Techno-Economic Analysis of a Hybrid Grid-Connected/PV/Wind System in Pakistan

By

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Dedication

Dedicated to my loving parents

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ABSTRACT

In view of the current energy crisis prevailing in Pakistan, renewable energy resources are considered as practical and economical alternatives. In this work technical as well as economic aspects of hybrid photovoltaic (PV) and wind systems connected to commercial grid, are investigated for selected locations of Pakistan. A pre-feasibility study of the renewable resources was done using NREL's Geospatial Toolkit software that has a broad meteorological database e.g. daily, monthly and annual profiles of solar irradiance, temperatures, wind speeds etc. and also a database of various renewable energy system components from different manufacturers. The locations were chosen on the basis of favorable environmental criteria based on meteorological data e.g. daily, monthly and annual profiles of solar irradiance, temperatures, wind speeds etc. The proposed hybrid system was simulated in NREL's HOMER software over the life span of the system guaranteed by the manufacturers. Performances and economic impacts of various components constituting this system in different locations were then analyzed and a conclusion was drawn with respect to the least calculated Net Present Cost (NPC). Finally, an optimum hybrid system with most appropriate components was suggested for such locations. The consumer end advantages of such systems over grid-alone system were also presented.

The system was implemented at four different locations in Pakistan. Keeping in view the current energy crisis in Pakistan, the system would be able to input adequate amount of energy into the main grid.

The system model for four different locations was run in HOMER software for its cost and technical analysis. With a large number of components available in a variety of prices the decision making for equipment procurement and implementation needs to be supported by economical and technical considerations. The systems suggested were economically and technically feasible as well as reliable. HOMER works for both grid-connected as well as stand-alone systems. It carries out a set of algorithms for each proposed system and demonstrates the optimum results keeping in view the optimum combination of meteorological resources and most economical components. The 'sensitivity analysis'

performed by HOMER is on the basis of the set of inputs and components suggested by the user. Therefore, the overall process in general is an iterative procedure.

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List of Abbreviations

NPC	Net Present Cost
COE	Cost of Energy
RF	Renewable fraction
PV	Photovoltaic
HOMER	Hybrid Optimization Model for Electric Renewables
NREL	National Renewable Energy Laboratories, USA
WAPDA	Water and Power Development Authority
NASA	National Aeronautics and Space Administration
kW	Kilo Watt
kWh	Kilo Watt hour
MW	Mega Watt
O&M	Operation and Maintenance