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Paper Title : Renewable Energy-Powered Desalination: A Techno-Economic Comparison of Photovoltaic and Wind Systems

Bio:

Dr. Ahmed Geweda is a Ph.D. candidate in the Department of Mechanical Engineering at King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia. He also serves as an Assistant Lecturer in the Department of Mechanical Power and Energy Engineering, Faculty of Engineering, Minia University, Egypt. Dr. Geweda received both his Bachelor of Science and Master of Science degrees in Mechanical Power and Energy Engineering from Minia University. His master's research focused on vehicle dynamics and suspension systems, including full-car modeling, MATLAB simulations, and control strategies for suspension systems. His current doctoral research interests include renewable energy and its applications, carbon capture, energy storage, thermal distillation, and membrane desalination systems integrated with renewable energy sources.

Abstract: This study evaluates the potential of photovoltaic (PV) and wind energy systems to supply electricity for a 25 MW reverse osmosis (RO) desalination plant in the southern Gaza Strip, where energy scarcity and water shortages remain critical challenges. Using the System Advisor Model (SAM), both systems were modeled to assess their technical performance and economic viability. The PV design, comprising 99,028 mono-crystalline modules with 20.95% efficiency and a 33.2 MW DC capacity, produced 64,010,332 kWh annually with a 22% capacity factor. Financial analysis yielded a levelized cost of energy (LCOE) of 7.93 ¢/kWh, an internal rate of return (IRR) of 5.78%, increasing to 15.98% by year nine and a capital cost of $48.9 million. The wind configuration, consisting of ten 2.5 MW turbines, generated 65,058,660 kWh annually with a 29.7% capacity factor, achieving stronger financial performance with an LCOE of 6.20 ¢/kWh, an IRR of 31.18%, and a lower capital investment of $40.9 million. Although wind energy demonstrated superior efficiency and financial outcomes, PV systems retain advantages in solar-rich regions due to predictable generation and reduced maintenance requirements. Both options significantly cut reliance on fossil fuels, supporting environmental and socio-economic sustainability. The results highlight the context-dependent feasibility of renewable energy integration into desalination, providing insights for optimizing energy–water systems in resource-limited regions such as the Gaza Strip.