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Article

Improving the Selection of PV Modules and Batteries for Off-Grid PV Installations Using a Decision Support System

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Abstract: In the context of isolated photovoltaic (PV) installations, selecting the optimal combination of modules and batteries is crucial for ensuring efficient and reliable energy supply. This paper presents a Decision Support System (DSS) designed to aid in the selection process of the development of new PV isolated installations. Two different multi-criteria decision-making (MCDM) approaches are employed and compared: AHP (Analytic Hierarchy Process) combined with TOPSIS (technique for order of preference by similarity to ideal solution) and Entropy combined with TOPSIS. AHP and Entropy are used to weight the technical and economic criteria considered, and TOPSIS ranks the alternatives. A comparative analysis of the AHP + TOPSIS and Entropy + TOPSIS methods was conducted to determine their effectiveness and applicability in real-world scenarios. The results show that AHP and Entropy produce contrasting criteria weights, yet TOPSIS converges on similar top-ranked alternatives using either set of weights, with the combination of lithium-ion batteries with the copper indium gallium selenide PV module as optimal. AHP allows for the incorporation of expert subjectivity, prioritising costs and an energy yield intuitive to PV projects. Entropy's objectivity elevates criteria with limited data variability, potentially misrepresenting their true significance. Despite these discrepancies, this study highlights the practical implications of using structured decision support methodologies in optimising renewable energy systems. Even though the proposed methodology is applied to a PV isolated system, it can effectively support decision making for optimising other stand-alone or grid-connected installations, contributing to the advancement of sustainable energy solutions.

Keywords: isolated PV installation; decision support system; multi-criteria decision making; PV module selection; battery selection

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1. Introduction

In recent years, there has been a global shift toward the widespread adoption of renewable energy sources (RESs). Many countries are actively encouraging and implementing policies to facilitate the large-scale integration of RESs into their energy mix, with the aim of gradually phasing out conventional power generation methods that rely on nuclear and fossil fuels [1]. In fact, the necessity of RESs in the energy sector is undoubted, not only to address the climate change, the fossil resource scarcity, and the increasing costs of nuclear power, but also to reduce the energy dependence on fuels imported from other countries [2–4]. However, when planning a new RES installation project, as in any other project, several criteria can affect the success of such a project. As a consequence, selecting the commercial model of the components involved in the future installation can be consid-

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