



Solar Thermal Energy



The more expansive the frontiers of science grow,
the conclusion that God has a place in all of it
becomes trivial.

...if I do not pray, how do I reset my computer...?

Talking Points: Professor Thomas Harms

Lynedock – 11 May 2007

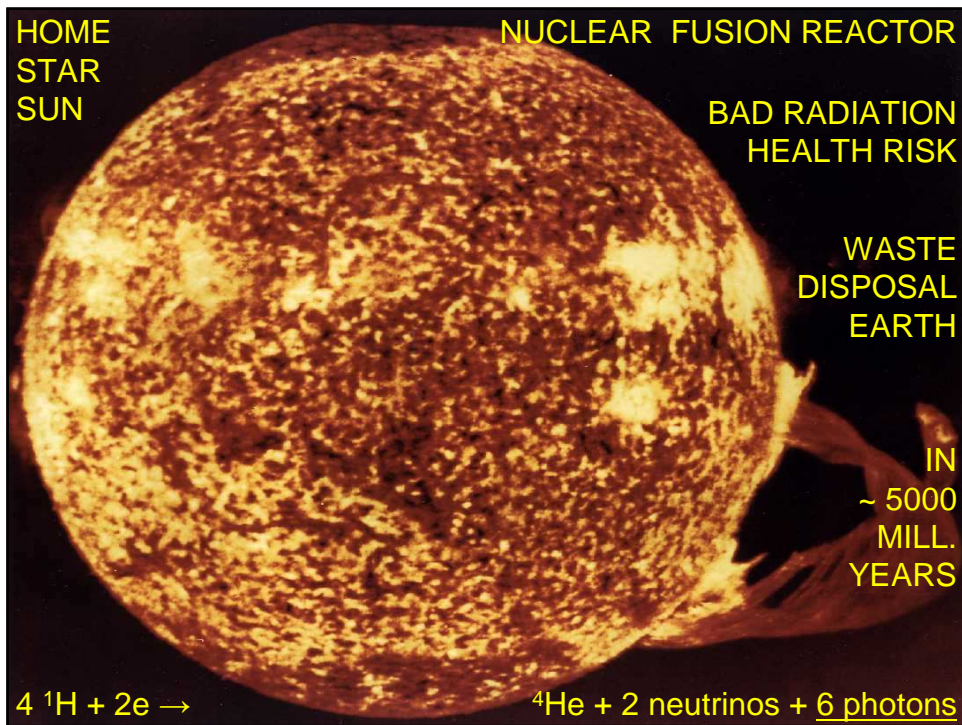
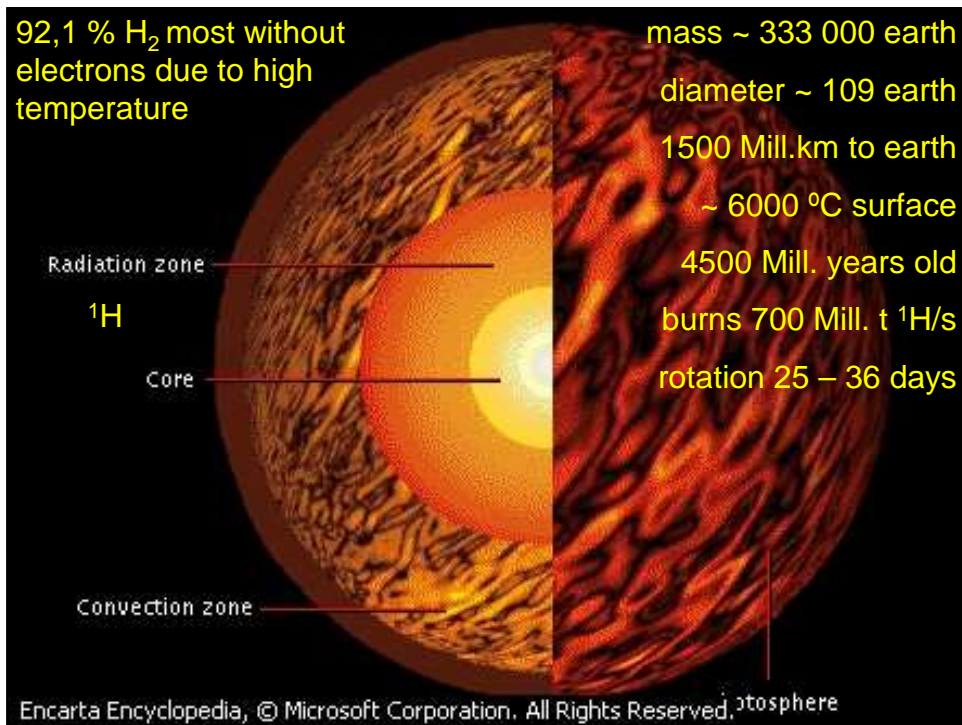


Solar Thermal Energy



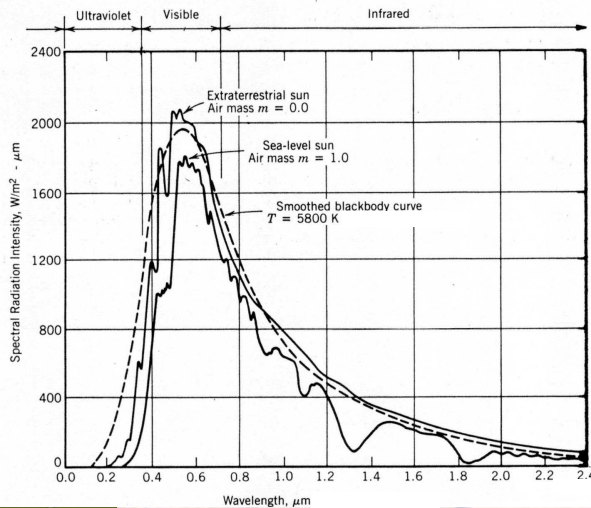
- Outline (15 min target)
- ❖ Zeroth Generation Nuclear Power
- ❖ Harvesting Solar Thermal Energy
- ❖ South Africa
- ❖ Agents for Change







Solar Thermal Energy



Solar Constant
← 1367 W/m^2
(above the atmosphere)



The Solar Spectrum



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



Solar Thermal Energy



Some Solar Theses:

- ❖ Direct use of solar power is surface intensive
- ❖ All renewable energy is derived from the sun.
(stored hydro carbon fuel, wind, waves, rivers, tides, biomass)
- ❖ South Africa has world leading solar energy resources
- ❖ Fossil fuels will not run suddenly out – 50... years?
(but are getting more expensive and atmospherically unusable)
- ❖ Power supply must diversify, decentralise and clean up
- ❖ Expect revolutionary advances as expensive clean power persists
(transition to the clean power is expensive)
- ❖ Renewable energy is not free, it must be harvested.
(this requires capital for technology)



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



Solar Thermal Energy



Earth bank account:

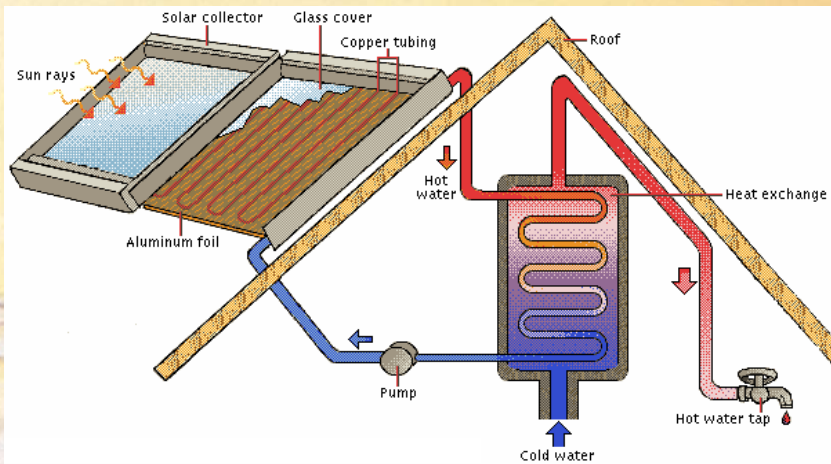
stored **solar** (flora) energy: coal, oil & gas 'reserves'

hydrocarbon fuel+ air → carbon dioxide

+water+nitrogen+heat



Solar Thermal Energy



Domestic Hot Water Heating





Solar Thermal Energy



Domestic Hot Water Heating

➤ Most likely a much needed and wise investment:

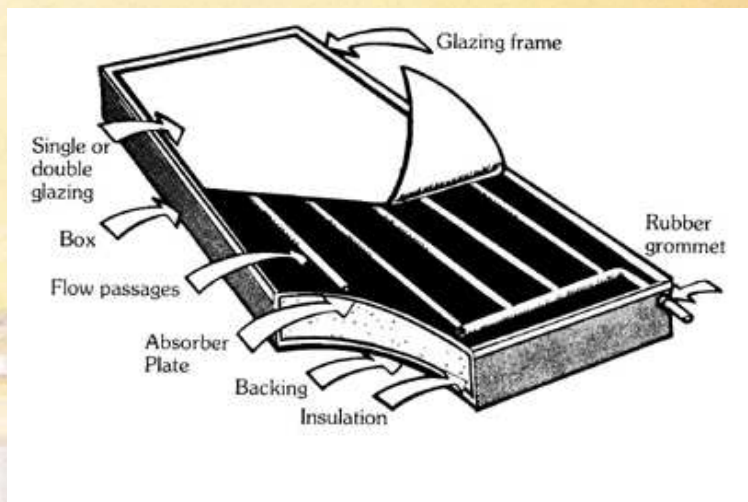
- ❖ local climate
- ❖ local electricity tariffs
- ❖ ~40 % of electricity bill
- ❖ mature efficient system (direct use of hot water)
- ❖ collector efficiencies 50 to 70 %
- ❖ subsidies



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



Solar Thermal Energy



Typical Flat Plate Collector



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



Solar Thermal Energy



(using heat pipes)



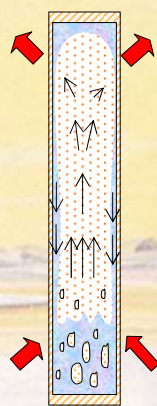
Evacuated Tube Collector



RENEWABLE & SUSTAINABLE ENERGY STUDIES



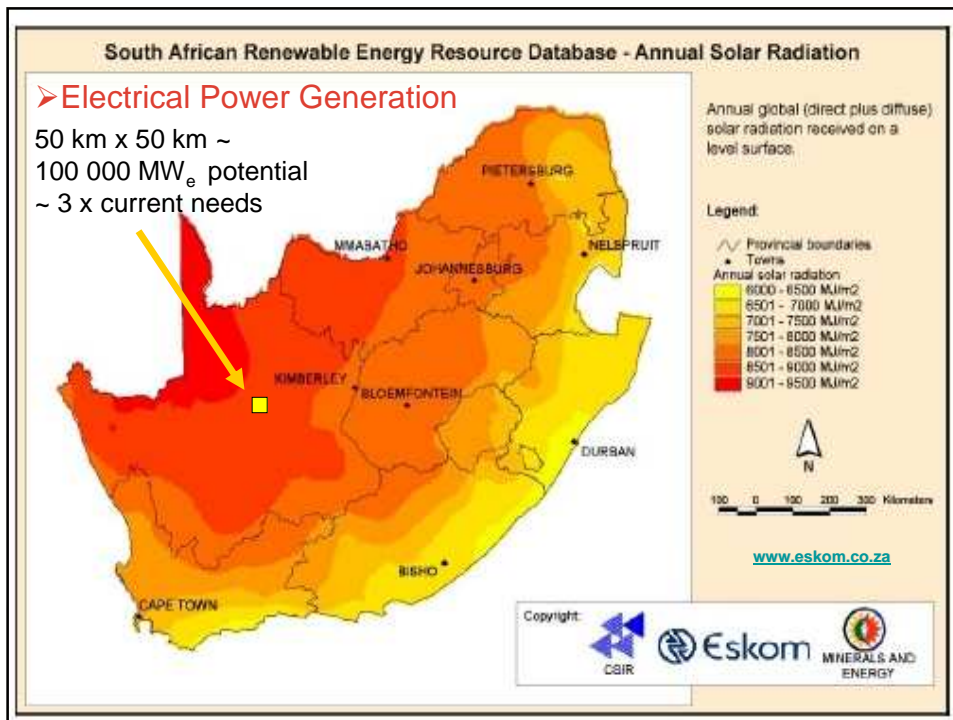
Solar Thermal Energy



In a **heat pipe** vapour flows in the one direction and liquid in the other direction.

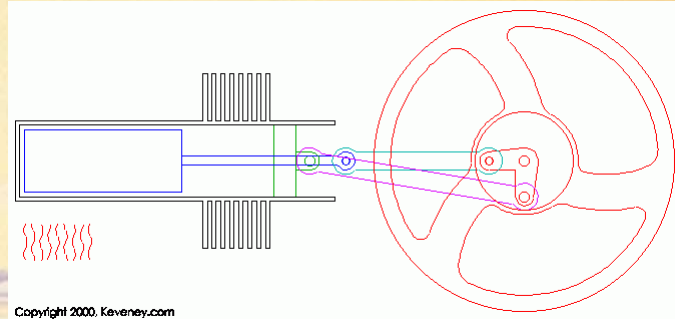


RENEWABLE & SUSTAINABLE ENERGY STUDIES





Solar Thermal Energy



Copyright 2000, Keveney.com

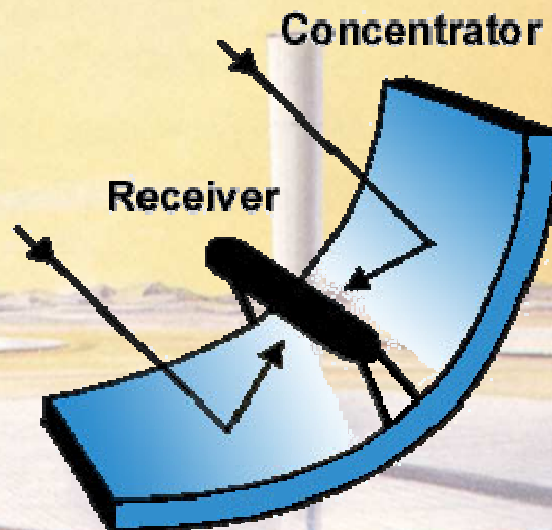
The cyclic, external combustion engine of the
Reverend Robert Stirling (1790-1878)



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



Solar Thermal Energy



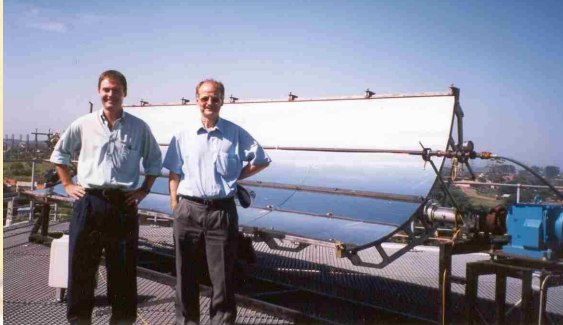
Parabolic Trough Collector



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



Solar Thermal Energy



Smit (1998)
Lamprecht (2000)
SU

Objective: learn about parabolic troughs: design, construction & testing

Result: largest parabolic trough in SA at Mangosuthu Technikon, construction and testing successful, highly controllable, design not optimized



Mike Brooks

(MSc - 2005): Parabolic trough



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



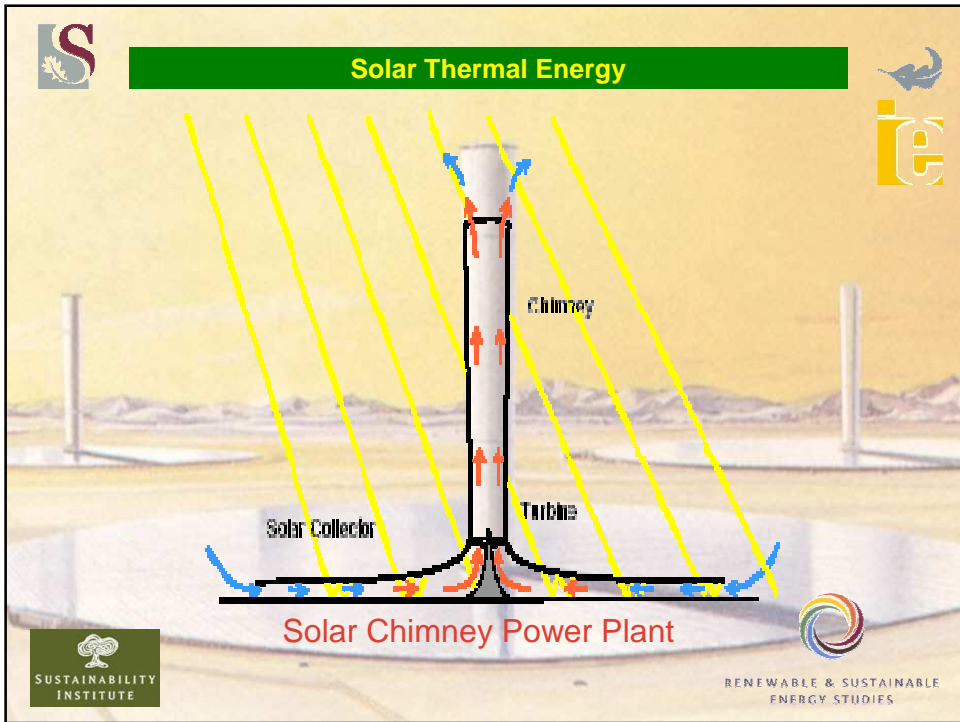
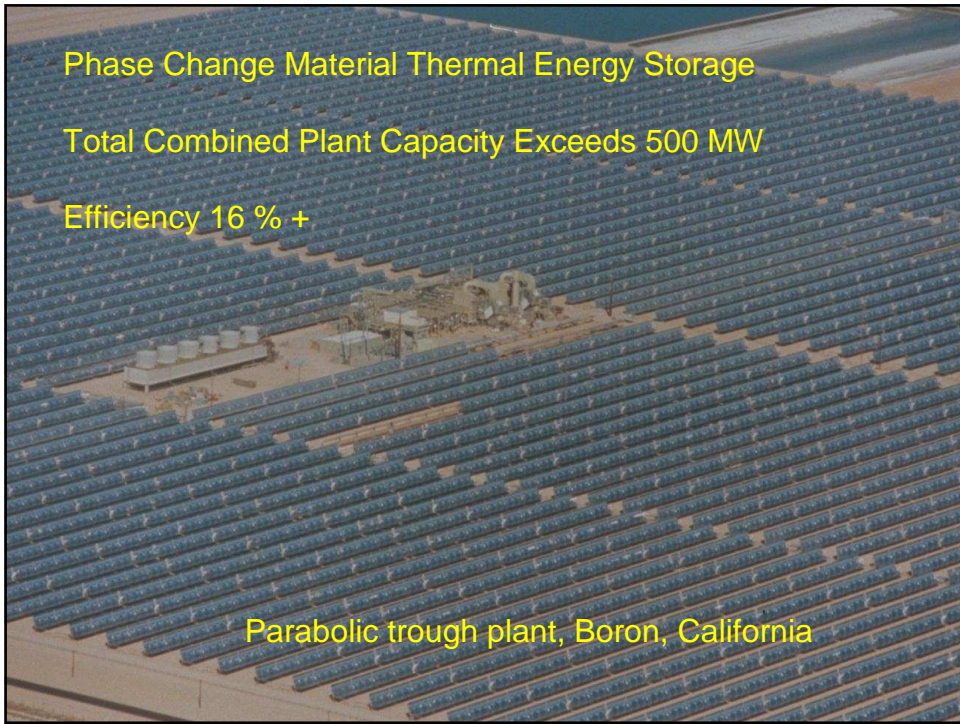
Solar Thermal Energy

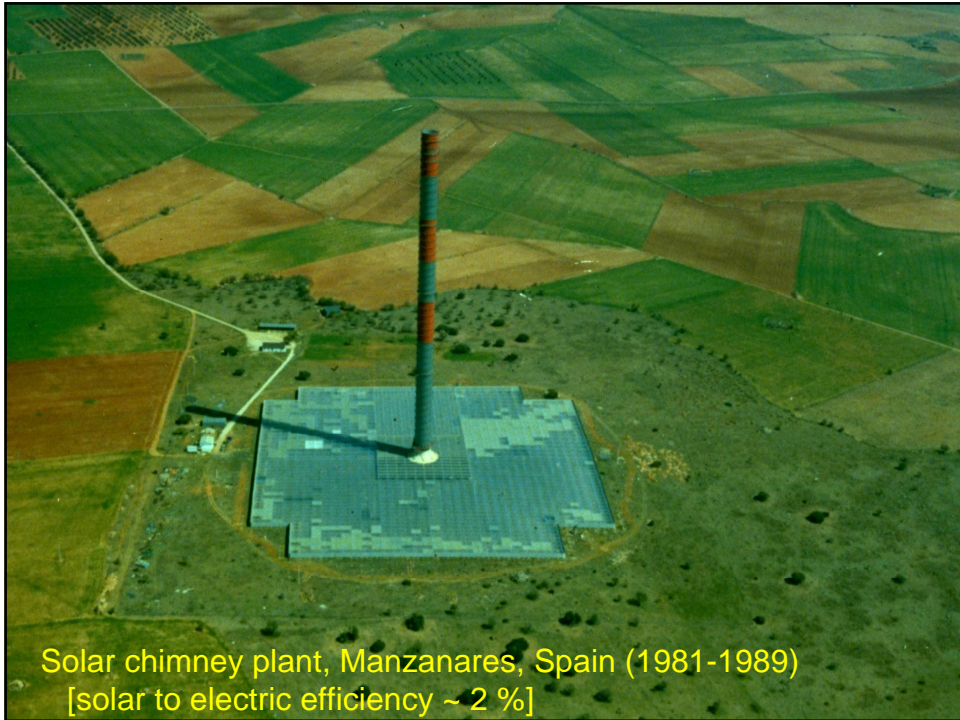


Evacuated Tube Receiver (with selective coating)



RENEWABLE & SUSTAINABLE
ENERGY STUDIES






Solar chimney plant, Manzanares, Spain (1981-1989)
[solar to electric efficiency ~ 2 %]





Central receiver solar power plant, Barstow, California, 10 MW_e
[solar to electric efficiency ~ 15 %]

Eskom plant (start construction 2008):
210 m tower, 6000 heliostats ~ 100 MW_e

Rob Coetzee (1996) BEng Design of solar power plant for SA
Dr Remar (Mech. Eng, SU) & Mike Pralle (Sandia Laboratories, USA)



S **Solar Thermal Energy** 


1 

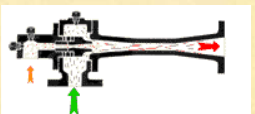
2 

3 

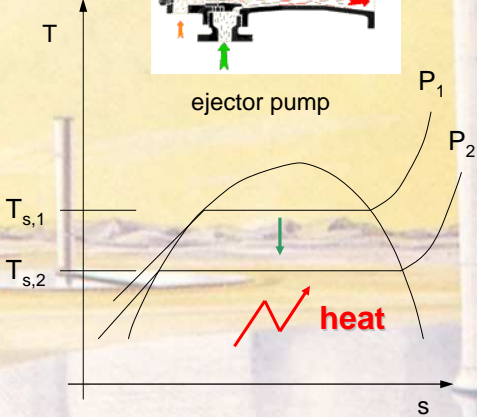
Recent Central Receiver Plant Southern Spain ~ 11 MWe


  RENEWABLE & SUSTAINABLE ENERGY STUDIES

S **Solar Thermal Energy** 





ejector pump



experimental setup 

Katot Meyer (MSc - 2006):
Solar refrigeration

  RENEWABLE & SUSTAINABLE ENERGY STUDIES



Solar Thermal Energy



The Sensible Things To Do:

White Paper On Energy Policy (1998) ~ **1%+ renewable/year**
National Research and Development Strategy
White Paper On Renewable Energy (2003)
National Renewable Energy Research Strategy
Energy Efficiency Strategy (2005)
Energy R&D Strategy Draft (DME&DST)
Policy Document (2006) commits to 10 000 GWh
of renewable energy consumed by 2013,
e.g. bio diesel, solar water heating, solar photovoltaics,
solar passive house design.



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



Solar Thermal Energy



- ❖ Mputumi Damane, CEO of the CEF (Pty) Ltd
“South Africa has one of the best solar regimes in the world, yet this clean form of energy is highly underutilised.”
- ❖ **Making R200 Mill./5 years available to further sustainable technologies in South Africa is putting your money where your mouth is.-**
- ❖ For Stellenbosch University to win **the hub for the national postgraduate programme in renewable and sustainable energy** as a multidisciplinary effort capably driven by Professor Wikus van Niekerk) is a great opportunity to enhance the integration all our efforts into the national fabric and has the potential to align many forces into a synergistic whole.



RENEWABLE & SUSTAINABLE
ENERGY STUDIES



Solar Thermal Energy



Conclusion: A new energy dawn can be discerned, which entails now a significant expansion of conventional centralized plant exposed to hardening emission legislation.

The resultant more expensive grid electrical power will lever increased drive and funding for a diversified private power production and dramatic improvement of market conditions for renewable power.

Government commitment is manifest and exciting!



Dawn, Quiver Tree Forest, Namibia, 2004



**Untold new opportunities for engineers,
in practice and research!**



RENEWABLE & SUSTAINABLE
ENERGY STUDIES