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Impact of the New Energy Context on the Feasibility of Solar Water Heating Systems in the Agri-Food Industry

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Abstract: The new energy context since 2021 has led to dramatic increases in the energy bills of agribusinesses, affecting the price of foodstuffs. A considerable part of energy consumption is due to the heating of water at high temperatures. The present study analyzed the feasibility of using a Solar Water Heating System (SWHS) with an evacuated tube collector. In particular, the required sizing changes, potential savings and cost-effectiveness were analyzed. The results show that the new energy context makes the SWHS investment highly attractive: a payback of less than 4 years in most of the scenarios analyzed; energy savings of more than 60% in the scenarios with higher irradiation; a reduction in total energy expenditure of more than 50% in the favorable scenarios close to the current reality. The new context especially favors cold and temperate climates, with very sharp drops in payback compared to the previous situation. To achieve these values, it is necessary to design an optimized sizing of the SWHS, reducing the risk of future variations in the price of energy. The results of the study should serve as a reference for decision making in the agroindustrial sector to reduce the energy bill and strategic dependence on fossil fuels from third countries.

Keywords: solar water-heating system; evacuated tube collector; agri-food industry; profitability; energy saving

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1. Introduction

The agri-food industry occupies a prominent role in global energy consumption. For example, in Spain, it was responsible for the highest industrial energy consumption, with 18.5% in 2019 [1]. A not inconsiderable part of this consumption is due to the heating of water for multiple applications (cleaning, cooking of products, etc.).

The dramatic increase in energy prices since 2021 has led to a significant rise in energy bills. In this new context, energy bills are up to three times higher than in 2020, which has a negative impact on the competitiveness of the sector and compromises its viability [2]. Faced with this new scenario, Solar Water Heating Systems (SWHSs) can contribute to reducing energy costs and the strategic dependence on fossil fuels from third countries.

Solar Water Heating Systems (SWHSs) are usually classified according to the type of collector and the fluid circulation system. The performance of the Evacuated Tube Collectors (ETCs) system is 41% better than the Flat Plate Collectors (FPCs) system, and the yearly useful energy gain of ETC is 30% more than that of FPC in cold climate [3]. Recent advances made to improve their performance through nanofluids [4–6], reflectors, phase-change materials [5], nanotechnologies [6], etc., ensure their growth in the coming years.

Active circulation offers greater flexibility for adaptation in case of high demand, such as in industrial processes [7]. Therefore, the present study focuses on SWHSs constituted by ETCs.