



Techno economic feasibility analysis of different combinations of PV-Wind-Diesel-Battery hybrid system for telecommunication applications in different cities of Punjab, India



Mohammad Junaid Khan^a, Amit Kumar Yadav^{b,*}, Lini Mathew^a

^a Electrical Engineering Department, National Institute of Technical Teachers Training and Research, Chandigarh, India

^b Centre for Energy and Environmental Engineering National Institute of Technology Hamirpur, 177005, Himachal Pradesh, India

ARTICLE INFO

Keywords:

Cost of energy
Battery
Diesel
Power
PV and Wind

ABSTRACT

The demand for power generation of the world is increasing day by day so the use of hybrid systems become an important solution. The hybrid systems are used for supplying power in different areas to overcome the intermittence of solar and wind resources. The hybrid system incorporate two or more renewable energy sources so techno economics analysis of different combinations of hybrid systems is necessary for efficient utilization of renewable energy resources. In this study an extensive review of power generation from different hybrid systems are carried out and research gaps are identified. To conduct our studies different hybrid systems such Photovoltaic (PV)-Wind-Diesel-Battery, PV-Diesel-Battery, PV-Wind-Diesel, Wind-Diesel-Battery, Wind-Diesel, PV-Diesel are investigated for different cities Amritsar, Ludhiana, Patiala, and Chandigarh in Punjab, India. The telecommunication load demand is used in HOMER simulation. The results show that the PV-Wind-Diesel-Battery produce more power in comparison to PV-Diesel-Battery, PV-Wind-Diesel, Wind-Diesel-Battery, Wind-Diesel, PV- Diesel system. The cost of energy (COE) is found to be 0.162 \$/kW h, 0.210 \$/kW h, 0.198 \$/kW h, 0.199 \$/kW h respective cities for load 1.3 kW peak, providing best combination PV-Wind-Diesel-Battery system are useful for generation of power.

1. Introduction

The demand for energy is increasing at an escalating pace and cannot be fulfilled entirely by conventional energy systems, due to their limited supplies. As fossil fuels are depleting and energy demands are increasing so power generation by renewable energy sources (RES) has drawn attentions worldwide. The single source of RES are not able to provide power continuously to the load, therefore hybrid based energy systems become an important option for maintaining feasibility between power and telecommunication load. The hybrid based system incorporate more than one renewable energy sources increasing the feasibility of power to load. Most of the researcher has described the cost analysis of hybrid energy system [1–3]. And also a review about design and analysis of the context of RES power generations [4–8].

In India, industrial load consumed more power followed by commercial, domestic and agriculture. The telecommunication is one of the fastest growing industries in India. In every month millions of mobiles subscribers are added in India. It is a big challenge to meet regular power supply to telecommunication loads with fuel which is expensive. The telecommunication tower is mostly equipped with only

diesel generator for power supply when there is no electric power. Due to this carbon emissions and cost get increases so it is necessary for the industry to use green energy for power sources.

India has the highest potentials for exploiting the renewable energy resources. Renewable energy (RE) is clean and inexhaustible. RE systems especially hybrid systems provide more power with increased efficiency and greater balance in energy supply. Thus, India's growing telecommunication tower industry can attain considerable cost savings by reducing fossil-fuel dependence and carbon emission by using hybrid renewable power generated electricity supply.

In this study, different types of Hybrid Renewable Energy Sources (HRES) are compared for power generation and optimum sizing in different cities of Punjab India. For all combinations of HRES the meteorological data of solar radiation and wind speed is taken for Amritsar (Latitude 31.64°N and Longitude 74.86°E), Ludhiana (Latitude 30.91°N and Longitude 75.85°E), Patiala (Latitude 30.34°N and Longitude 76.38°E) and Chandigarh (Latitude 30.35°N and Longitude 76.78°E) [9–11]. The prototype of consumption load of the typical load profile of telecom is duly modelled. The Hybrid Optimization Model Electric Renewable (HOMER) software is used

* Corresponding author.

E-mail address: amit1986.529@rediffmail.com (A.K. Yadav).

Nomenclature

AC	Air Conditioning
AE	Aqua Electrolyzer
BEM	Blade Element Momentum
BESS	Battery Energy Storage System
BOS	Balance of System
Brb	Battery Replacements
COD	Cost of Desalination
COE	Cost of Energy
CPPW	Cost Per Peak Watt
CTPP	Coal Thermal Power Plant
DFIG	Doubly Fed Induction Generators
DG	Distributed Generation
DLC	Direct Load Control
EE	Embodied Energy
EMS	Energy Management System
EUE	Expected Unserved Energy
FC	Fuel Cells
FOCV	Fractional Open-Circuit Voltage
FW	Flywheel
GA	Genetic Algorithm
GHG	Greenhouse Gas
GT	Gas Turbine
HOMER	Hybrid Optimization Model for Electric Renewable
HPS	Hybrid Power Stations
HRES	Hybrid Renewable Energy Sources
HS	Harmony Search
HSWSO	Hybrid Solar-Wind System Optimization Sizing
ICA	Imperialist Competition Algorithm
ICC	Initial Capital Cost
IRP	Integrated Resources Planning
LCC	Life Cycle Cost
LLP	Loss of Load Probability
LOLE	Loss of Load Expectation

LOLR	Loss of Load Risk
LOPS	Loss of Power Supply
LPSP	Loss of Power Supply Probability
LRIC	Long Run Incremental Cost
MG	Micro Generation
MOGA	Multi-Objective Genetic Algorithm
MPSO	Modified PSO
N	North
E	East
NPC	Net Present Cost
NPV	Net Power Variation
NPV	Net Present Value
PEM-FC	Polymeric Exchange Membrane Fuel Cell
PEM-WE	PEM Water Electrolyzer
P&O	Perturb & Observe
PSO	Particle Swarm Optimization
PSO-CF	PSO With Constriction Factor
PSO-RF	PSO With Repulsion Factor
PSO-W	PSO With Adaptive Inertia Weight
PUEC	Per Unit Electricity Cost
PV	Photo Voltaic
RES	Renewable Energy Source
SA	Simulated Annealing
SHS	Solar Home Systems
SPV	Solar Photovoltaic
STPS	Solar Thermal Power System
SVM	Support Vector Machine
$T_{\text{each Max}}$	The Maximum Control Time Allowed For Each Time
T_{each}	The Control Time For Each Time
TOU	Time-Of-Use
TS	Tabu Search
UC	Ultra Capacitors
WAsP	Wind Atlas Analysis and Application Program
WT	Wind Turbine
WTGs	Wind Turbine Generators

for analysis of hybrid power generation system. This software compares the broad range of equipment with distinct sensitivities and constrains for optimization of the design system. The technical properties and Life Cycle Cost (LCC) of the system are used for analysis of the system. The LCC consists of operation cost, installation cost and initial capital cost over the duration of system life. HOMER software provides simulations to satisfy of demand using resources availability and alternate technology options.

This paper is organized as follows: the literature review is given in Section 2. The methodology is given in Section 3. The results and discussions are shown in Section 4. Finally, conclusions are given in Section 5.

2. Literature review on hybrid systems

The hybrid power generation systems provide techno-economic feasibility and applied to cover the demand of a typical off-grid residence for a 20 year period. Each one of these hybrid power solutions should involve at least one renewable energy source technology and to cover all demanded load. Four applications are investigated for each hybrid system accounting for different geographical areas in Greece with diverse solar and aeolic profile. A comparative analysis of hybrid system which produces the optimal solution based on a minimal total cost criterion.

Several studies [12–17] have been performed by different authors worldwide regarding power generation using the different hybrid system. But in India only few studies are reported on designing of

hybrid energy system for a locality and its implementation is an uphill task as the input parameters of the sources considered are randomly varying with time and are also independent of the load requirements [18,19]. The different combinations of hybrid system used by various researchers for different sites for India is shown in Table 1.

Panapakidis et al. [28] examine four combinations of hybrid systems (PV-Diesel, PV-Wind, Wind-Diesel and Wind-Fuel cell) for different sites of Greece. It is found that for an average wind speed of 3 m/s PV-Diesel system is best for power generation.

Phuangpornpitak et al. [29] incorporate a hybrid system for Thailand and suggested that addition of Diesel generator to PV system improves reliability of the power supply. Liu and Wang [30] used Wind-PV system for China locations by taking load as road light of city, pumping system and made policy for the government for flourishing hybrid power utilization.

Omer Kaynakli [31] reviewed that to determining the optimum thickness of the thermal insulation material in a building envelope and its effect on energy consumption was carried out. The results, the optimization procedures and the economic analysis methods used in the studies were presented comparatively. Additionally, a practical application on optimizing the insulation thickness was performed and investigated the effective parameters based on the optimum value.

Chaurey and Kandpal [32] reviewed and analysis of the PV literature pertaining to decentralized rural applications in the categories such as technical-economic aspects and experiences of rural electrification and technology demonstration. The trade-off between capacity storage or loss-of-load and levelized cost of energy are a

Download English Version:

<https://daneshyari.com/en/article/5482179>

Download Persian Version:

<https://daneshyari.com/article/5482179>

[Daneshyari.com](https://daneshyari.com)