Title: Techno-economic feasibility of stand-alone hybrid energy system with battery storage in educational buildings: A case study of Uttara University.

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Abstract: Stand-alone hybrid energy systems (HES) have the potential to significantly reduce pollutant emissions and alleviate strain on the national grid. The selection and sizing of stand-alone HES for buildings can serve as a methodological approach toward establishing a resilient and clean electrical energy system in urban areas of developing countries. To explore this further, a case study was conducted using Hybrid Optimization of Multiple Energy Resources (HOMER) to assess the feasibility of implementing a HES at Uttara University in Dhaka, Bangladesh. This study examined the technical, economic, environmental, social, and reliability aspects of a stand-alone HES. The findings of this study suggested that the PV-WT-DG-BT is the most cost-effective solution for the University when compared to other hybrid configurations. Additionally, this HES benefits the surrounding communities by creating employment opportunities and contributing to human development. The sensitivity analysis showed that the COE and NPC of the optimal HES are sensitive to fuel price changes. A PV slope angle of 23.88° was cost-effective, and a 20-meter wind turbine hub height was optimal. It was observed that increased solar radiation decreases COE. Further, sensitivity analysis showed that fuel costs, CO_2 emissions, and NPC will decrease if average daily load demand declines. It was also found that 1 kWh of Li-Ion-based HES performed the best compared to other batteries. Finally, the results of the genetic algorithm (GA), and grey wolf optimizer (GWO) showed that they provide the same optimum configuration as HOMER but with the lowest NPC. The findings of this study can serve as a foundational model for designing HESs in other large educational buildings located in low and middle-income countries with environmental conditions and socio-economic characteristics similar to Bangladesh.

Keyword: Techno-Economic, Stand-Alone, Hybrid Energy Syste, Building, HOMER.

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