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3E Analysis of a Solar-Powered Near-Zero Energy Community: A Case Study in Najran, Saudi Arabia

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Abstract

Over recent decades, electricity consumption in Saudi Arabia has risen significantly, driven by population growth, rapid economic development, and expanding infrastructure. Despite the region's high solar radiation potential—particularly in the city of Najran- there has been little investigation into the feasibility of using solar power to meet the needs of near-zero energy communities. This study employs HOMER 2.68 software to perform a 3E (Energy-Economic-Environmental) analysis of a grid-connected solar power system with battery backup for a near-zero energy community in Najran. The results indicate that large-scale battery use is not economically viable in this location. To meet a daily energy demand of 18 MWh and a peak load of 2.2 MW, the optimal solution is a 50 MW solar power plant equipped with a 40 MW electric converter. This system can supply 98% of the community's energy needs. The levelized cost of electricity is $0.104 per kWh—24% lower than the global average. Additionally, the system would prevent the annual emission of over 57,400 tons of pollutants.

Keywords
3E, Near-zero energy communities, energy communities, Solar.

Biography
Dr. Saeed Alqaed is currently working as Associate Professor in Mechanical Engineering Department, Najran University, Saudi Arabia. He acquired his Ph.D. in 2017 from the University of Dayton, Dayton OH, USA. His research interests have been vastly diverse, beginning with combined heat and power systems, which led to the dissemination of numerous novel applications in combined heat and power systems to focus on in-building energy informatics, and to community energy reduction, and finally, geothermal energy and renewable energy. He is currently involved in several research projects in solar thermal energy nanoparticles applications in heat transfer processing, sustainable energy, and energy transition.