



SASEC 2018

5TH SOUTHERN AFRICAN SOLAR ENERGY CONFERENCE

25 - 27 June 2018 | Durban, South Africa



CENTRE FOR RENEWABLE &
SUSTAINABLE ENERGY STUDIES

Proceedings

ISBN 978-0-7972-1765-2



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PREFACE

The SASEC 2018 organizing committee warmly welcomes you to the 5th Southern African Solar Energy Conference, taking place for the first time in the city of Durban. A special welcome to international delegates who join us from across the globe, including Africa and Europe—your presence enriches our gathering and continues to ensure that SASEC represents a truly international event.

In this year's edition of SASEC we have a wide spectrum of quality, informative academic papers, falling in the broad categories of Solar Thermal Energy, Photovoltaics, Policy and Solar Resource. As in years past, SASEC 2018 also offers a tremendous opportunity for university students to present the results of their work, interface with leaders of industry and academia and to develop as world-class researchers.

This year's conference places particular emphasis on the testing of PV modules, the interaction between PV systems and the electrical grid, and on the modelling and simulation of solar thermal systems and components. We are especially pleased to introduce three outstanding keynote speakers:

- Dr Claudia Buerhop-Lutz from the Bavarian Center for Applied Energy Research
- Dr Michael Geyer from Abengoa Solar
- Professor Kumar Venayagamoorthy, the Duke Energy Distinguished Professor of Power Engineering at Clemson University

We wish you an enjoyable visit to our warm shores and a productive experience as you listen to the presentations, establish new linkages with researchers in your field and confer on the growing importance of solar energy in our planet's future.

Michael Brooks
Conference Chair

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Review of papers

All submissions to the 5th Southern African Solar Energy Conference have undergone peer-review by members of the International Advisory and Technical Review Committee. This includes an initial review of submitted abstracts and a second, full-paper review of final submissions.

PROGRAMME

DAY I: MONDAY, 25 JUNE 2018

1.1 Opening Session (08h30 - 10h10) – Fontainebleau

Chair: Dr Michael Brooks

08h30 Introduction – *Prof Sampson Mamphweli (Director: CRSES)*

08h40 Welcome to SASEC on behalf of UKZN – *Prof Deresh Ramjugernath (DVC: UKZN)*

09h00 Welcome to Durban: Mayor’s Office – *eThekweni Municipality representative*

09h10 SASEC opening address – *Dr Rebecca Maserumule (Chief Director: Hydrogen and Energy: Department of Science and Technology)*

09h30 Keynote address – *Dr Michael Geyer (Abengoa)*

TEA / COFFEE BREAK (10h10 - 11h00)

1.2 Plenary Session (11h00 - 12h20) – Fontainebleau

Chair: Prof Sampson Mamphweli

11h00 [Expert Elicitation of the Impact of R&D Budget on CSP in South Africa](#)
– *Toyosi Craig, Alan Brent and Frank Dinter*

11h20 [Investigation into the Costs of Large-Scale Solar Thermal Systems in SADC Countries](#) – *Angelo I. Buckley, Karin Kritzinger and Sampson Mamphwelip*
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11h40 [Monitoring of Domestic Solar Water Heating Systems in the National Mass Housing Project under National Housing Enterprise in Namibia](#)
– *Fenni M.T. Shidhika, Helvi Ileka and Matthias Kinateder*

12h00 [The Impact of Small-Scale Distributed PV Generation on South Africa's System Demand Profile](#) – Lewis S. Waswa and Bernard Bekker

LUNCH BREAK (12h30 - 13h30)

1.3a PV Modules (13h30 - 15h10) – Fontainebleau

Chair: Dr Bernard Bekker

13h30 [An Investigation into the Failure Mechanisms of Schottky Barrier Diodes, Specifically when Implemented as Bypass Diodes in Photovoltaic Modules](#) – K.M. Coetzer, P.G. Wiid and A.J. Rix

13h50 [Parameter Optimisation of Individual Cells Through Voltage Dependent Electroluminescence of an Experimental Si Module](#)
– Ross M Dix-Peek, Isaac Kwembur, E. Ernest van Dyk, Frederik J. Vorster and Christiaan J. Pretorius

14h10 [Optimisation of Electroluminescence Setup for Characterisation of Photovoltaic Module Degradation](#) – I.M Kwembur, J.L. Crozier, E.E. van Dyk and F.J. Vorster

14h30 [Correlation of Thermal Imaging and Current-Voltage Measurements on PV Module Strings](#) – M.Vumbugwa, J.L. Crozier, E.E. van Dyk, F.J. Vorster and T.J. Serameng

14h50 [Performance Analysis of PV panel Connected in Various Orientations Under Different Climatic Conditions](#) – A.A Adebiji, I. Lazarus, A.K Saha and E.E Ojo

1.3b Solar Thermal: Cycle and Plant Modelling (13h30 - 15h10) – Concord

Chair: Prof Johan van der Spuy

13h30 [Dynamic modelling of the HPS2 CSP molten salt parabolic trough test facility](#) – Robert Temlett and Pieter Rousseau

- 13h50 [Transient Simulation of a Supercritical CarbonDioxide \(sCO₂\) Concentrated Solar Power \(CSP\) System](#) – *R. van der Westhuizen and R.T. Dobson*
- 14h10 [A Study of an Integrated Biomass Gasification Combined Cycle Process Facilitated with Concentrated Solar Power](#) – *Shahid H. Ansari and Xinying Liu*
- 14h30 [A Second Law Analysis of the Effects of Reheating and Intercooling on the Optimal Net Power Output and Irreversibility of a Solar Thermal Brayton Cycle](#) – *Matthew R. Meas and Tunde Bello-Ochende*
- 14h50 [Polygeneration of Power, Cooling and Desalinated Water by Concentrated Solar Energy Plants Equipped with @GICE Engine](#) – *L. Chennaoui, G. Cerri and S.B. Alavi*

TEA / COFFEE BREAK (15h10 - 15h40)

1.4a Solar Thermal: Heat Transfer (15h40 - 17h20) – Fontainebleau

Chair: Mr Jean Pitot

- 15h40 [Development and Optical and Thermal Analysis of a Novel Parabolic Trough Thermal Receiver: Heteroconical Tubular Cavity Receiver](#) – *Neelesh Maharaj and Tunde Bello-Ochende*
- 16h00 [Development and Validation of a Molten Salt Parabolic Trough Receiver Model](#) – *Christoph A. Pan, Frank Dinter and Thomas M. Harms*
- 16h20 [Flow Regime Maps for Fully Developed Flow in Horizontal Solar Receiver Tubes](#) – *Marilize Everts and Josua P. Meyer*
- 16h40 [Design and Development of a Next Generation Thermal Rock Bed Storage Experimental Facility](#) – *Stephanus J. Erasmus, Theodor W. von Backström, Matti Lubkoll and Frank Dinter*
- 17h00 [Solar Drying of Faecal Sludge from On-Site Sanitation Facilities](#) – *Santiago Septien, Tendayi R. Mugauri, Anusha Singh and Freddie Inambao*

I.4b Policy and Economics II (15h40 - 17h20) – Concord

Chair: Prof Ernest van Dyk

- 15h40 [Comparative Analysis of Residential PV Installation Development Across the World](#) – Nikkie Korsten, Karin Kritzinger and Louise Scholtz
- 16h00 The Impact of Servicizing on Consumer’s Willingness to Adopt Photovoltaic Energy – Coenrad Ehlers and Jako Volschenk
- 16h20 [Facilitating Solar-Based Rural Electrification Projects in South Africa by Applying a Bottom-Up Energy Demand Modelling Approach](#) – Cristina Dominguez, Kristina Orehounig and Jan Carmeliet
- 16h40 [The Insurance Industry as a Solar Water Heater Driver in South Africa](#) – Karin Kritzinger and Theo Covary
- 17h00 [Performance Analysis for a Photovoltaic System with Solar Tracking](#) – Sengiphile N. Simelane, Unarine B. Mudau and Talent Duma

COCKTAIL EVENT(18h00 - 20h00)



DAY 2: TUESDAY, 26 JUNE 2018

2.1 Plenary Session (08h30 - 10h30) – Fontainebleau

Chair: Prof Frank Dinter

- 08h30 Keynote Address: Photovoltaic solar operations in grid-connected and stand-alone systems – Prof K. Venayagamoorthy (Clemson University)
- 09h10 [Investigation into the Effects of Distributed PV Generation on Electrical Distribution Grids: A Cape Town Residential Network Case Study](#) – Anrich F.W. Steyn and Arnold J. Rix
- 09h30 [Potential of Solar Heat for Industrial Processes: A Summary of the Key Findings from Solar PayBack](#) – Peter Klein, Karen Surridge and Markus Wolf
- 09h50 [High Turbidity Clear Sky Model Validation on Data from South Africa](#) – Pierre Ineichen
- 10h10 [The Development and Deployment of a Southern African Reference Energy Yield Network System \(SAREYNS\)](#) – Ross D. Schultz, Frederik J Vorster and E. Ernest van Dyk

TEA / COFFEE BREAK (10h30 - 11h00)

2.2a Photovoltaics: PV Systems (11h00 - 12h30) – Fontainebleau

Chair: Prof Freddie Vorster

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- 11h00 [Single and Multi-Objective Optimisation of Photovoltaic \(PV\) Plant Designs](#) – Tafadzwa Gurupira and Arnold J. Rix
- 11h20 [Validation of PVsyst for Different Photovoltaic Module Technologies and System Design Configurations of PV Systems Operating in Central Part of South Africa](#) – Tshepo J. Serameng, E.E van Dyk and Kittessa T. Roro
- 11h40 [Current Methods for PV Generation to Participate in the Inertial Response of a Power System](#) – Warren J. Farmer and Arnold J. Rix

12h00 [Identifying the Potential Rooftop PV of Residential Areas in South Africa – A Case Study of Llandudno](#) – *Ndamulelo Mararakanye, Karin Kritzinger, Anrich Steyn and Arnold Rix*

2.2b Solar Thermal: Heat Transfer II (11h00 - 12h20) – Concord
Chair: *Dr Willem le Roux*

11h00 [Jet Impingement Heat Transfer Effect on SCRAP](#) – *David McDougal I, Theo von Backström, Matti Lubkoll and Ben Sebitosi*

11h20 [Manufacturing Trials of a Ribbed Tube for the Spiked Concept Air Preheater](#) – *Jaap Hoffmann and Ben Brand*

11h40 [Improving the Heat Transfer Characteristics of the Spiky Central Receiver Air Pre-heater \(SCRAP\) using Helically Swirled Fins](#) – *Dewald Grobbelaar, Matti Lubkoll and Theodor W von Backström*

12h00 [Radial Thermal Characteristics of a Domestic Oil Storage Tank During Charging](#) – *Ashmore Mawire, Adedamola Shobo and Denis Okello*

LUNCH BREAK (12h30 - 13h30)

2.3a Solar Thermal: Systems (13h30 - 15h10) – Fontainebleau
Chair: *Prof Ken Craig*

13h30 [Barriers to Introducing Solar Thermal Heat into Minerals Processing: A Case Study on Replacing a Diesel Burner at a Sinter Plant](#) – *S.A.C. Hockaday, F. Dinter and T.M. Harms*

13h50 Sensible Heat Based Indirect Solar Injera Baking Stove – *Asfafaw H.Tesfay, Mulu B. Kahsay and Mesele H. Hailu*

14h10 An Oil based Direct Solar Fryer for Injera Baking Application – *Mesele H. Hailu, Mulu B. Kahsay, Asfafaw H.Tesfay and Ole J. Nydal*

14h30 [The Use of Natural Gas to Facilitate the Transition to Renewable Electric Power Generation in Southern Africa](#) – *Stephen R. Clark, Johannes L. van Niekerk and James Petrie*

- 14h50 [Pre-Feasibility of Incorporating Non-Concentrating Solar Thermal Energy Systems in the Kenyan Tea Industry](#) – *Claude O. Piessou, Mike Owen and Matti LubKoll*
- 2.3b Solar Resource: PV and Forecasting (13h30 - 15h10) –Fontainebleau
Chair: *Dr Kittessa Roro*
- 13h30 [Forecasting of Solar Irradiance in Durban, South Africa Using Cluster Analysis](#) – *Paulene Govender, Michael J. Brooks and Alan P. Matthews*
- 13h50 [Direct Normal Irradiance Prediction for South Africa Using Clearness Number Contour Maps](#) – *C. Siakachoma, M.A. Moghimi, M. Sharifpur and J. P. Meyer*
- 14h10 [Solar Photovoltaic Numerical Plant Model for a 75 MW Fixed-Tilt Plant to Assist with Yield Forecasting](#) – *Felix A. Asoba and Arnold J. Rix*
- 14h30 [Forecasting the Short-Term Solar Irradiance of a Fixed-Tilt 75 MW Photovoltaic Plant in South Africa](#) – *Felix A. Asoba and Arnold J. Rix*
- 14h50 [Nonparametric Bootstrap-based Tolerance Intervals for the Assessment of Photovoltaic Energy Output](#) – *Jani Deyzel, Chantelle Clohessy, Warren Brettenny and E. Ernest van Dyk*

TEA BREAK (15h10 - 15h40)

- 2.4a Solar Thermal: Heat Transfer III (15h40 - 17h20) – Fontainebleau
Chair: *Dr Jaap Hofmann*
- 15h40 [Investigation into Central Receiver Design for Optimal Optical and Thermal Performance](#) – *M. Sootweg, K.J. Craig and J.P. Meyer*
- 16h00 [Heat Transfer Enhancement in Molten Salt Central Receiver Using Jet Impingement](#) – *Ken J. Craig, Marcel Sootweg and Josua P. Meyer*
- 16h20 [Design and Testing of Externally Finned Tube Cavity Receiver for Brayton Cycle Preheating Purposes](#) – *Elias J.J. Basson, J.E. Hoffmann and A.B. Sebitosi*

16h40 [Small-Scale Solar Thermal Brayton Cycle Recuperator: Experimental Testing and Heat Loss Analysis](#) – Kyle Dellar, Willem G. Le Roux, and Josua P. Meyer

17h00 [Aiming Strategy for Molten Salt Receivers](#) – Alberto Sánchez-González, María Reyes Rodríguez-Sánchez and Domingo Santana

2.4b Photovoltaics: PV and Grids (15h40 - 17h00) – Concord
Chair: Dr Arnold Rix

15h40 [Power Quality analysis of a Grid tied 3.3 kWp Rooftop Solar Photovoltaic System with Battery Storage](#) – Siyasanga I. May, Manjunath Basappa Ayanna, Lawrence Pratt, Sebastian Mienie, Kittessa Roro and Stephen Koopman

16h00 [The Development of a Modular Mini-Grid for Electrification in Rural Areas](#) – Ross D. Schultz, Mno M Govuzela, Frederik J. Vorster and E. Ernest van Dyk

16h20 [Mitigating Residential Tariff Uncertainty: The Viability of Combining Off-Grid PV and Grid Supply](#) – Reality L. Mashiri and Bernard Bekker

16h40 [The Integration of Second Live EV Battery into Micro-Grid with Solar Energy](#) – Xander Theron

CONFERENCE DINNER (18h00 - 23h00)
To be addressed by DST DDG, Mr Mmboneni Muofhe



DAY 3: WEDNESDAY, 27 JUNE 2018

3.1 Plenary Session (08h30 - 10h30) – Fontainebleau

Chair: Prof Ernest van Dyk

- 08h30 Keynote Address – *Dr. Claudia Buerhop-Lutz (ZAE Bayern)*
- 09h10 [Update on the Re-Establishment of the South African Weather Services \(SAWS\) Radiometric Network in All Six Climatological Regions and the Quality of the Data](#) – *Brighton Mabasa, Joel Botai and Lucky Ntsangwane*
- 09h30 [The Effect of Soiling on the PV Performance Ratio for Different PV Systems](#) – *Sebastian Mienie, Manjunath Basappa Ayanna, Lawrence Pratt, Kittessa Roro and Mmantsae Diale*
- 09h50 [The Suitability of Clear Sky Diffuse Irradiance Models for South African Atmospheric Conditions](#) – *Hartmut Winkler*
- 10h10 [Hourly Solar Radiation Forecasting on SAURAN Network Datasets Using Deep Learning Method: La Reunion and Durban Case Study](#) – *Mathieu Delsaut, Claire Quatrehomme, Patrick Jeanty, Miloud Bessafi and Jean-Pierre Chabriat*

TEA / COFFEE BREAK (10h30 - 11h00)

3.2a Solar Thermal: Optics, Process Heating and Fuels (11h00 - 12h40)

– Fontainebleau

Chair: Dr Matti Lubkoll

- 11h00 [Integrating Solar Process Heat into Manganese Ore Pre-Heating](#) – *M. Lubkoll, S. A. C. Hockaday, T. M. Harms, T. W. von Backström, L. Amsbeck and R. Buck*
- 11h20 [Small-Scale Fuel Production Using a Solar-Dish Distillation System](#) – *Jordan D. Smith and Willem G. Le Roux*

- 11h40 [Microstructured Façade Elements for Energy Efficient Office Room Illumination by Sunlight Combined with LED Light](#) – *Michael Jakubowsky, Andreas Neyer and Helmut Mülle*
- 12h00 [Development of the SERAFF Solar Flux Measurement System](#) – *Brandon van Bakel, Michael J. Brooks and Jean-Francois Pitot de la Beaujardiere*
- 12h20 [Analysis of a Parabolic Dish Solar Collector via Lunar Flux Mapping](#) – *Tamryn M.Wolff, Willem G. Le Roux and Josua P.Meyer*

3.2b Photovoltaics: Testing and Validation (11h00 - 12h40) – Concord
Chair: Dr Bernard Bekker

- 11h00 [PV Module Reliability Research in South Africa](#) – *Lawrence Pratt, Kittessa Roro, Manjunath Basappa Ayanna and Stephen Koopman*
- 11h20 [Overview of Laboratory Based and On-site Quality Testing Techniques of Photovoltaic Modules](#) – *J. Crozier, E.E. van Dyk and F.J. Vorster*
- 11h40 [Effect of Using Global Horizontal or Plane of Array Irradiance to Determine the Performance Ratio of Sun Tracking Solar PV Plants](#) – *Manjunath Basappa Ayanna, Lawrence Pratt, Sebastian Mienie, Kittessa Roro and Stephen Koopman*
- 12h00 [Global Horizontal Irradiance on Solar Energy System](#) – *Hlaluku W. Mkasi, Lawrence Pratt, Manjunath Basappa Ayanna, Kittessa Roro and Stephen Koopman*
- 12h20 [Fraunhofer Chile Research – Activities of Center for Solar Energy Technologies \(FCR-CSET\)](#) – *Prof Frank Dinter*

CLOSE OF CONFERENCE AND LUNCH
(13h00 - 14h00)