinator: Aletta Jordaan

A: Mr Alejandro Lupion-Romero – Lecturer
B: Ms Jos Liebenberg – Administrative & Financial Office
C: Ms Therese Lambrechts – Schools Programme Manager
D: Ms Corli Leonard – Research Engineer
E: Mr Eugène Joubert – Research Engineer
F: Mr Cebo Silinga – Research Engineer
G: Ms Carla Nel – Marketing and Course Coordinator
H: Mr Athi Ntisana – Researcher
I: Prof Alan Brent – Associate Director
J: Mr Ulrich Terblanche – Research Engineer
K: Ms Karin Kritzinger – Researcher
L: Prof Wikus van Niekerk – Director
M: Ms Sandelize Heydenrycht – Receptionist
Absent: Ms Imke Meyer – Research Engineer

