ISSN: 2320-5407

International Journal of Advanced Research

Publisher's Name: Jana Publication and Research LLP

www.journalijar.com

REVIEWER'S REPORT

Manuscript No.: IJAR-51113 Date: 19-04-2025

Title: Smart Solar-Powered Water Pumping System with Energy Storage and Bidirectional Power Flow Mechanism

Recommendation:
Accept as it is……**YES……**
Accept after minor revision……
Accept after major revision ……
Do not accept (*Reasons below*) ……

Rating	Excel.	Good	Fair	Poor
Originality	√			
Techn. Quality		√		
Clarity		√		
Significance			√	

Reviewer's Name: Tahir Ahmad

Reviewer's Decision about Paper: **Recommended for Publication.**

Comments (*Use additional pages, if required*)
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Reviewer's Comment / Report

General Evaluation:
This paper presents a timely and technically robust study on the integration of solar-powered water pumping systems with grid-interactive capabilities. The focus on maximum power point tracking (MPPT), bidirectional power flow, and system operation under multiple modes demonstrates a comprehensive approach to improving energy efficiency and reliability in water pumping applications, especially in agricultural contexts. The paper is well-organized, grounded in relevant literature, and contributes meaningfully to the ongoing discourse on renewable energy applications in rural and industrial settings.

Abstract and Keywords:
The abstract offers a concise and technically sound summary of the paper. It clearly outlines the motivation, system functionality, and simulation approach. The use of technical terms such as VSI, VSC, and MPP is appropriate for the target audience. The keywords are well-chosen, reflecting the core areas of the research.

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Introduction:
The introduction effectively sets the context by highlighting the limitations of conventional water pumping systems and the benefits of solar photovoltaic (SPV) alternatives. It provides a compelling rationale for the transition from diesel to solar energy, especially in the Bangladeshi context, and underscores the relevance of clean energy in remote and agricultural settings. The references to technological limitations of DC motors and the advantages of AC motors are accurate and well-supported. The discussion on single-stage and two-stage topologies adds technical depth and clarifies the design decisions underlying the proposed system.

Technical Content and Design Rationale:
The paper explains the selection of power electronic components and their roles in facilitating efficient and smart energy management. The explanation of MPPT, impedance matching, and the importance of VSI in single-stage topologies is technically sound. Furthermore, the rationale for excluding bulky magnetic components aligns with the aim of making the system more compact, efficient, and less noisy. The choice of an induction motor and the consideration of energy storage and grid feedback mechanisms reflect a mature design philosophy suited to real-world implementation.

Control Strategy and Simulation:
The paper proposes a universal control scheme adaptable to four operational modes, which is a strong feature. Although the detailed control strategy and the modes are not elaborated in this excerpt, the mention of such adaptability indicates a well-thought-out system capable of handling dynamic energy and operational conditions. The inclusion of a MATLAB/Simulink model to validate the proposed design further strengthens the study's empirical foundation.

Application and Relevance:
The relevance to the agricultural sector, especially in regions with limited grid access like rural Bangladesh, is clearly articulated. By addressing both irrigation needs and excess power feedback into the grid, the system supports energy sustainability and utility grid efficiency. The acknowledgment of socio-economic and environmental aspects—such as noise, pollution, and maintenance costs—demonstrates the paper's holistic understanding of the subject.

Language and Clarity:
The language is mostly clear and technical, appropriate for readers with a background in electrical engineering or renewable energy systems. There are minor typographical inconsistencies, but they do not detract significantly from the overall clarity. The tone remains academic and focused throughout.

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Conclusion and Structure:
The logical progression from problem identification to system design, control strategy, and validation is evident and well-structured. The outlined structure of the paper is coherent and ensures that the reader can follow the flow of information effectively.

Overall Assessment:
This paper is a significant contribution to the field of smart renewable energy systems. Its integration of MPPT, bidirectional grid interaction, and control flexibility enhances the technological and practical appeal of solar-powered water pumping solutions. The focus on agricultural and rural applicability makes it especially relevant in the context of developing nations.