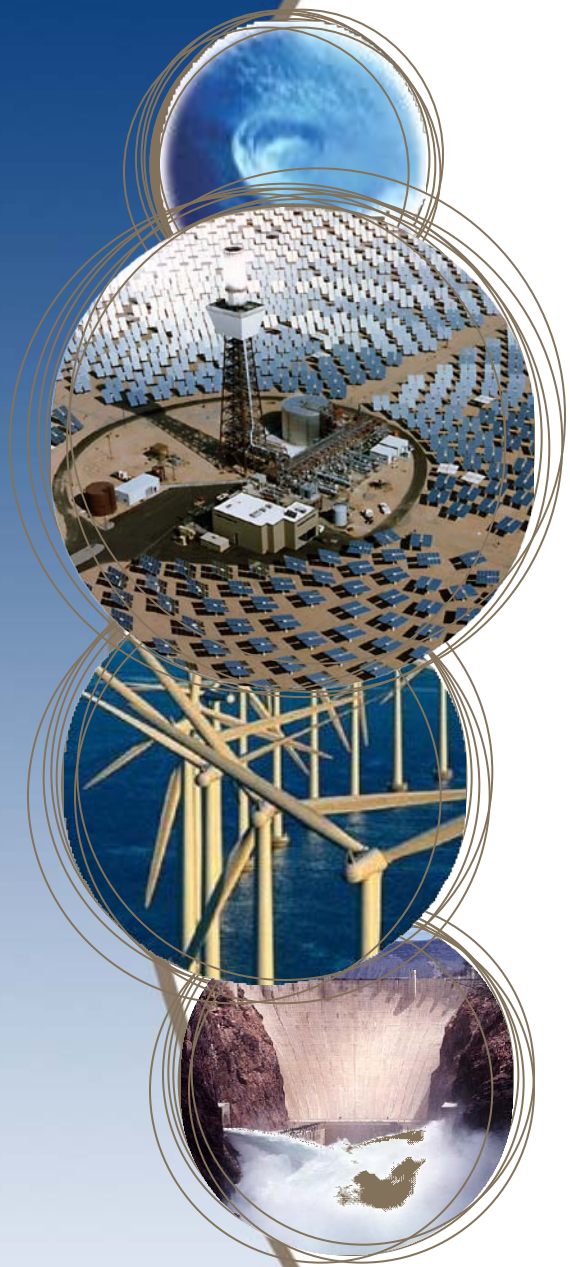

WREF 2012:

Meeting Dual Goal of Energy Access & Sustainability: CSP Deployment in South Africa

Ayanda Nakedi

20 May 2012

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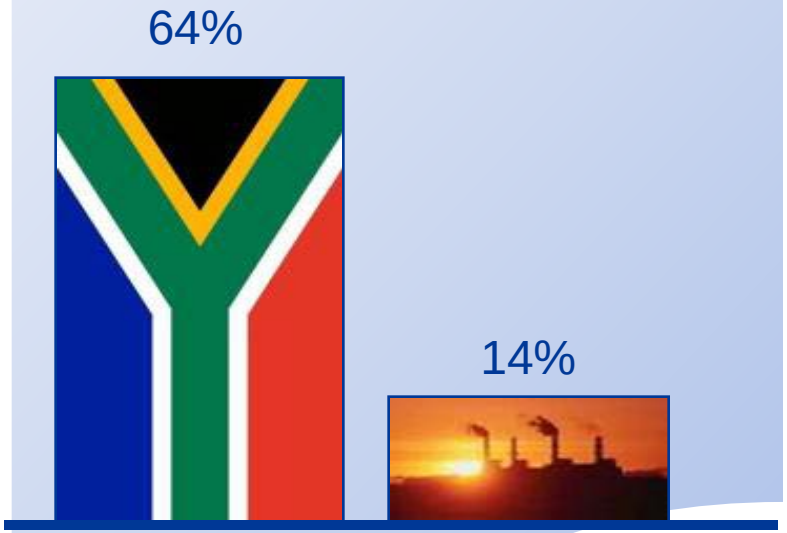
- South African background
- A better strategic fit for South Africa
- Eskom ‘s Renewables aspirations
- CSP Challenges & Opportunities in South Africa

Strategic Drivers

South Africa 1994 - 2008 growth



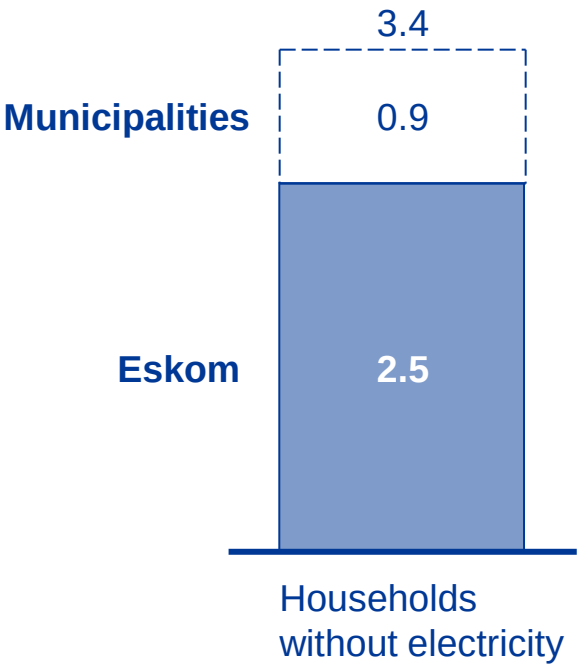
The gap between demand and supply requires vast investments in power generation capacity: To meet the demand, Eskom total generating capacity has to increase to 70 000 MW by 2025

There is still a significant backlog of between 3.4 million households, of which 1.8 million are in proclaimed Eskom areas

APPROXIMATE FIGURES

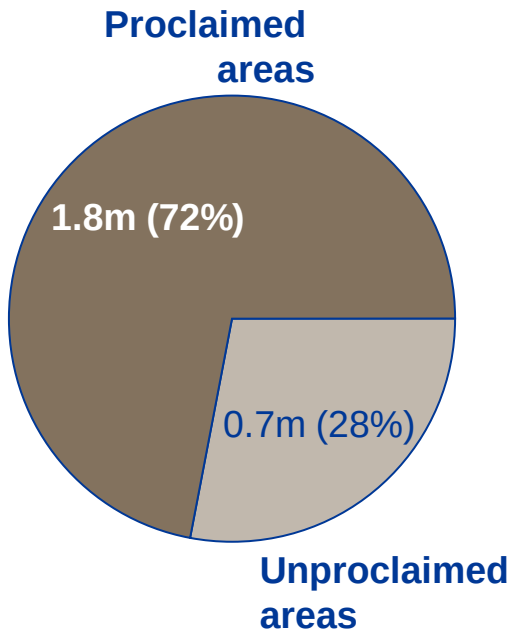
There are estimated 3.4m households without electricity[1], 2.5m of which are in Eskom areas

Number of households without access to electricity[1]
Millions, 2011



Of the 2.5m households in Eskom areas, 1.8m are in proclaimed areas

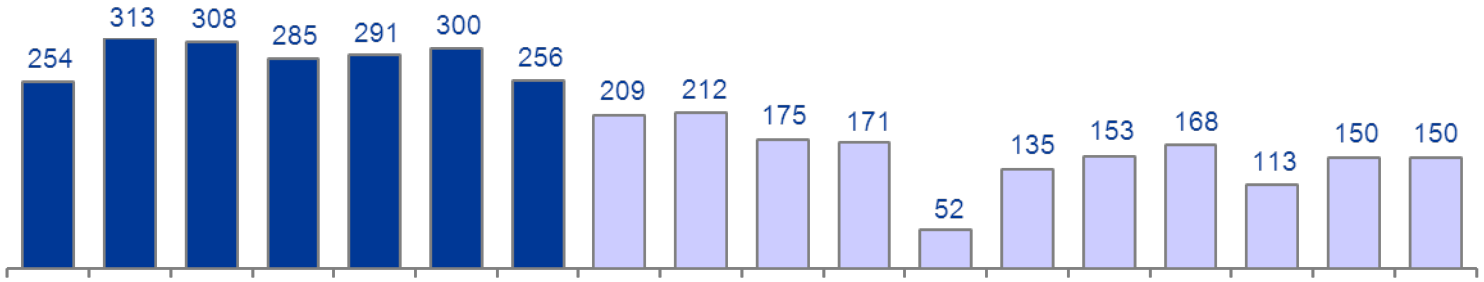
Number of households without access to electricity in Eskom areas[1]
Millions, 2011
Total = 2.5m



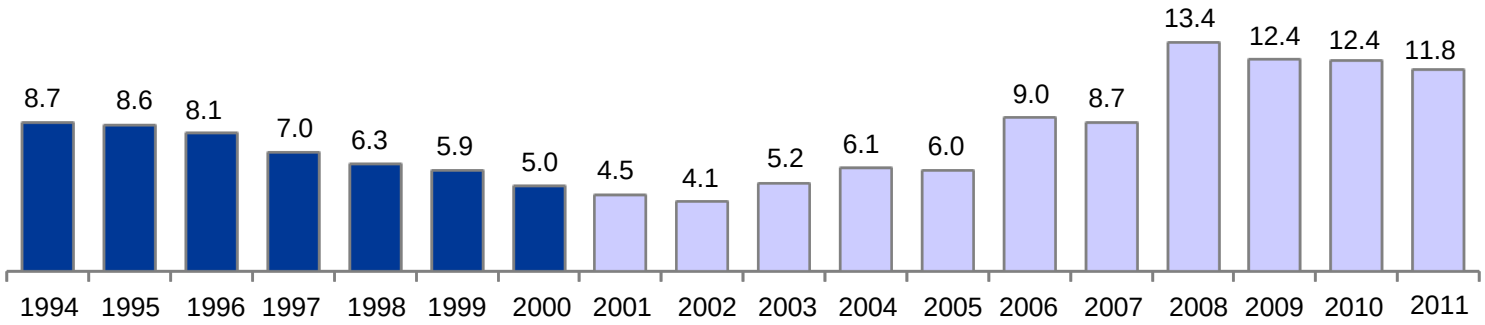
1. The figure is based on an assumed increase in households without access at a rate of between 2-5% per annum, from 2.5 million in 2005, including Eskom's areas of supply. The certainty in these figures is low and checks will have to be done in the pre-engineering.
Source: Eskom

Electrification – There have been two distinct eras of installation: pre-2000 and post-2000

Number of annual grid connections
Thousand



Cost per connection
R '000



Self-funded and managed programme

- Eskom exceeded the government's target of 1.75M connections between 1994 and 2000
- Connection every 30 seconds, pole every 10 seconds, 200M cable every minute
- Connection costs steadily came down

Government funded programme

- The numbers of annual connections by Eskom have dropped, partly due to
  - Increased investment in infrastructure
  - The stringent processes that need to be followed

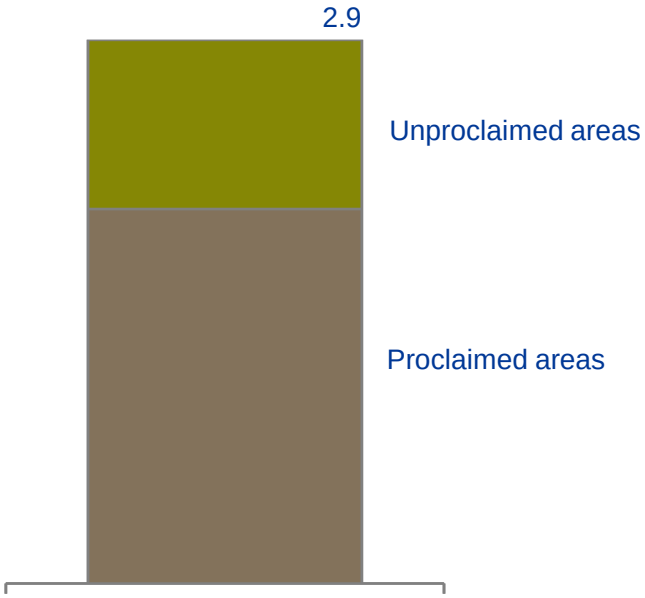
Total investment from 1991 – 2011 to date: R7.5 bn

Electrification – Still significant backlog of 2.5 to 2.9 million households (Eskom's area of supply)

2.9 million households with no access …

Number of households without access to electricity[1]

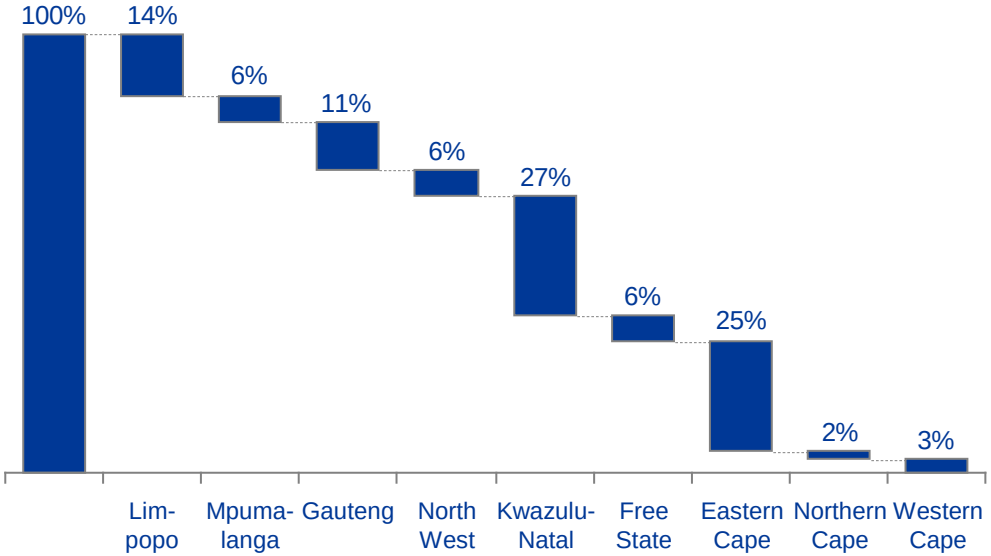
Millions, 2011



… whereof 70% in proclaimed areas

Breakdown of households without access to electricity by area[1]

%, 2011
Total: 2.5–2.9M



1. The figure is based on an assumed increase in households without access at a rate of between 2–5% per annum, from 2.3M in 2006. It is also in Eskom's areas of supply. The certainty in these figures is low and checks will have to be done in the pre-engineering phase
Source: Eskom

We have committed to achieving Universal Access by 2020 to help government achieve its broader development objectives

In terms of the White Paper on Energy, the responsibility for funding and planning of the Integrated National Electrification Programme is the function of the Dept of Energy (DoE) with Eskom being the implementing agent in own areas of supply.

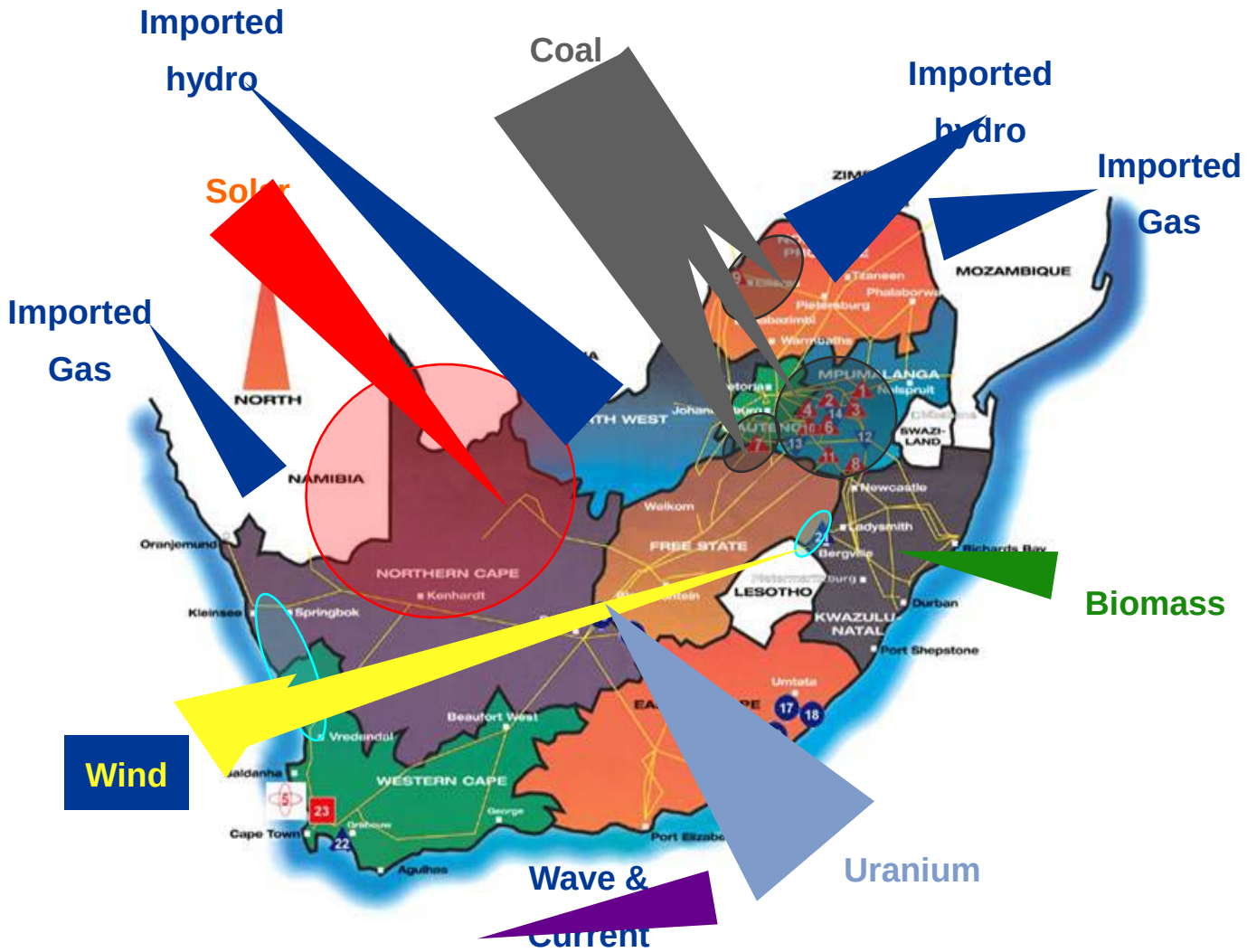
- With current DoE funding of ~ R1.7bn p.a., universal access will only be achieved in SA in 2033/4 (proclaimed and unproclaimed),, against the original government target of 2014
- Past experience shows that this can be achieved much sooner
- We are committed to helping government in achieving its objective by 2020

Positive social impact

- **Economic development** – electricity creates value-adding opportunities and improves the GDP
- **Health impact**, e.g. reduced exposure to smoke from fires used for cooking
- **Education impact** e.g. improved ability to study after dark
- **Improving gender equality** e.g., women not having to spend hours a day collecting firewood
- **Better public safety** e.g. street lighting and reduced illegal connections

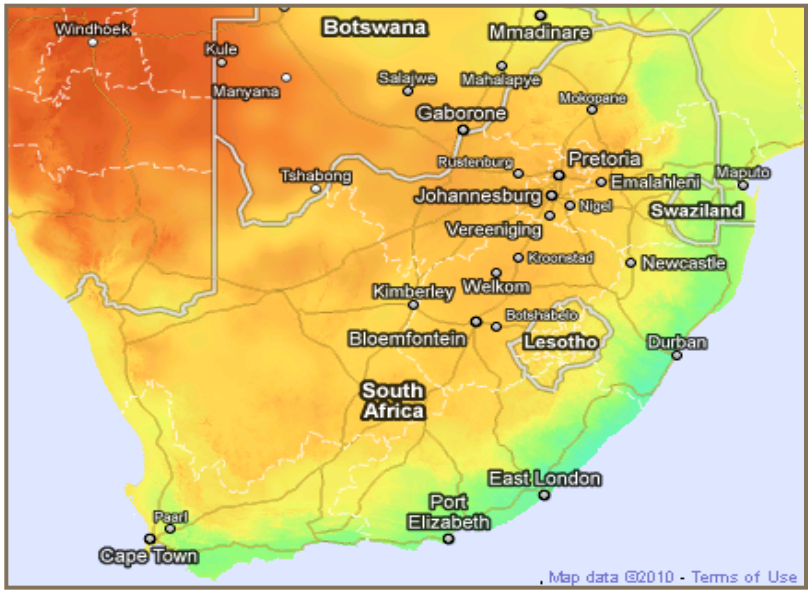
Source: Eskom

Available resources in South Africa

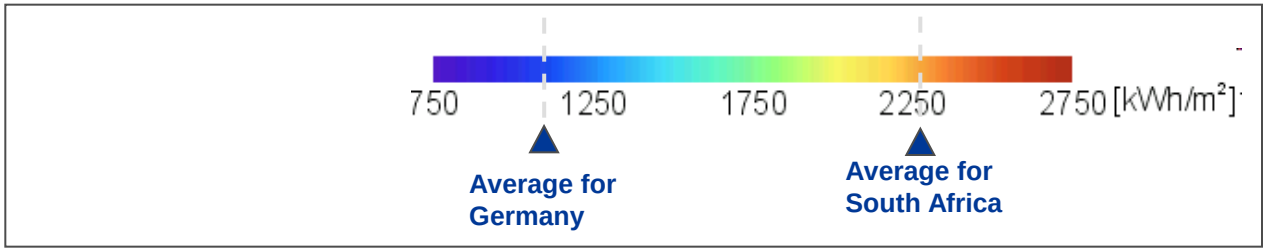


Very high solar irradiation in South Africa excellent for Solar Technologies

Solar irradiation in South Africa ...



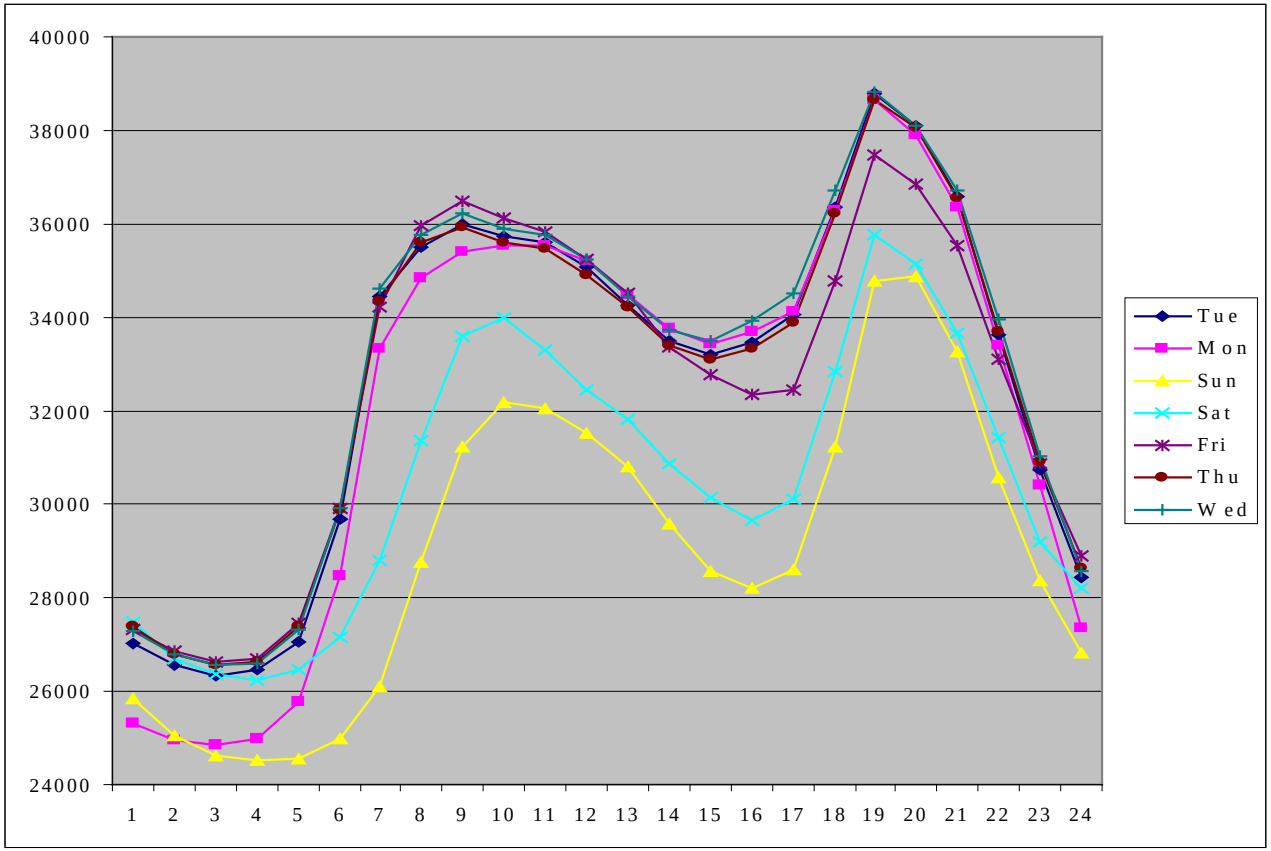
... as compared to Germany, where residential grid parity will be reached soon



SOURCE: Joint Research Center of the European Commission; PVGIS; BCG analysis

Typical SA demand profile

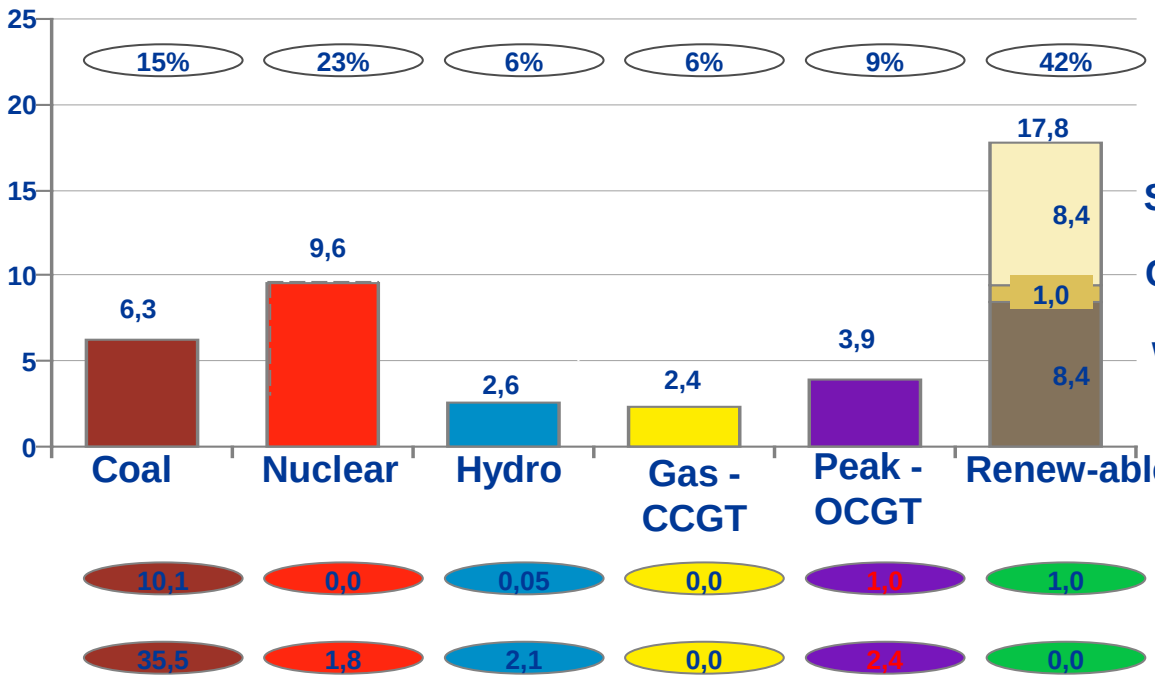
- The country is blessed with one of the highest solar irradiation profiles in the world but the power available from conversion technologies does not align with the needs of the system operator to meet demand. Both demand peaks fall outside solar irradiation times and thus there is a strong need for an energy storage solution to enable the system operator to respond to power requirements.



Current IRP driven by DoE

Policy-Adjusted IRP (Capacity)

Total additional new capacity (without committed) until 2030 in GW



		Coal	Nuclear	Hydro	Gas - CCGT	Peak - OCGT	Renew-ables	
in 2010	Σ = 260 TWh	90%	5%	5%	0%	< 0,1%	0%	Energy share
in 2030	Σ = 454 TWh	65%	20%	5%	1%	< 0,1%	9%	

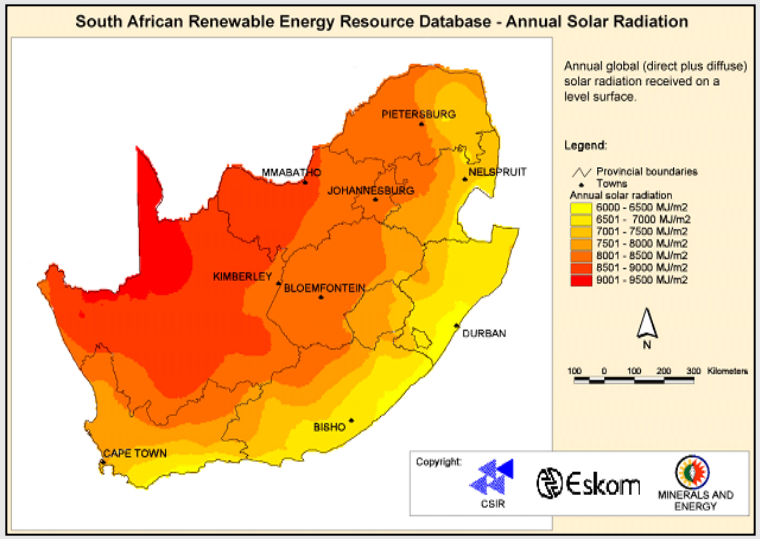
Source IRP 2010

South Africa's IPP Programme

Onshore Wind	1 150	1 850	633.99	650
	2 850	1 450	631.53	450
Concentrated Solar Power (CSP)	2 850	200	150	50
	1 070	12.5	0	12.5
Biogas	800	12.5	0	12.5
	840	25	0	25
Small Hydro	1 030	75	0	75
		100	0	To be announced
Total		**3 725**	**1 415.52**	**1 275**

Strategic Drivers for Solar Power

- Solar energy a significant resource in South Africa and region
- Solar power could potentially have a significant impact on a supply-side base load generation
- The potential supply of dispatchable power in future is in the GW range
- Energy storage an option
- Positive impacts on local industry and GDP growth
- Local green job and skills base



South Africa experiences some of the highest levels of solar radiation in the world.

The average daily solar radiation in South Africa varies between 4.5 and 6.5 kWh/m2 (16 and 23 MJ/m2), with excellent areas such as Upington

- 8.17 kWh/m2/day.

Eskom‘s Renewables aspirations

- With its focus on coal fired power generation South Africa ranges among the top 15 countries with the highest total CO_2 emissions with Eskom being the 2nd largest single emitter of CO_2 in the world
- In this context Eskom has design its climate change strategy that consists of the three elements "Reduce carbon footprint", "Adapt to climate change" and "Actively participate in national and international initiatives"
- Part of this initiative is the foundation of a renewables unit that focuses on large, currently approved renewable power generation capacity, namely Wind, Solar PV and Solar CSP
- This builds seamlessly on Eskom's long history of renewable power generation that up until now focussed mainly on hydro power
- The intensified focus on renewables is complemented by an additional push to reduce demand through more efficient energy use
- By implementing these measures Eskom aims on reducing its specific carbon footprint by approx. 34 % by 2030

Eskom being a top CO_2 emitting power company in the world has an obligation to curb emissions

Comparison of annual CO_2 emissions by country in 2009

Rank	Country	Annual CO_2 emissions (Mt)
Total	**World**	**30,398**
1	China	7,711
2	United States	5,425
-	EU	4,310
3	India	1,602
4	Russia	1,572
5	Japan	1,097
6	Germany	766
7	Canada	541
8	South Korea	528
12	**South Africa**	**450**
27	Egypt	192
36	Algeria	114

Source : EIA International Energy Statistics

Highest CO_2 emitting power companies in the world

Rank	Company	Annual CO_2 emissions (in Mt)	MWh Energy (in M)
1	Huaneng Power International	285	260
2	**Eskom**	**210**	**208**
3	China Huadian Group	207	195
4	Southern Co	206	279
5	NTPC Ltd	186	182

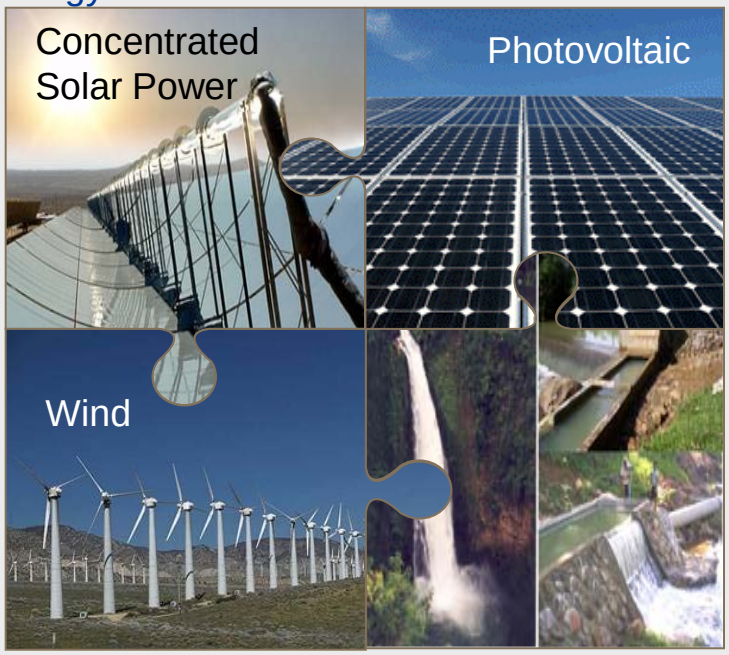
If Eskom was a country, it would rank 26th globally with its emission, higher than any other African country

We aim to contribute to a cleaner, more sustainable energy future for South Africa

Addressing climate change requires addressing both supply and demand factors in the energy sector

Reduce carbon intensity of energy supply

One key lever is to increase the share of renewable energy and nuclear in the overall energy mix



Reduce demand through more efficient energy use

Eskom is also driving a number of demand side management initiatives

Solar water heaters	Often 30-40% of electricity is used for water heating, which can be saved with solar water heaters
Energy efficiency program	Installation of energy efficient equipment e.g. compact fluorescent lights bulbs.
Industrial demand side management	Energy auditing & optimizations for industrial clients

CSP: A better strategic fit for South Africa

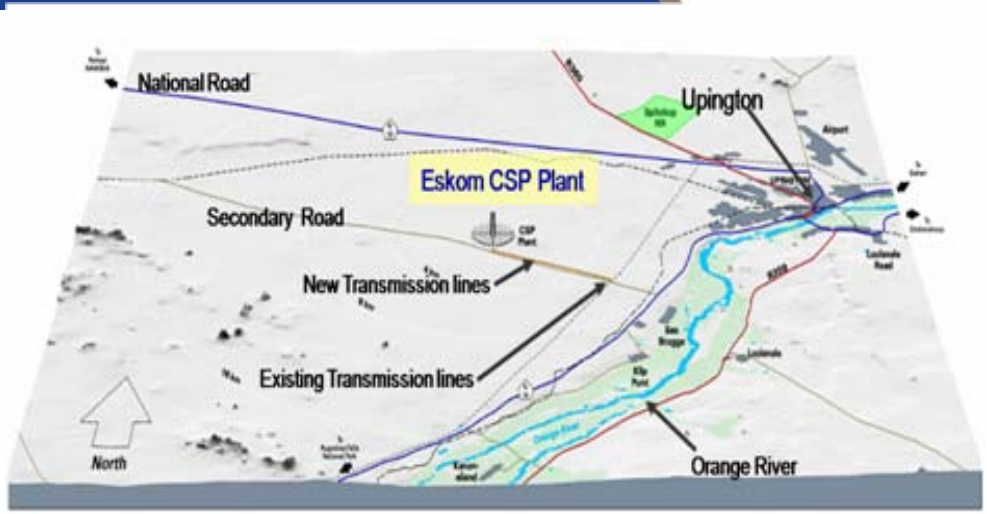
- Vast Areas of South Africa has some of the best solar resources in the world
- Integrating increasingly larger intermittent RE power supply in the national grid is a major challenge both technically and back up generation:
  - Peak generation limited and entirely dependent on expensive liquid fuels
  - Energy cost of peak power from liquid fuel exceeds US$0.30 per kwh
  - Serious infrastructure constraints for new peaking capacity to match new RE generation capacity as new RE capacity will be in remote regions of South Africa
  - Majority of new RE capacity locations away from load centers and will require major new Transmission build program
- Most solar PV projects in IPP process lack energy storage feature, placing additional balancing strains on the grid system
- CSP with optimal energy storage is a unique solution for South African market

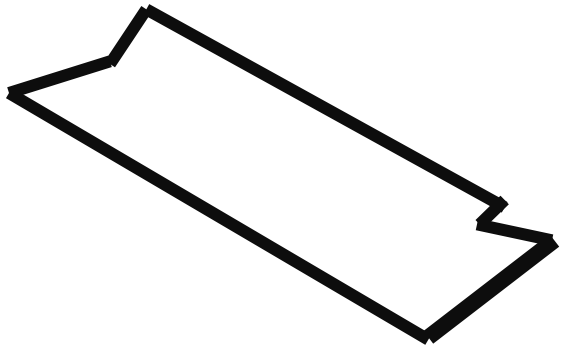
Eskom - CSP demo plant

- Central Receiver (often refer to as the Power Tower).
- Molten Salt as the heat transfer fluid.
- 100 MWe with a capacity factor in excess of 60 %.
- Two tank molten salt storage systems, designed to operate the power plant at an optimised Levelised Energy Costs.
- The plant will be of dry cooled or hybrid cooled designed to optimise the water usage.
- All auxiliary power will be sourced from the National grid and backup will be sourced from diesel generators.
- Life of plant will be a minimum of 25 years.
- Planned to be commissioned in 2016.

Eskom CSP demo

- EIA complete – ROD obtained - Revision in progress
- Land Procured
- Funding secured
- Solar data – site and satellite has been collated
- Water Supply – 300 ML / annum secured
- IWULA application in progress.
- Road basic designs in progress – route may change





CSP Tower Technology

- It uses sun tracking mirrors called heliostats that concentrate sun energy to the tower.
- The heat converts water into steam and the steam drives the turbine to generate electricity
- Heat is stored in molten salt to be used when there is no sun
- This allows longer generation period and higher utilization factor.
- The plant will displace 9m tons over the life of the plant
- It can electrify up to 400 000 standard homes p.a. if 200kW per month is assumed.
- 1000 – 1500 jobs can be created during construction and 65 – 70 during operation

Typical CSP Plant With Storage

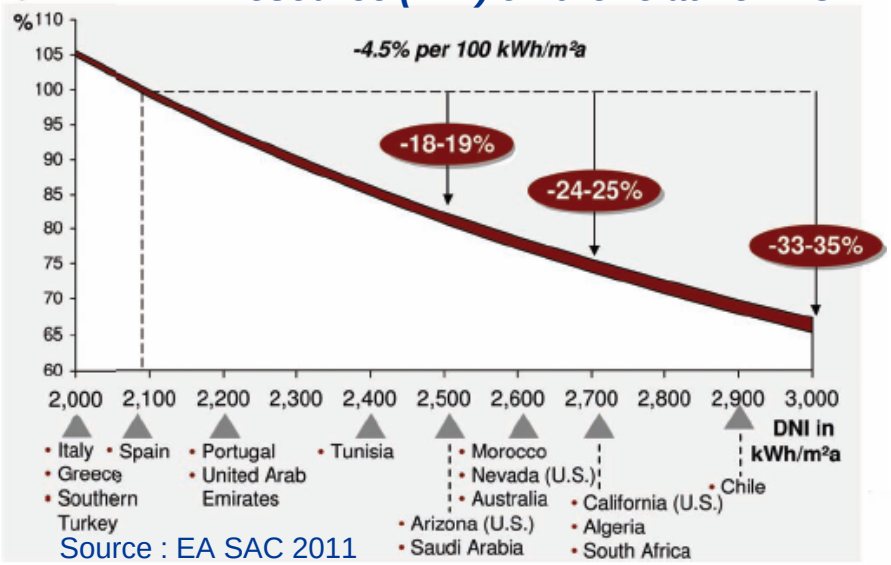
The Gemasolar Plant

CSP Challenges and Opportunities in South Africa

Challenge	Opportunity
• CSP technology is in early stages of development life cycle • Long term commercial and technical viability unproven • Efficient and cost effective storage for mid merit and/or baseload generation a priority for sizable and sustainable implementation • Cost of technology • Achieving balance between cost, risk and affordability • Local industry involvement non-negotiable • Funding structures require an innovative approach and risk capital limited • Local currency funding limited and foreign exchange risk a challenge	• South Africa and Eskom are committed to strategic change in respective of climate change and CSP will feature prominently in the mix • Learning's and innovation resulting from development of pilot project (largest storage project in the world) will provide substantive platform for future projects • Financial risk can be mitigated by innovative funding solutions (CTF and DFI funding a good start) • Risk sharing structuring of projects will benefit both the developers and industry in the long term • Local manufacture has to form part of the mix - country can provide direction by providing long term planning parameters for large scale rollout • Local manufacture will contribute to addressing cost, foreign exchange challenge and provide access to large regional potential for suppliers • Partnership model key to unlocking challenges

Challenge – current cost of CSP

Impact of the quality of the solar resource (DNI) on the relative LEC



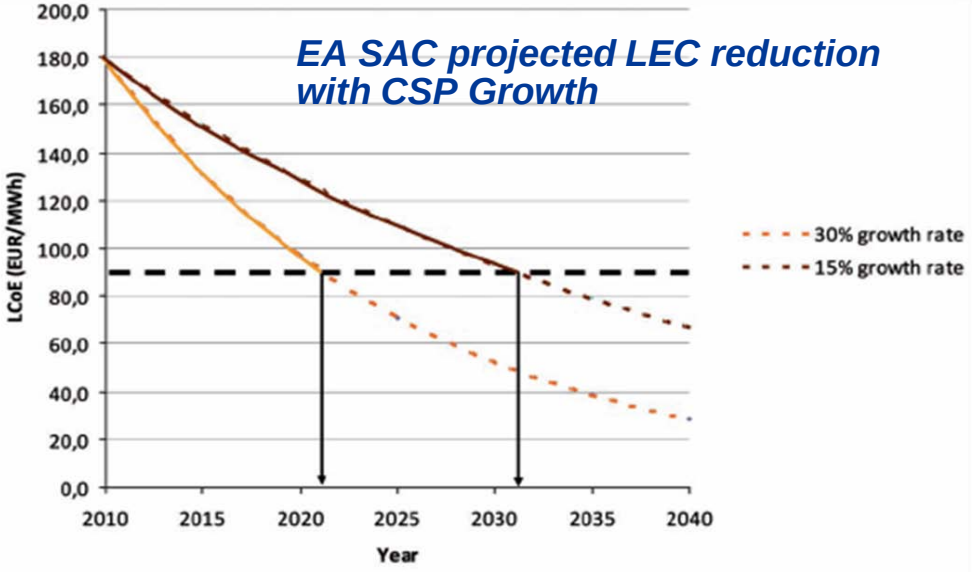
Source : EA SAC 2011

Barrier to entry: Current cost of CSP. European Academies Science Advisory Council -Nov 2011- predicts grid price parity with Fossil between 2020 and 2030 in Europe, and sooner in places with higher DNI.

Eskom anticipates CSP cost reduction through:

- **Capacity expansion,**
- **Research and Development,**
- **Localisation**

EA SAC projected LEC reduction with CSP Growth



Conclusion

- Government support is imperative in embarking on Sustainable projects.
- Effective diversification not possible without concessional funding.
- Benefits to Local industry must be demonstrated to harness support:
- Job creation
- Poverty alleviation
- Thorough Environmental Impact Assessment with no fatal flaws is key in obtaining local support.
- Site selection - Should be close to established infrastructure like**:**

  - Water supply, National roads, Transmission connection, Airport etc.
- Since local expertise is limited, consultants may be required initially but with emphasis on training and development.
- In procuring the plant, emphasis should be placed on local supply, T&D, and technology transfer.

THANK YOU

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