African - European Radio Astronomy Platform

RadioNet

SEVENTH FRAMEWORK PROGRAMME

SKA-AAVP

SKA SQUARE KILOMETRE ARRAY

SKA: towards a zero-carbon footprint next generation telescope

With contributions from : **IAA, ASTRON, MPG, KASI, UCAM, ESS,SPO, CTAER, JPL, CICGE-UP, ESKOM-SA, ARGUS TICE, ENERGYIN, LOGICA**

Domingos Barbosa

Brussels, 9th Oct. 2012

INSTITUIÇÕES ASSOCIADAS:

INSTITUTO SUPERIOR TÉCNICO

Faculdade de Ciências e Tecnologia da Universidade de Coimbra

universidade de aveiro

PT Inovação

SIEMENS Communications

instituto de telecomunicações

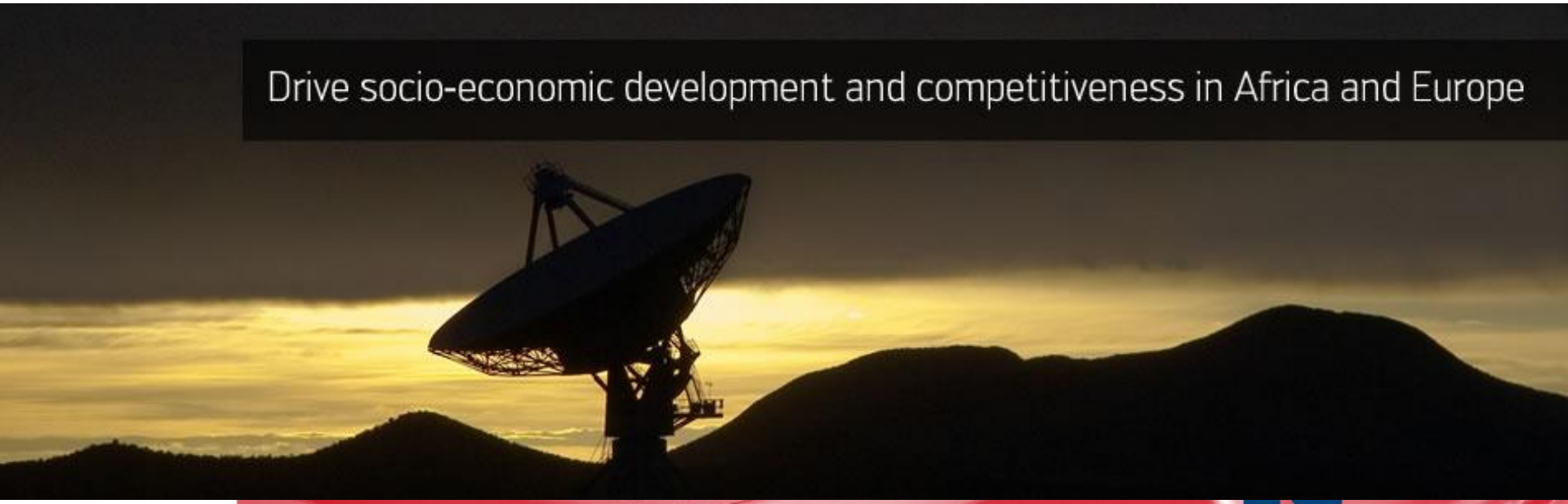
creating and sharing knowledge for telecommunications

SKA, a Green ICT machine:

Research Infrastructures

Thomas Parker: Must act when facility is new

They have the Responsability to lead Science & Social Development
Early Engagement of Industry for the benefit of Science and Society



Workshop:
The Power Challenges of Mega-Science Infrastructures the example of SKA:

Moura, Portugal and Sevilla Spain
20th-21st June 2012

http://www.av.it.pt/workshops/pcska/index.html

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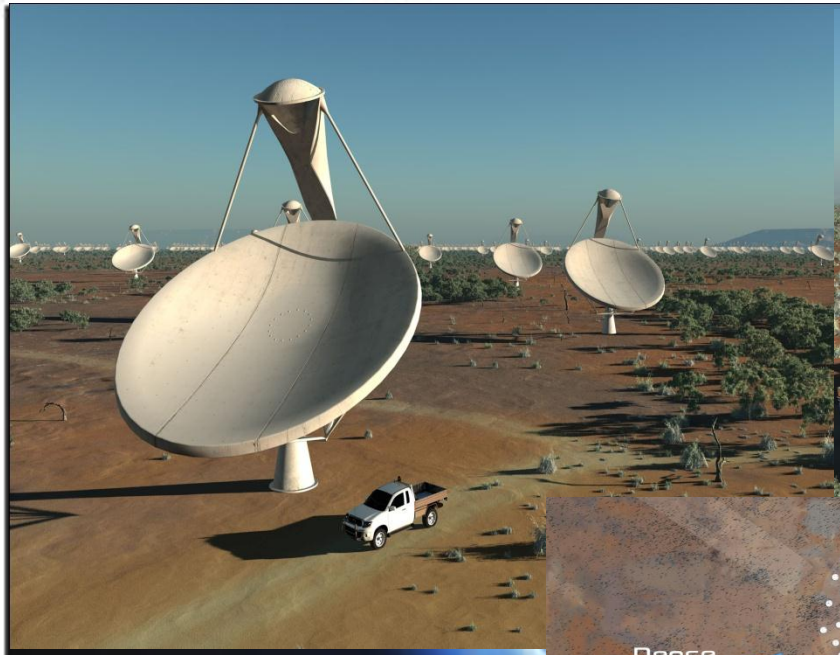
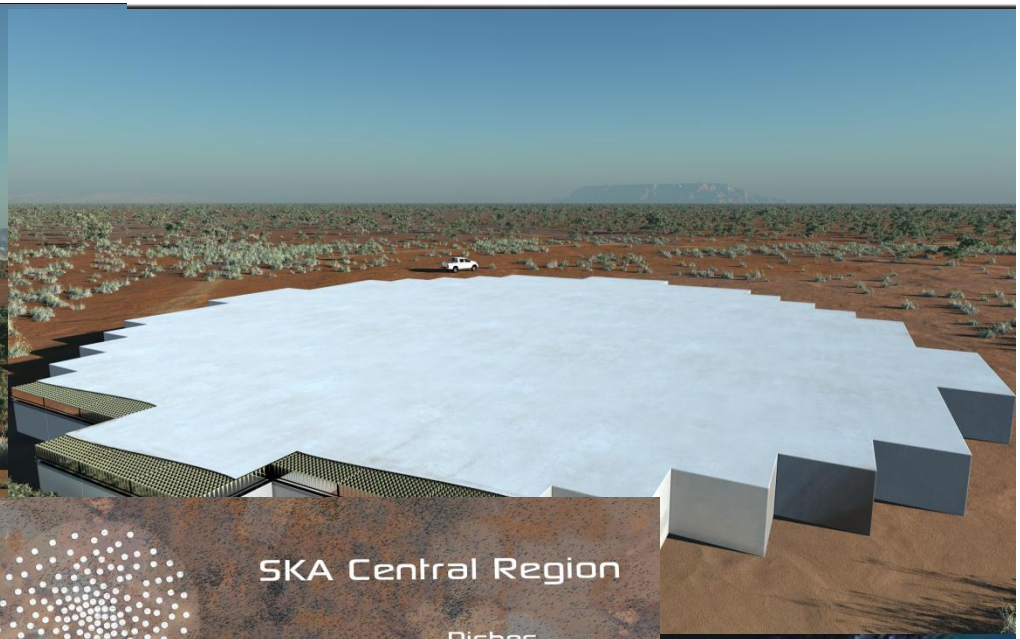
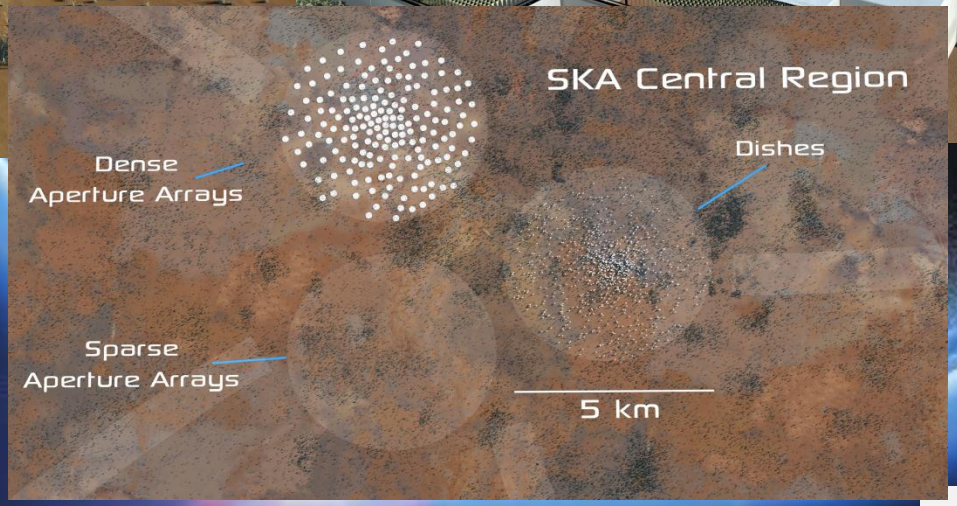






The SKA Program is a collaboration between institutions in 20 countries including Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, Korea, The Netherlands, New Zealand, Poland, Portugal, Russia, South Africa, Spain, Sweden, United Kingdom and the United States.

SKA
SQUARE KILOMETRE ARRAY

The Square Kilometre Array

Swinburne Astronomy Productions

SKA, a Green ICT machine:

It is not:

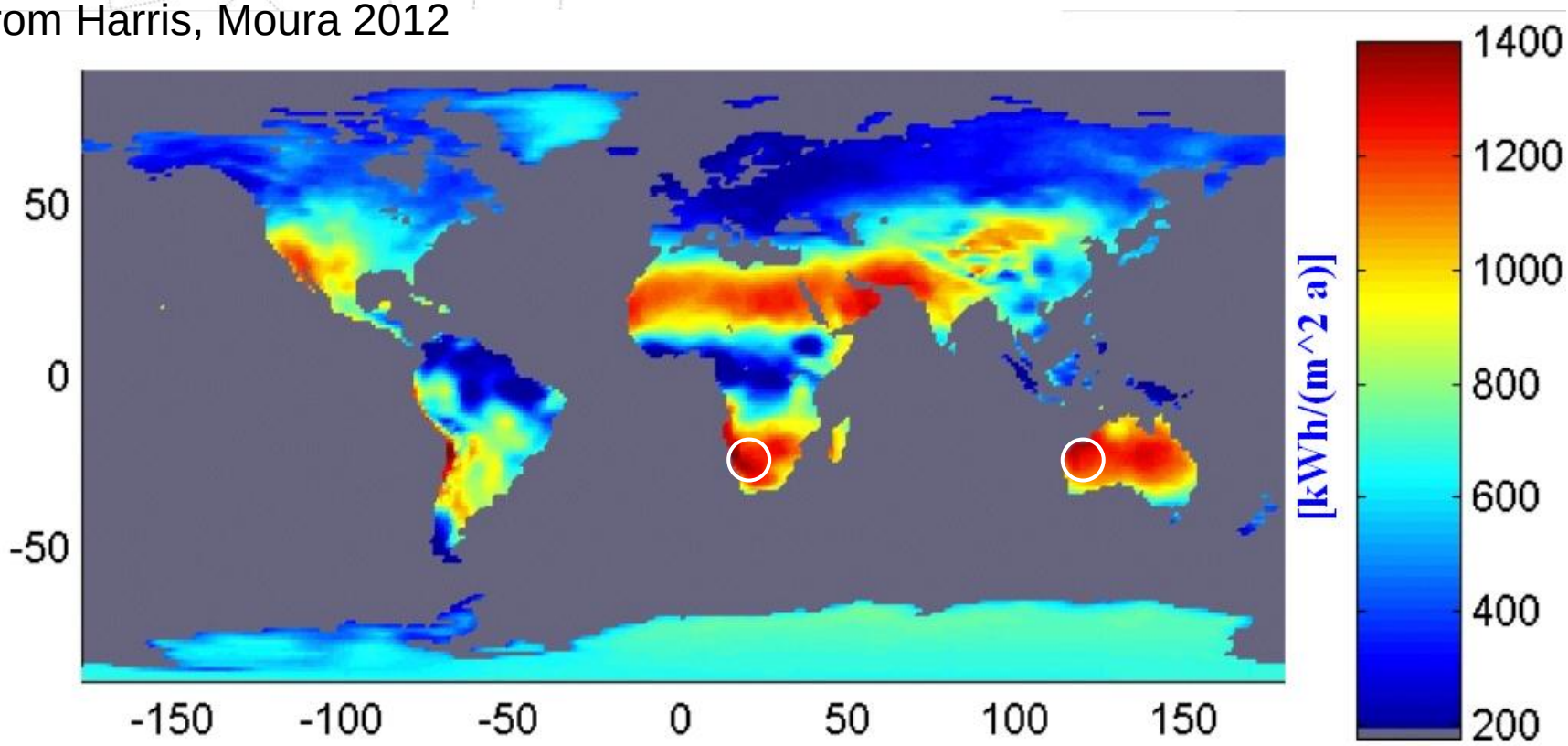
- A house on top of a mountain with a machine inside
- A tunel ring under a valley
- A Bio data center

It is:

- Its core: a city!
- Remote stations: spread villages
- The Universe camera, after an Exabyte and an Exaflop

SKA Location – Solar Energy Resource

From Harris, Moura 2012



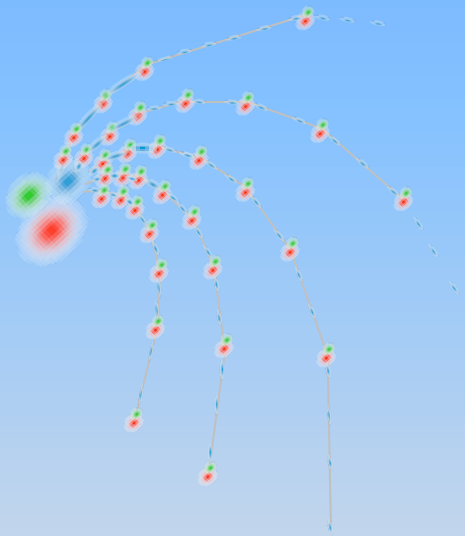
SKA, a Green ICT machine:

- Power supply Infrastructure & sustainability;
- 24/7 operation : storage; which form ?
- Radio Frequency Interference mitigation
- Smart Grid : power loads, maintenance costs, continuity
- Scalability SKA_1 -> SKA_2
- Off-grid options

Energy supply

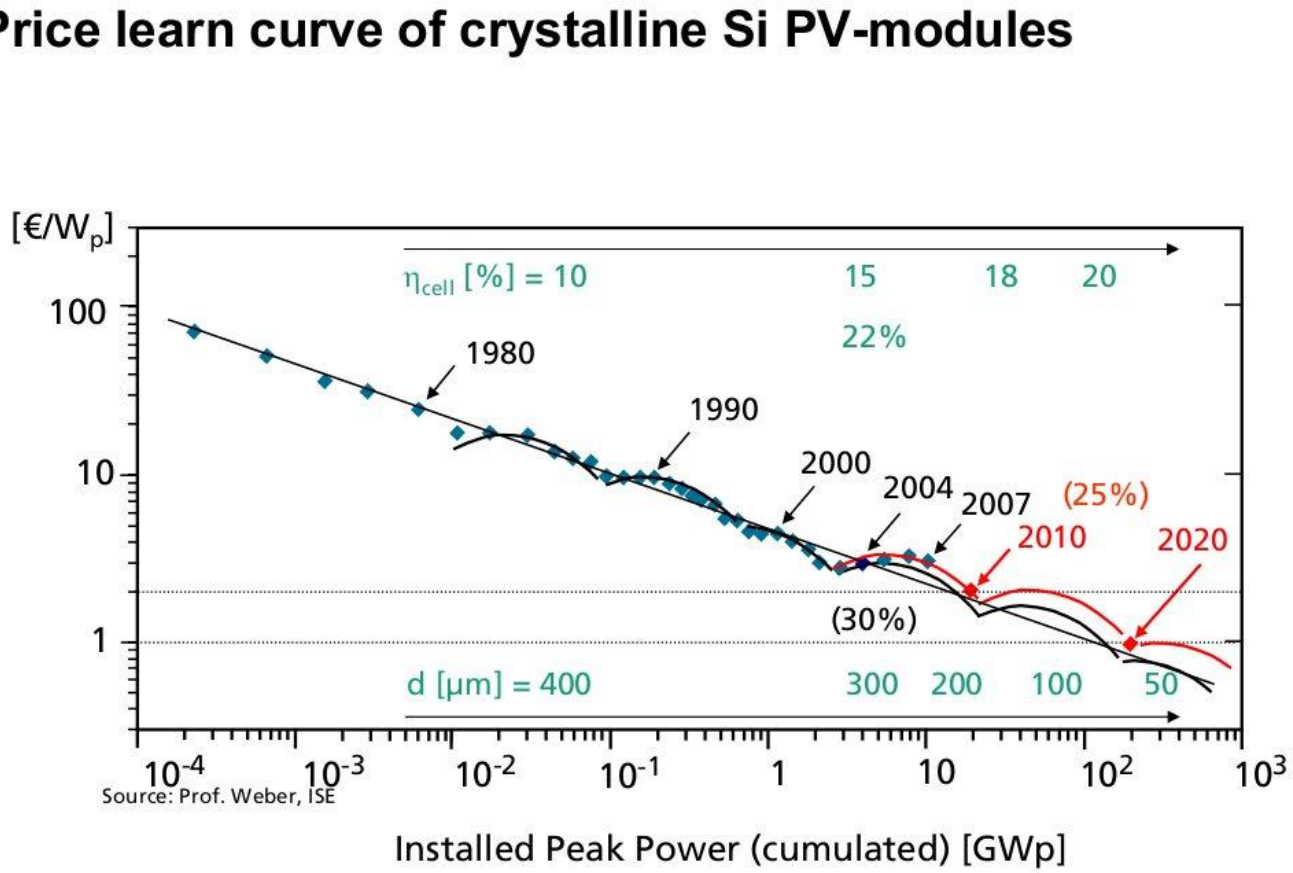
From Kramer, Moura 2012

- Digital electronic needs power and needs cooling
- Running costs probably dominated by energy costs
- Sites are far away from civilisation centres and power grid



- Different power requirements – energy mix!
  - Core(s): ~30 to 50 MW
  - HPC centre near core: ca. 50 MW
  - Distant stations: each ~100 kW for ca. 80 stations
  - Differences in peak and average demand (Electronic, cooling, telescope movements)
- Continuous operation 24/7: Storage required?!
- Avoid variations in power supply: power stability
- Environment: Temperature changes, wind, rain

Solar Energy considerations : Motivations



From E. Weber, I. Frauenhoffer, COST 2010, Rome 2010

© Fraunhofer ISE

Solar Energy considerations : Motivations

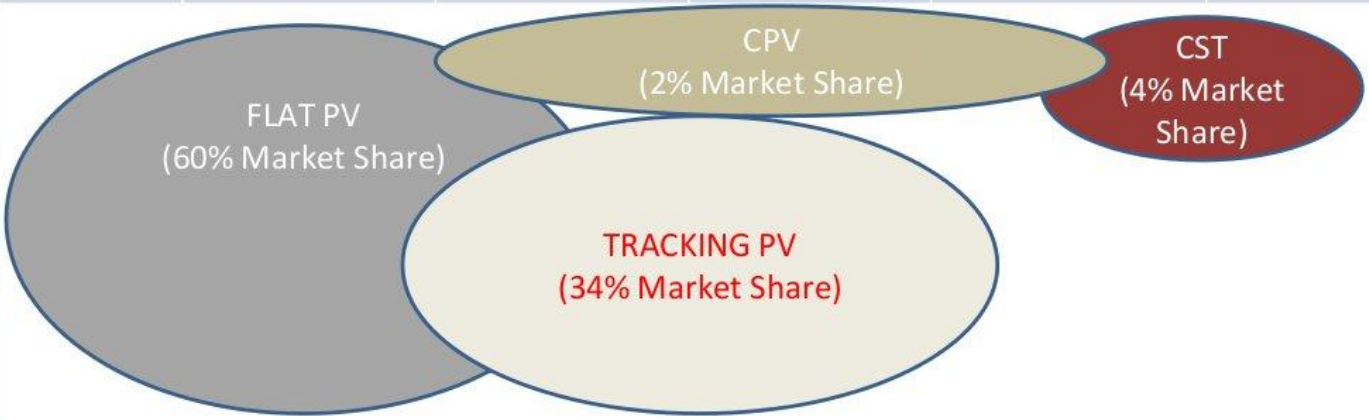
ENERGY MIX

Overview on some possible solutions

MARTIFER ENERGY SYSTEMS

Markets and Applications Shares for Solar Power in 2020…

	SMALL INSTALLATIONS		MEDIUM INSTALLATIONS		LARGE INSTALLATIONS	
RADIATION LEVEL	< 10 kW	10 kW to 100 kW	100 kW to 1 MW	1 MW to 10 MW	10 MW to 100 MW	> 100 MW
HIGH RADIATION						
MEDIUM RADIATION						
LOW RADIATION						

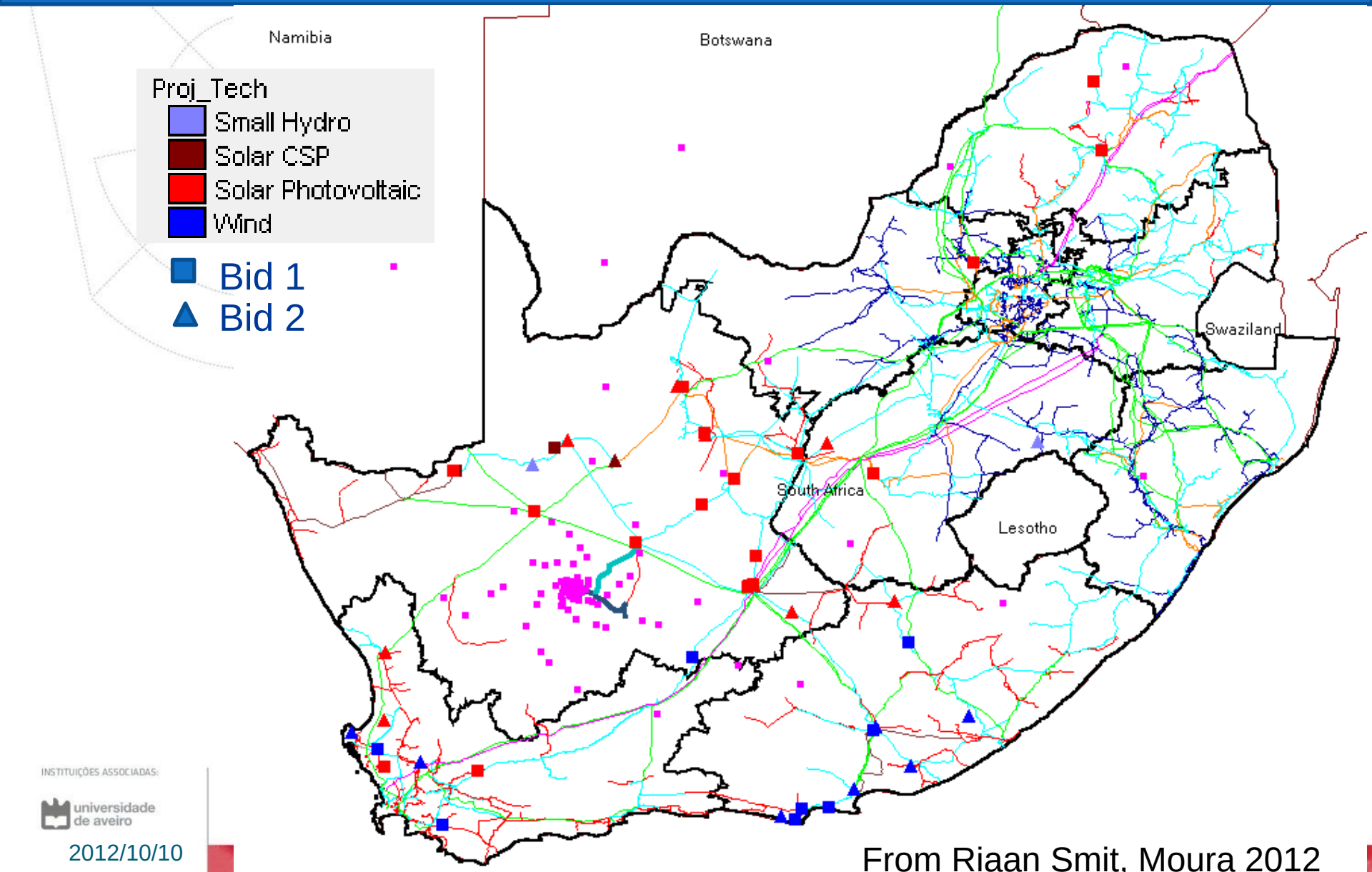


Source: Concentrating Solar Power - Technology, Cost, and Markets - 2008 Industry Report (Prometheus Institute)

Driving Markets ?: USA, Mexico
South Africa, Australia

From M.Matos, MARTIFER, Manchester, PITF 2009

SKA and renewable energy Bid 1 & 2



From Riaan Smit, Moura 2012

Iberian Collaboration + EU (FP7) : BIOSTIRLING-4SKA

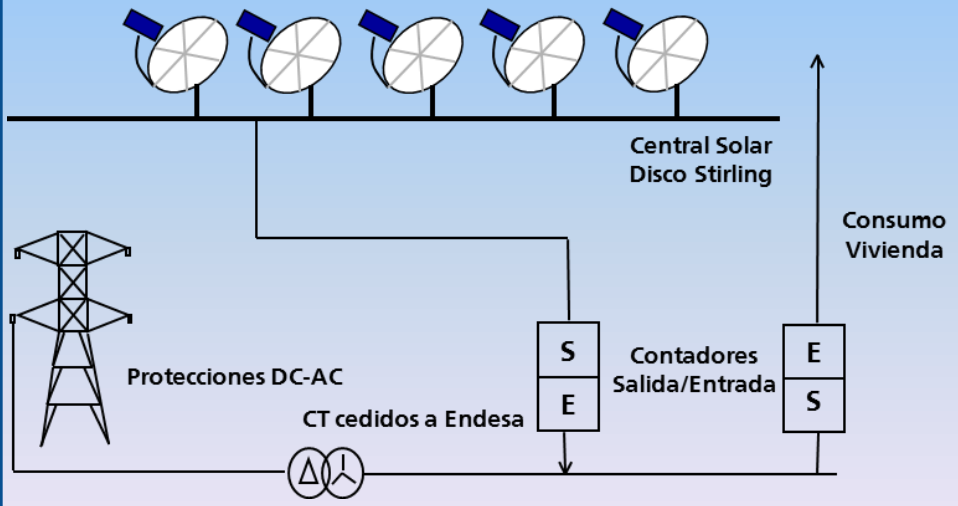
1st Stage FP7 proposal (2011): SP (lead), PT, GER, NL, SE, FIN, BE

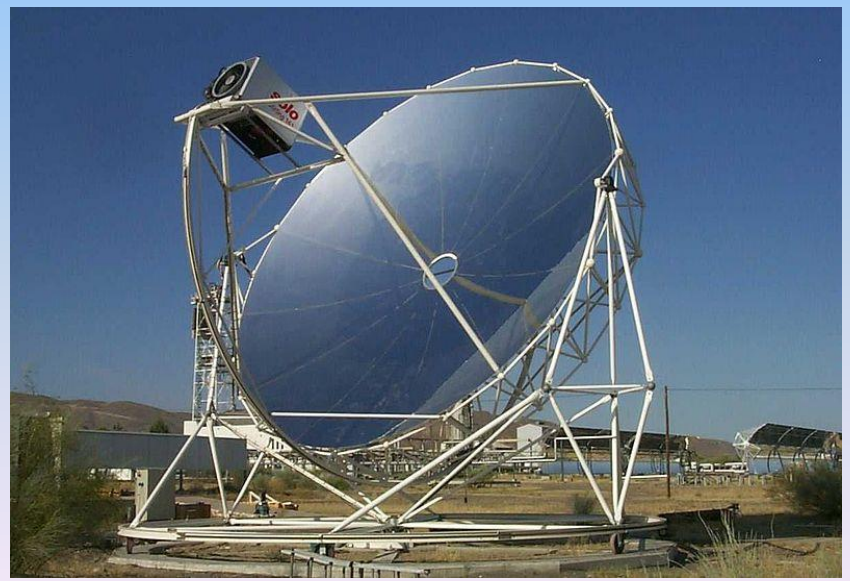
Improvement in the efficiency and reduction of costs of solar dish systems, with specific application as renewable energy option for the SKA telescope (with AA prototypes)

2nd Stage (2012)

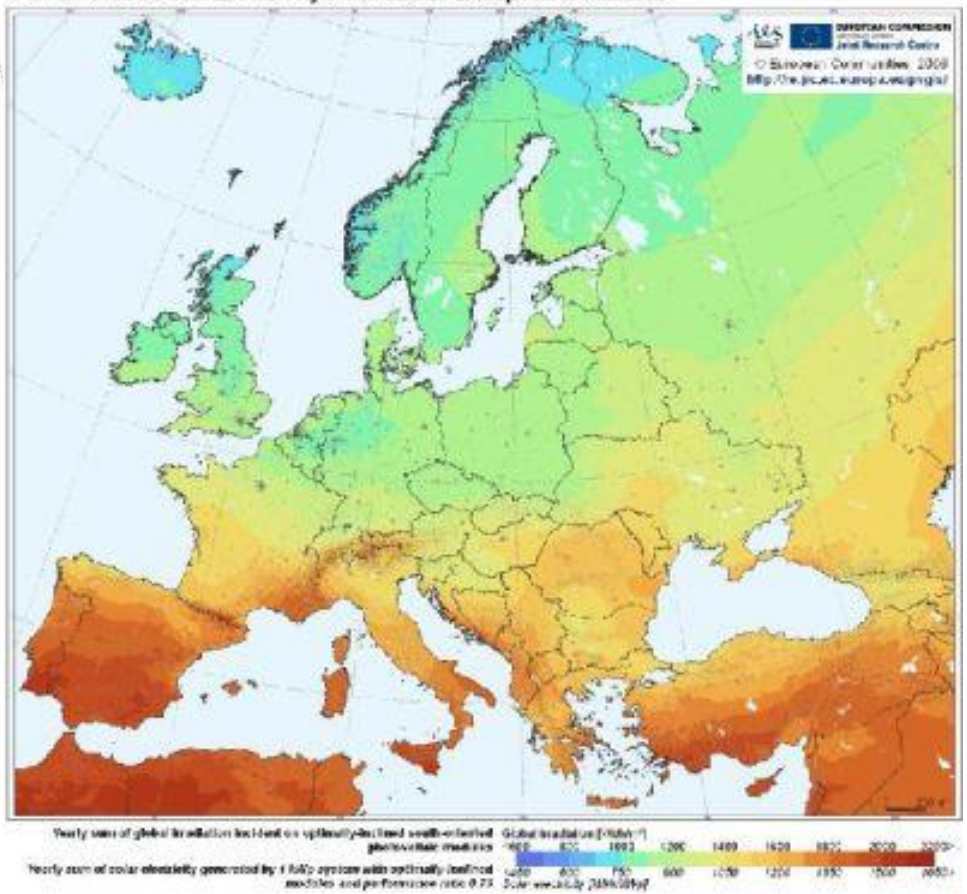
Iberian X-border Collaboration: EU-Region INTEREG program ; Energy+ ICT/e-science

Design of a SD power plant conected to grid.





Photovoltaic Solar Electricity Potential in European Countries



Source: European Comittee, IES– Institute for Environment and Sustainability Joint Research Centre

The region has the highest levels of solar radiation in Europe

2.200 KWh/m2
Sum of the annual incident irradiation on photovoltaic modules oriented to the south.

1.650 KWh/KWp
Annual sum of the electricty generated by 1kWp for a system with the optimal inclination.

Suitable Orography

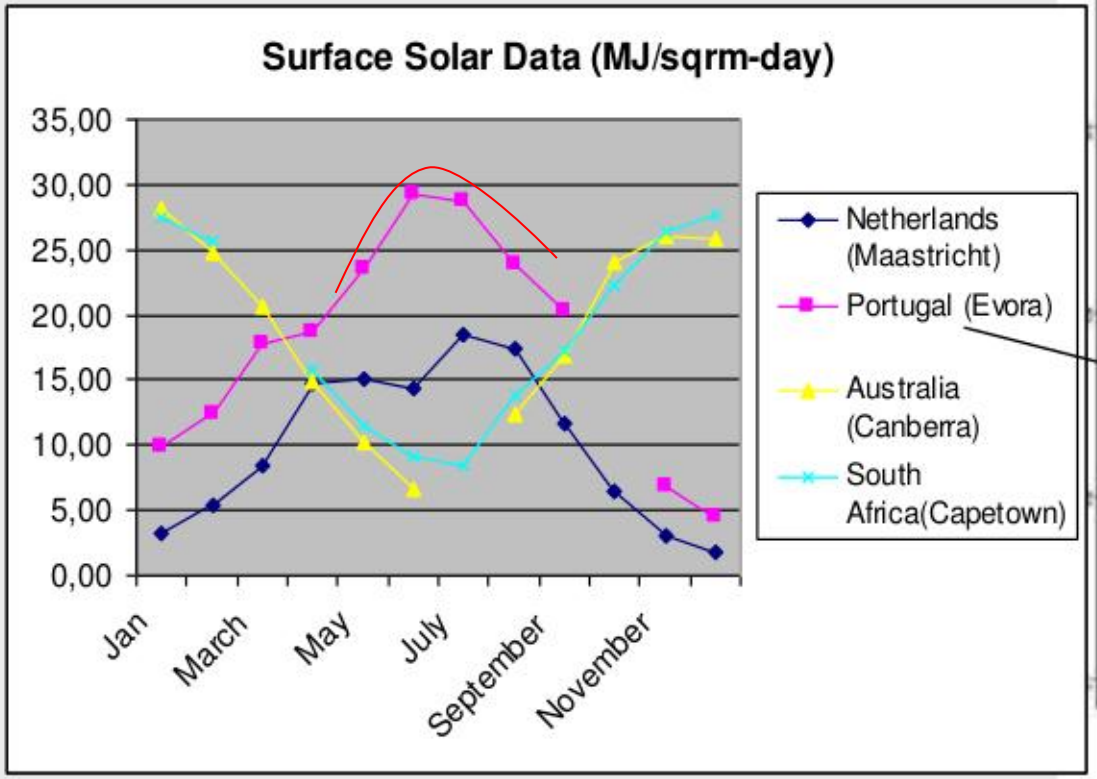
Optimal Sun Exposure

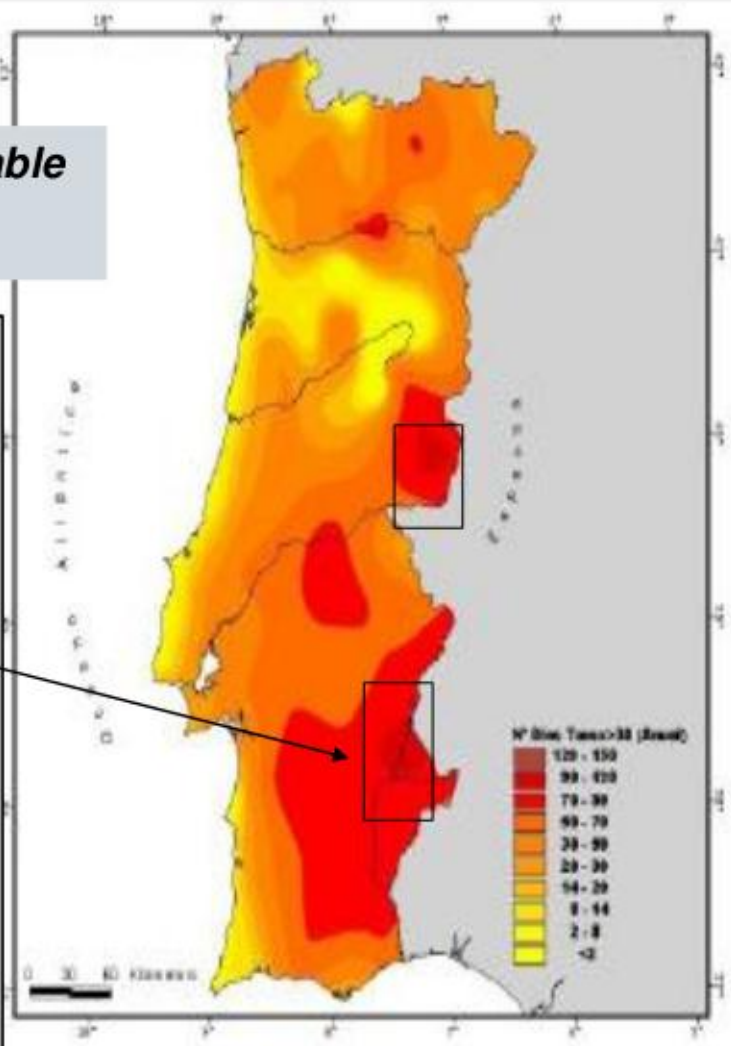
Very low RFI

From AvA 2010

Conclusion: Solar Energy levels Evora roughly comparable with the larger potential SKA site areas

Source:Solar Energy Pocket reference (Int.Solar Energy Soc.) 2005, ISBN 0-997128





Hot days Tmax>30; dark red – 120-150 days; red – 90-120 days

- **Moura (2h30 from Lisbon by car)**
- **Site (45mins away from Moura; 20km)**
- **Portugal/Spanish border - 10km; Sevilha - 120Km**

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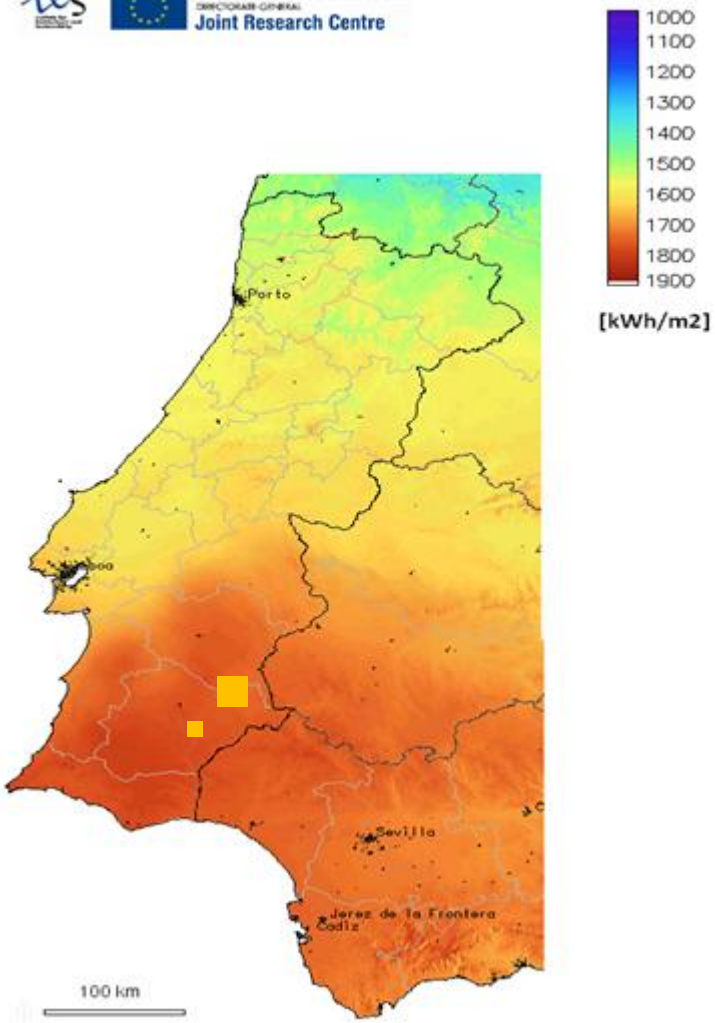
16

Aperture Arrays : Green Powered demonstrator (SKA AAVP)
Arnold van Ardenne : EMMA ?

An oportunity for science to drive Societal changes.

Potential of Solar Power

EUROPEAN COMMISSION
Joint Research Centre



Solar Power production

- **225Km2 = 15x15 Km <> 50 TWh = Total Annual Consumption in Portugal**
- **100Km2 = 10x10 Km <> 24 TWh = Total Consumption – (Hydro + Wind)**

12 GW. 1800 kWh/m2; Ef=13,3%; 2000 heq
50 b€ ! (in 2009…)

<u>Cost of Electricity:</u>

Renewables: High => does not grow.
Fossile: Smaller => does not decrease.

Towards Convergence! !

Moura PV Plant:

- 45 MW peak
- 250 hectars ; 2520 trackers; 144 m² / tracker
- 93GW /year : Enough for 30 000 households
- Investment: 230M€
- Supply chain lessons
- CAPEX vs OPEX

SanLucar Plant:

- PS20: 20MW ; tower – 165 m high
- 1255 heliostats, 120m²/heliostat, 48GWh/year
- Commercial Operation

- Near future: 300MW~180k homes or Sevilla!
- CAPEX vs OPEX

SKA, a Green ICT machine:

- Precursor of the city of the Future :
- Green Power /sustainability
- Power the Internet of the Future technologies
- Impact on African Infrastructure
- Impact on remote communities

SKA, a Green ICT machine:

Let's make it together!

driving innovation,
societal changes,
market capitalization,
fulfilling H2020