

four solar multiples. The power plant has two different logic of heliostat adjustments, in order to control the average incident flux of the receiver and the exceeding of TIT, and both are coordinated with the mass flow control system. The results show as the best configuration has SM 1.3, with small size heliostats; this allows to produce 1.08 MWh per year, and make a precise control of the peak power. Finally, this configuration represents the most suitable one for the mass flow control system employed in this kind of plant. The plant object of the present work does not use fuel; therefore, the optimization of the heliostats field has been performed with the aim of maximizing the conversion of solar energy. Energy production is sensitive to the efficiency of the field and therefore to the type of heliostats used.

ACKNOWLEDGMENT

Special thanks to Matteo Gallina for his precious support and to researchers of the Thermodynamics Department of University of Seville for their essentials suggests.

REFERENCES

[1] Noussan M, Roberto R, Nastasi B. (2018). Performance indicators of electricity generation at country level—the case of Italy. *Energies* 11(650). <https://doi.org/10.3390/en11030650>

[2] Ferraro V, Mele M, Marinelli V. (1975). Sky luminance measurements and comparisons with calculation models *73(13): 1780-1789*.

[3] De Rosa A, Ferraro V, Kaliakatsos D, Marinelli V. (2008). Calculating diffuse illuminance on vertical surfaces in different sky conditions. *Energy* 33(11): 1703-1710. <http://dx.doi.org/10.1016/j.energy.2008.05.009>

[4] Lo Basso G, Nastasi B, Salata F, Golasi I. (2017). Energy retrofitting of residential buildings—How to couple combined heat and power (CHP) and heat pump (HP) for thermal management and off-design operation. *Energy and Buildings* 151: 293-305. <http://dx.doi.org/10.1016/j.enbuild.2017.06.060>

[5] Castellani B, Gambelli AM, Morini E, Nastasi B, Presciutti A, Filippini M, Nicolini A, Rossi F. (2017). Experimental investigation on CO₂ methanation process for solar energy storage compared to CO₂-based methanol synthesis. *Energies* 10(855). <https://doi.org/10.3390/en10070855>

[6] Rovense F. (2015). A case of study of a concentrating solar power plant with unfired Joule-Brayton cycle. *Energy Procedia* 82: 978-985. <http://dx.doi.org/10.1016/j.egypro.2015.11.855>

[7] Rovense F, Amelio M, Scornaienchi NM, Ferraro V. Performance analysis of a solar-only gas micro turbine, with mass flow control. *Energy Procedia* 126: 675-682.

[8] Rovense F, Amelio M, Ferraro V, Scornaienchi NM. (2016). Analysis of a concentrating solar power tower operating with a closed joule Brayton cycle and thermal storage. *International Journal of Heat and Technology* 34(3): 485-490. <http://doi.org/10.18280/ijht.340319>

[9] Noussan M, Nastasi B. (2018): Data analysis of heating systems for buildings—a tool for energy planning,

policies and systems simulation. *Energies* 11(233). <https://doi.org/10.3390/en11010233>

[10] Rovense F, Perez MS, Amelio M, Ferraro V, Scornaienchi NM. (2017). Feasibility analysis of a solar field for a closed unfired Joule-Brayton cycle 35(Sp.1): S166-S171. <http://doi.org/10.18280/ijht.35Sp0123>

[11] Amelio M, Beraldi P, Ferraro V, Scornaienchi M, Rovense F. (2016). Optimization of heliostat field in a thermal solar power plant with an unfired closed Joule-Brayton Cycle. *Energy Procedia* 101: 472-479. <http://dx.doi.org/10.1016/j.egypro.2016.11.060>

[12] Saito H, Latcovich J, Fusselbaugh M, Dinets M, Hattori K, Sakaki N. (2003). Microgas Turbine, Risks and Markets, IMIA Conference, Stockholm- September 2003.

[13] Technical Description T100 Natural Gas, T100 micro turbine system; D 14127-03 Version 3 09/12/29.

[14] AORA Tulip, Joining hands through sustainable energy for sustainable livelihoods; Overview of the Technology Solution. www.aorasolar.com. <https://www.nrel.gov/SolarPILOT>User Guide, 2016>.

[15] Moreno TS. (2016). Solar resource assessment in Seville, Spain, statistical characterisation of solar radiation at different time resolutions. *Solar Energy* 132: 430-441.

[16] Segal A, Epstein M. (2001). The optics of the solar tower reflector. *Solar Energy Supplement* 6(69): 229-241. [http://dx.doi.org/10.1016/S0038-092X\(00\)00137-7](http://dx.doi.org/10.1016/S0038-092X(00)00137-7)

[17] Téllez F, Burisch M, Villasente, Sánchez M, Sansom C, Kirby P, Turner P, Caliot C, Ferriere A, Bonanos CA, Papanicolas C, Montenon A, Monterreal R, Fernández J. (2014). State of the Art in Heliostats and Definition of Specifications, STAGE STE Projec, Deliverable 12.

[18] Ávila-Marín AL. (2011). Volumetric receivers in solar thermal power plants with central receiver system technology. *Solar Energy* 85(5): 891-910.

[19] Gomez-Garcia F, González-Aguilar J, Olalde G, Romero M. (2016). Thermal and hydrodynamic behaviour of ceramic volumetric absorbers for central receiver solar power plants: A review.

[20] Grobler A, Gauché P. (2014). A Review of Aiming Strategies for Central Receivers, in Proceedings of the second, Southern African Solar Energy Conference, Port Elizabeth, South Africa, 2014.

NOMENCLATURE

MGT	Micro Gas Turbine
DNI	Direct normal radiation [W/m ²]
SM	Solar multiple
CSPs	Concentrating Solar Power system
HTF	Heat Transfer Fluid
NREL	NationalRenewableEnergy Laboratory
TMY	Typical Meteorological Year

Greek symbols

ϕ	Solar radiation [W/m ²]
θ	Angular distance [°]