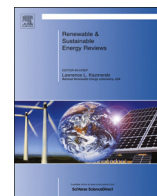




ELSEVIER

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Techno-economic feasibility study on Integrated Renewable Energy System for an isolated community of India



Anurag Chauhan*, R.P. Saini

Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee, Uttarakhand 247667, India

ARTICLE INFO

Article history:

Received 17 March 2015

Received in revised form

18 December 2015

Accepted 27 December 2015

Keywords:

Renewable energy

Isolated

Levelized cost of energy (LCOE)

Net present cost (NPC)

HOMER

ABSTRACT

In the recent years, small scale power generation has been recognized as a suitable option for energy access in isolated rural areas due to uneconomical grid extension. A techno-economic feasibility study on the development of an Integrated Renewable Energy System (IRES) is carried out in the paper in order to meet the electrical and cooking energy demands of cluster of village hamlets of Chamoli district of Uttarakhand state (India). An attempt has been made to estimate the potential of locally available renewable energy resources and demands of the study area. The selection of small wind turbine model for the site specified is performed among the various models available in market. Further, nine different combinations of renewable energy resources have been investigated by considering economic, technical and social aspect criteria. Finally, a sensitivity analysis has also been carried out in order to determine the most sensitive parameter of the system.

© 2016 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	389
2. Modelling method	390
2.1. Step I – Identification of study area	390
2.2. Step II – Estimation of electrical and cooking energy demand	390
2.3. Step III – Potential assessment of available resources	393
2.4. Step IV – Estimation of mean annual wind power density of a specific site	393
2.5. Step V – Selection of small wind turbine model	393
2.6. Step VI – Selection of integration configuration	395
2.7. Step VII – Development of optimization model	395
3. Estimation of mean annual wind power density of a specific site	395
3.1. Frequency distribution of wind speed	395
3.2. Annual wind energy density	395
3.3. Mean annual wind power density	396
4. Selection of small wind turbine model	396
4.1. Technical specifications of small wind turbine models	396
4.2. Comparison of small wind turbine models	396
4.2.1. Annual energy production of wind turbine	396
4.2.2. Capacity factor of small wind turbines	397
4.2.3. Comparison of capacity factor of small wind turbine models	397
5. Energy management strategy	398
5.1. Charging of battery bank	398
5.2. Discharging of battery bank	398
6. Optimization method	398
6.1. Economic assessment criteria	398

* Corresponding author. +91 8171015620.

E-mail address: anurag.chauhan36@gmail.com (A. Chauhan).

6.1.1.	Net present cost	398
6.1.2.	Total annualized cost	398
6.1.3.	Capital recovery factor	399
6.1.4.	Levelized cost of energy	399
6.2.	Technical assessment criteria	399
6.3.	Social aspect assessment criteria	399
7.	Database needed for simulation	399
7.1.	Hourly electrical energy demand	399
7.2.	Monthly average daily solar radiation	399
7.3.	Monthly average discharge availability	399
7.4.	Monthly average wind speed	399
7.5.	Monthly average biomass availability	399
7.6.	Economical data	400
8.	Simulation results and discussions	400
8.1.	Simulation results	400
8.1.1.	Combination 1: MHP-Battery	400
8.1.2.	Combination 2: Biogas-Battery	400
8.1.3.	Combination 3: Biomass-Battery	400
8.1.4.	Combination 4: MHP-Biogas-Battery	400
8.1.5.	Combination 5: MHP-Biomass-Battery	400
8.1.6.	Combination 6: MHP-Biogas-Biomass-Battery	401
8.1.7.	Combination 7: MHP-Biogas-Biomass-Wind-Battery	401
8.1.8.	Combination 8: MHP-Biogas-Biomass-PV array-Battery	401
8.1.9.	Combination 9: MHP-Biogas-Biomass-Wind-PV array-Battery	401
8.2.	Comparison of simulation results	401
8.2.1.	Achievement of 0% capacity shortage	401
8.2.2.	NPC and LCOE for different combinations	401
8.2.3.	Battery storage requirement for different combinations	401
8.2.4.	Employment generation for different combinations	401
8.3.	Selection of a suitable combination based on the results obtained considering total NPC, LCOE, battery storage, capacity shortage and employment as important criteria	402
8.4.	Cost breakdown of the total NPC	402
8.5.	Annual generation of renewable energy sources	402
8.6.	Frequency histogram for state of charge of battery bank	402
9.	Sensitivity analysis	402
9.1.	Effect of the electrical energy demand	402
9.2.	Effect of mean annual wind speed	402
9.3.	Effect of maximum annual capacity shortage	402
9.4.	Effect of biomass price	402
10.	Conclusion	403
	Acknowledgment	404
	References	404

1. Introduction

In developing countries like India, most of the rural areas at remote location have no access of electricity due to cost and complexity associated with the grid extension. However, these remote areas are rich in the availability of locally available renewable energy resources such as cattle dung, waste from agricultural field, forest foliage, water streams, solar intensity, wind etc. Therefore, utilization of renewable energy resources in decentralized mode would be the most economical and sustainable option for electricity supply in rural areas. As renewable energy resources (solar, wind etc.) are intermittent in nature, therefore it is essential to integrate such resources to provide a reliable and economical power supply at user end. Electrification of rural areas has the potential to improve the living standard, health conditions, standard of education and empowering the youth of the nearby population [1–8].

The concept of Integrated Renewable Energy System (IRES) has been proposed various researchers for energy access in rural households [9–15]. In IRES, electrical and cooking energy demands of an isolated area, far away from the utility grid, match with the potential of locally available renewable energy resources. In IRES, resources are utilized in appropriate and cost effective manner

based on the resource availability and energy demand of the area. Therefore, IRES offers energy conservation and high energy efficiency resulting from the combination of renewable energy resources. In order to design IRES, a careful and strategic planning is essential for matching needs and available resources to maximize benefits and efficiency of end uses.

Patil et al. [9] considered four scenarios during modelling and optimization of IRES. From four different scenarios, they found that microhydro-biomass-biogas-energy plantation-wind-solar based integrated energy system offered the lowest cost of energy and recognized as a suitable option to supply required energy for cooking and electrical appliances. Rohani et al. [10] performed a techno-economical analysis of hybrid renewable power system comprised of photovoltaic array, wind turbines, batteries and diesel generators.

Fazelpour et al. [16] carried out a feasibility analysis of solar photovoltaic (SPV)-wind-diesel generator-battery based hybrid system to satisfy electrical energy needs of medium-size hotel. Gupta et al. [17] optimized the cost of hybrid system in such a way that resources with lesser unit cost would share the greater of the total energy demand based on mixed integer linear mathematical programming. Moura et al. [18] optimized the cost of solar-wind-hydrobased integrated energy system and maximized the

Download English Version:

<https://daneshyari.com/en/article/8113985>

Download Persian Version:

<https://daneshyari.com/article/8113985>

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