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#### SKA Power Procurement Programme

MASUM 2022-05-10

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# SKA Power Procurement Program (PPP)

- SKA Energy requirements are significant
  - $\sim 13$  MW total continuously (24/7/365 @ >95% availability)
  - > 98% of Observatory CO<sub>2</sub> emissions
  - Contracts worth Eur 100's of millions
- SKA-Low Murchison
  - 9 Remote stations: +-25kW ea
  - Central Power Station (CPS): +-3300kW
- SKA-Low Perth
  - SPC Requirements (Pawsey): +-3000kW
- SKA-Mid Karoo
  - 21 Remote stations: 8 12 kW ea
  - New 132kV transmission line\*: +-3400kW
- SKA-Mid Cape Town
  - SPC Requirements + Ref Design (SARAO/iThemba): +-3500kW
  - On-site PV (2200kW) + Battery + Backup Generators



#### Power Locations

PLS-CADD Overlay







# SKA Power Procurement Program (PPP)

- SKA Capital funding does not include power supply infrastructure! SKAO intends to issue tenders to Independent Power Producers
- (IPPS)
  - Enter into Power Purchase Agreements (PPAs) Power stations and supporting infrastructure to be constructed,
  - owned and operated by IPPs
- Electromagnetic Interference (EMI) is a major, major concern Strictest EMC standards in the world
- - Overriding consideration for SKAO, but...
  - Something virtually no IPPs have experience with
  - Previous attempts to shift risk to IPPs failed completely



# SKA Power Procurement Program (PPP)

- PPP adopted several risk mitigation strategies:
  - Multi-stage process: Rfl (completed), RfP and RfT
  - Sharing of risk between SKAO and IPP
  - Allocating risk to the party most able to handle it, SKAO handles:
    - The overall risk on tariff due to the EMI mitigation measurements
    - CO2 emissions (by means of tender scoring criteria)
    - Demand & sizing, locations, etc.
- Only realistic means to limit SKAO risk:
  - Create detailed, qualified refence designs
  - Create detailed guidance material (Basis of Design, Design Reports, EMC Control Plans, etc.)
- Please refer to Power Procurement Plan for details



## Status: Mid Remote Power Stations

- Spatial, electrical and control system design mostly complete
- Major review in Jan / Feb 2022
  - 107 documents
  - 49 reviewers
  - 500 observations!
- Currently performing detailed EMC design and investigations
- Started developing
  commercial documents
- Target Q3 issue of Request For Proposal





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MAIN LV FEEDER CABLE. (SKA1\_MID) LV SERVICE CABLE. (SKA1\_MID) INTERMEDIATE VOLTAGE CABLE. (SKA1\_MID) LV KIOSK DISTRIBUTION KIOSK MITH Y'D FETNING THE MUNBER OF LV SERVICE CONNECTIONS. (SKA1\_MID) SRA1\_MID) MASS OVERHEAD LINE





## Status: Mid Remote Power Stations



SCALE 1:100

#### Status: Mid Remote Power Stations



SECTION B-B CONTAINER - A ASSEMBLY (SCALE: 1:30)







#### Status: Mid Central Power Station

- Upcoming trade-off:
  - On-site shielded vs
  - Off-site + 132kV
    transmission line
- On-site re-use Low CPS reference design
- Off-site completed costed substation and line reference design



ALIGNMENT	T BEND	POINTS

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Line	Station	(Elevation)	(Northing)	(Easting)	Structure
(deg)	(m)	(m)	(m)	(m)	
0.0000	0.000	1073.000	-3324366.029	128091.113	1
63.8120	30.000	1074.000	-3324336.029	128091.113	2
74.8322	300.415	1074.266	-3324216.690	128333.770	2
79.5549	448.932	1074.000	-3324328.170	128431.900	4
29.7937	1837.944	1065.000	-3325419.747	127572.039	10
44.4392	2532.580	1058.780	-3325680.043	126928.916	13
-86.1583	5095.024	1051.000	-3324702.242	124560.367	24
20.5592	7638.652	1037.000	-3326983.083	123434.398	34
-28.0995	8675.606	1028.000	-3327692.490	122678.080	39
6.7346	12582.442	1045.000	-3331392.349	121423.326	57
40.1227	17255.501	1013.000	-3335611.297	119413.859	77
-17.6899	36101.456	973 288	-3343399.348	102252 382	157
22.9866	40776.099	993.179	-3346533.287	98783.851	177
-7.4255	44829.272	989.863	-3347860.381	94954.095	194
4.3289	45568.929	980.339	-3348190.852	94292.368	197
18.2686	48809.057	941.520	-3349415.569	91292.619	210
-32.3160	50271.015	946.000	-3349516.030	89834.117	216
9.8973	52589.778	951.887	-3350887.368	87964.332	225
15.9821	55087.427	953.944	-3351996.340	85726.380	235
-36.3149	57806.118	951.904	-3352486.072	83052.162	246
-29.7371	59345.198	954.183	-3353606.035	81995.486	252
-23.0317	64497.229	957.069	-3358614.233	80787.615	274
61.9256	71818.618	971.047	-3365836.029	81991.113	302
10.7528	72704.776	979.871	-3366375.925	81288.412	306
-13.7479	73815.396	971.069	-3366876.382	80296.939	310
+10.8757	75577.584	969,793	-3368021.552	78957.576	318
29.9042	78157.945	970.919	-3370038.340	77347.971	328
-27.4176	82769.579	973.000	-3371728.684	73057.295	346
-21.0044	64661.487	976.052	-3373320.624	71669.532	354
-16.2327	86655.012	979.000	-3374993.292	71079.981	361
2.3163	92065.086	985.511	-3380414.990	70778.486	382
-7.8795	96037.804	1007.166	-3384349.515	70399.688	398
23.5158	97080.339	1011.000	-3385391.150	70442.987	402
-7.5687	99915.425	1024.137	-3388035.522	69420.728	414
-8.1896	101618.320	1027.146	-3389690.902	69021.265	421
-29.6657	103197.933	1038.814	-3391263.563	68873.237	428
5.9139	104593.710	1050.965	-3392535.794	69447.363	434
61.6280	106281.791	1059.962	-3304137.810	69979.495	441
17.5646	109022.068	1067.934	-3396133.606	68101.753	452
-22.7066	110975.611	1074.715	-3397086.099	66396.148	461
0.3379	113978.262	1098.301	-3399448.593	64542.898	473
0.0000	114013.295	1098.990	-3399476.029	64521.113	474





#### Status: Mid Central Power Station







### Status: Mid Science Processing Centre Power

- SPC site shared with iThemba labs
- Subject to load shedding from Eskom
- SKAO & iThemba differing load shedding approaches
- Completed and costed reference design:
  - 2.2MW PV
  - 6 MWh Battery
  - RUPS
  - Diesel generators





## Status: Mid Science Processing Centre Power

- Reference design (continued):
  - Successfully mitigate load shedding
  - Combination of capital and IPP contracts
  - Alternative option: shared UPS system with iThemba
  - Handed over to SARAO & NRF, expert consultant appointed
- Supplemented by "wheeled" energy

\*







#### Status: Issues

- Critical issues identified and being studied / prototyped:
  - DC filter influence on MPPT operation
  - Large number of DC filters (>800 on RPSs), use attenuation of cable in soil as alternative?

  - Generator EMI measurement campaign & EMI-quiet design Hydrogen fuel cells as alternative backup source Trade-off on-site / distant CPS (based on Low design) SPC UPS option selection (shared / separate)
- Other issues:
  - Resourcing: limited number of EMI experts, availability of design consultants

  - Changes in power estimates (you know who you are!) Uniqueness of reference designs and commercial model



### Thanks to:

- SKAO:
  - Director of Operations: Lewis Ball
  - EMC Team: Braam, Treasure and Paul
- Design Consultants:
  - Mesa Solutions (EMC)
  - Zutari Pty Ltd (ZA)
  - Aurecon Pty Ltd (Aus)
- SARAO & CSIRO for their participation & assistance
- Reviewers and other SKAO personnel
- Suppliers

#### Ball and Paul

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### Thank you!

We recognise and acknowledge the indigenous peoples and cultures that have traditionally lived on the lands on which our facilities are located.





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