# Abstract

This thesis delves into the detailed exploration of Bifacial Photovoltaic (PV) systems, placing specific emphasis on optimizing their energy yield through the adjustment of tilt angles. The selection of an appropriate tilt angle is intricately linked to various factors, such as geographical location and local weather conditions. A novel method for analyzing bifacial modules is introduced, coupled with an improved rear side irradiance model that enhances the accuracy of energy yield estimation. The research also scrutinizes optimal tilt angles, particularly for South-North orientation, with the aim of maximizing energy production. To account for diverse climatic conditions across India, the analysis extends to locations including Kharagpur, Ahmadabad, and Delhi.The proposed model undergoes rigorous validation, utilizing both simulation software (PVSyst version 6.7.6) and real field test measurements from the intsalled Bifacial PV system at IIT Kharagpur demonstrates the reliability of the proposed model.

Furthermore, the thesis presents an equivalent electrical model that integrates the front and rear sides of bifacial PV modules into a single-circuit representation, enhancing the precision of energy yield predictions. It challenges the simplistic treatment of photocurrent in bifacial modules and offers insights into the electrical response of these modules.

Additionally, the thesis discusses the importance of maximizing power output in PV systems, particularly bifacial modules, for rural electrification through hybrid DC off-grid topologies. It addresses the lack of proper techniques for harnessing maximum power potential in standalone bifacial PV applications by introducing a modified algorithm designed to estimate maximum power output from bifacial PV systems. This algorithm is tested in a proposed bifacial PV/Battery tri-port hybrid system.

In terms of economic considerations, the thesis focuses on the Levelized Cost of Energy (LCOE) and compares traditional monofacial panels with bifacial panels, highlighting the latter's superiority in electricity generation and shorter payback periods for rooftop solar installations.

In conclusion, this thesis offers a comprehensive understanding of bifacial PV systems and provides practical insights for their application, significantly contributing to the field of renewable energy.

***Keywords:*** Albedo, Bifacial PV technology, Bifaciality factor, Electrical circuit model, Energy storage devices, Five parameters model, I−V characteristics, LCOE, Rear side irradiance modeling.