


Renewable Energy and Grid Integration & SKA High Voltage supply


Riaan Smit
Chief Engineer

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- Renewable energy overview for South Africa
- SKA High Voltage supply
- Conclusion


*Klipheuwel Wind Energy
Demonstration Facility*




*Darling Wind
Power*



*Middelgrunden,
Denmark*



*Favonius,
Sweden*



South African Generation Capacity



Energy Source	Eskom MW	Eskom GWh	IRP 2010 MW
Coal-fired (13) [*]	37 745	220 219	6 250
Hydro-electric (6)	661	1 960	2 609
Pumped storage (2)	1 400	2 953	
Gas turbine (4)	2 426	197	6 280
Nuclear (1)	1 910	12 099	9 600
Renewable energy (1)	3.16 (wind)	2	17 800
Total production	44 145 [3]	237 430	Engineering challenge
Foreign imports		13 613	
Local IPP and co-generation [2]		1 833	

[1] Excluding municipal & private power stations

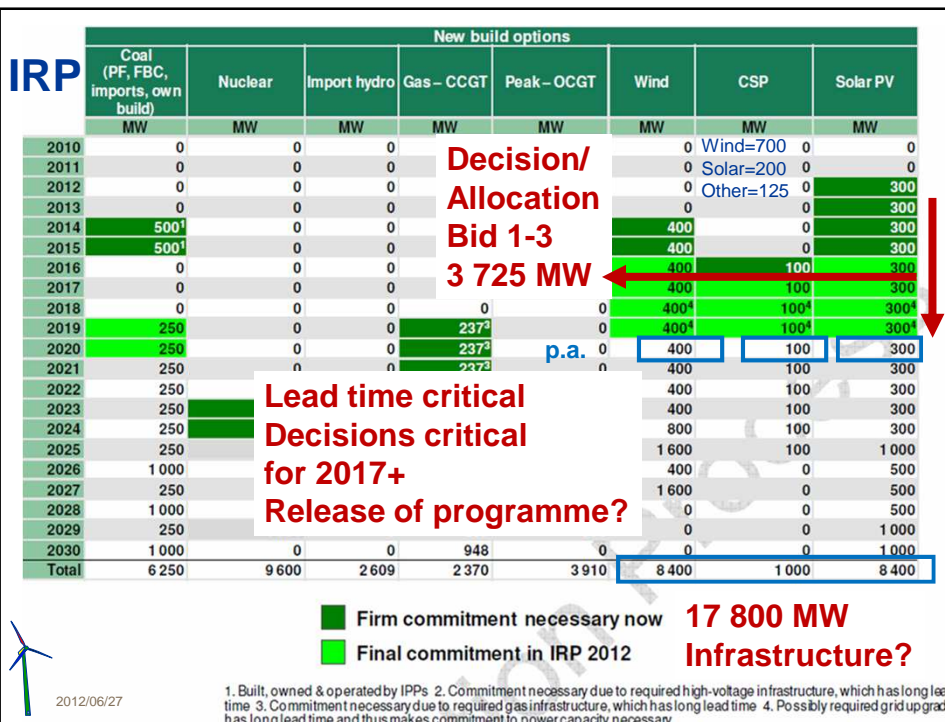
[2] Including Darling Wind Power (5 MW) and Coega wind (1.8MW)

[3] Roughly 95% of South Africa generation



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Source: www.eskom.co.za – Annual Report 2011



Renewable Energy in MW

Nr Projects/MW (100 MW for 1-5 MW prgm)



	Wind	PV	CSP	Other	Interest	TOTAL
<i>Interest / Ideas</i> <i>Constantly changing</i>	158/ 17 400	311/ 11 344	17/ 1 734	55/ 364		541/ 30 900
RE IPP Prgm	1850	1450	200	125+100		3625+100
RE IPP Bid 1 Allocated (2014)	8/634	18/632	2/150	0	53/2160	28/1416
RE IPP Bid 2 Allocated (2016)	7/563	9/417	1/50	2/14	79/<3300	19/1044
Price c/kWh	114 >89	275 >165	268 >251			
RE IPP Bid 3 Available	653	401	0	111		1165
Future	6550?	6950?	800?	?	Till 2030	17 800
Annual allocation	400	300	100	?		



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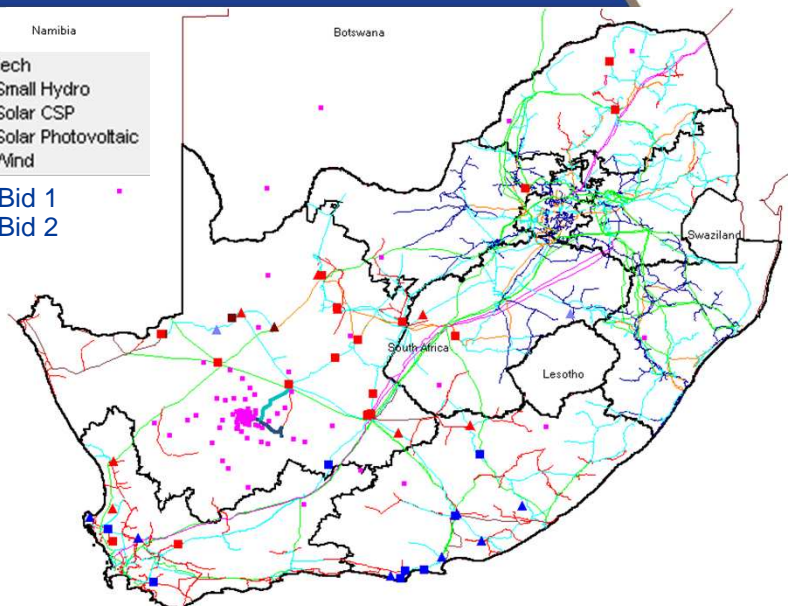
SKA and renewable energy Bid 1 & 2



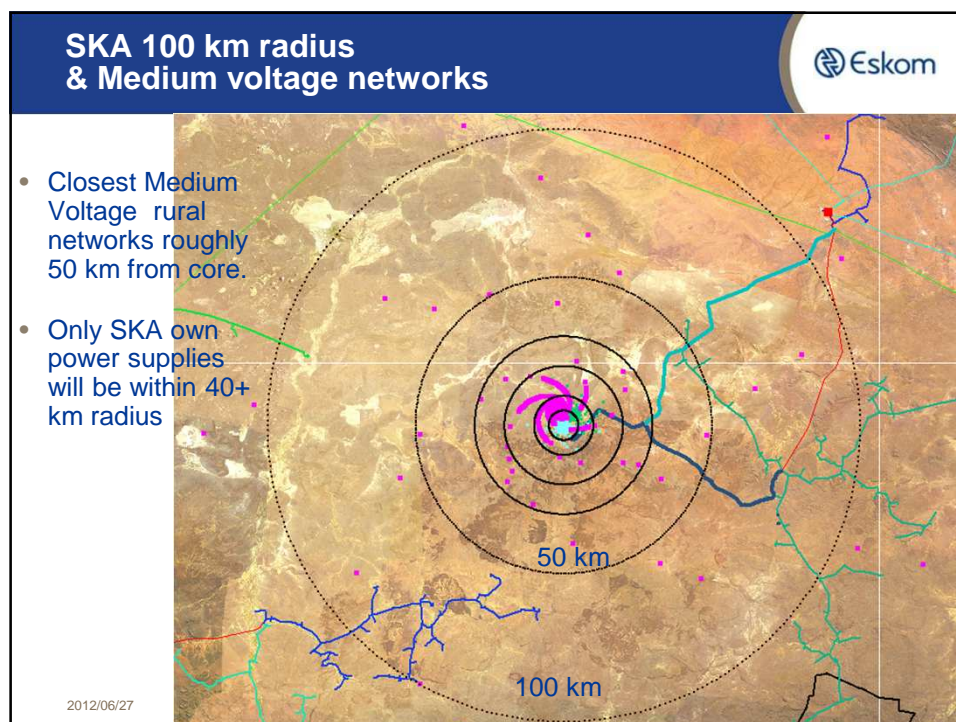
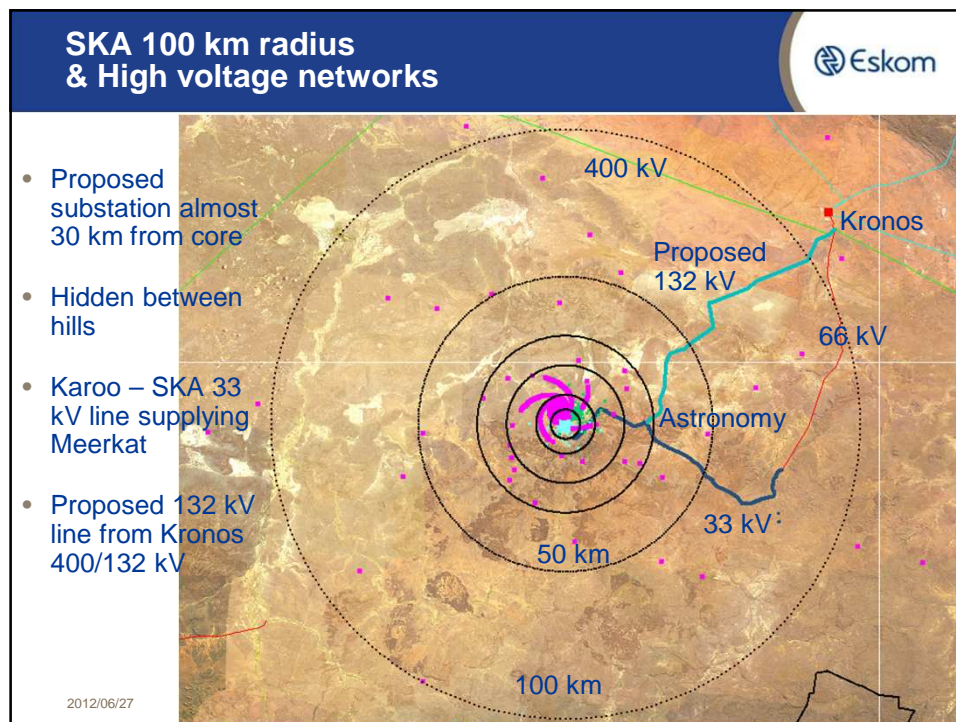
Proj_Tech

- Small Hydro
- Solar CSP
- Solar Photovoltaic
- Wind

■ Bid 1
▲ Bid 2



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11 km Clump exclusion zone



- Astronomy substation location at T-junction Carnarvon – Losberg - Van Wyksvlei
- Used 11 km exclusion zone from SKA clumps (cluster of instruments)
- Need to add screening from topography, making impact even less
- RFI studies done by Tony Britten and Dr Pieter Pretorius

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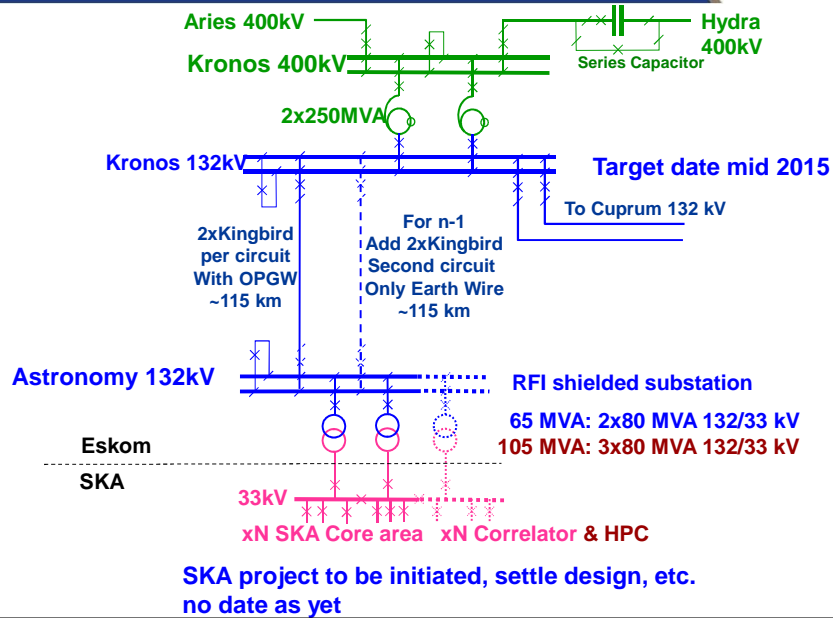
Potential Astronomy substation site



- Astronomy substation location at T-junction Carnarvon – Losberg - Van Wyksvlei
- Used 11 km exclusion zone from SKA clumps (cluster of instruments)
- At least 1 square kilometer area available for substation and any potential infrastructure
- Well screened by topography

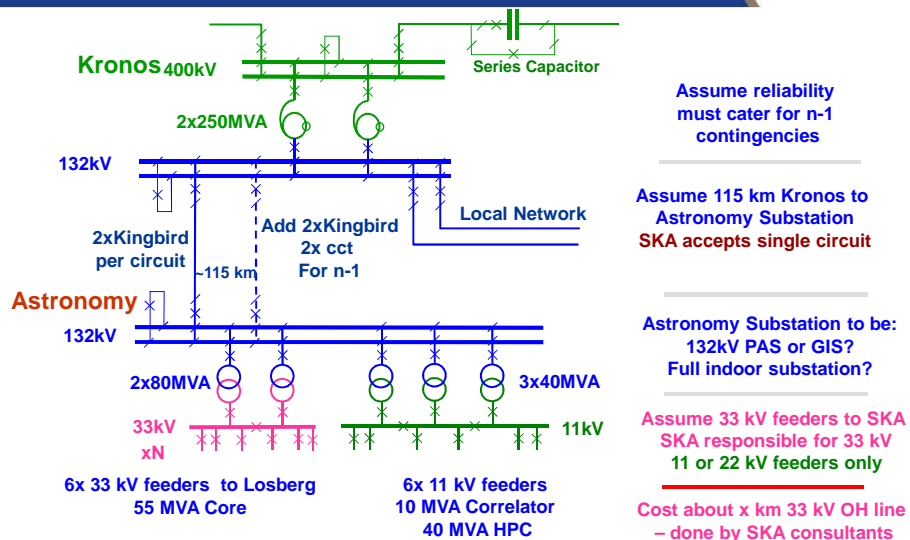
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Grid Alternative – 65-105 MVA @ 33 kV



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Grid Alternative 3 – 55 + 10+40 MVA



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SKA Power Distribution and EMC



Aspect	Value / Level	Unit	Remarks
Applicable Frequency Range	0,07-10	GHz	(70 MHz to 10 GHz)
Power Flux Density Threshold	258	dBW/m ² /Hz	Continuum observations
Altitude of Site	1052	m	
Power Requirements	100	MW	50 Hz
Proposed Buffer Zone 1	0 - 20	km	33 kV Cable (20 km)
Proposed Buffer Zone 2	20 - 50	km	132 kV Cable (30 km)
Proposed Buffer Zone 3	50 -120	km	132 kV Overhead Line (70 km)
Proposed Exclusion Distance 1	> 8*	km	132 kV Lines
Proposed Exclusion Distance 2	> 14	km	400 km Lines
Proposed Exclusion Distance 3	> 20	km	400 kV / 132 kV Substations

- * 11 km exclusion zones (similar to that applied to roads) have been applied to the 132 kV line.

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Considerations



- Line route & topography
- Exclusion zones defined by SKA, as well as proposed exclusions
- Conductor bundle design – 2xKingbird – corona, transfer optimal
- Structure insulation, consider e.g. 220 kV design last section
- Lightning design – Tower footing resistance ≤ 20 ohm
- Substation design and shielding
- Corona cage studies – bundle, moisture / wet conditions

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EMI Interference – study by Tony Britten & team



- The main conclusions are:
 - (i) The extent of the predicted impact of EMI from the grid power supply to the SKA site has been analysed in depth.
 - (ii) The analysis shows that a practical system which will not interfere with the operation of the SKA can be specified, engineered and maintained.



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Conclusion



- High Voltage alternatives considered
- Distance from core and shielding critical
- High volume of requests to be processed at current 10% success rate - high risk
- Need project release to initiate various activities
- Critical lead times?
- Various renewable energy resources being developed
- Eskom needs to purchase all renewable energy, unless private arrangements
- Team confidence in proposals

**Extract
Energy
Expand
Vision**



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Questions ?




- riaan.smit@eskom.co.za

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Riaan Smit Background (Pr.Eng.; B.Eng. Electrical; MBA; GCC)



- Joined Eskom, South Africa, in Jan 1983, working briefly in Generation (Duvha Coal fired and Koeberg Nuclear)
- May 1986 - Network Planning for Southern Cape (33-132 kV)
- 1992-4 Responsible for Cape Distributor Network Planning 3.3 - 132 kV (Western & Eastern Cape)
- 1995-7 Eskom re-organisation planning and process changes (MBA came in very useful)
- 1997- March 2012 *Chief Engineer: Network Planning for Eskom Distribution Western Operating Unit (Western and Northern Cape networks ≤132kV)*
- April 2012 to date – *Chief Engineer Group Technology Engineering: Power Delivery – Center of Excellence*
- Member of Research Steering Committees on Renewable Energy and Power Systems
- 2000-2003 Team member for establishing 3.16 MW Klipheuwel Wind Energy Demonstration Facility
- 2010-2011 “Wind Energy Development and Use” course by SIDA and Life Academy, Sweden
- Grid connection negotiations with all renewable energy developers/IPP's in Western OU & national support
- Contributions to several conferences – London - UK, Cairo - Egypt, Rabat & Casablanca - Morocco, Bhopal – India, Various in Cape Town & Johannesburg – South Africa
- Technical support on behalf of Eskom to Dept of Energy / National Treasury IPP Renewable Energy Programme



Middelgrunden
Copenhagen
Denmark



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Grid connection “technical concerns/awareness”



- Need to do technical studies / analysis to ensure acceptance
- Thermal loading of lines and transformers
- Voltage variations during normal operation
- **Over voltages studies for Renewable Energy projects**
- Voltage recovery after faults (incl. Low Voltage Ride Through)
- Phasing out old networks vs new higher capacity and voltage for RE
- Reactive power control
- Focus on load modelling (new active and reactive power combined profiles)
- Short circuit currents (3-phase & single line to ground Fault Levels)
- Limit system losses vs maximum use of thermal capacities
- Reliability required by wind, PV, CSP, other developers
- Impact on Power Quality aspects (Harmonics/Flicker, IEC 61400-21)
- Transmission system requirements such as voltage stability
- Dynamic studies for various technologies, including MV networks
- Impact on sub-synchronous resonance for Cape network
- Voltage sags due to breaker operation
- Cable/Transformer inrush currents
- Influence on ripple control systems

*Depends on
Size & location*



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