**Solar Energy: A Critical Review of Techniques and Applications**

M Alnajideen1,\* A Valera Medina1

1 Cardiff School of Engineering, Cardiff University, CF24 3AA, Wales, UK

\* Corresponding author: [AlnajideenMI@cardiff.ac.uk](mailto:AlnajideenMI@cardiff.ac.uk)

Solar energy technologies, such as photovoltaic (PV) cells, solar thermal collectors (STC), and thermoelectric generators (TEG), hold significant potential when integrated into hybrid systems to optimize solar radiation conversion. By employing solar energy optics to concentrate sunlight onto receivers, the objective is to boost power output while minimizing costs. Nevertheless, conventional concentrated photovoltaic-thermal/thermoelectric (CPV-T/TE) systems encounter various challenges, including PV cell overheating, spectral mismatch between incident light spectrum and PV spectral response, and thermal coupling between PV cell and thermal/thermoelectric converter. In this chapter, we present a comprehensive and critical review of solar energy utilization methods and techniques, spanning from theoretical considerations to experimental findings. The aim of this review is to lay the groundwork for future research and advancements in sophisticated solar energy systems.