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Economic and Sustainability Assessment of Floating Photovoltaic Systems in Irrigation Ponds: A Case Study from Alicante (Spain)

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Abstract

Environmental problems, along with the increasing energy demand and high electricity costs in the agricultural sector, justify the need to explore renewable energy sources in order to improve irrigation efficiency and sustainability. Therefore, the objective of this study is to analyse the feasibility of installing floating photovoltaic panels in the irrigation ponds of irrigation communities (ICs) in the province of *Alicante*. To this end, a practical case study based on the operating data of a photovoltaic installation on an irrigation pond, which shows 31% self-consumption and a 27% reduction in energy costs, is presented. Based on these results, this type of installation has been considered for the rest of the ponds in the province of Alicante, with an estimated total investment of EUR 130 million and annual savings of EUR 23 million in energy costs. Additionally, barriers such as the initial investment and the need for public financing for large-scale implementation are identified. Finally, it is concluded that the adoption of floating photovoltaic energy represents a key opportunity to reduce dependence on fossil fuels, mitigate environmental impact, and promote the circular economy in the agricultural sector.

Keywords: photovoltaic energy; self-consumption; sustainability; circular economy; energy savings; water management; irrigation; land use

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1. Introduction

Environmental problems, such as global warming, which is a direct consequence of an increase in the concentration of greenhouse gases (GHGs), and air pollution, are considered to be among the most important global challenges. Furthermore, increasing energy demand and the depletion of primary sources are additional global concerns [1].

In recent years, scientific evidence has shown that high carbon dioxide emissions are responsible for global warming, which requires a radical change in the energy sector model [2]. To counteract this serious environmental impact, the trend of reducing fossil fuels by increasing the efficient use of renewable energy can be considered as one of the solutions, primarily through the replacement of these fuels by more sustainable and environmentally friendly energy sources [3,4].

In the last two decades, solar energy has become one of the most important renewable energy sources [5]. Recent initiatives at the European level call for climate neutrality by 2050, whereby the European Commission holds Member States accountable for approving national plans that integrate energy and climate. Spain recently fulfilled this commitment