DESIGN AND OPTIMIZATION OF HYBRID ENERGY SYSTEM OF A REMOTE AREA OF BANGLADESH

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"I hereby declare that this thesis is my original work and it has been written by me in its entirety. I have duly acknowledged all the sources of information which have been used in the thesis.

This thesis has also not been submitted for any degree in any university previously."

MD ROSAIDULMAWLA

November2020

DEDICATION

To my mother and my beloved family

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ABSTRACT

Mitigation of powerdemand of a remote area of Bangladesh has been studied here.SwarnaDweep, an island in the Bay of Bengal, is considered for the work.Due to its geographical location, it is not economically feasible to connect SwrnaDweep with grid connection. People of this island need to depend on diesel generator which is not environment friendly. To obtain the environment friendly power, a detail survey is conducted to assess the renewable resources available in SwarnaDweep and to estimate the component cost. In the study, optimum configuration of a solar-wind-biogas-diesel-battery hybrid energy system is determined for the uninterrupted power supply system for the SwarnaDweep using Hybrid Optimization Model for Electric Renewables software developed by National Renewable Energy Laboratory. Besides that by economic modeling, the economic viability is tested. Moreover, an effort is taken to validate the result of HOMER by intelligent system and functional test is conducted on the proposed hybrid design. Payback period and internal rate of return are calculated and compared with the hybrid energy systems reported in the literature. A combination of 100 kW PV array, 25 Wind turbine (10 kW each), a diesel generator with a rated power of 40 kW, 30 kW biomass generator, 2000 piece of storage battery and 650 kW converter is the most commercially reliable in terms of Cost of Energy (21.655 Tk/kWh), Net Present Cost (171,171,120 Tk) and initial cost (40,451.200Tk). The proposed hybrid energy system has the electricity generation mix of 29 % from PV, 56% from the wind turbine, 5% from diesel generator and 10% from biogas resources. The proposed hybrid system was able to produce 1957 kWh/day against the 1694 kWh/day required for lighting and power loads. Considering 25 taka per kilowatt hour, the payback period is only 9 years and considering 30 taka, the payback period is 8 years. After calculation of internal rate of return becomes 9.33% which is beneficial as the interest rate is considered 8% for the project.The sensitivity analysis is undertaken to assess the effect solar, wind,biogas resource and diesel costs,on the net present cost and CO_2emissions.The results indicate that available solar, wind and biogas resource can be utilized economically using hybrid energy systems for decentralized applications in remote areas of Bangladesh.

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LIST OF ACRONYMS & ABBREVIATIONS

AC	Alternating Current
BPDB	Bangladesh Power Development Board
COE	Cost of Energy
ETAP	Electrical Transient Analyzer Program
GDP	Gross Domestic Product
GHGs	Greenhouse gases
GoB	Government of Bangladesh
HOMER	Hybrid Optimization Model for Electric Renewable
IEA	Internal Energy Association
EPCD	Environment Pollution Control Department
IDCOL	Infrastructure Development Company Limited
IPPs	Independent Power Producers
IRR	Internal Rate of Return
MATLAB	Matrix Laboratory
NASA	National Aeronautics and Space Administration
NPC	Net Present Cost
NREL	National Renewable Energy Laboratory
PSMP	Power System Master Plan
PV	Photo Voltaic
RE	Renewable Energy
SDG	Sustainable Development Goal
SHS	Solar Home System
SREDA	Sustainable & Renewable Energy Development Authority
UNDP	United Nations Development Programme