now less titles with bigger projects

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same titles with bigger projects – really busy

moments silence please for those in Pretoria

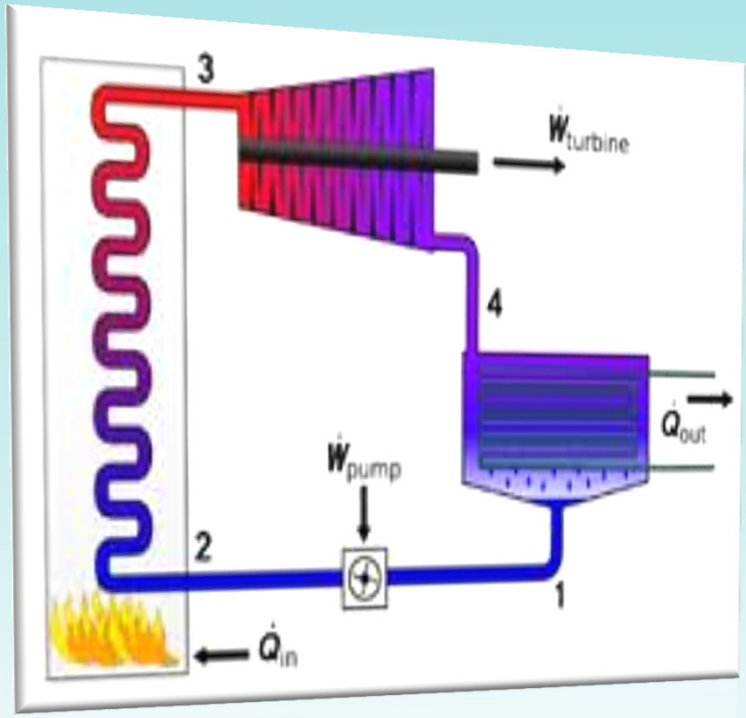
Stellenbosch

July 2013

solar what?

- you say potato I say potatho
- even changed during research: solar assisted power generation to solar aided power generation
- also known as solar boosting or solar augmentation

regenerative Rankine cycle



- increase efficiency of power plant
  1. increase average temperature at which heat is added
  2. decrease average temperature at which heat is rejected
  3. increase operating pressure
- regenerative Rankine cycle (no 1)
  - preheating of boiler feedwater with extracted steam from turbine

who cares?

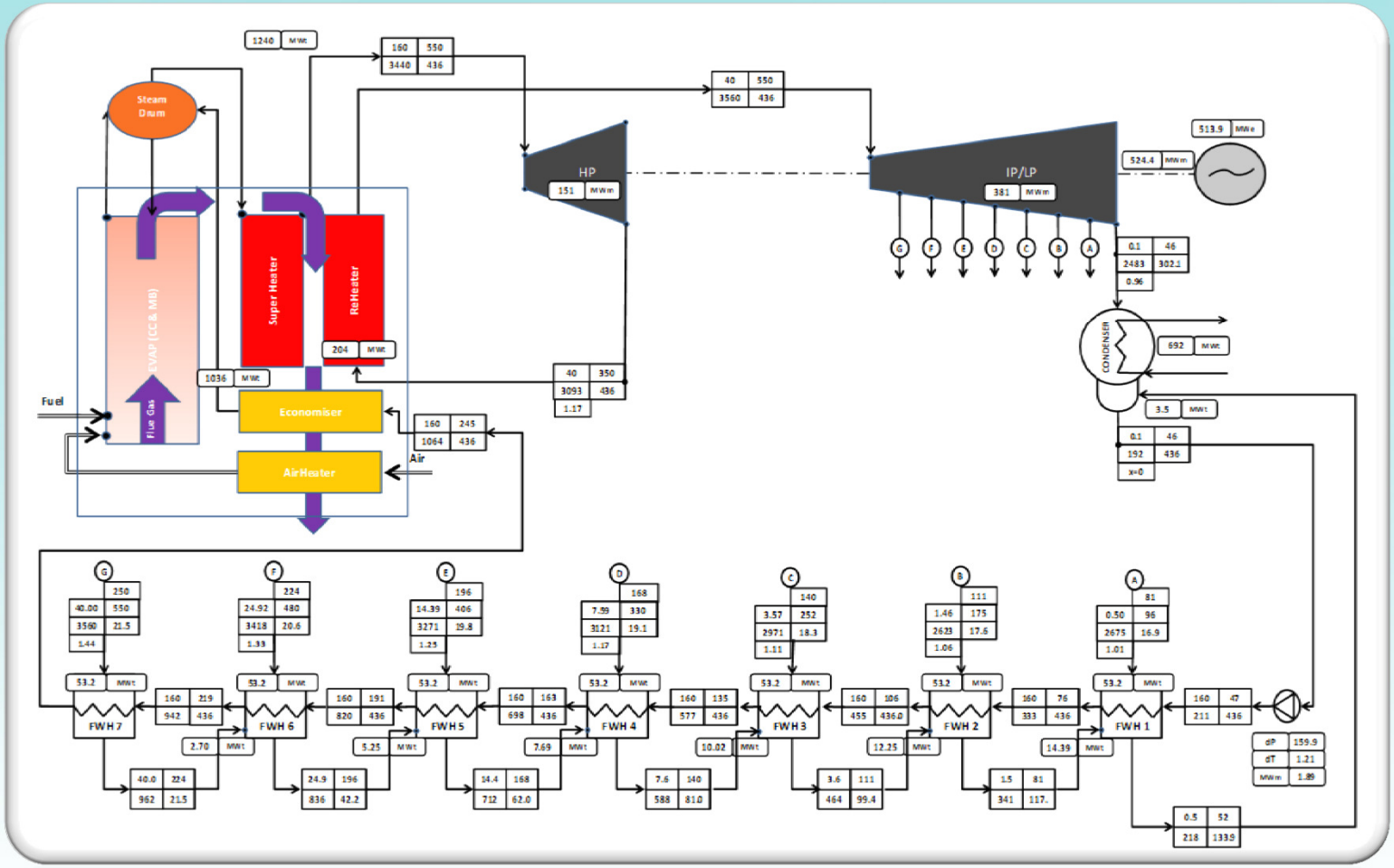
NREL, EPRI, ESKOM, AREVA, AURECON, STERG

research game plan

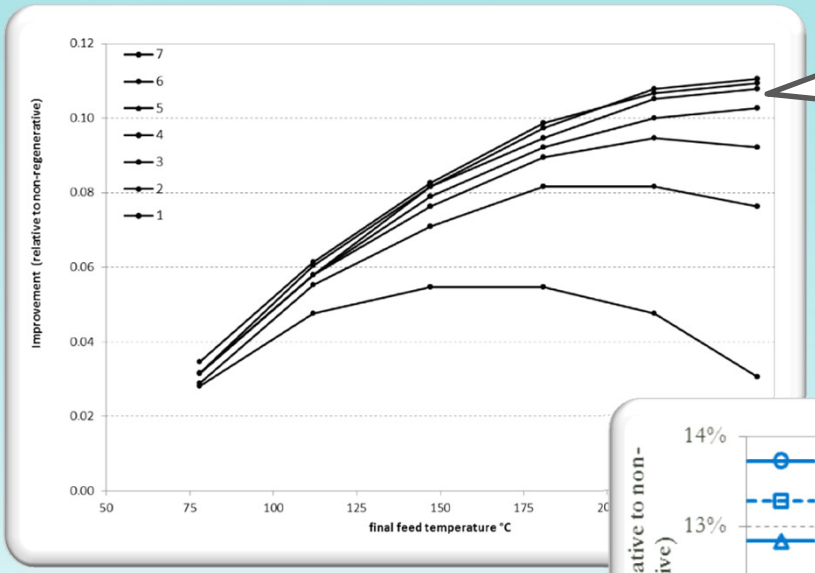
a. energy efficiency
b. add solar to coal

a. energy efficiency

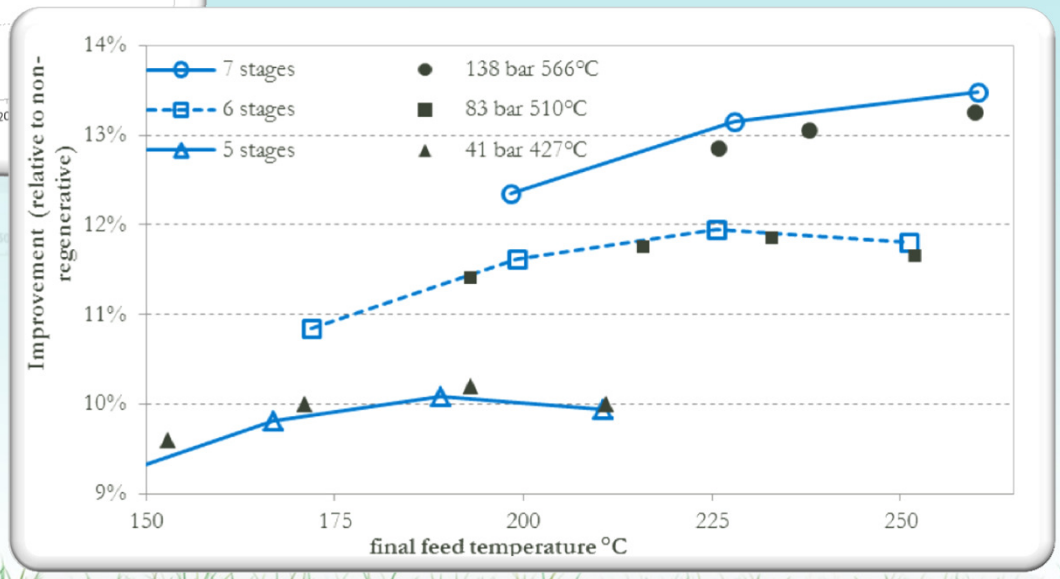
power plant modelled in Excel



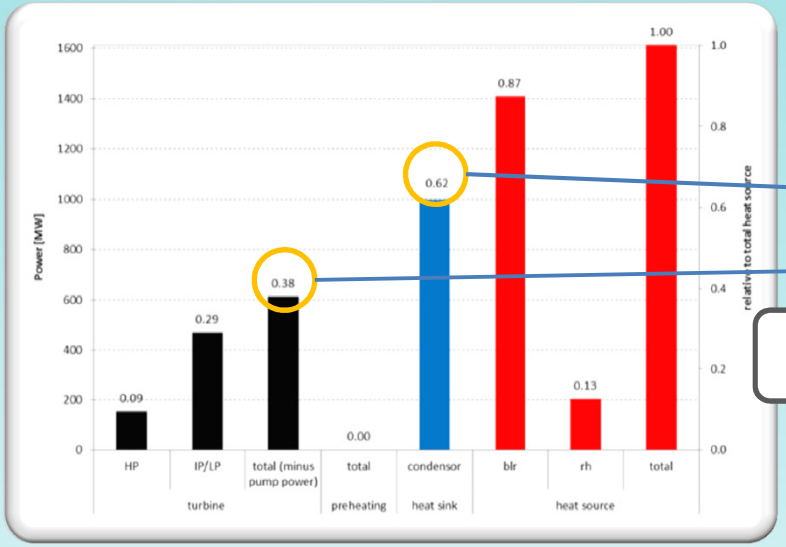
a. energy efficiency
power plant model results and validation



diminishing returns: less improvement per subsequent addition of FWH, typically around 6 FWH at utility scale

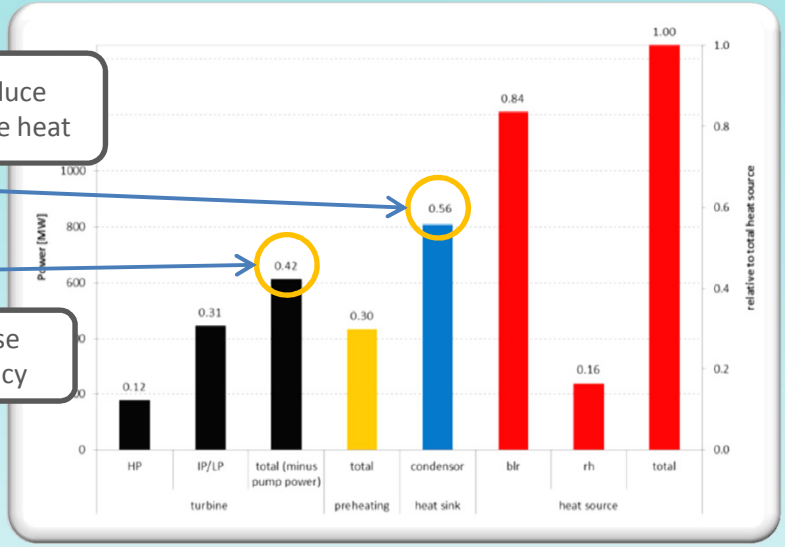


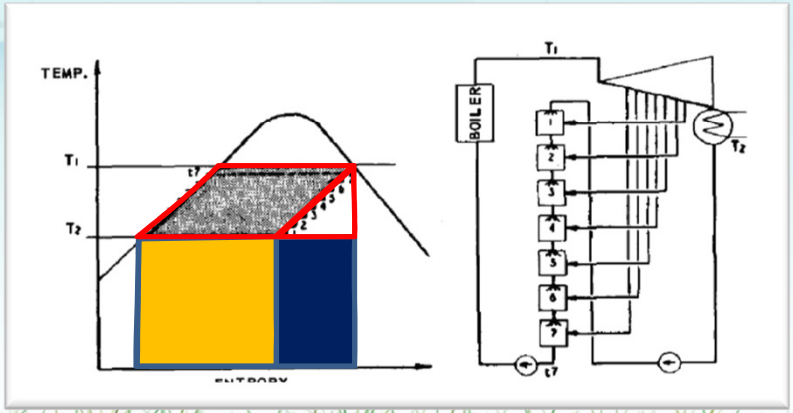
a. energy efficiency - results



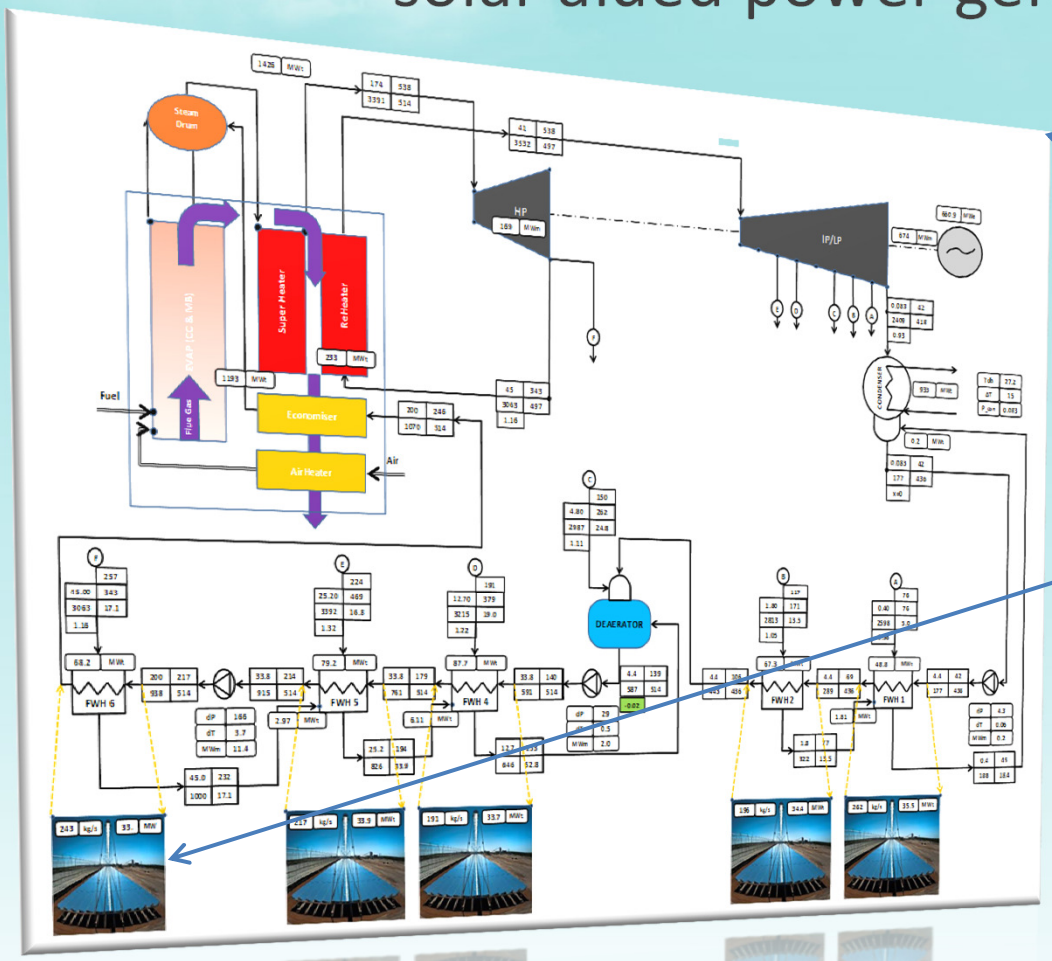
reduce waste heat

increase efficiency



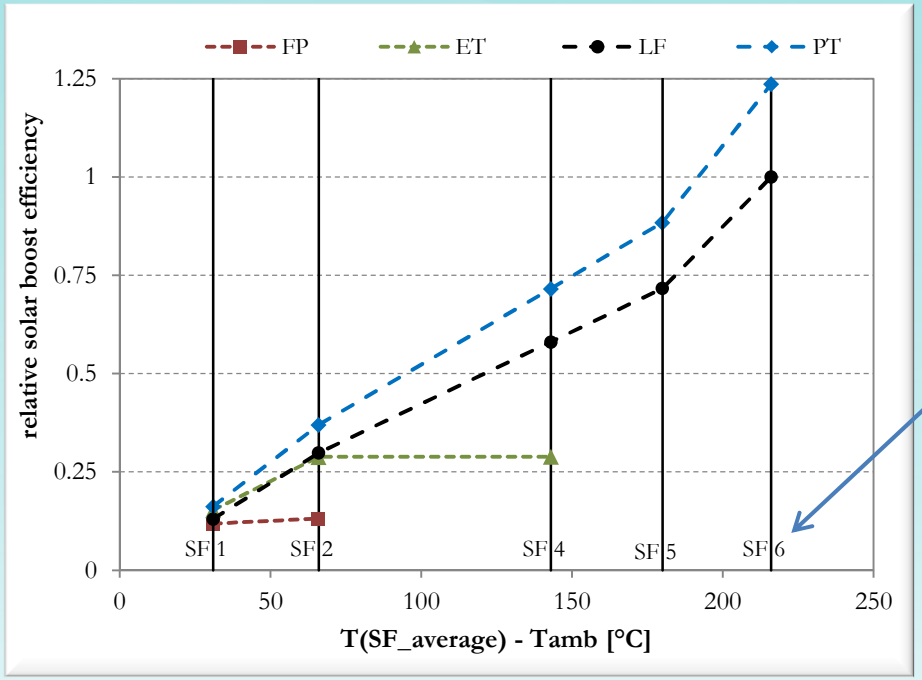


b. add solar to coal:
solar aided power generation (SAPG)



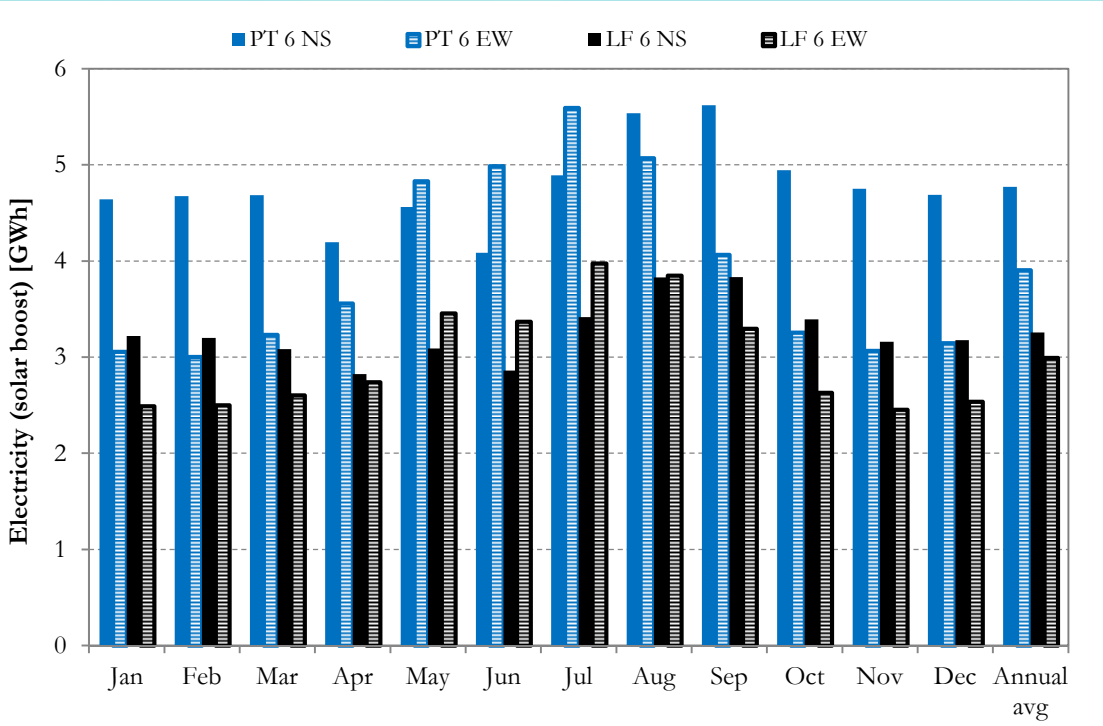
- power plant modelled in Excel
- solar field modelled with SAM and feed into power plant model
- preheating of boiler feedwater
- compliment extracted turbine steam with solar heat
- efficient use of low to medium temperature solar heat (less than 250°C) for power generation

results – various solar collectors



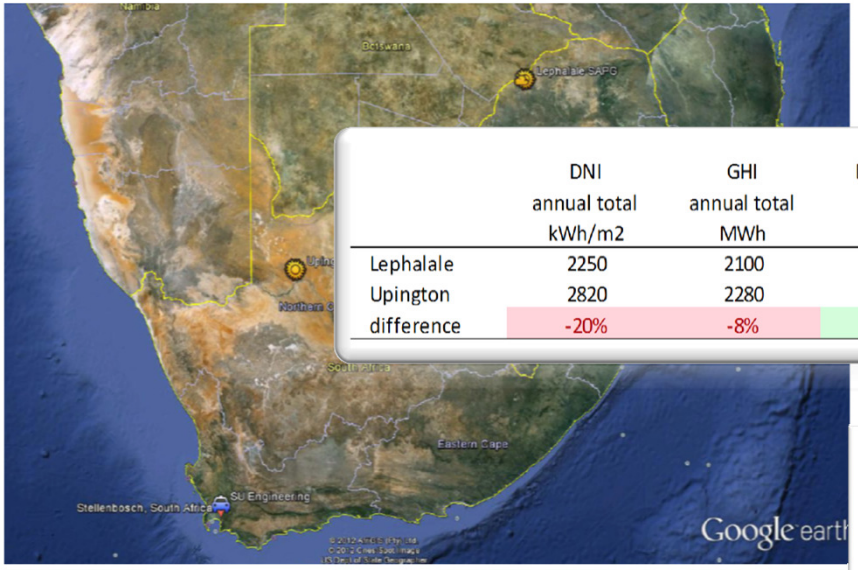
- relative to LF performance
- preference of higher feedwater temperatures/stages
- preference of concentrating technologies

results – Linear Fresnel (LF) & Parabolic Trough (PT)



- annual simulations with Lephalale weather data, solar field in SAM
- solar boost is additional electricity generated due to augmented steam
- both N-S and E-W solar field orientations considered
- N-S greater annual total
- cost parity: LF 53% of specific installation costs ($\$/m^2$) of PT (more to it than this…)

SAPG vs stand-alone CSP

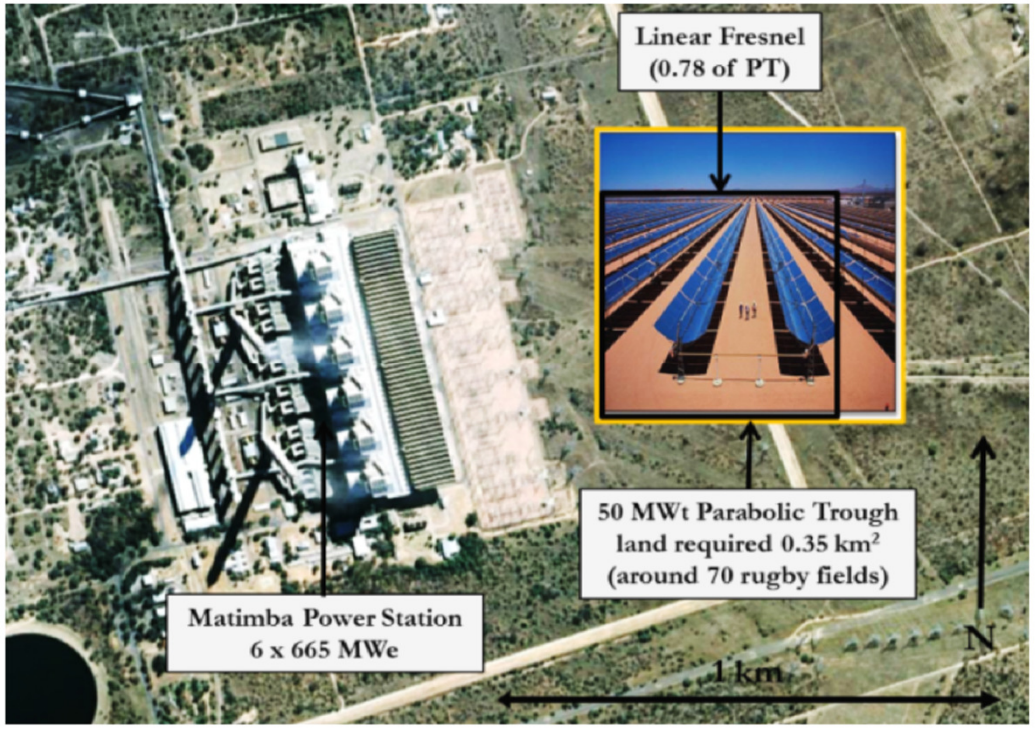


	DNI annual total kWh/m2	GHI annual total MWh	Dry bulb T average °C
Lephalale	2250	2100	19.9
Upington	2820	2280	21.5
difference	-20%	-8%	-1.6

site locations

- SAPG : Lephalale (home to Matimba and Medupi power stations)
- stand alone CSP – Upington (solar park) 20% more annual total DNI

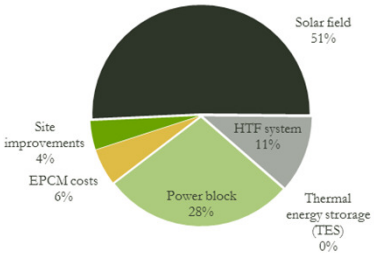
aerial view of Matimba power station

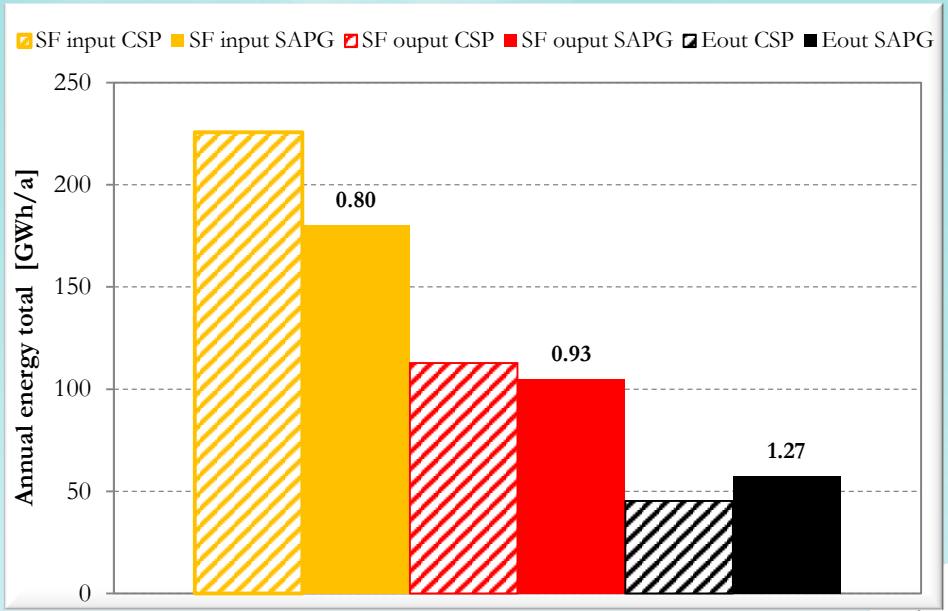


land footprint

- low energy density compared to coal
- land availability might be limiting factor

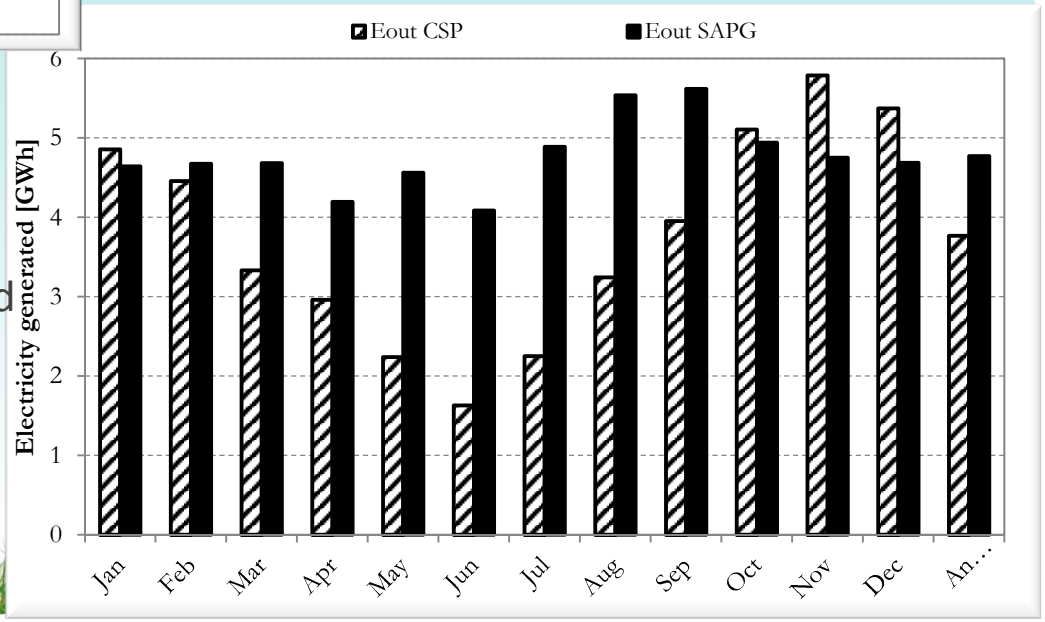
results – SAPG vs stand-alone CSP





- Upington ('solar park') CSP vs Lephalale (Matimba and Mudupi) SAPG
- based on PT technologies with same power block performance, annual simulations
- SAPG 1.27 times more electricity into the grid
- If SAPG cost taken as 72% of stand-alone CSP => 1.8 times more cost effective

- better performance in high demand months (SA winter)
- other benefits: existing infrastructure and zoning (EIA), storage capabilities, scale, vicinity to loads and manufacturing industry



conclusions

- **Solar thermal is coal friendly**
- SAPG is
  - a commercial technology at utility scale
  - a viable solution for short to medium term
  - well suited to South Africa with significant coal base and good solar resource
  - shorter lead time than stand alone CSP
  - more cost effective than stand alone CSP
  - is not competition to stand alone CSP but a mechanism to **promote CSP**
- there is more to solar projects than DNI totals

thank you for your attention,
please thank Paul for presenting

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MEng report http://hdl.handle.net/10019.1/80139

Article: watch this space ☺