

Renewable Energy Research at Stellenbosch University (SUN)

General Overview of the Activities of CRSES and SUN



CENTRE FOR RENEWABLE AND SUSTAINABLE ENERGY STUDIES

Prof JL (Wikus) van Niekerk
Director of CRSES
Stellenbosch





RENEWABLE & SUSTAINABLE
ENERGY STUDIES



UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

The Centre for Renewable and Sustainable Energy Studies was established in 2007 to facilitate and stimulate activities in renewable energy study and research at Stellenbosch University.

The Department of Science and Technology has been funding the Renewable and Sustainable Energy (RSE) Hub at Stellenbosch University since its establishment in August 2006. The aims of the RSE Hub are to develop human capital, deepen knowledge, and stimulate innovation and enterprise in the field of RSE. Currently the DST is still sponsoring the work of the Centre with an annual grant administered by the National Research Foundation.

Stellenbosch University was designated as the Specialisation Centre in Renewable Energy Technology as part of the Eskom Power Plant Engineering Institute (EPPEI). The research and teaching activities sponsored by Eskom focus on concentrating solar power (CSP) and wind energy and also includes the Eskom Chair in Concentrating Solar Power.

The Sasol Technology group sponsored the new facilities for the Centre for Renewable and Sustainable Energy Studies as well as the work and facilities of the Solar Thermal Energy Research Group at Stellenbosch University in support of their New Energy business unit.



sasol
reaching new frontiers





Vision & Mission

The Centre for Renewable and Sustainable Energy Studies enables Stellenbosch University in partnership with other universities and research institutions in South Africa to be recognised as the leading, ***best-known and most productive R&D network in the field of renewable energy in Africa***

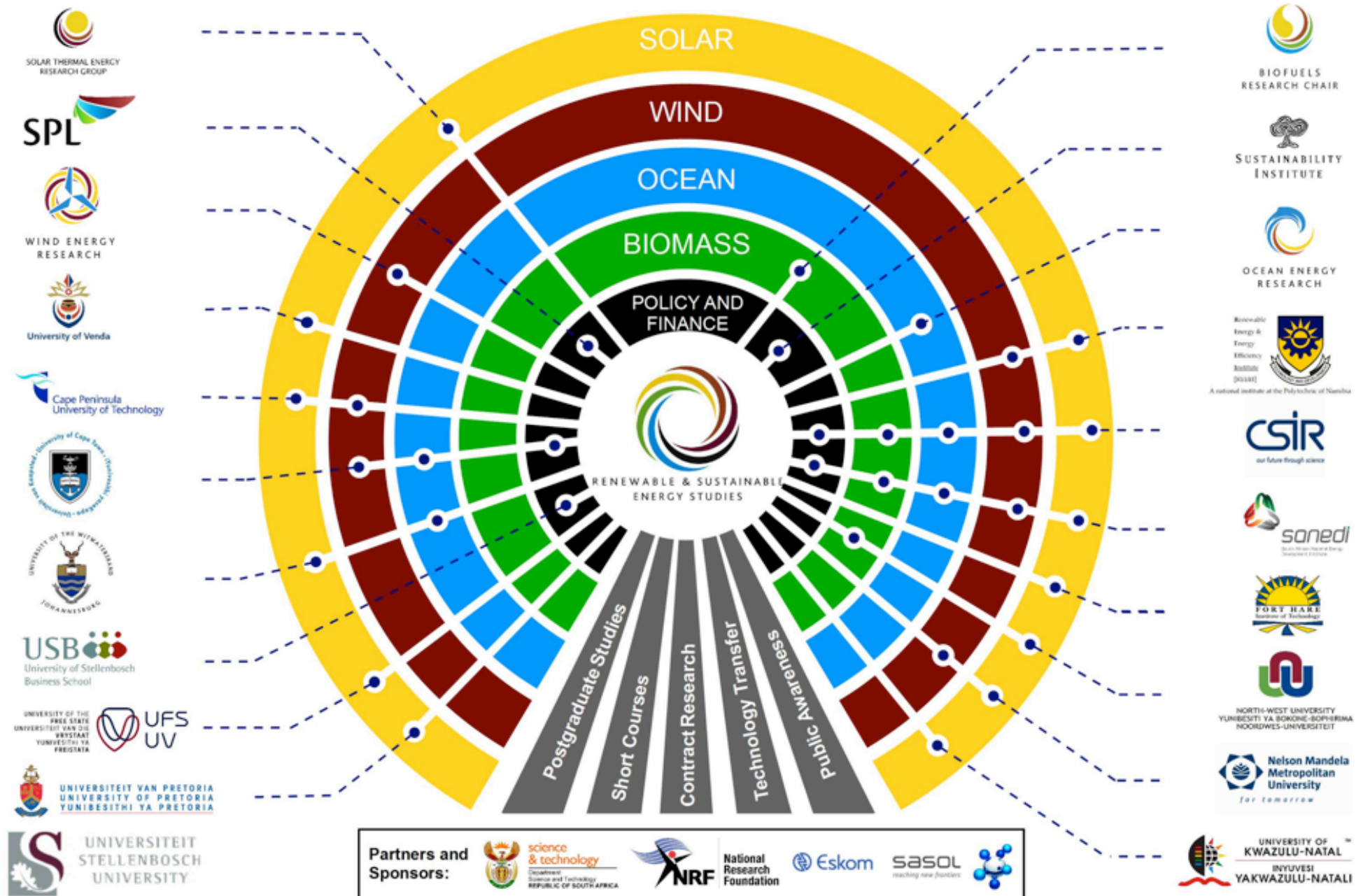
Stellenbosch University supports the transition to Renewable Energy of the South African economy and society by:

- Producing sought-after **postgraduate students and specialist engineers** for the private and public sectors.
- Providing cutting-edge **technical solutions** that can be applied in practice.
- Enabling the **transfer of appropriate knowledge**.
- Facilitating and coordinating **national initiatives**.
- **Creating an awareness** in the public and private sectors and the general public.
- Obtaining **adequate funding** to support these activities.



Our Network

CRSES ACADEMIC NETWORK





Main Activities

- **Academic**
 - Fund academic positions at Stellenbosch University
 - Coordinate postgraduate programmes
 - Present and sponsor postgraduate modules
 - Supervise research and coursework postgraduate students
 - Award bursaries to postgraduate students
- **Research**
 - Identify, formulate and propose research projects
 - Conduct research, as contract research or academic research projects
 - Publish results in theses, reports, papers and articles
- **Consulting**
 - Specialist consulting, e.g. feasibility studies and assessments
 - Technology evaluation
 - Policy advice for the public sector
- **Training**
 - Short courses (as part of the academic modules)
 - Workshops, specialised and in-house short courses
- **Awareness**
 - Forums, open days, lectures
 - Schools programme





Faculties Involved in RE

- **Engineering**
 - Mechanical & Mechatronic
 - Electrical & Electronic
 - Process (Chemical)
 - Civil
 - Industrial
- **Economic and Business Science**
 - School for Public Leadership
 - (Sustainability Institute)
 - University of Stellenbosch Business School
- **Natural Sciences**
 - Microbiology
- **Agri-Sciences**
 - Forest & Wood Sciences
 - Research Chair in Postharvest Technology
- **Law**
 - Environmental Law





National Initiatives

- Wind Energy Training Centre – SARETEC at CPUT (with GreenCape)
- National Solar Energy R&D Centre – On-going
- National Solar Resource Database and Maps – Measurement Network www.sauran.net
- National Energy Modelling Alliance
- National Postgraduate Programme in Renewable Energy





Postgraduate Programmes

- Postgraduate Diplomas
 - Postgraduate Diploma Engineering (Renewable Energy)
 - Postgraduate Diploma in Sustainable Development (RE)
- Masters Programmes
 - Coursework masters: M.Eng.(Structured)
 - Research/Coursework masters: M.Phil.(Sustainable Dev)
 - Research Masters: M.Eng.(Research), M.Sc.
- PhD Programmes
 - All the different faculties of the University





Postgraduate Modules

- Renewable Energy Systems (Overview of technology)*
- Renewable Energy Policy*
- Renewable Energy Finance (Project financing)*
- Introduction to Solar Energy (Both PV and thermal)*
- Advance Photovoltaic Systems*
- Wind Energy*
- Hydro & Ocean Energy*
- Bio-Energy (Including bio-fuels)*
- (Conventional) Thermal Energy Systems*

* Also available as short courses to industry

- Solar Thermal Energy Systems (Focus on CSP)



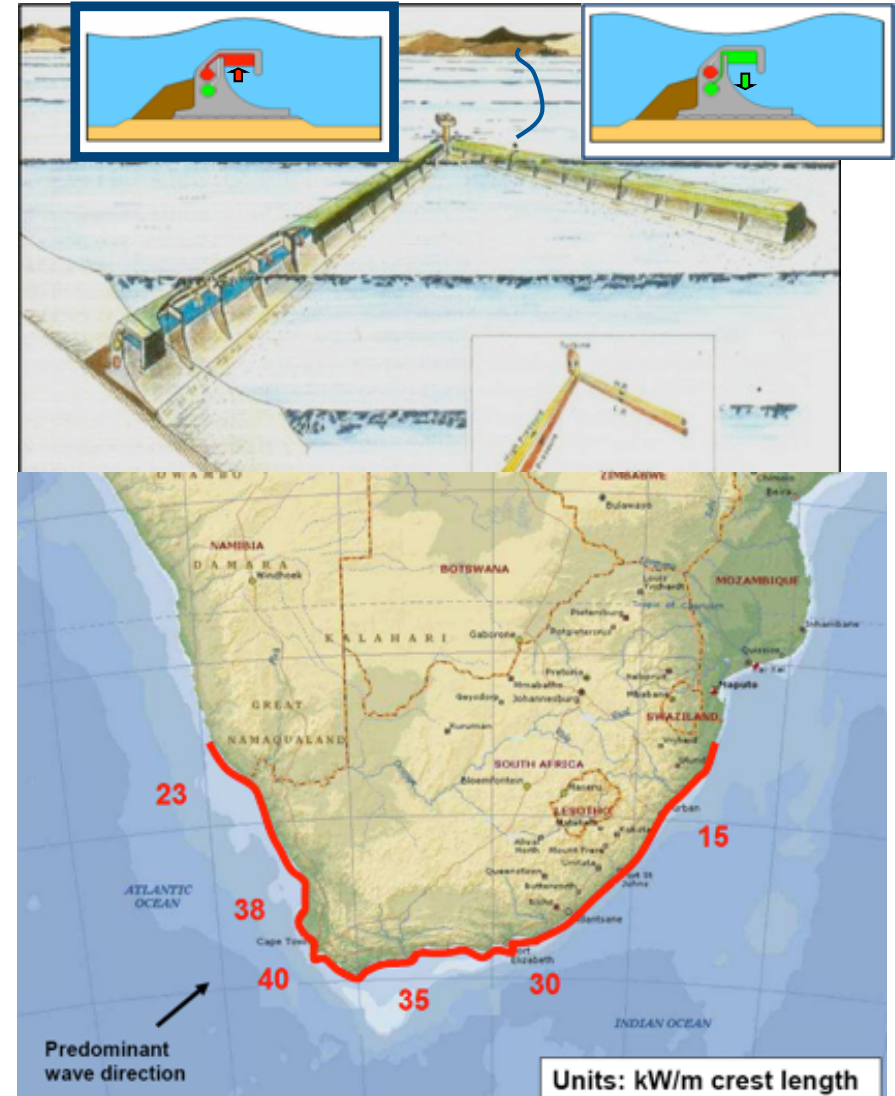
Research Areas

- **Solar Thermal Energy**
 - STERG: Solar Thermal Energy Research Group (find more from slide 18 onwards)
- **Wind Energy**
 - Direct-drive permanent magnet generators
 - Grid integration
 - Conditioning monitoring of large wind turbines
- **Bio-Energy**
 - 2nd Generation – Lignocellulose to bio-ethanol
 - Thermal conversion (Pyrolysis, gasification, combustion)
 - Bio-diesel
- **Ocean Energy**
 - Wave energy
 - Ocean current (Agulhas)
 - Resource and technology assessment
- **Photovoltaics**
 - Focus on PV systems (Scate Solar Chair)
- **Systems Modelling**
 - Focus on modelling the SA electricity supply



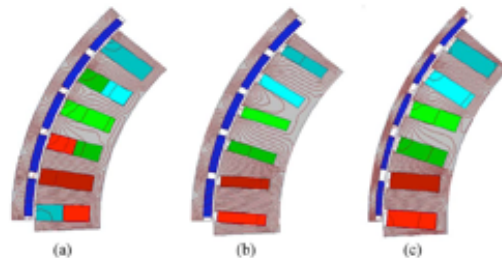
Ocean Energy

- Focussed on wave energy and the SWEC
- ShoreSWEC for V&A Waterfront
- Wave energy resource modelling
- Developed shroud for ocean current turbine
- Resource assessment of the Agulhas Ocean Current



Wind Energy

- Based in Department of Electrical & Electronic Engineering
- Design and development of permanent magnet, direct-drive generators for smaller wind turbines
- Grid integration of wind turbines (and other renewables)
- Condition monitoring, operations & maintenance of large wind turbines



TIA Project – Helio 100

*Small, smart, modular-scalable
heliostat & receiver system
technology development project*



*10 STERG experts | 18 months | 100m²
300 kW_{th} pilot facility*



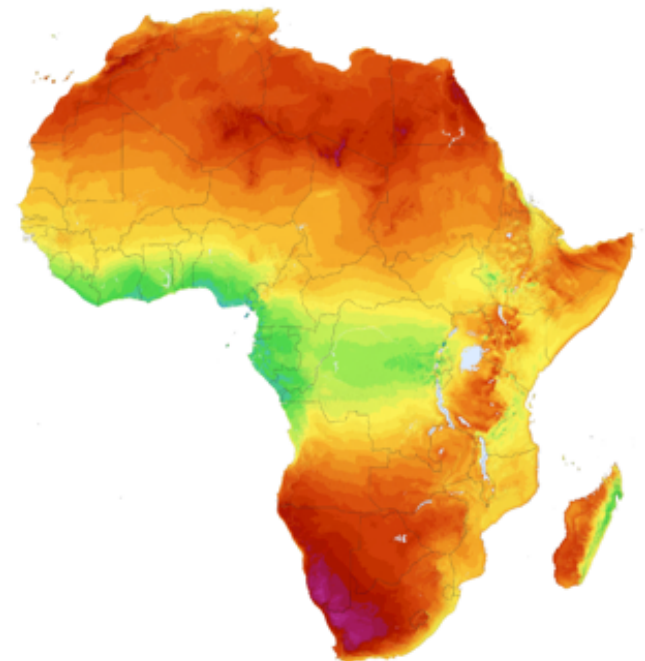
GeoSUN Africa (Pty) Ltd



Spin-off company with GeoModel Solar a key shareholder

SERVICES – anything to do with solar resource

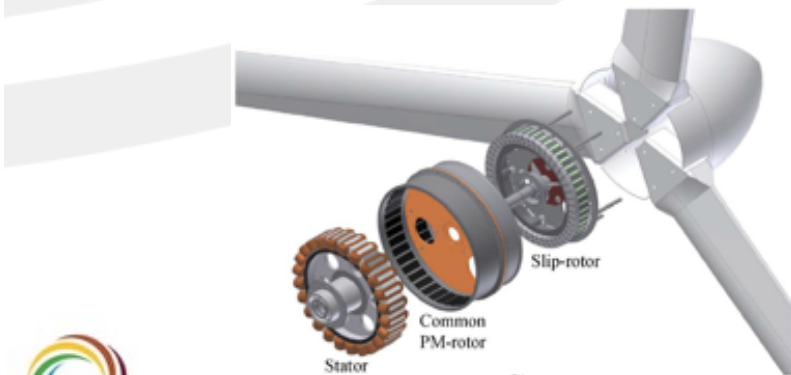
- Site selection studies
- Supply of satellite derived data time series including P50 and P90 Typical Meteorological Year (TMY) files
- Onsite solar measurements – the specification, procurement, installation, monitoring and maintenance of these stations including data download and quality checks
- Bankable solar resource reports for utility scale solar plants (PV, CPV and CSP) plants. This is also provided for rooftop PV projects.
- Bankable generation forecast (yield) reports as required for a RE-IPPPP bid submission (PV only)
- Independent review of solar resource or yield reports (PV, CPV and CPS)
- Bankable solar data for solar plants in operation (PV, CPV and CSP)
- Monitoring services for smaller PV plants (roof or ground mounted)
- Various solar maps (poster maps, GIS or Google Earth layers)





SWET (Pty) Ltd

- Established by E&E staff, students and Innovus to take wind energy technology to market
- Innovus brings strong business and marketing capability
- Strong focus on electrical Innovations with patents registered on:
 - Air core generator design
 - Suitable for small wind applications
 - Trialled and tested on 3 and 6 kW scale
 - SSPMG (Slip Synchronous Permanent Magnet Generator)
 - Suitable for small and medium scale applications
 - Trialled and tested at 15 kW scale
 - Could scale up to 250 kW feasibly



SWET
STELLENBOSCH WIND
ENERGY TECHNOLOGIES





Lessons Learned

- Nothing beats “smart students” and “motivated staff”
- Leverage off other, existing research groups/colleagues/departments/faculties etc in the university and other national partners
- Always seems to be bigger than you really are, partnerships!
- It helps to have money to support the research efforts of your colleagues, “spread it around”
- Industry support is key, but it has to be earned
- Don’t try to be “the only game in town”
- Focus on those areas where you have a competitive edge while growing competencies in the others you have identified



Solar Thermal Energy Research Group “STERG”

Prof Frank Dinter

Eskom Chair in Concentrating Solar Power (CSP)
Director of Solar Thermal Energy Research Group (STERG),
University of Stellenbosch

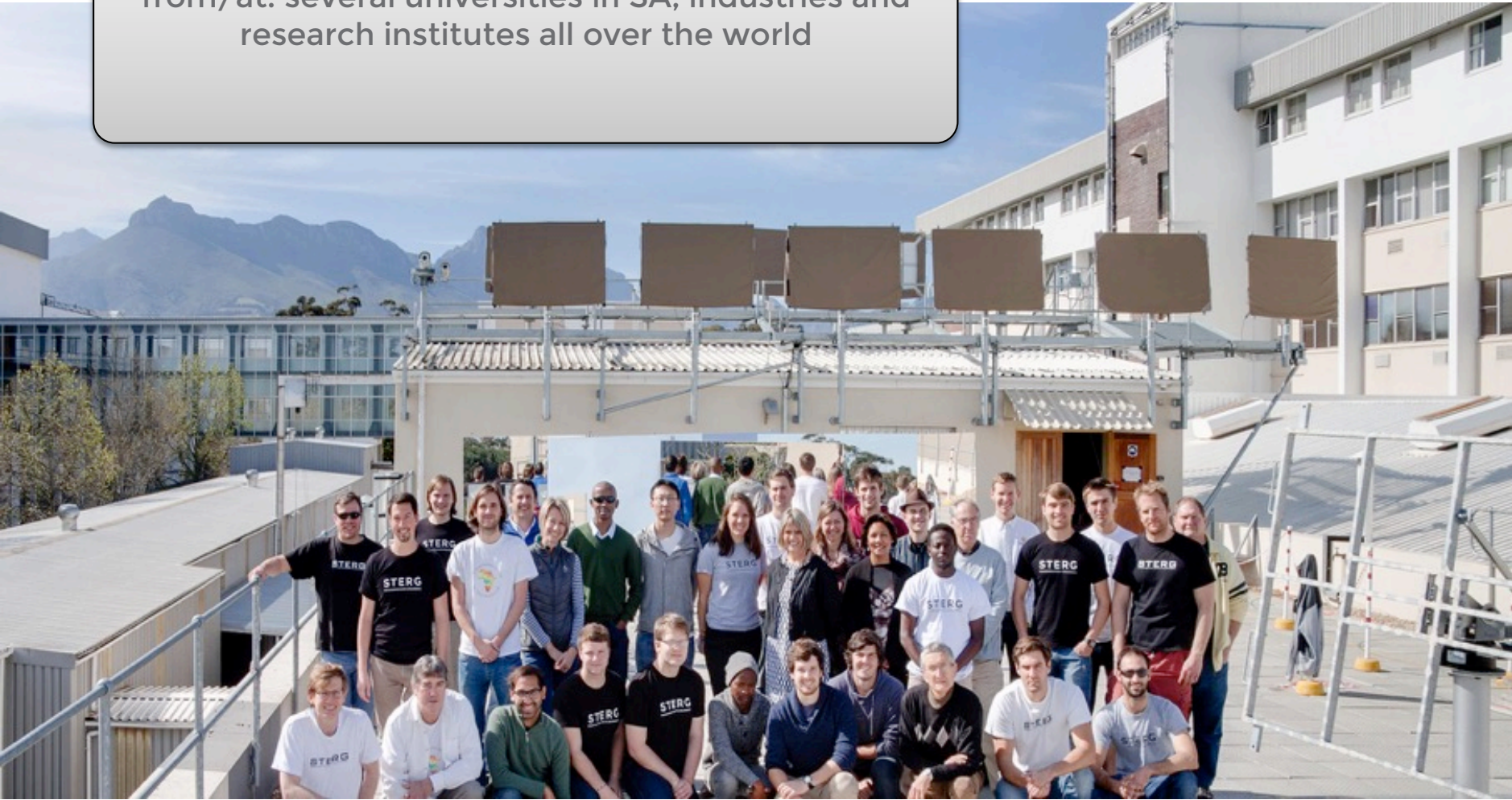


CENTRE FOR RENEWABLE AND SUSTAINABLE ENERGY STUDIES

STERG: First and biggest SA University CSP research group (I)



~ 75 members
from/at: several universities in SA, industries and
research institutes all over the world



STERG: First and biggest SA University CSP research group (II)



- ~ 75 Members mainly from SUN, but also international (~40 Master & PhD)
- Staff: ~5 (Eskom/Sasol researchers, administrative, engineering and technical support)
- 1,000 m² solarroof laboratory & control room, offices, workshop
- 18 m lattice tower (multi-use)
- 40 m² heliostat field
- 25 kW_{th} receiver test facility
- 25 kW_e McDonnell Douglas Stirling Dish (donated by Eskom)
- TIA Helio 100: first 100 % South African Heliostat development
- Member of national and international CSP associations

STERG: First and biggest SA University CSP research group (III)



- ADA Solar water heating test facility
- Solar resource station with free web download (K&Z full tracker and shadow ring)
- 1,200 °C kiln for material tests
- 600 °C, 1.5 m³ packed bed storage rig



STERG History I

1980 - 1989	1990 - 1999	2000 - 2009	2010 -
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First Parabolic Trough Research



Dry cooling research at SU commences



Solar chimney research at SU commences


RENEWABLE & SUSTAINABLE
ENERGY STUDIES

National SANERI/DST
RE centre founded

SANERI/DST Solar
thermal spoke
& Hope project



sasol
realising new frontiers
Sasol researcher



Solar roof lab commissioned


SASTELA
Research and academic
committee representative



**SOLAR THERMAL ENERGY
RESEARCH GROUP**



Solar resource station at SU



CENTRE FOR RENEWABLE AND SUSTAINABLE ENERGY STUDIES

visit concentrating.sun.ac.za
contact sterg@sun.ac.za

STERG History II

2010 7 – 15 people	2011 ~ 30 people	2012 ~ 45 people	2013 – ~ 60 (75) people
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SOLAR THERMAL ENERGY RESEARCH GROUP



Solar roof lab expansion (with tower, kiln, etc)



Solar resource station at SU



Eskom Chair in CSP and Centre of Specialisation

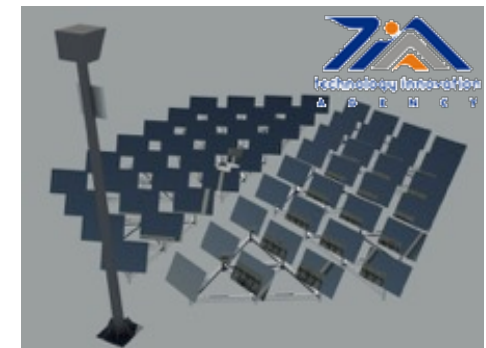


NRF solar thermal spoke 2013 - 17

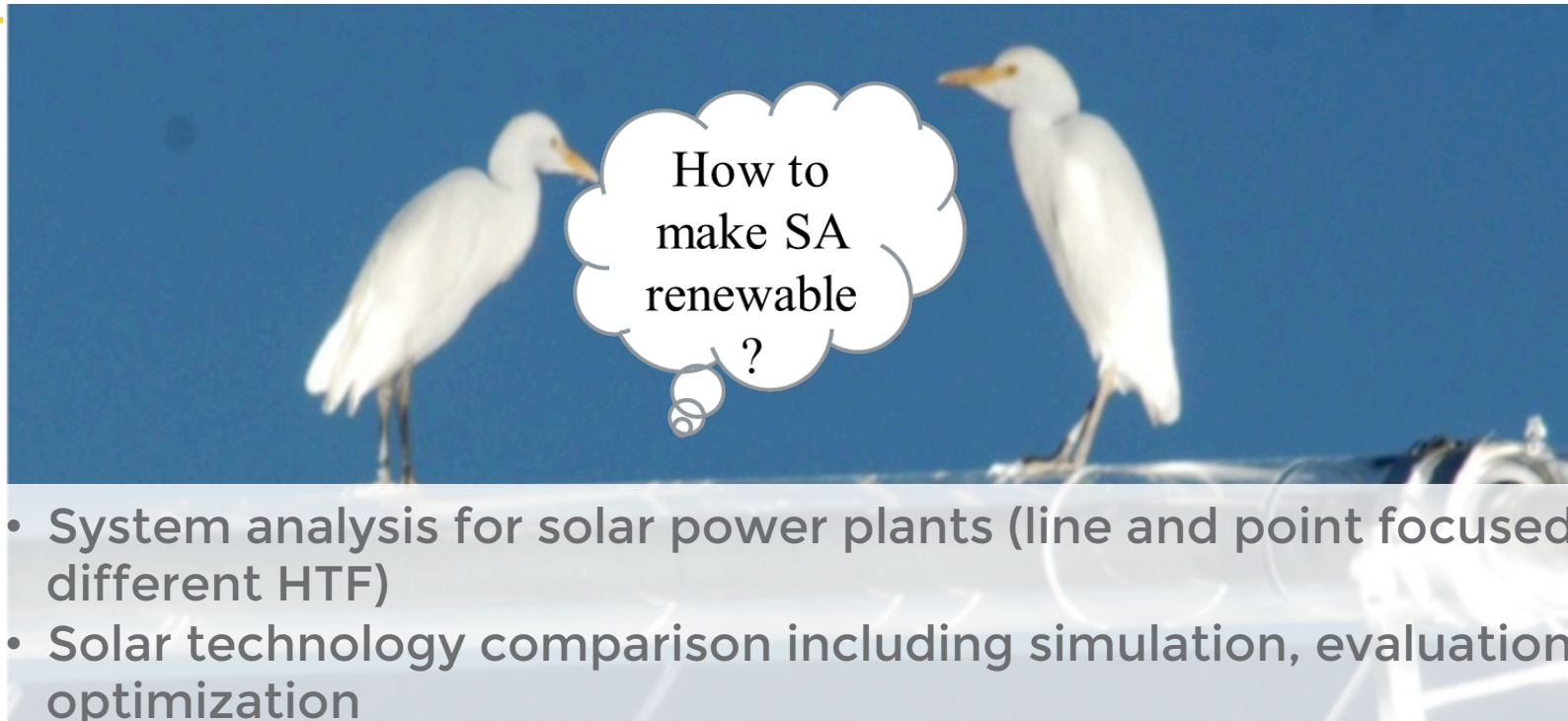


SASOL
Sasol 40 m² heliostat field

2014



STERG research areas



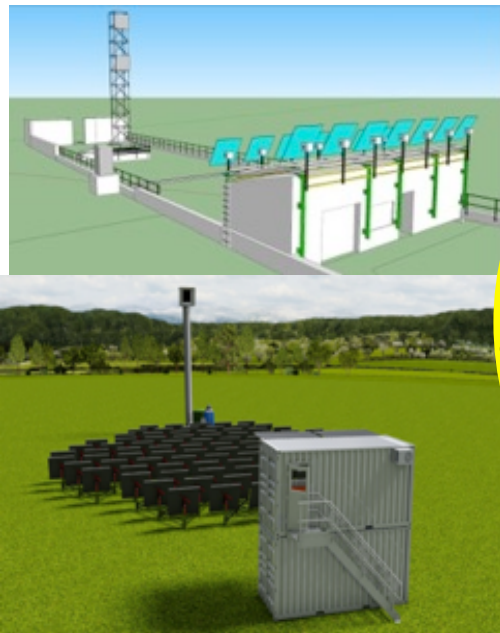
- System analysis for solar power plants (line and point focused with different HTF)
- Solar technology comparison including simulation, evaluation and optimization
- System and subsystem optimization in CSP power plants development and design of cost reduced components (collector-, receiver-, storage, cooling-systems) and their **impact on energy production costs**
- Prototype development of receivers, storage systems and other components
- Industrial heat applications with solar energy from 100 to 900 °C
- Scenario development and calculations for South African power demand

STERG current research priorities



Overview

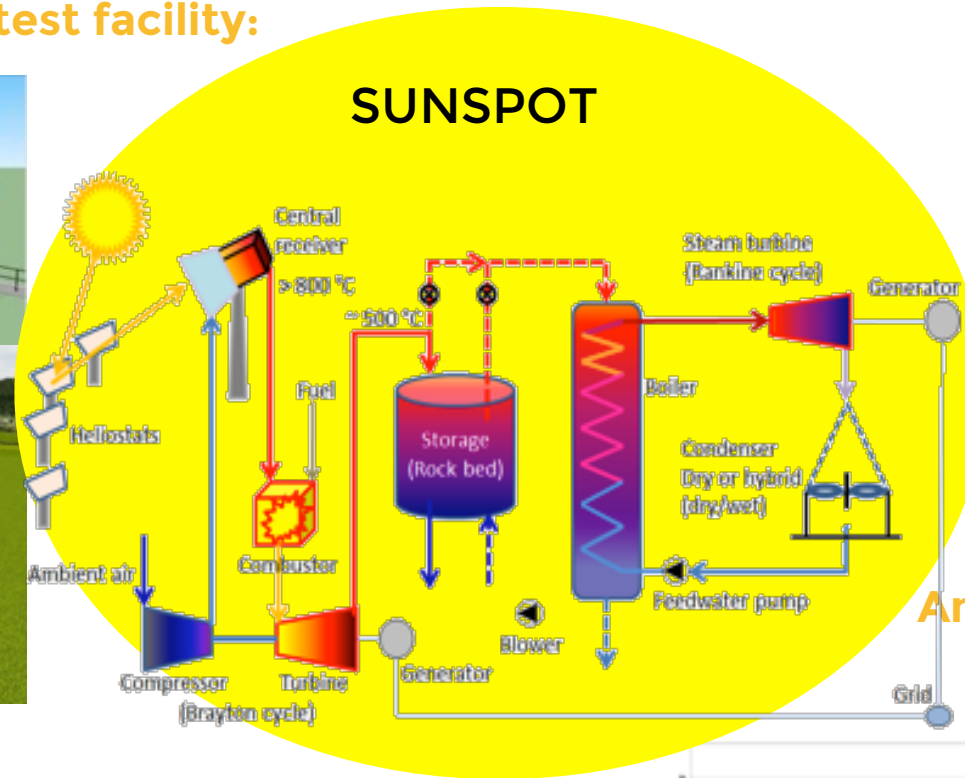
Optics and receiver test facility:



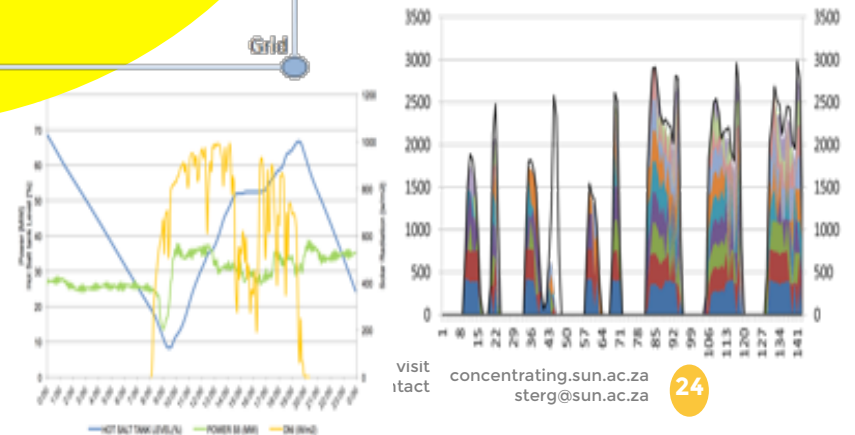
Thermodynamics:



HTF and Storage:



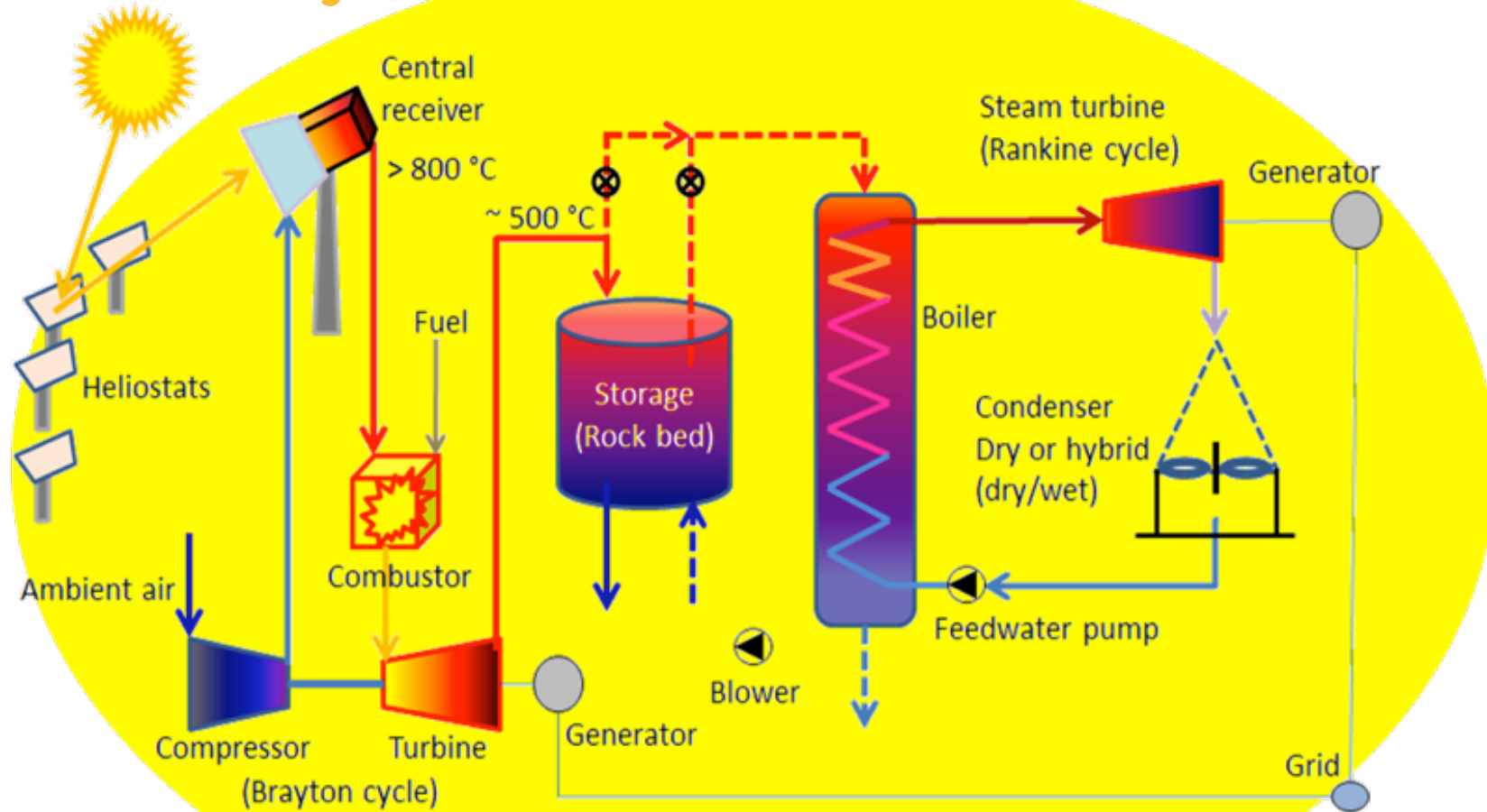
Analysis and optimization



STERG current research priorities



“SUNSPOT Cycle”



Stellenbosch University Solar POWER Technology = SUNSPOT

STERG current research priorities



Optics and receiver test facilities

“STERG roof top lab with Helio 40 during construction phase (2014)”



STERG current research priorities



Optics: South Africa's first commercially viable heliostat



"Helio 100"

- Low cost
- High local content
- "Plonkable" - Minimal site preparation on nearly any terrain
- Suitable for large and small installations
- Attractive for process heat applications due to its flexibility, as clients may have irregularly shaped, uneven pieces of land available

STERG current research priorities



HTF and storage

different HTFs
(liquids: metals, salts and “air”)
rock bed storage

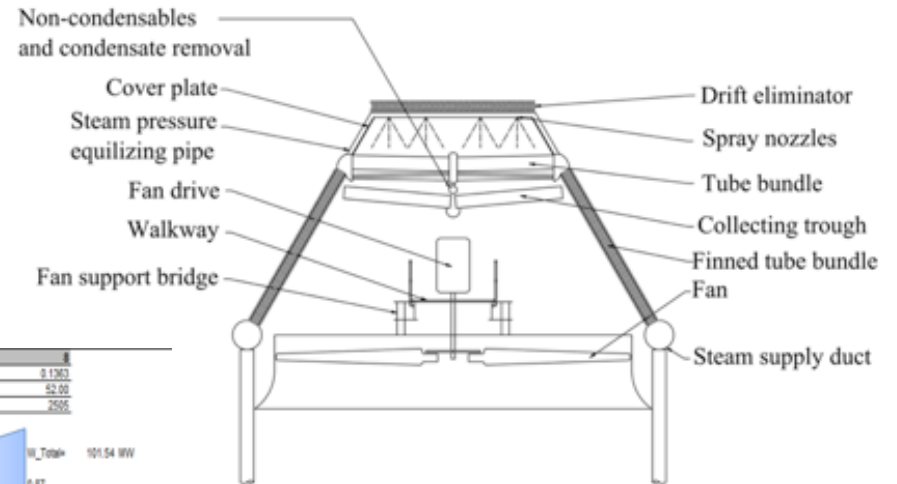


STERG current research priorities:

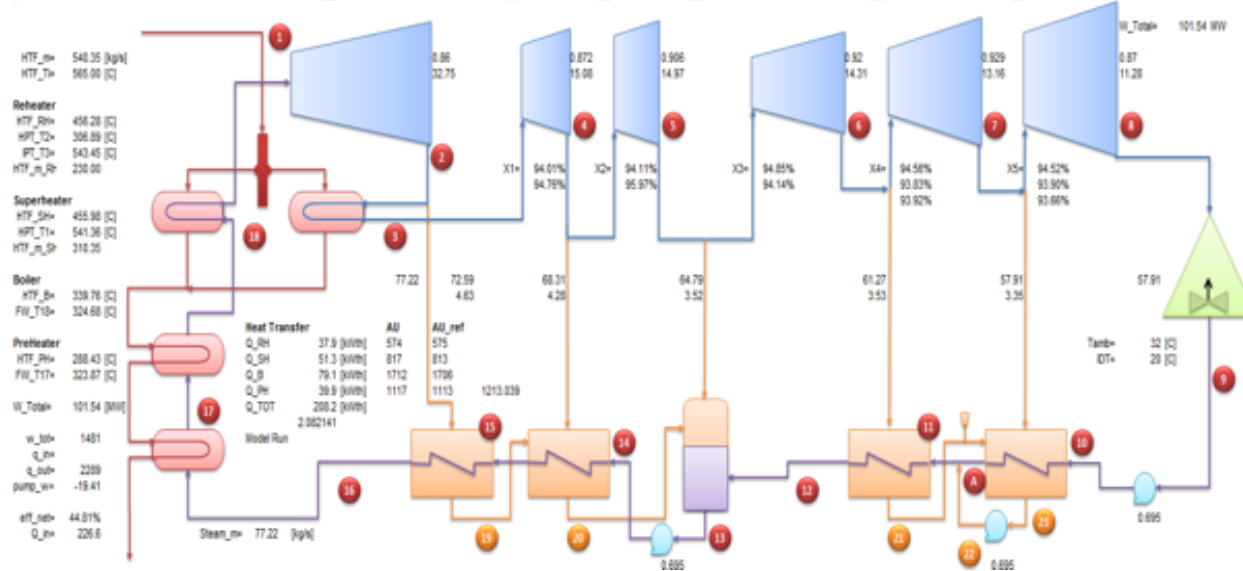


Thermodynamics

- process simulation and optimization
- optimized dry & hybrid cooling



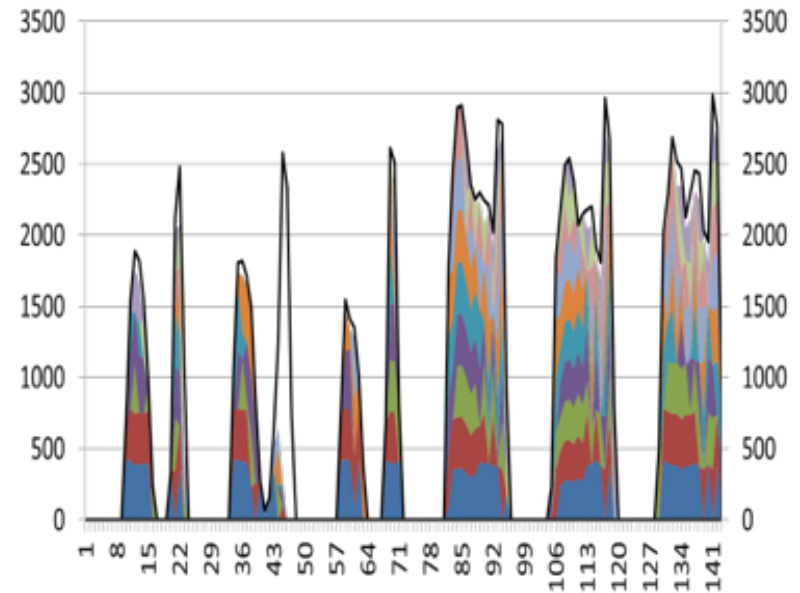
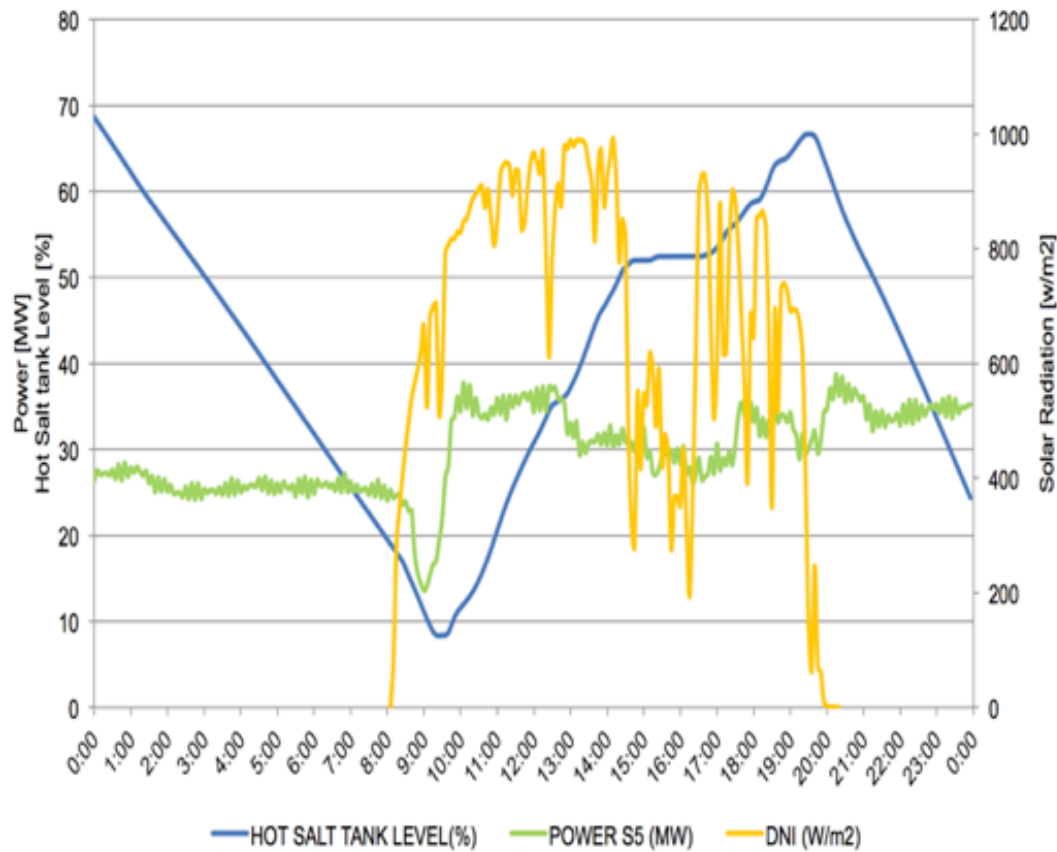
	1	2	3	4	5	6	7	8
Pressure [bar]	120.00	21.79	21.79	10.94	4.87	1.06	0.58	0.1363
Temperature [C]	541.36	306.89	543.45	442.99	334.28	221.67	109.47	52.00
Enthalpy	3459	3035	3563	3355	3136	2815	2790	2595
s	6.63		7.51	7.56	7.59	7.63	7.68	



STERG current research priorities:



Analysis and optimization



Spatial-temporal system & thermodynamic modelling & simulation

Commercial CSP Projects



Status of CSP plants in South Africa

Window 1 (150 MW)

Khi – 50 MW tower - Abengoa

Kaxu – 100 MW trough - Abengoa

Window 2 (50 MW)

Bokpoort – 50 MW trough - ACWA

Window 3 (200 MW)

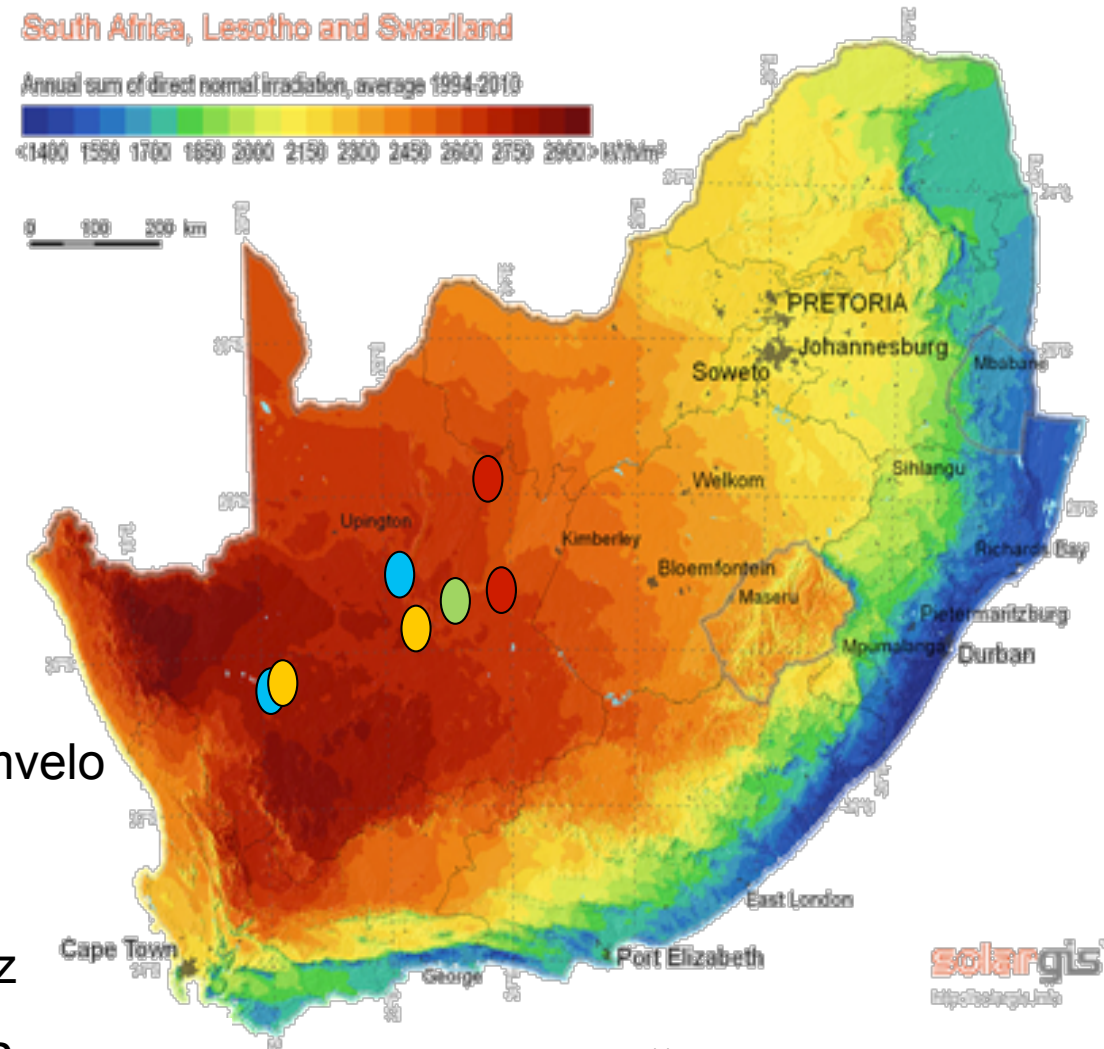
Xina – 100 MW trough - Abengoa

Ilangaletu 1 – 100 MW trough - Emvelo

Window 3.5 (200 MW)

Kathu – 100 MW trough - GDF Suez

Redstone – 100 MW tower - Solar Reserve



Contact Details:

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<http://concentrating.sun.ac.za>

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