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Theoretical and experimental analysis of an innovative dual-axis tracking linear Fresnel lenses concentrated solar thermal collector

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Linear concentrating solar thermal systems offer a promising method for harvesting solar energy. In this paper, a model for a novel linear Fresnel lens collector with dual-axis tracking capability is presented. The main objective is to determine the performance curve of this technology by means of both experiment and theoretical analysis. A mathematical model including the optical model of the concentrator and the heat transfer model of the receiver pipe was developed. This tool was validated with experimental data collected using a proof of concept prototype installed in Bourne, UK. The performance curve of the collector was derived for temperatures between 40°C and 90°C. The results show that the global efficiency of the collector is limited to less than 20%. The energy losses have been analysed. The optical losses in the lens system accounts for 47% of the total energy dissipated. These are due to absorption, reflection and diffraction in the Fresnel lenses. Furthermore, manufacturing error in the lens fabrication has to be considered. One third of the solar radiation collected is lost due to the low solar absorptance of the receiver pipe. Thermal radiation and convection accounts for 6% of the total as relatively low temperatures (up to 90 °C) are involved. In order to increase the performance of the system, it is recommended to install an evacuated receiver and to insulate the recirculation system. Considering data from manufacturers, these improvements could increase the global efficiency up to 55%. Utilising the results from this work, there is the intention of building an improved version of this prototype and to conduct further tests.

References:

C. Sansom, X. Tonnellier, P. King, S. Perini, ""Theoretical and experimental analysis of an innovative dual-axis tracking linear Fresnel lenses concentrated solar thermal collector"", *Solar Energy*, under review.

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Simone Perini was born in 1990 in Cremona, Italy. Simone graduated with a MSc in Energy Engineering for an Environmental Sustainable World in 2015 from Politecnico di Milano. During this period, Simone attended the MSc in Energy Systems and Thermal Processes at Cranfield University in UK where he graduated in 2014 with a thesis about a comparative study of solar hybrid combined cycle power systems. In 2014 he joined Lark Energy as Knowledge Transfer Partnership (KTP) Associate from Cranfield University to assess and improve the performance of an innovative solar thermal collector. He developed a thermal model and wrote a paper currently under revision. In 2016 he became Project Engineer for Lark Energy. He is currently responsible for the feasibility study of an integrated renewable park for low carbon hydrogen generation.