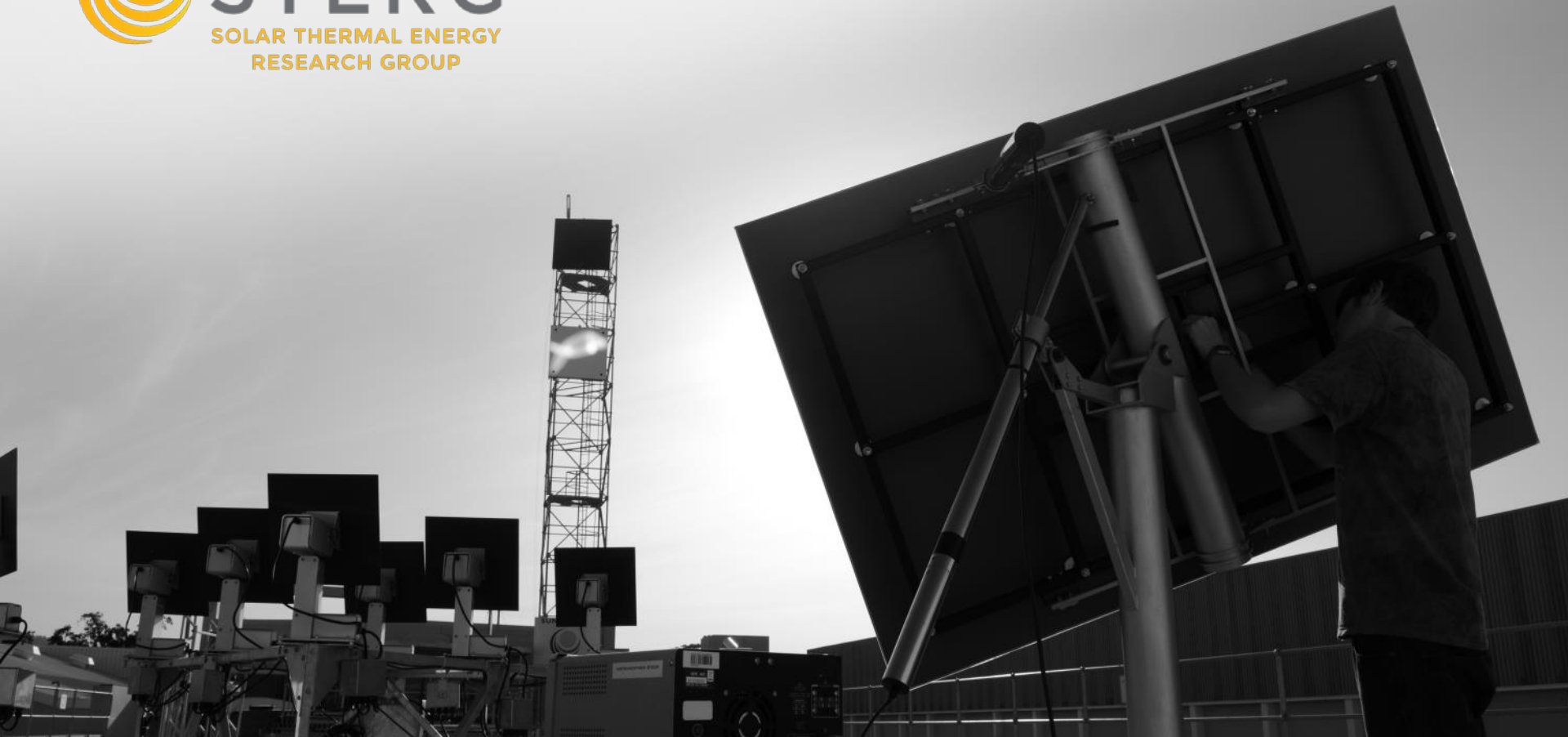
STERG

SOLAR THERMAL ENERGY RESEARCH GROUP



Solar Live Steam Generation and Solar Bagasse Drying for South African Sugar Mills

Krog W.[1], Hess S.[2] and Hoffmann J.[1]

[1]Solar Thermal Energy Research Group (STERG), University of Stellenbosch

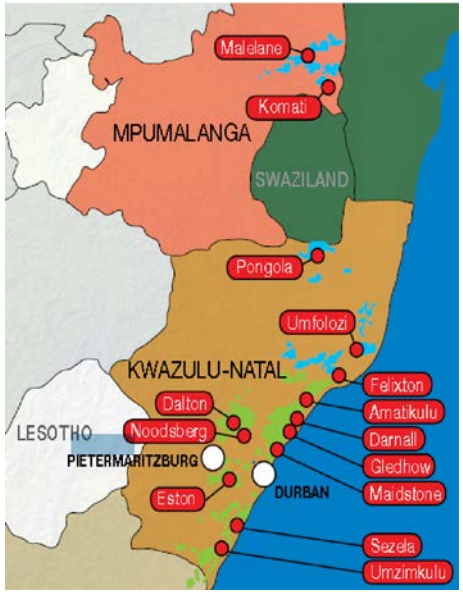
[2]Karlsruhe Institute of Technology, Germany

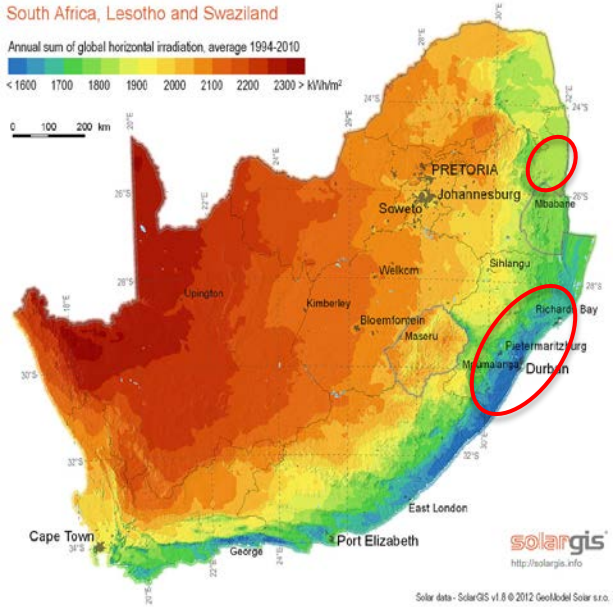
Agenda

- Background on South African sugar mills
  - STEP-Bio Project
- Solar integration points
  - Solar live steam generation
  - Solar bagasse drying
- Simulation results and estimations
- Conclusion

South African Sugar Mills

- South Africa has 14 sugar mills





South African sugar mills

- Crushing season is from March to November.
- 22 million ton sugarcane is processed p.a.
- 73 MW_{th} power demand per mill on average.

South African sugar mills

- Bagasse is used as boiler fuel.

- Coal is used as an auxiliary fuel.

STEP-Bio Project

The Sugarcane Technology Enabling Programme for Bio-Energy (STEP-Bio) was started to:

- Reduce running costs
- Create additional income streams

STEP-Bio Project

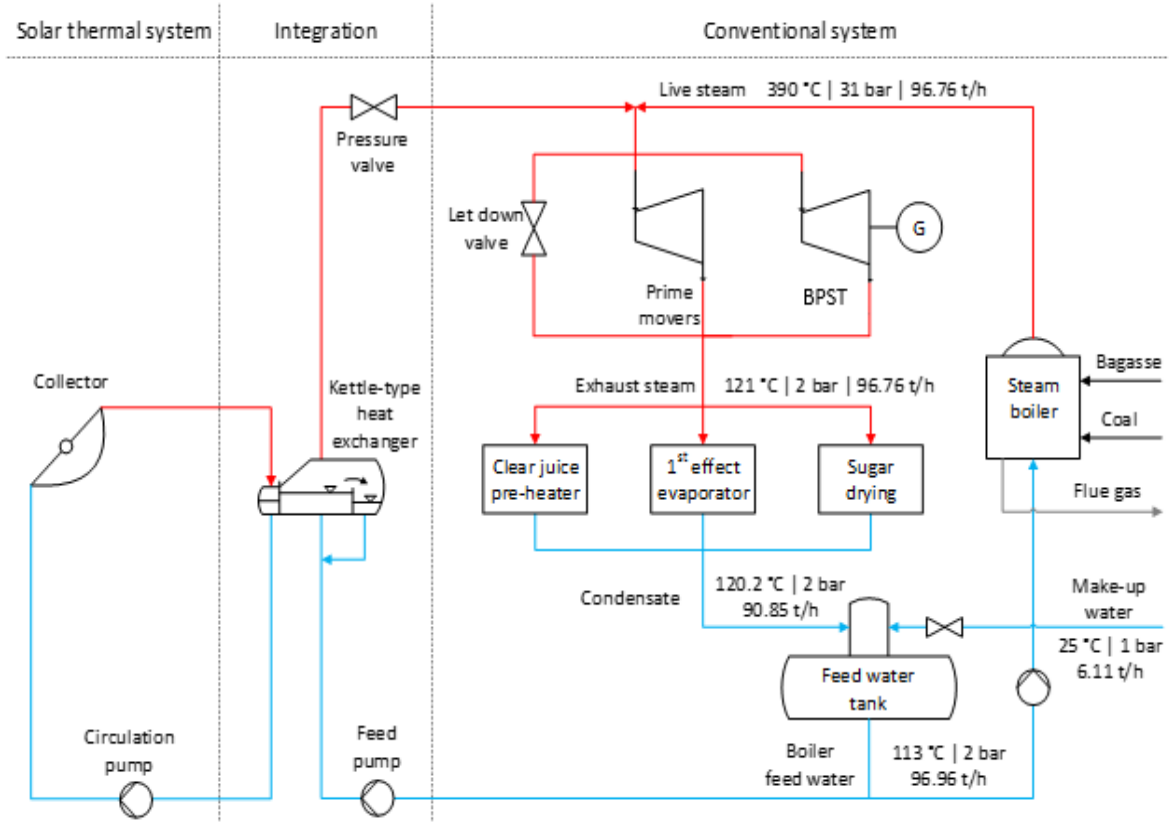
- In a previous STEP-Bio study by Dr Stefan Hess, six possible solar integration points were identified.
- Two were deemed feasible
  - Solar live steam generation
  - Solar bagasse drying

Agenda

- Background on South African sugar mills
  - STEP-Bio Project
- Solar integration points
  - Solar live steam generation
  - Solar bagasse drying
- Simulation results and estimations
- Conclusion

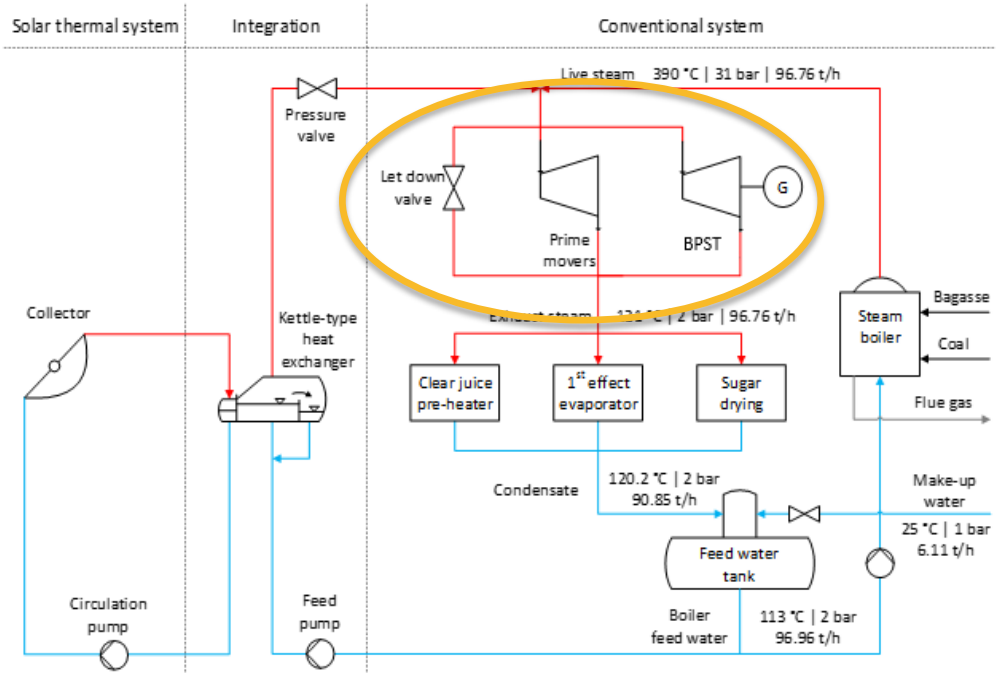
Solar Live Steam Generation

Setup 1



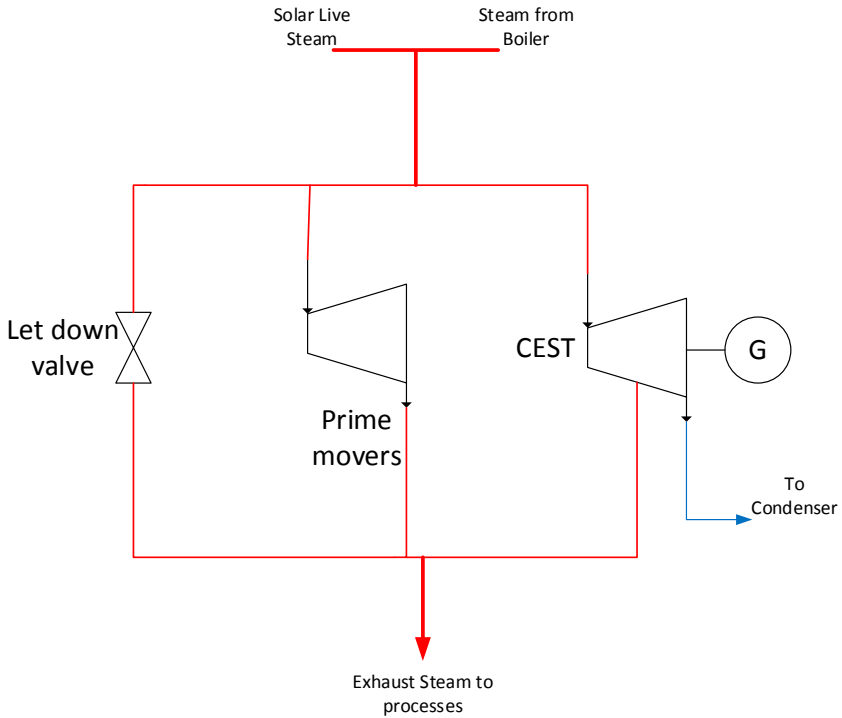
Solar Live Steam Generation

Integration point adopted from Hess et al.



Solar Live Steam Generation

Setup 2



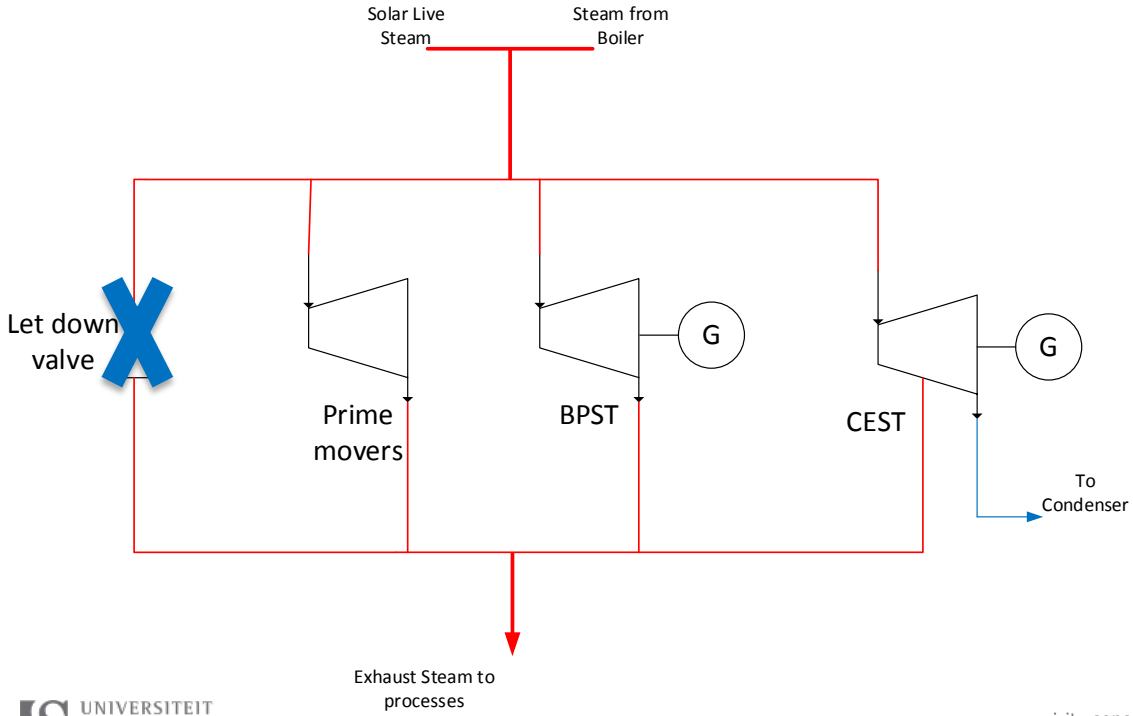
Solar Live Steam Generation

Setup 2

- Boiler runs as in previous setup, with the solar generated steam easing its load.
- The amount of steam flow through the CEST is equal to the amount which used to flow through the BPST
- This configuration will allow for bagasse savings during the crushing season and extra electricity generation outside of the crushing season .

Solar Live Steam Generation

Setup 3



Agenda

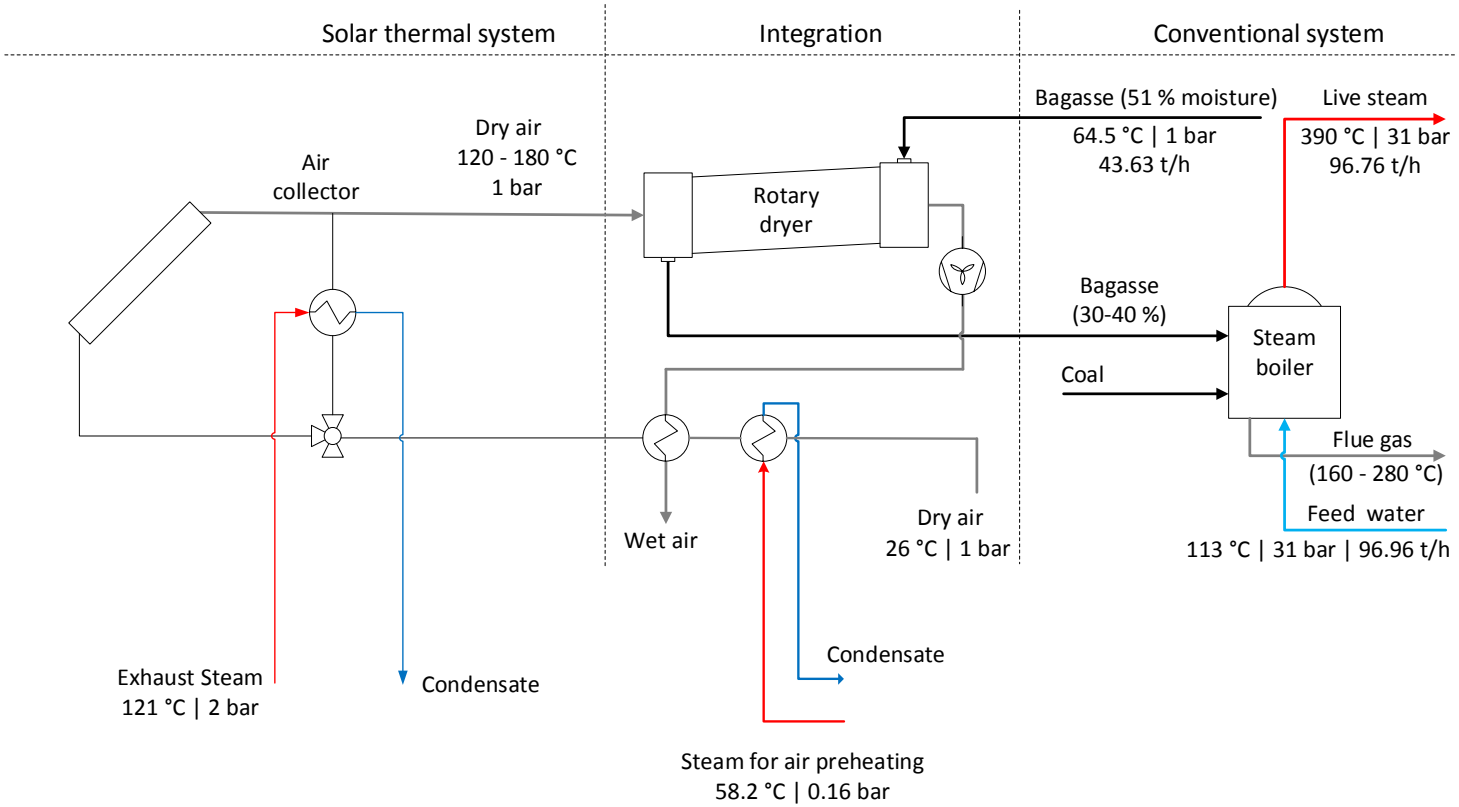
- Background on South African sugar mills
  - STEP-Bio Project
- Solar integration points
  - Solar live steam generation
  - Solar bagasse drying
- Simulation results and estimations
- Conclusion

Solar Bagasse Drying

Advantages of bagasse drying

- It increases the calorific value of the bagasse, leading lower fuel usage.
- Increases the boiler efficiency.

Solar Bagasse Drying



Solar Bagasse Drying

- The steam heater is similar to that in the sugar drying operation.
- Uses exhaust steam to heat the air.
- If just solar energy is used to dry, bagasse savings is 20.8 %
- If just exhaust steam is used, bagasse savings is still 11.6 %

Agenda

- Background on South African sugar mills
  - STEP-Bio Project
- Solar integration points
  - Solar live steam generation
  - Solar bagasse drying
- **Simulation results and estimations**
- Conclusion

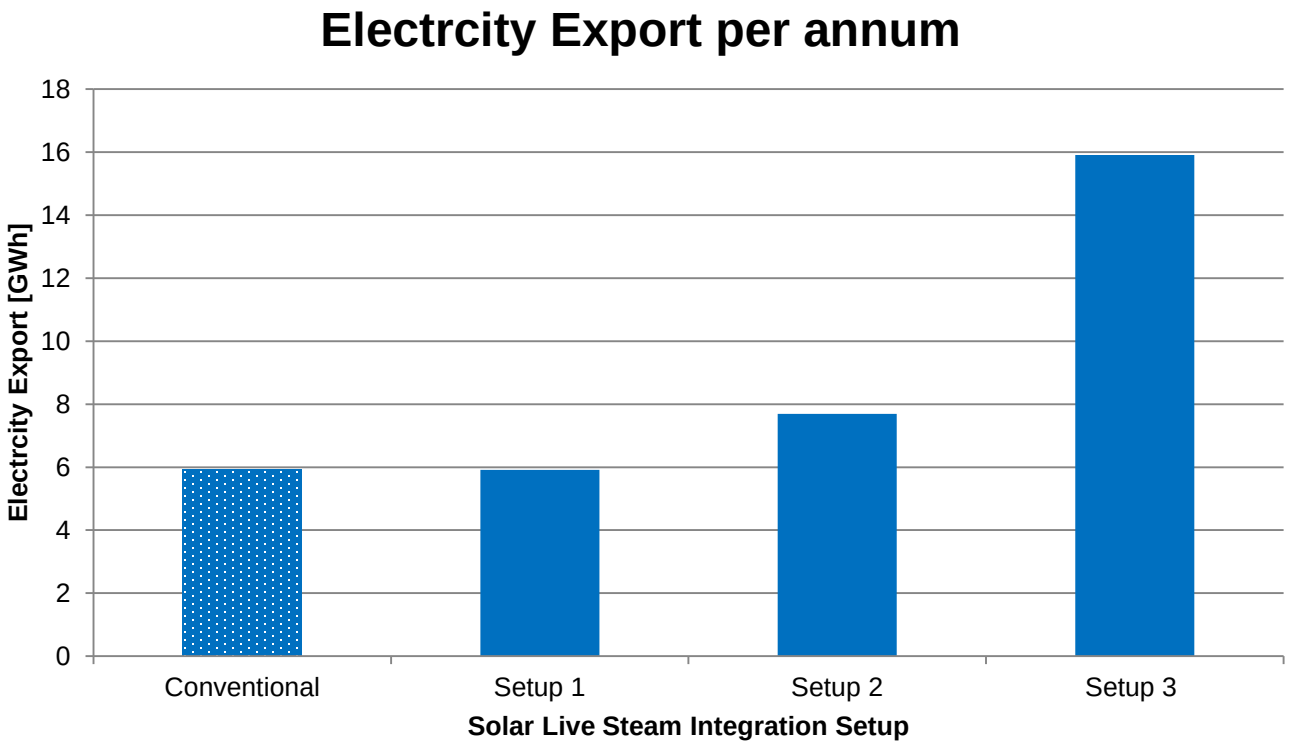
Simulations results and estimatiosn

- 23 MW_{th} Parabolic trough system was modelled in System Advisor Model (SAM).
- Simulation shows that 25.7 GWh_{th} can be produced p.a.
- Results show a low capacity factor of 12.8 %, normally it is between 20-25 %.

Simulations results and estimations

- TMY data show that Durban receives a yearly sum of 1350 kWh/m^2; considerably less compared to what normal CSP plants receive.

Simulations results and estimations



Simulations results and estimations

- The evacuated tube air collector system is estimated to deliver 17.34 % of the necessary heat to dry all of the bagasse during the crushing season.
- This will lead to a 13.2 % reduction in bagasse usage.
- Or saving 7900 tons of coal.

Agenda

- Background on South African sugar mills
  - STEP-Bio Project
- Solar integration points
  - Solar live steam generation
  - Solar bagasse drying
- Simulation results and estimations
- Conclusion

Conclusion

- Study still has to simulate the effect thermal storage can have on the integration points.
- The financial feasibility of the integration points need to be determined to see if they are worth while.
  - Internal rate of return (IRR)
  - Levelised cost of heat (LCOH)

THANK YOU

ACKNOWLEDGEMENTS:

- Dr Stefan Hess
- Dr Jaap Hoffmann
- Prof Frank Dinter
- Henri Beukes
- South African Sugar Milling Research Institute SMRI

CONTACT DETAILS:

Willem Krog
17013674@sun.ac.za
Solar Thermal Energy Research Group (STERG)
Stellenbosch University
South Africa

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

visit us: concentrating.sun.ac.za