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

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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.

Contents

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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