



STERG

SOLAR THERMAL ENERGY
RESEARCH GROUP



— “The Role and Value of CSP in the SA Power System”

at Africa New Energy 7th March 2017

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Agenda

1. CSP Situation in South Africa
2. Value of CSP with storage
3. Intention to get CSP back into the Integrated Resource Plan (IRP)

1. CSP Situation in South Africa

Status of CSP plants in South Africa

Window 1 (150 MW)

Kaxu - 100 MW trough - Abengoa

Khi - 50 MW tower - Abengoa

Window 2 (50 MW)

Bokpoort - 50 MW trough - ACWA

Window 3 (200 MW)

Xina - 100 MW trough - Abengoa

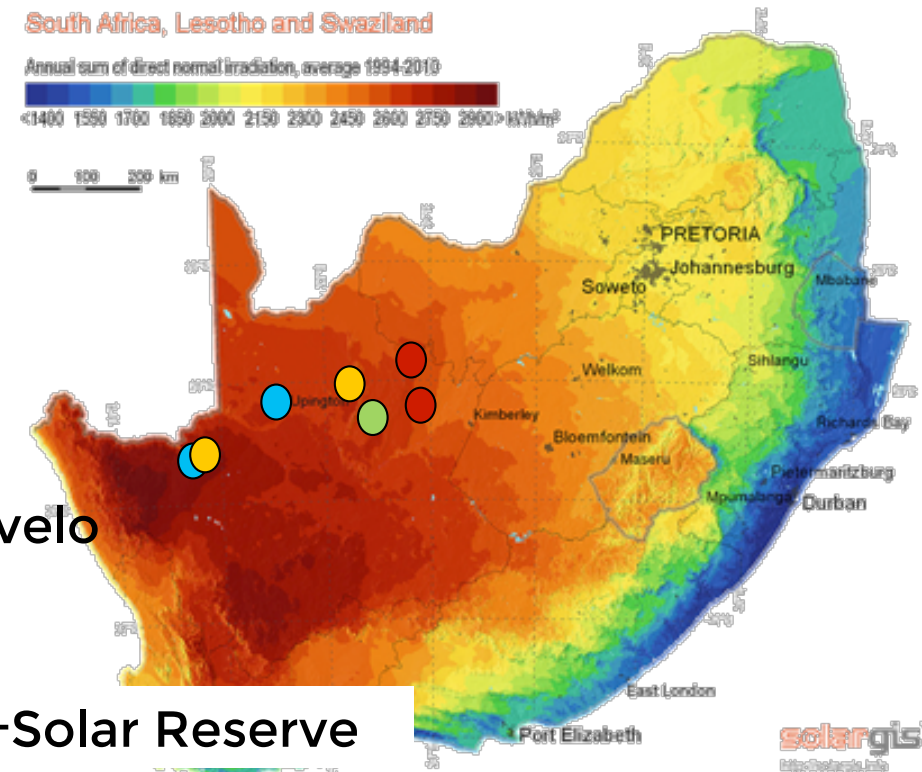
Ilangaletu 1 - 100 MW trough - Emvelo

Window 3.5 (200 MW)

Kathu - 100 MW trough - Engie

Redstone - 100 MW tower - ACWA+Solar Reserve

Window 4.5 (450 MW): All waiting for response from government !



1. CSP Situation in South Africa

IRP Update presentation Nov. 2016

Cumulative Capacity from Procured Determinations

	Renewables							Coal	Gas	Import Hydro	Nuclear	Co-Gen
	PV	Wind	CSP	Landfill	Hydro	Biomass	Biogas					
2016	1328	1373	200	-	14	-	-	-	-	-	-	-
2017	1478	1994	300	13	14	-	-	-	-	-	-	11
2018	1842	2378	600	13	14	17	-	-	-	-	-	-
2019	2412	3188	1050	28	59	142	25	-	-	-	-	-
2020	2811	4006	1050	-	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	900	-	-	-	-

• And no further CSP in future !!! ???

1. CSP Situation in South Africa

Cost in IRP
2016 proposal

Generic Technologies Levelised Cost at
8.2% Discount Rate

Renewables					
CSP Trough 3 hours storage	CSP Trough 6 hours storage	CSP Trough 9 hours storage	CSP Tower 3 hours storage	CSP Tower 6 hours storage	CSP Tower 9 hours storage
32	40	44	34	42	48
2887.56	2796.32	3068.50	2585.85	2379.06	2335.93

	Base Load					Mid Merit		
	Coal PF	Coal FBC	Coal Pulverized with CCS	Coal IGCC	Nuclear (DoE)	CCGT	Internal Combustion Engine (ICE) 2MW	Internal Combustion Engine (ICE) 10MW
Typical Load Factor (%)	86	86	86	86	90	36	36	36
Levelised Cost (R/MWh)	862.50	888.54	1514.35	1292.85	970.81	1183.22	1615.55	1620.39

	Storage				Peaking	
	Pumped Storage	Lithium-ion_1hrs Storage	Lithium-ion_3hrs Storage	CAES_8hrs Storage	OCGT	Demand Response
Typical Load Factor (%)	22	2	6	20	6	1.5
Levelised Cost (R/MWh)	1390.32	8721.11	5615.52	2015.36	2993.97	1362.66

- Numbers of 2.3 to 3.0 R/kWh are much too high?!

	Renewables															
	Wind	PV, Crystalline Silicon Fixed Tilt	PV, Crystalline Silicon Tracking	Concentrated PV	CSP Trough 3 hours storage	CSP Trough 6 hours storage	CSP Trough 9 hours storage	CSP Tower 3 hours storage	CSP Tower 6 hours storage	CSP Tower 9 hours storage	Biomass Forestry Residue	Biomass MSW	Landfill Gas	Biogas	Bagasse Felixton	Bagasse Gen
Typical Load Factor (%)	36	24	22	22	32	40	44	34	42	48	70	70	80	80	50	50
Levelised Cost (R/MWh)	805.30	931.24	1087.645	2425.812	2887.56	2796.32	3068.50	2585.85	2379.06	2335.93	1835.90	3203.67	732.58	1213.05	2381.23	2210.51

1. CSP Situation in South Africa

This is where the disaster began – Reasons?

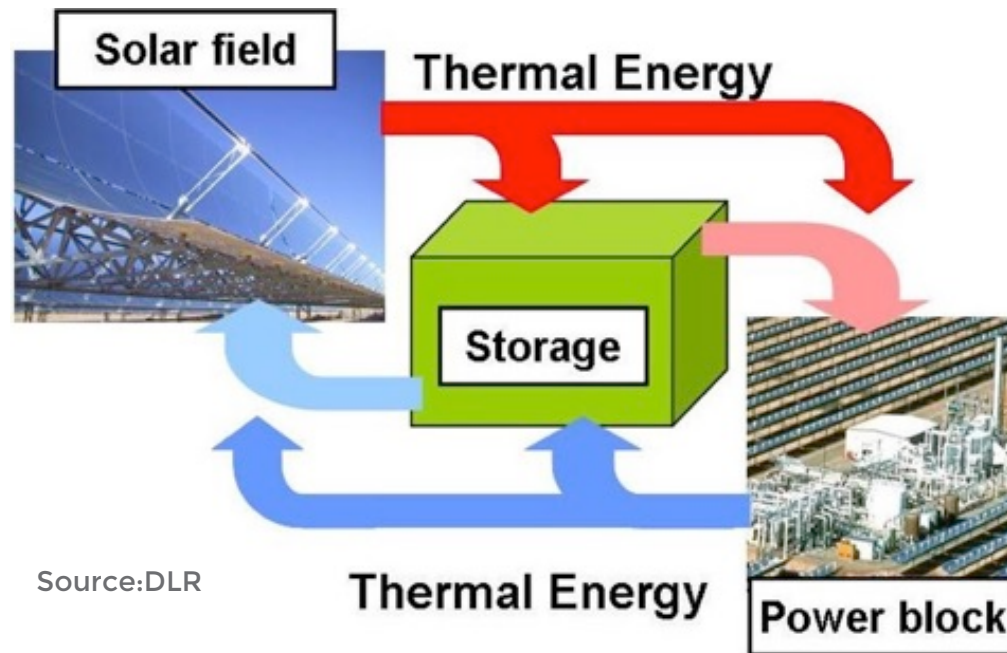
- Maybe the nuclear deal?
- Maybe the numbers used by DoE were outdated?
- Maybe CSP is too expensive?
- Maybe because the sun shines only during daytime?
- Maybe CSP industry slept nice and deeply?
- Maybe the dispatchability and operational flexibility of CSP plants were not acknowledged properly?
- Maybe hidden agendas?
- ...

Agenda

1. CSP Situation in South Africa
2. Value of CSP with storage
3. Intention to get CSP back into the Integrated Resource Plan (IRP)

2. Value of CSP with storage

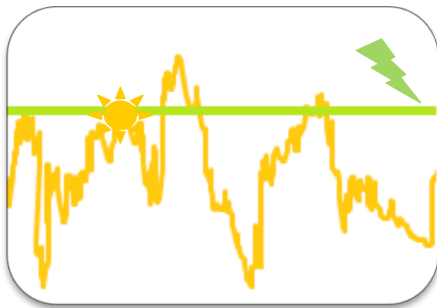
The main advantage of CSP technology against other RES as PV or wind power is the capability to **provide dispatch-able power** by storing solar energy through thermal energy storage.



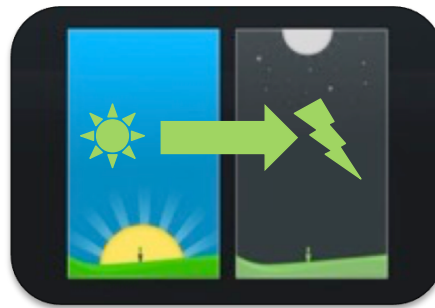
Source:DLR

2. Value of CSP with storage

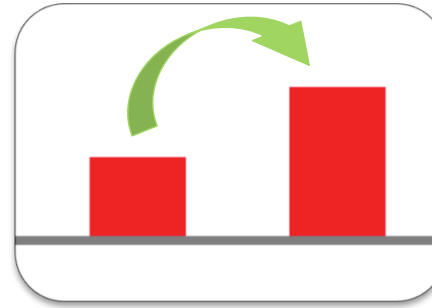
Additional benefits:
Flexible and predictable electricity generation



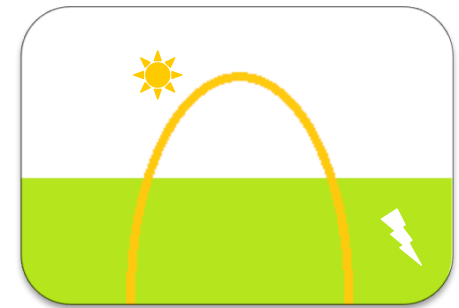
Avoidance of production interruptions resulting from the intermittency of solar radiation



Generation of solar power decoupled from weather conditions and time



Shifting of power generation to periods of highest demand



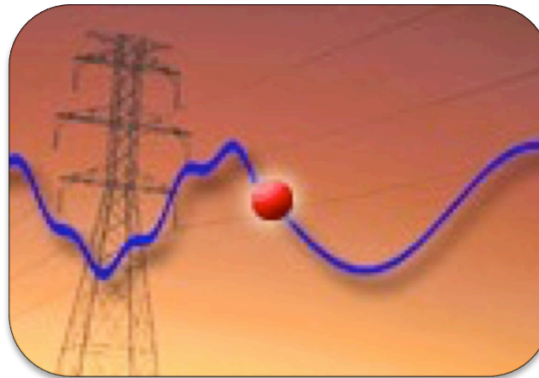
24 h/d continuous production capability

2. Value of CSP with storage

Additional benefits for the Eskom power system:



Regulation and frequency response



Support for power quality



Contribution to system flexibility supporting the integration of other RE sources

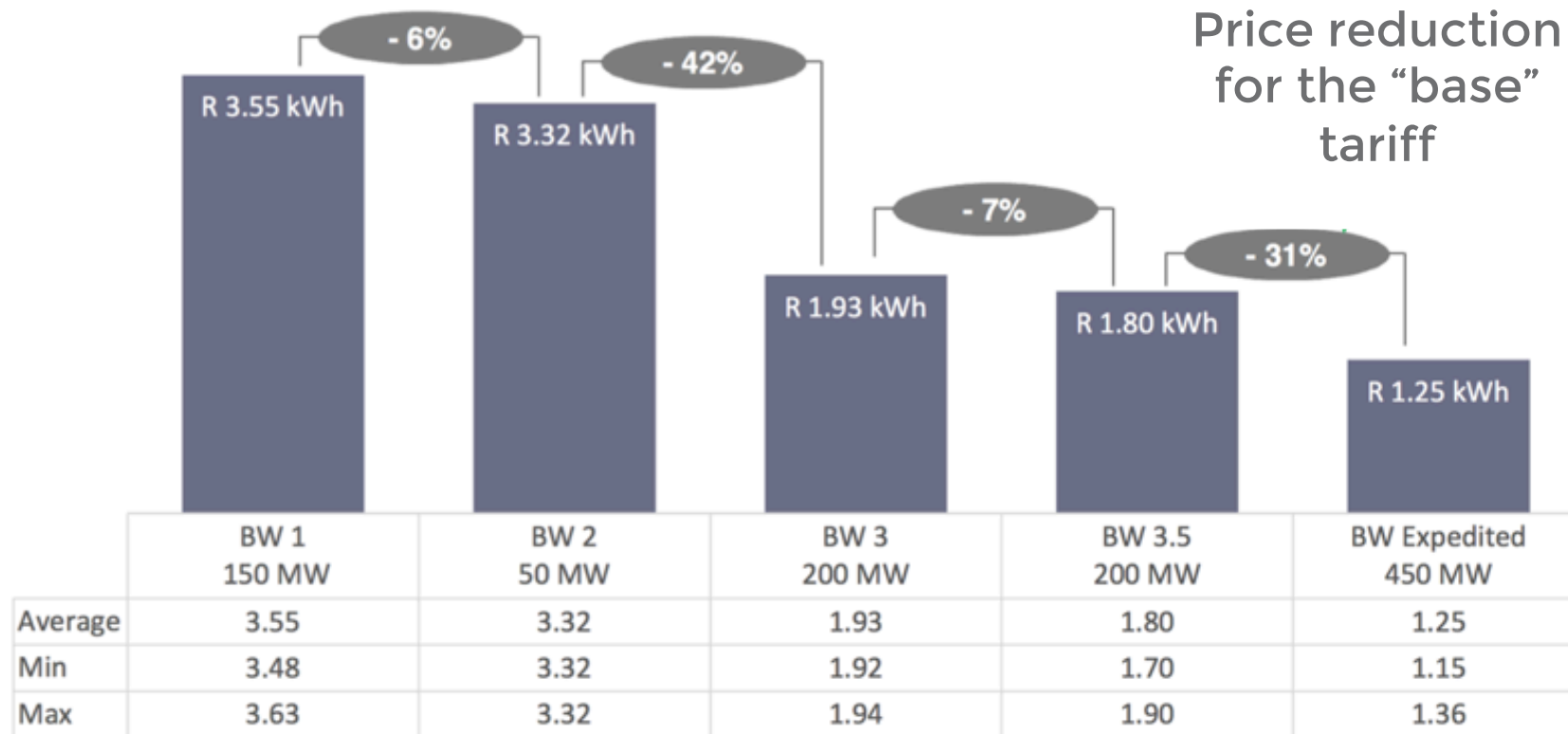
There is a need CSP plants for grid stabilization!

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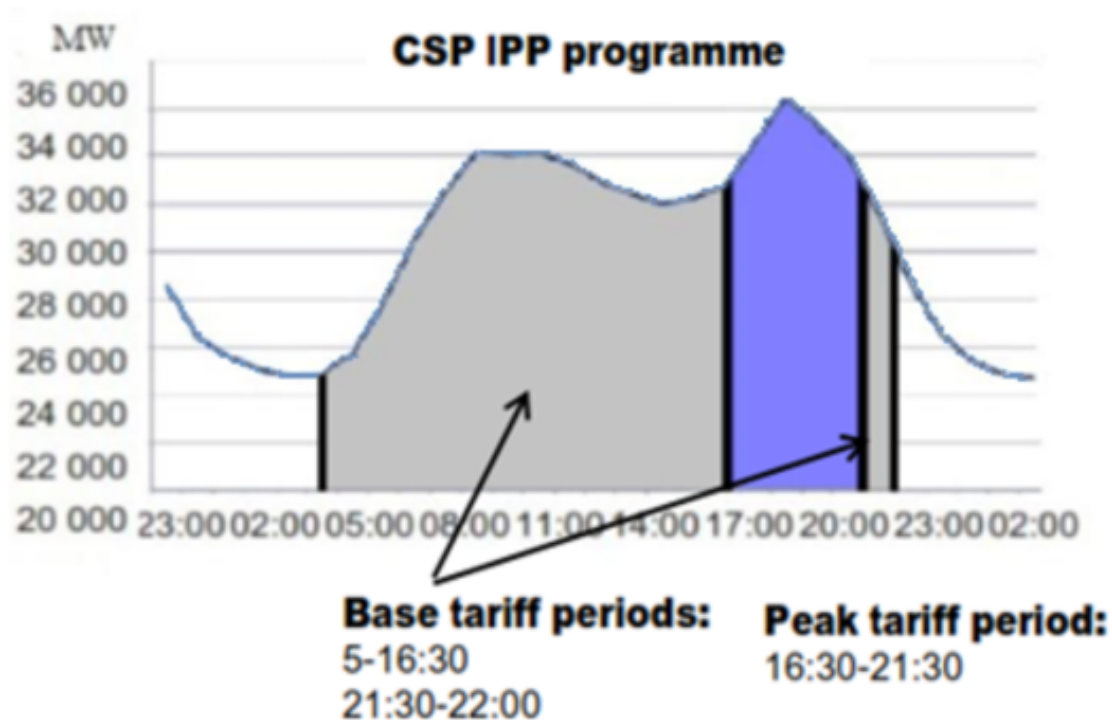
3. How to get CSP back into IRP?

Price trend in CSP R/kWh (April 2016) Bid windows



3. How to get CSP back into IRP?

Bid window structure from BW3 onwards



- Peak tariff is 2.7 times base tariff
- No payments at night time for electricity production

3. How to get CSP back into IRP?

Technical benefits from CSP with storage

- 24 h production and **high load factors** to 99 % possible (NREL) like in coal fired or nuclear or combined cycle gas plants
- CSP effectively contributes to the **grid stability** (inertia, etc.)
- **Higher shares of RE** technologies (PV+Wind) possible
- **Fully flexible and reliable** electricity production
- **Free fuel supply forever** from the sun
- ...
- „**Golden end**“ because long lifetime after payback period

3. How to get CSP back into IRP?

Macroeconomic benefits from CSP

- Higher local content creates **GDP contribution**
- **SA Industry gets involved** more and more as CSP suppliers
- **Job creation** (regional and in the whole country)
- **Economical development** (maintenance, spares, etc.)
- Less unemployment subsidies and **more tax income**
- Attraction of investment of **already R 53 Billion for 600 MW of CSP** approved in SA
- The **South African CSP industry** has advanced to a stage of **maturity** with demonstrated increases in local content of CSP plants beyond the REIPPP programme goals.

3. How to get CSP back into IRP?

Costs for CSP are falling

- A 110 MW CSP plant with 17.5 hours of storage, partly hybridized with PV, was recently selected in **Chile** with a PPA of **\$110/MWh**
- **\$64/MWh** has been offered by a CSP plant in the most recent auction **2016 in Chile**
- In the Dubai tender process 2016 announcing a goal of **\$80/MWh for a 200 MW CSP Plants** 30 promoters have presented their expressions of interest. Several are already prequalified.

That means: CSP costs are coming down seriously

3. How to get CSP back into IRP?

International WS organized by CRSES on 16th Jan 2017

- Centre for Renewable and Sustainable Energy Studies (CRSES) organized an international Workshop on **“The Role and Value of CSP in the South African Power System”**
- Participants: NREL, DLR, TH Aachen, CSIR, STERG and industry
- A number of **studies** were presented at the meeting, which **investigated the South African power system**, using different methodologies and parameter assumptions
- The outcomes independently indicate that in **all cost-optimized scenarios** there is **no requirement to build new coal or nuclear plants** in South Africa.
- Find all workshop presentations: www.crses.sun.ac.za



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3. CSP needs to be in IRP for the future !

Because:

Summary

- CSP can deliver base, mid and peak load and is much more flexible than coal fired and nuclear power plants
- LCOEs are still higher than for PV/wind but CSP has additional values
- **LCOE should not be the only value to compare CSP with other RE electricity producing technologies**
- CSP has special values for grid operation and is **real installed capacity**
- **Research in CSP will continue to reduce costs but we need it fast !**
- Support from researchers can help also during operation
- **SA can make the change to become a real CSP-Nation**

CSP is **the** large scale power plant technology — **for the future**

Summary

- CSP technology can play a **significant role** in a **cost optimized South African power system**
- CSP has technical merits, which **add value** to the **power system** that should be allocated in the coming IRP
- LCOE of CSP are coming down so that CSP can be **compatible with new coal and nuclear plants** in SA in the future

What to do:

- Make people **aware** of the benefits of CSP technologies!
- Lets get **CSP back to IRP** to support SA industry and get flexible power production to the SA grid
- Because an **appropriate allocation of CSP** in the IRP is required to sustain the local industry
- **SA can make the change to become a real CSP-Nation**



Thank you !

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