



STERG

SOLAR THERMAL ENERGY
RESEARCH GROUP



Simulations showing how the SUNSPOT system cycle improves on conventional combined cycle technology

Jan-Louis Janse van Vuuren^a, Frank Dinter^a and Theodor W. von Backstrom^a
Stellenbosch University

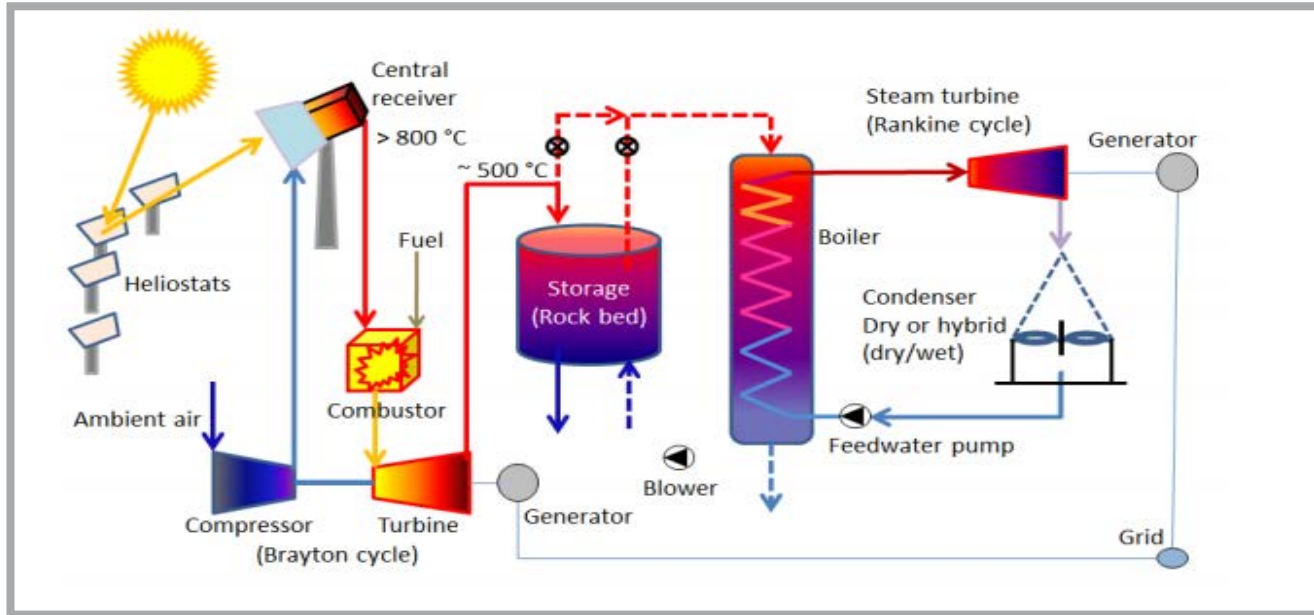
^aSolar Thermal Energy Research Group (STERG),
University of Stellenbosch

Content of presentation



- Overview on the SUNSPOT cycle
- Focus of study
- Simulation method and critical assumptions
- Validation of models
- Site selection
- A progressive outlook on the SUNSPOT
- Project Outlook
- Questions

Overview on the SUNSPOT cycle



Stellenbosch University Solar Power Thermodynamic cycle by Kröger (2012)

Focus of study



- Modelling of the combined cycle and SUNSPOT specific components
- Showing the progression of the SUNSPOT cycle for a 14 MW scale industrial plant
- Developing a high level feasibility model, including the thermo-economic implications

Simulation method and critical assumptions

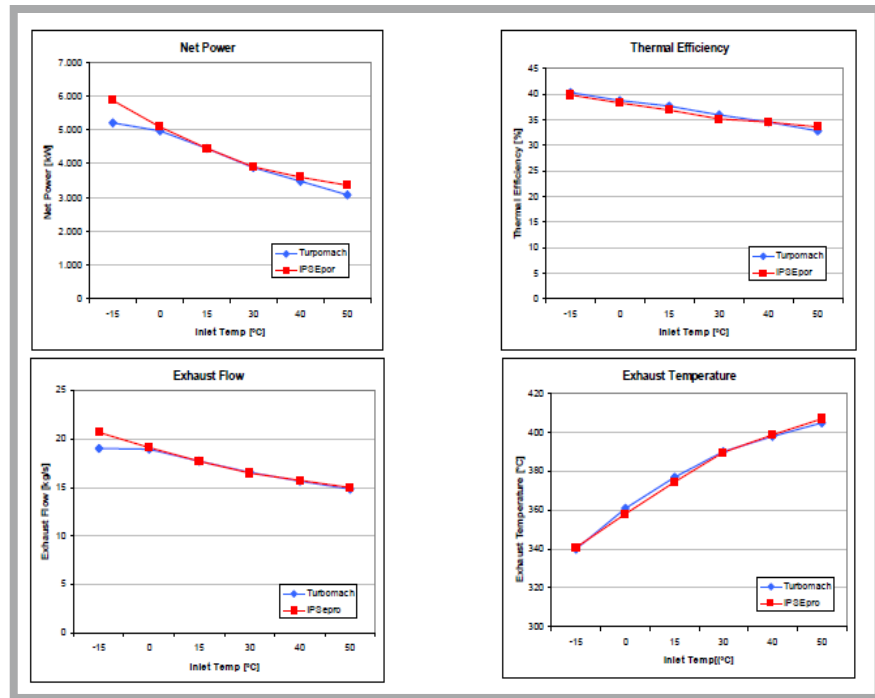
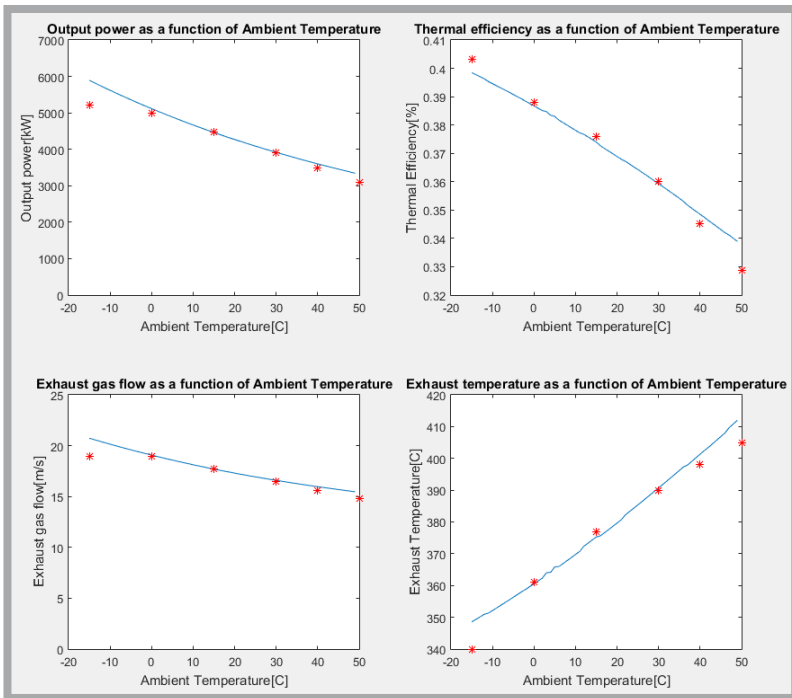


- Thermodynamic models in Matlab
- Representative “Black Box” equations are derived for off-design conditions for gas turbine, steam turbine and combined cycle.
- Transient simulation - Load Following
- Assumptions

Validation of models



- Gas Turbine - Mercury 50



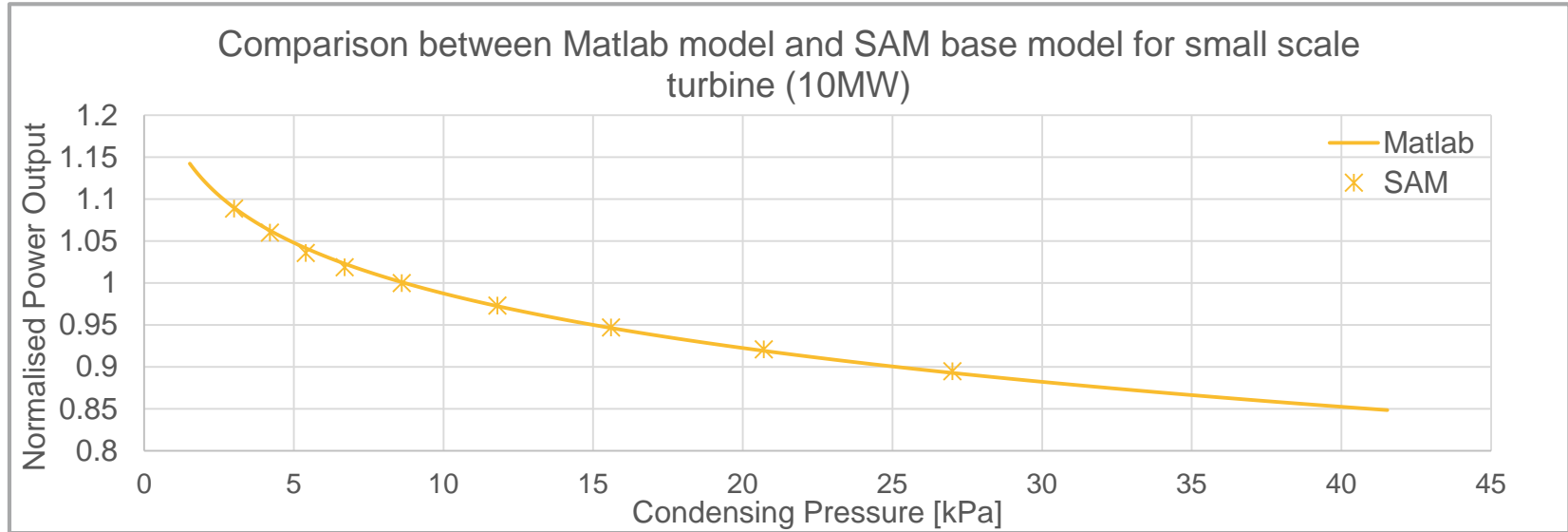
Matlab simulation results compared with experimental data from the Mercury 50 (Ushyne, 2008)

IpePro simulation results from the DLR compared with experimental data from the Mercury 50 (Ushyne, 2008)

Validation of models

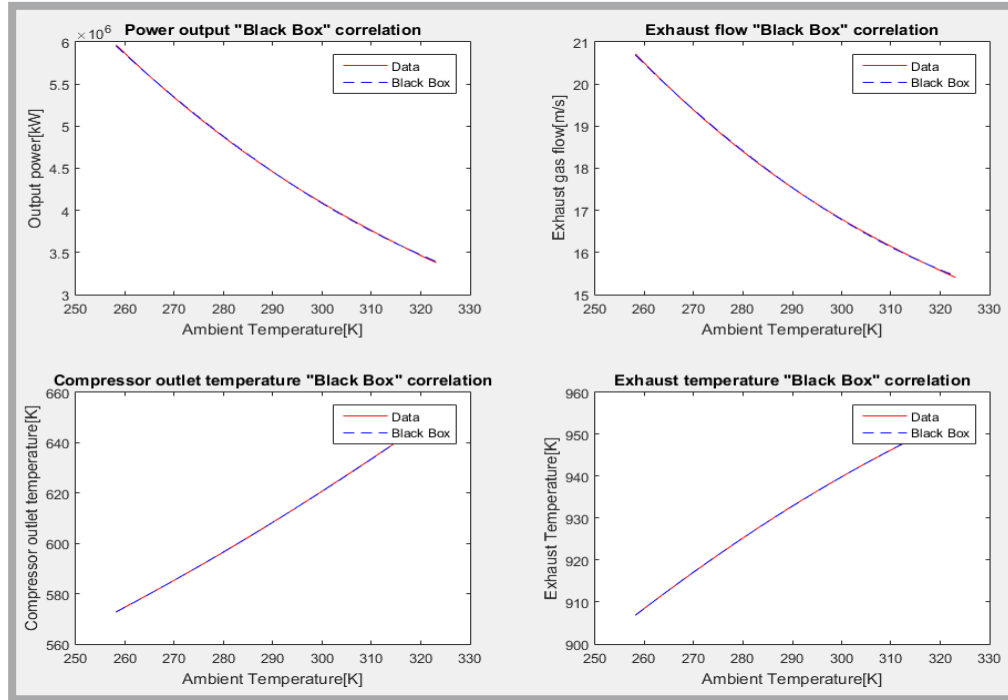


- Steam Turbine - Normalized model



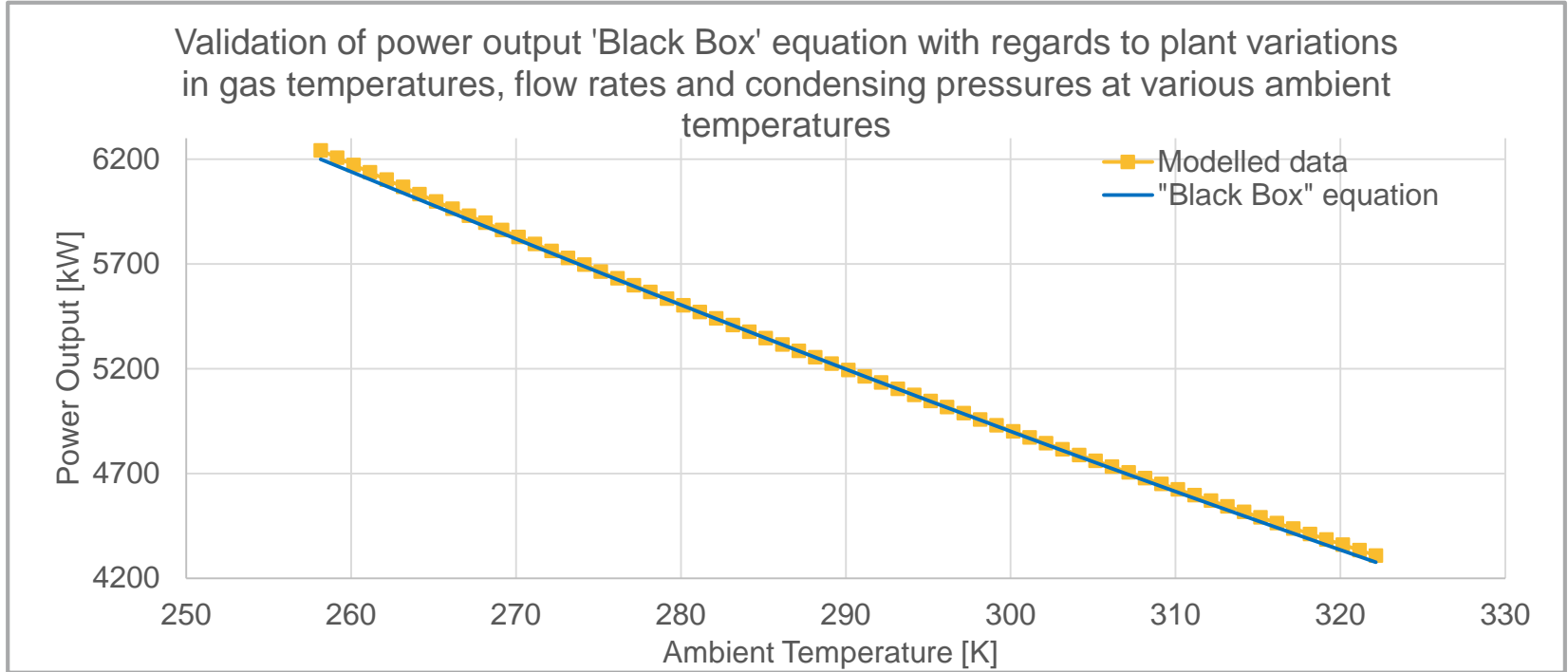
*Data from SAM model derived from a Technical Manual supplied by NREL (2011)

Validation of "Black Box" models



Gas Turbine

Validation of “Black Box” models



Steam Turbine

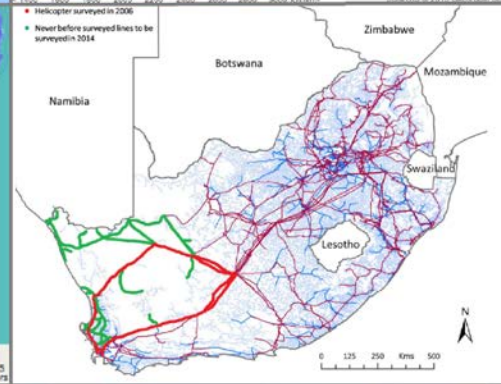
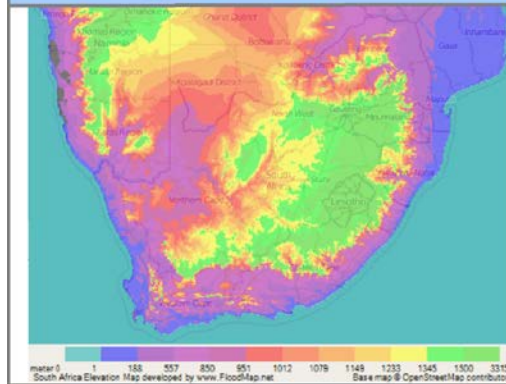
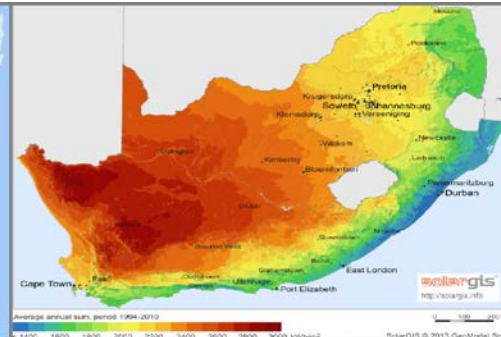
Site selection



Sites and gas reserves



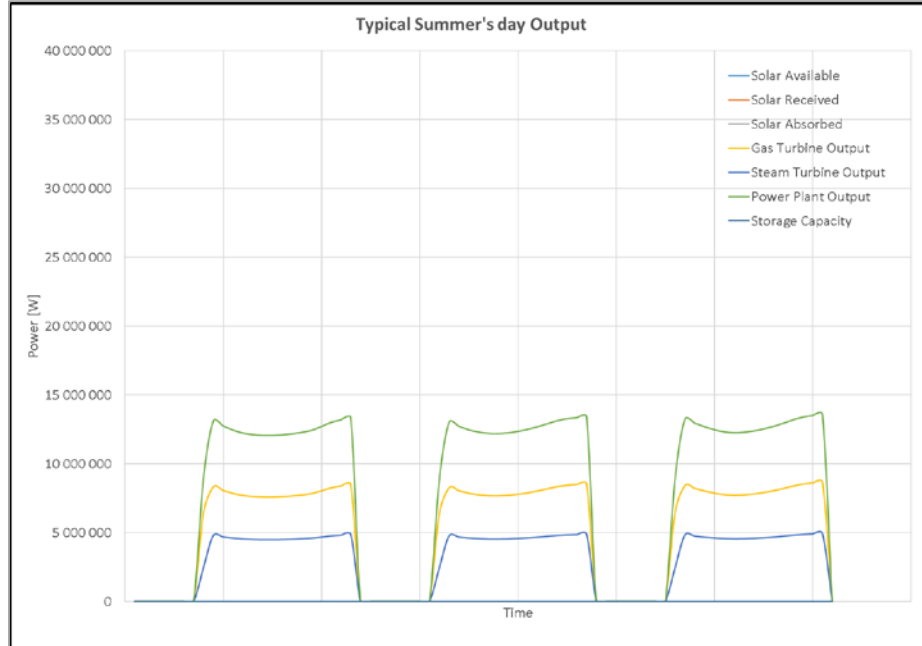
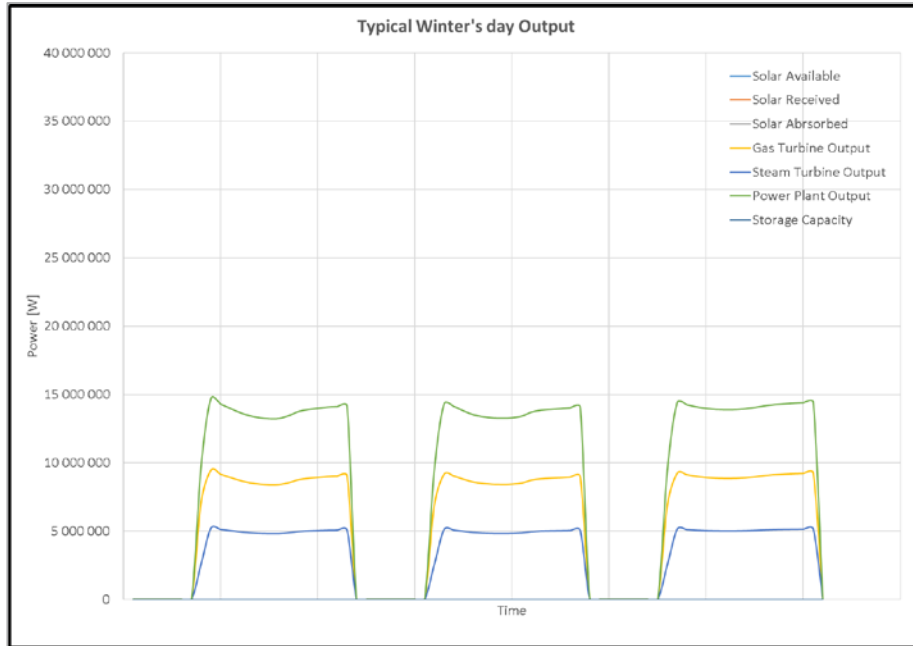
Direct normal irradiance



Elevation

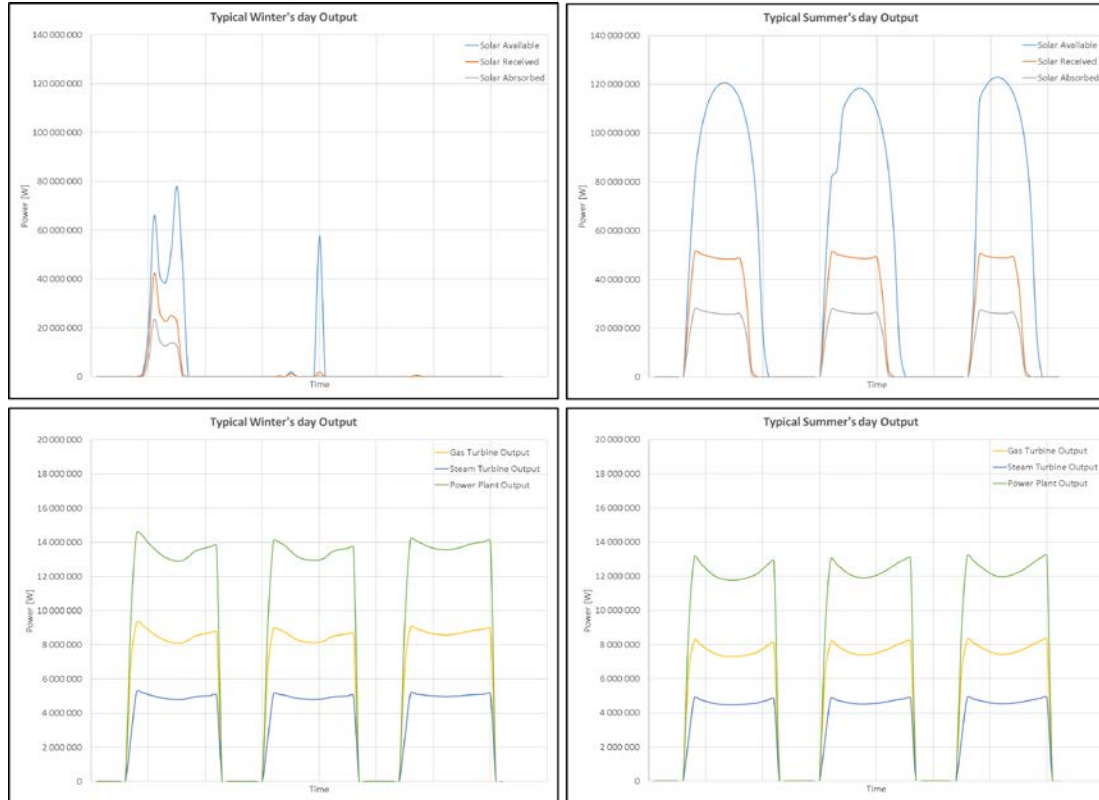
Electricity grid

A progressive outlook on the SUNSPOT

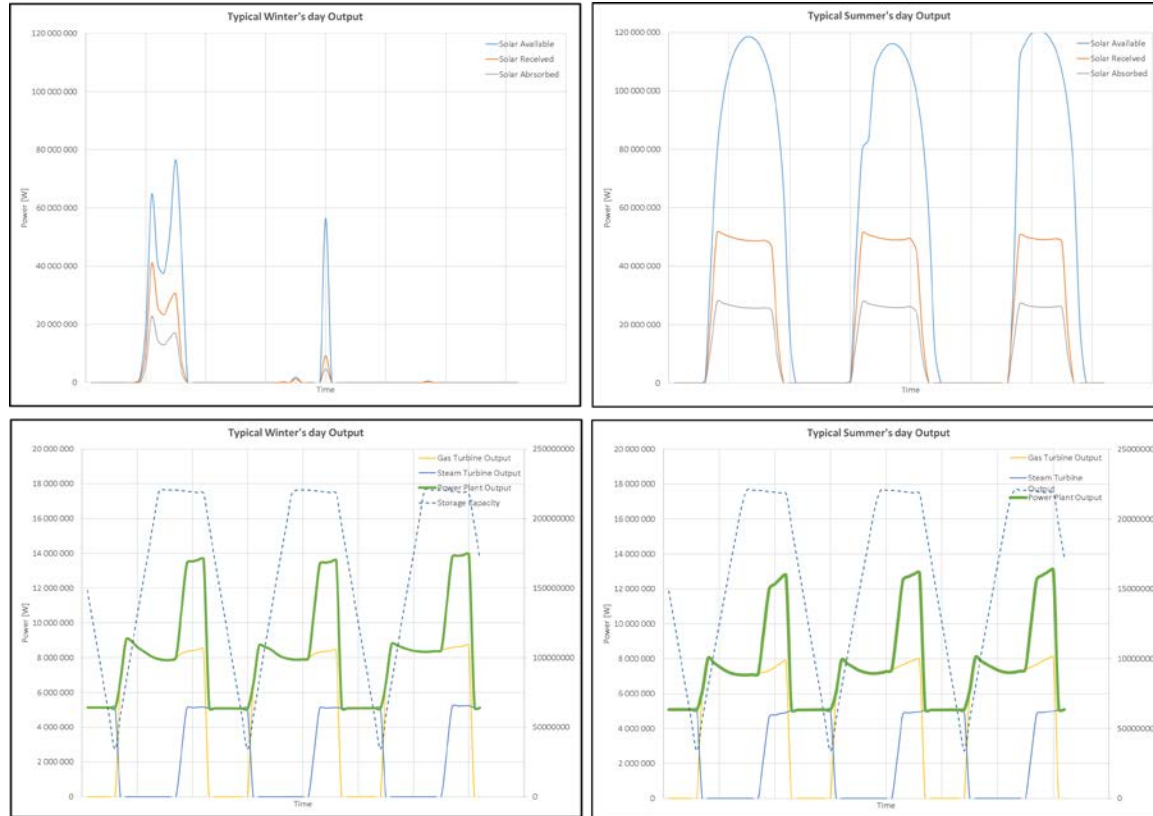


Combined cycle simulation

A progressive outlook on the SUNSPOT



A progressive outlook on the SUNSPOT



SUNSPOT cycle simulation

Summary



Performance Parameters	System		
	Combined Cycle	Solar Retrofit Combined Cycle	SUNSPOT Cycle
Annual Power Production [MWh]	77596.70	75816.63	69968.01
Annual Fuel Usage [Ton]	15375.13	9457.59	9198.44
Thermal Efficiency	37.57%	59.68%	56.62%
Load Factor	62.63%	61.19%	56.47%
Solar Efficiency	N/A	20.23%	21.52%
Solar Fraction	N/A	34.58%	36.22%

Project Outlook



- Thermo-economic evaluation
- Namibian locations

Questions?



Thank you for watching

ACKNOWLEDGEMENTS:

Prof F Dinter
Prof TW Von Backstrom
Solar Thermal Energy Research Group
K419'ers

CONTACT DETAILS:

Jan-Louis Janse van Vuuren
Solar Thermal Energy Research
Group (STERG)
Stellenbosch University
South Africa

16988477@sun.ac.za
+27 (0)21 808 4016

visit us: concentrating.sun.ac.za