A Comprehensive Financial Analysis for Dual-Axis Sun Tracking System in Iran Photovoltaic Panels

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***Abstract*— Renewable energy sources are defined as free and clean sources of energy, which encourage investment in electricity production industry to move from conventional power plants to renewable energy sources such as photovoltaic (PV) systems. Regarding to the geographical characteristics, solar panels can be used widely around the most populated cities of Iran. One of the most important factors, which affects the amount of harvested energy by panels, is the adjustment of tilt angle of the panels. In this paper, the cost effectiveness analysis (CEA) of installing the dual-axis sun tracking system in comparison to single-axis sun tracking system is carried out. The analysis is accomplished on three currently available panels installed in Iran cities, as case studies including Yazd, Semnan and Tehran. Financial analysis is conducted based on solar radiation, inflation rate, temperature, and characteristics of solar panels such as degradation effect on solar panel efficiency. The investigations are developed by simulation results, which show that although the dual-axis sun tracking system can increase the produced energy, the total investment and maintenance cost is greater than the profit of extra energy attained using the dual-axis system with respect to the single-axis system considering the financial indexes and geographical situation of case studies in Iran.**

Keywords*— *Sun tracking system, financial analysis, photovoltaic system, power system planning

I. INTRODUCTION

Solar energy as a clean source of energy can respond to the world increasing demand for the electrical energy considering increment of population and development of societies. On the other hand, by gradually depletion of fossil fuels as one of the main sources of electrical energy generation, the need for a consistent source of electrical energy is defined as a challenging issue for power system operators and researchers [1, 2]. The use of solar energy has become pervasive all over the world, which has attracted remarkable efforts in recent years [3]. Utilizing solar energy in different points of the world such as Saudi Arabia has been dramatically increased in last years [4]. This is due to the fact that this source of energy has the high potential of harvesting in mentioned area [5]. Local climate conditions and orientation of photovoltaic (PV) panels with respect to the horizon are considered as effective factors which affect the absorbed energy of such systems [6, 7].

Recently, several investigations are conducted in different places around the world for analyzing the impact of installing the solar tracking systems. In this context, the assessment of solar energy with considering the optimum tilt angel are performed for Sindh, Pakistan [8]. Also, harvested energy from a flat plate collector at various tilt angle positions is calculated for Basrah. Moreover, the procedure for optimizing the tilt angle is discussed in this study. The results show that by adjusting the tilt angle eight times per year, the harvested energy by panels is almost equal to the harvested energy by daily adjustment [9]. The economic analysis of installing PV systems in State of Kuwait is studied in [10], where the cost-benefit analysis of implementation of PV systems proved that such project is beneficial in Kuwait considering positive characteristics of solar radiation. A similar research is accomplished as a PV park for Cyprus in [11], where different parameters such as PV park orientation and capital investment, and pollutant gas emission trading system price are considered. The authors in [12] studied integration of PV and electrical energy storage systems considering the energy storage management and grid-connected characteristic of the system. In [13], the financial analysis and environmental aspects of large-scale PV systems installation in United Arab Emirates is studied. The cost-benefit analysis shows that implementation of PV systems is not beneficial due to high initial costs and low power purchase price. The authors in [14] investigated economic benefits of grid-connected residential PV systems in United Kingdom and India proposing prosumer electricity unit cost (PEUC) parameter to evaluate the benefits from installing such systems.

The cost analysis of PV systems has attracting considerable interest in recent publications. The harvested electrical energy from the modules is maximized using time-varying evolution