Design and cost analysis of a heliostat field in an air-based 150 MWe solar tower power plant

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The chief advantage of air solar tower power plants compared to the other concentrating solar power technologies is the ability of achieving temperatures as high as 700°C. This latter depends on the receiver design and the heat transfer fluid used. The heliostat solar field in central receiver systems is considered as the main subsystem due to its high costs (up to 50% regarding the capital expenditure of the total plant). Therefore, the main focus of this study is the design and cost analysis of a heliostat field in an air-based 150 MWe solar tower power plant. Due to its high insolation with annual DNI of 2712 kWh/m², this study was conducted for De Aar region in South Africa. The SF is designed, using SolarPILOT, such that the power delivered meets only the power required by the PB or the TESS at design conditions in order to have an operation strategy that covers peak hour demand with a receiver thermal power of 1210 MWth. In order to demonstrate the high potential of multi-tower configuration in terms of solar energy gained and reduction of investment costs, this configuration was compared to a multi-receiver configuration, where four receivers are mounted on the top of the same tower. Each receiver was designed with a thermal capacity of 302.5 MWth. The results show that, in the first configuration, the annual energy reaching the receiver is about 2296.33 GWh, with a 477 M$ of solar field cost investment, while in the second configuration, the annual energy produced is about 2490 GWh with only 184 M$ of solar field cost investment.It can be concluded that the greatest gain of energy is achieved with multi-tower configuration with a low cost comparing with the first configuration.Future work includes an estimation of the overall techno-economic performance of the plant coupled with thermocline packed bed storage system and steam Rankine cycle.

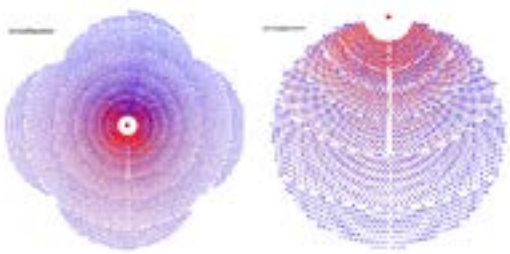

Figure 1: Wind farm site suitability map, 1=least suitable and 6=most suitable

Recent Publications:

1. Y Jemmal N Zari and M Maaroufi (2016) Thermo physical and chemical analysis of gneiss rock as low cost candidate material for thermal energy storage in concentrated solar power plants. Journal of Solar Energy Materials and Solar Cells. 157:377-382
2. Y Jemmal, N Zari and M Maaroufi (2017) "Experimental characterization of siliceous rocks to be used as filler materials for air-rock packed beds thermal energy storage systems in concentrated solar power plants", Journal of Solar Energy Materials and Solar Cells 171:33-42.

3. S Bouaddi, A Fernández-García, C Sansom, J A Sarasua, F Wolfertsetter, H Bouzekri, F Sutter and I Azpitarte (2018) A review of conventional and innovative- sustainable methods for cleaning reflectors in concentrating solar power plants. Sustainability 10(11):3937

Biography

Mr. Hicham Bouzekri, PhD (Male): he received his PhD in wireless communication at Texas A&M University in 2002. He is a senior engineer in Electronics and Communication graduated from Mohammadia engineering School and has a master from the university of Florida. Currently, he is the director of the R&D and Industrial Integration department at Masen. With his 20 years of professional experience in the Research and Industry sectors, Dr. BOUZEKRI brings his expertise and knowledge to make a considerable contribution to Masen's R&D and Industrial Integration Activities.

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