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Energy and Economic Comparison between Traditional APV and Concentrating APV-CPV Agrivoltaic Systems

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Extended Abstract

In recent years, agrivoltaics has taken on a primary role as an innovative technology in the agricultural and energy sectors [1]. Thanks to its synergistic approach, it allows the production of electricity and cultivation on the same land, significantly reducing conflicts over land use [2]. Traditional solutions are based on the use of opaque photovoltaic panels that generate partial shading on the underlying ground. According to some studies, this aspect could compromise the optimal growth of crops. [3]. However, recent innovations have been made in the field of agrivoltaics such as the use of concentrated photovoltaic systems (APV-CPV) [4]. This technology splits solar radiation to take advantage both of direct sunlight for an efficient electricity generation and of diffuse light for crop benefits [5]. In this study, a detailed comparison was conducted between the installation of a traditional agrivoltaic system (APV) and a concentrating agrivoltaic system (APV-CPV) using Fresnel lens technology, which allows the separation of direct and diffuse radiation [6]. An agricultural user from southern Italy specialized in tomato cultivation was taken into consideration. Thanks to the predictions derived from an Artificial Neural Network (ANN) model, in both cases the effects of shading on water demand (ET_0) and crop growth rate (CGR) were evaluated [7]. The model predicts a greater reduction in water demand compared to the open field in the case of the APV, equal to 38%, and a more pronounced decrease in the growth rate of 54%, due to the increase in shading. Conversely, in the APV-CPV case, thanks to the Fresnel lenses which partially allow the passage of solar radiation, a smaller reduction in water demand, 22%, and a more modest decrease in the growth rate, 33%, are expected. These aspects influenced the trend of cash flows. Through an energy analysis, it has been highlighted that in both cases, the electrical output of the system meets the energy demands of the user for several months, resulting in significant savings and revenue from selling surplus energy. This enables diversification of income sources for farmers. The economic analysis has allowed the calculation of the main indicators in both cases, including the Net Present Value (NPV) and the Discounted Payback Period (DPBP). In particular, a DPBP of 6 years has been obtained for the traditional agrivoltaic system (APV), and 9 years for the concentration agrivoltaic system (APV-CPV). Considering the presence of incentives, in both cases greater economic benefits and significantly shorter amortization times of the investment could be obtained. Furthermore, the analyzes were conducted on the same cultivation area. Future developments include a feasibility study with equal performance in terms of yield in order to highlight the advantages of APV-CPV systems in achieving greater productivity, thanks to their partial transparency and smaller size.

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