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STERG Symposium

Summary of SolarPACES conference 2014.
Invitation to SolarPACES conference 2015.
Update on Eskom CSP

15 July 2015

Salient Facts

SolarPACES

- Implementing Agreement of the International Energy Agency. The IEA has 40 implementing agreements with 10 in renewable energy.
- Cooperative network bringing together teams of national experts from around the world to focus on the development and marketing of concentrating solar power systems
- SolarPACES attracts the largest nonmember country participation from all implementing agreements within IEA, and is the largest conference hosted by the IEA.
- Member countries work together on activities aimed at solving the wide range of technical problems associated with commercialisation of concentrating solar technology,
- In addition to technology development, market development and building of awareness of the potential of concentrating solar technologies are key elements of the SolarPACES program.

SolarPACES Conference

- The 2014 conference was the 20th annual symposium,
- Attended by 581 participants, a drop from the 695 in the previous year.
- It was the first time the conference was held in Asia, and cost of travel combined with financial constraints in Europe were seen to be key contributors to the low turnout.
- The majority of the participants came from China (185) followed by Germany (74), Spain (56) and USA (47). There were 10 from South Africa.

Technical Tour

- Visit to Badaling Solar Thermal Pilot Plant
- CSP R&D and test facility of IEE-CAS,

Salient Facts

Host Country

- The conference opened with a key note address from Dr Jhifeng Wang, Chair of the National Solar Thermal Energy Alliance in China, and the SolarPACES 2014 conference chair.
- Dr Wang stated that by 2015, China's installed solar power capacity will reach 35 GW.
- By 2020, the installed capacity will be 100 GW, comprised predominantly of PV as it is a fully developed industry in China.
- The Chinese National Energy Administration has set the installation target for CSP as 3 GW by 2020, and it is expected that CSP will be deployed on a large scale in China going forward.

International Energy Agency

- The 2020 Roadmap targets set in 2010 for PV will be met by 2015, while CSP moves to 2027.
- Key takeaway from the presentation:
 - The IEA predicts that CSP will dominate PV in areas with high DNI, such as Africa, Chile, and Middle East by 2050.
 - The IEA projects CSP investment capital costs will reduce to \$ 4000 / kW by 2030.

	End of 2009	End of 2013
Total installed capacity	600 MW	3.6 GW
Annual installed capacity	100 MW	882 MW
Annual investment	USD 1.8 billion	USD 6.8 billion
Number of countries with 50 MW installed	2	5
Solar thermal energy generated during the year	0.9 TWh	5.5 TWh



The conference topics were as follows

Solar collectors	Reliability and service life prediction
Thermal receivers	Commercial and demonstration projects
Heat transfer fluids	Policy and markets
Thermal/thermochemical energy storage	Solar fuels
Power cycles	Measurements and control
CSP systems	Water desalination and detoxification
Grid integration	Solar resource assessment
Advanced manufacturing for CSP	General topics in CSP

These can be classified into four categories

- Trends in CSP - Solar Collectors
- Trends in CSP - Thermal Receivers
- Trends in CSP - CSP Systems
- Trends in CSP - Technology

The papers showed progress in Trough, Linear Fresnel and Central Receiver, with minimal focus on dish collectors

Topics presented

- Impact on and control of operating conditions (wind load, heliostat vibration, resistance /field behaviors).
- New Engineering solutions for dry cooling.
- How to deal with transients in PT.
- New optical solutions / improvements / new components
 - Larger troughs
 - New LFR
 - New heliostats incl. varying heliostat arrangement, curvature, size and stiffness
 - New components – evacuated tubes for molten salt
- Better materials and material degradation
 - Effect of sand on glass surfaces
 - New absorber coatings for non-evacuated tubes in LFR
- Testing – more precise and simple methods.
- Performance assessment and market assessment studies.

Conclusion from solar collectors category:

- Solar collector technology has made good progress with many solutions on the market, but the technology can still evolve enormously. Aspects still to be addressed are increasing collector efficiency, decreasing collector costs, and optimising energy storage.

There were 43 papers on thermal receivers, 23 oral and 20 poster

Consistent Challenges

- Optimization
 - Low hanging fruit
 - Often funds cover a one-off point design
- Integrated system design
 - Important to consider collector characteristics
 - Storage imposes additional constraints
 - Higher performance cycles may impact receiver performance
- Materials
 - Fluid compatibility
 - Structural durability
 - Air side corrosion
- Cost must be contained

Conclusion from thermal receivers category:

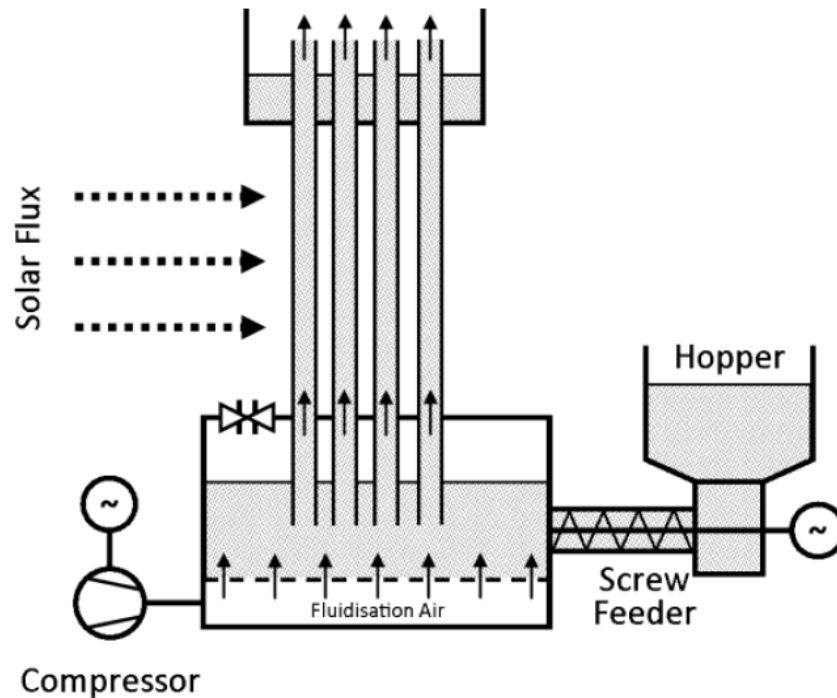
- There was emphasis on tower, which was consistent with the US DoE Sunshot programme and yet again confirms Eskom's choice of tower over trough.
- The highlight was considered to be the particle receivers with different options for receiver concept and mechanisms to get the solid particles to the receiver.



Particle Receivers: Upflow



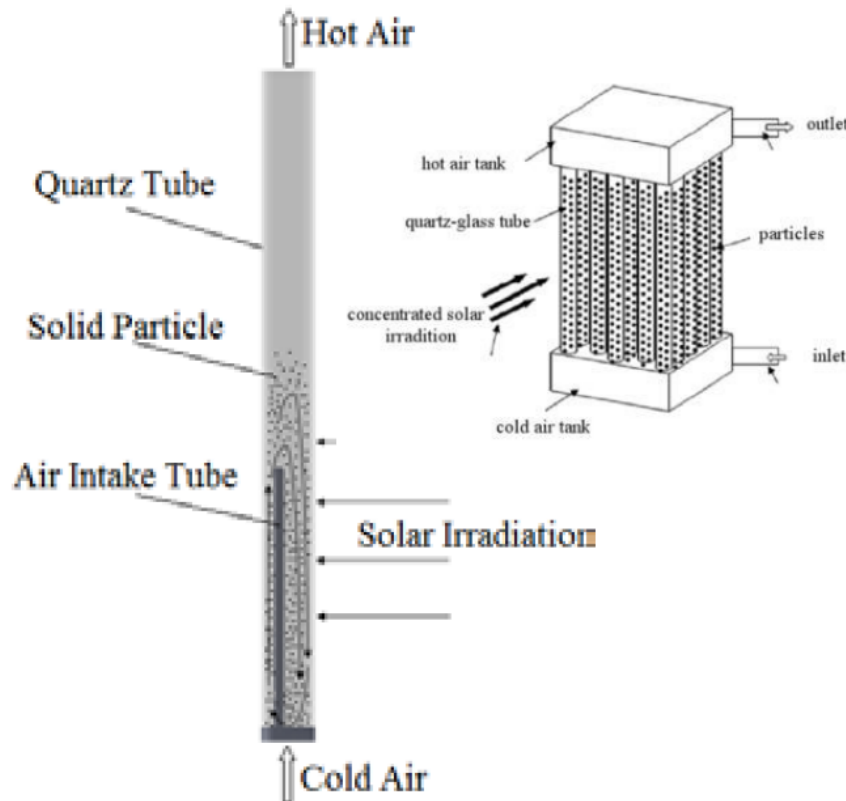
- Galloa (Spain): Dense particle suspension
 - 100 kW prototype for 10MW design
 - Sensible heat to particles entrained in air
 - Control residence time
 - Particles are HTF replacement
 - 81.3% efficient (70% target)



Particle Receivers: Upflow



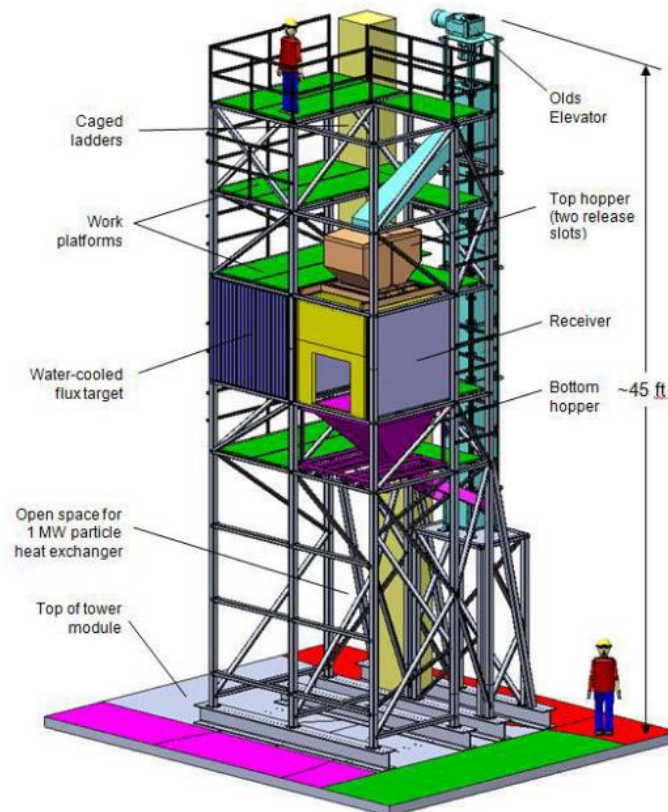
- Zhang (China): Volumetric Air Receiver
 - Stationary fluidized bed of particles in upflow air
 - Quartz tube containment
 - Vary particle fractional load
 - Overcomes the need for beamdown
 - Experimental results as well as modeling



Falling Particle



- Ho (USA): Multi-pass falling particle system design
 - Large test hardware
 - First test of a multi-pass receiver
 - Hot particle elevator to accomplish sufficient residence time
 - Testing planned this fall



Trends in CSP systems

- Again particle receivers emerged in this conference as a promising technology for tower technology.
- On parabolic trough, the trend is towards using molten salt instead of oil, with the advantage being higher temperatures and efficiency with decrease in storage size.
- Interesting for the Eskom solar augmentation project is the finding in one paper that air preheating in a coal fired power plant brings higher efficiency and higher solar share than augmenting with feedheating.

Trends in CSP technology

- There were a total of 56 papers presented in this category, with
 - 30 focusing on sensible heat (thermocline, solid particles, and molten salts),
 - 20 on latent heat (metal alloys, heat transfer enhancements, packed bed encapsulation of phase changing materials, PCM for direct steam generators, cascade superheat for supercritical CO₂),
 - 6 on thermo chemical processes.
- The conclusion in this category was that research conducted on storage is growing and that latent heat has made significant progress since 2011.

Conference Conclusion

- The conference concluded with an announcement that the 2015 SP conference will be held in Cape Town from 13 to 16 October 2015.
 - Since returning from the conference, all papers have been downloaded for sharing on Hyperwave and on Sharepoint. They have also been given to Eskom Group Technology, RT&D, North West University and CSIR.
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Implications for Eskom and Recommended way forward.

- Since South Africa is hosting the next SP conference, and Eskom is currently the country representative on the Solar PACES Exco, it is expected that Eskom would take an active role in organising the conference.
- It is recommended that Eskom send more participants, especially engineers involved in CSP activities to future conferences as SolarPACES is a unique opportunity that offers:
 - A forum for industry, research, politics and financing stakeholders to discuss the future of concentrating solar energy,
 - A scientific and technical conference programme with world leading experts and a special emphasis on R&D results.
 - Insights into new developments in technology, politics, the market and financing presented by experts in the field.

1 MW Tower plant, wet cooled, with 1 hour steam storage, volumetric air receivers



© Badaling Solar Thermal Pilot Plant

South Africa

Welcomes SolarPACES

Cape Town International Convention Centre

13 – 16 October 2015





Stellenbosch University solar roof labs and Helio100, combined with some good old Stellenbosch wining and dining.

Abengoa Khi Solar 1 or Kaxu Solar 1 optional

A decorative graphic on the left side of the slide, consisting of three overlapping circles. The top circle shows a close-up of solar panels. The middle circle shows a large industrial facility with several tall cooling towers and a body of water. The bottom circle shows a helicopter performing maintenance on a high-voltage power line tower. The circles are outlined with multiple concentric lines.

Thank you

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Powering your world



Technology

- 100 MWe minimum with CF > 60 %.
- Molten Salt Central Receiver
- Dry Cooled

Procurement.

- EPC main package - six applicants pre-qualified.

Funding.

- Loan Agreements signed with IBRD, CTF, AfDB, AFD, KfW, EIB.

Schedule .

- Construction 2016 to 2019

CSP
1



Source: Solar Reserve

Technology

- 100 MWe minimum with storage.
- Molten Salt Central Receiver or Parabolic Trough with salt storage.
- Dry Cooled

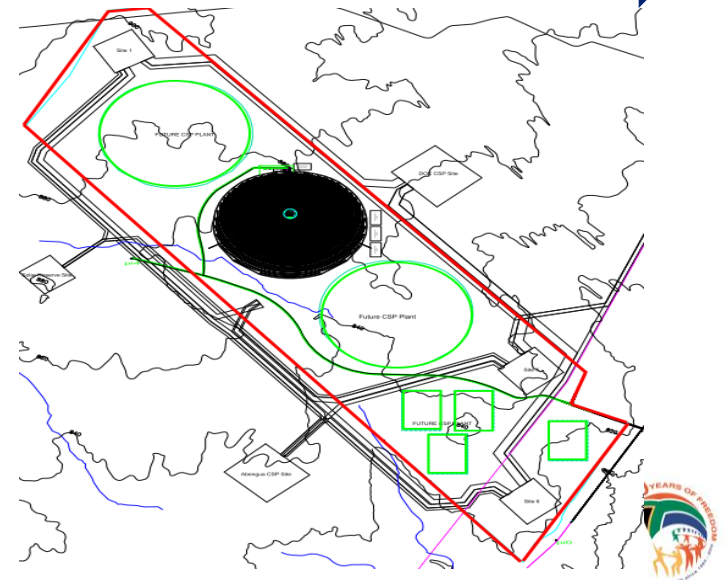
Way forward

- EIA commenced.
- Identify sources of funding.
- Address legislative and regulatory issues.

Procurement and Funding.

- Strategic Partnerships with equity injection.
- SPV – Joint development and execution

CSP
2 & 3



Solar Augmentation- Eskom work and way forward

Technology

- Technology Neutral (CR, PT, CLFR)
- No Storage except steam accumulators
- Size is site specific for best integration opportunity (min 10 MWe). No integration option excluded.
- Boosting to increase output and / or Fuel Saver to reduce emissions, Peaking to assist system..

Way forward

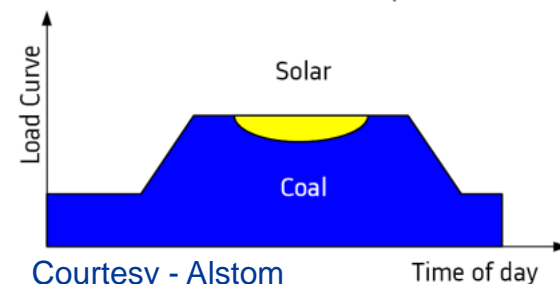
- Determine value of energy
- Identify strategic partners – equity and technology
- Establish suitable PPA prices
- Engage with National Treasury as custodians of Public Private Partnerships (PPP)



Courtesy: Alstom SA

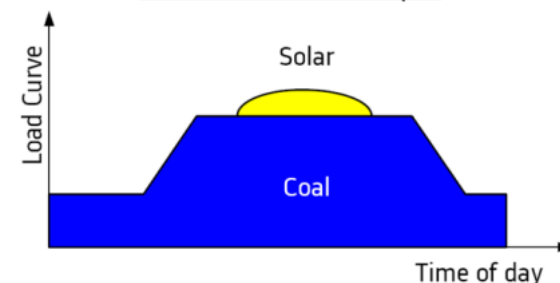
Operation modes

Reduced Coal Consumption



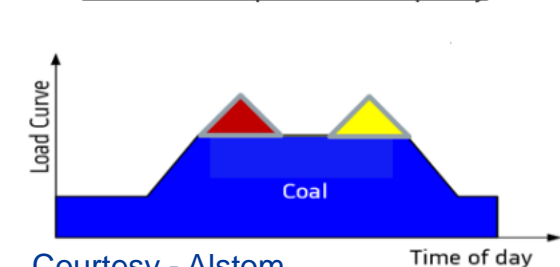
Courtesy - Alstom

Additional Power Output



Courtesy - Alstom

Additional Dispatchable Capacity



Courtesy - Alstom



Peak 1 (morning)

Peak 2 (evening)

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Thank you

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