2021 major project: Modelling and testing of bifacial PV systems

Literature review

1. Raina G., & Sinha S. (2020). A simulation study to evaluate and compare monofacial vs bifacial PERC PV cells and the effect of albedo on bifacial performance. Materials Today: Proceedings. The paper discusses the effect of albedo on the back of a bifacial photovoltaic cell and compares the efficiency of the panel with that of a monofacial under similar conditions (STC- AM 1.5G; 1 sun; 100mW/cm^2) and the results provided in J_{sc} (mA/cm^2). Bifaciality factor is used to compare the performance of both sides and modelling of the panel is also done under same circumstances as listed above using SunSolve^{TM} . The calculations are done in the same software with comparisons of both the panels under varying albedos are provided.
2. Katsaounis T., Kotsovos K., Gereige I., Basaheeh A., Abdullah M., Khayat A., Tzavaras A. E. (2019). Performance assessment of bifacial c-Si PV modules through device simulations and outdoor measurements. Renewable Energy, 143, 1285-1298. The article emphasizes the efficacy of bifacial PV cells by findings their potential through simulations and modelling experiments. The simulation is conducted solely for the transport equation solutions and outdoor experiment for getting applied results. Mono-facial panels were used for comparative study. The numerical values were attained through linear finite element analysis and the input was obtained from outdoor environmental parameters. The simulation and experiment were compared based on the current-voltage values calculated in respective methods.
3. Nussbaumer H., Klenk M., Morf M., & Keller N. (2019). Energy yield prediction of a bifacial PV system with a miniaturized test array. Solar Energy, 179, 316-325. The corresponding paper compares the energy output of a small-scale bifacial PV system with that of a commercial bifacial system. The commercial bifacial PV system is set up as a 3 x 3 array of 60-cell modules namely Megacell MBF-GG60-270 and the array is termed BIFOROT (Bifacial Outdoor Rotor Tester). The miniature version is of the same cell setup with a scale of 1:12, which was chosen for quick mounting and testing purposes. The results were compared with respect to the daily scaling factor and the reading were taken for various tilt angles. Plots were made nominal power at different timings at a particular tilt angle. The main aim was to conclude if a miniaturized version of a bifacial PV system is viable for testing to make optimisation parameters a easy calculation.
4. Patel M. T., Vijayan R. A., Asadpour R., Varadharajaperumal M., Khan M. R., & Alam M. A. (2020). Temperature-dependent energy gain of bifacial PV farms: A global perspective. Applied Energy, 276, 115405. The effect of temperature-dependent efficiency on the energy yield and levelized cost of energy is studied in this paper. Factors such as input irradiance, environmental conditions, mounting configurations, type of cells and module setup, thermal coefficient are taken into consideration to divulge the efficiency characteristics. The experiment is done on both mono-facial and bifacial PV modules for comparative purposes and between single bifacial PV module and a bifacial farm to check the efficiency and energy degradation trends. The results are compared with that of existing physically validated temperature-dependent efficiency models across the world.
5. Baumann T., Nussbaumer H., Klenk M., Dreisiebner A., Carigiet F., & Baumgartner F. (2019). Photovoltaic systems with vertically mounted bifacial PV modules in combination with green roofs. Solar Energy, 190, 139-146. This paper discusses the effects of green roof on bifacial PV modules. Green roofs have special environmental benefits and when integrated with bifacial PV system performs better when compared to mono-facial modules. Modules are

mounted on top of a flat roof with a nominal power of 9.09 kWp. They are mounted vertically at predesignated parameters such as angle, coordinates etc. The study is subjected to two types of green roofs namely standard green roof with a mixture of green-leaved plants and bright green roof consisting of gravel and silver-leaved pants to achieve higher albedo. PVSyst and MATLAB simulations were carried out for energy yield for over a year and compared to standard mono-facial PV systems. The experiment resulted in bifacial modules providing results comparable with that of mono-facial systems and that of bright green roof providing more efficiency.

6. Zhu Q., Zhu C., Liu S., Shen C., Zhao W., Chen Z., Lv J. (2019). A model to evaluate the effect of shading objects on the energy yield gain of bifacial modules. Solar Energy, 179, 24-29. Shading effect on the modules due to the panel area and additional accessories such as wires, frames and holders is discussed in this paper. Height of the panel is from the ground is also subjected to change due to considerable effect on shading phenomenon. An optical model for both wires and frame is created to check the optical loss and compared with the experimental results where frames and wires are kept a varied height from the ground to see their effect on shading, Isotropic light is used for negligible deviation due to shading and the results are plotted on graph showing the optical loss variation with the height changes. The shading effect or optical loss is given by fraction between shading angle and 90°.
7. Chudinzow D., Haas J., Díaz-Ferrán G., Moreno-Leiva S., & Eltrop L. (2019). Simulating the energy yield of a bifacial photovoltaic power plant. Solar Energy, 183, 812-822. The paper reviews the current energy yield model and proposes improvement techniques. Simulation of a bifacial power plant is done using tools such as NREL's SAM, PVsyst, MoBiDiG and BIGEYE for accounting various parameters like view factors, irradiation from all source points, LCOE, shading effect etc. The modelling is divided into input, calculation and result and written using MATLAB. The Chilean bifacial PV power plant, La Hormiga in San Felipe was taken as reference for this model. The plant was downscaled to a capacity of 19.44kWp for simulation. Upon getting results, improvement on ground reflectivity, shading area, tilt angles were provided.