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Forecasting and Management of Load for Rural Areas

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Abstract- In a remote areas supply of energy from national grid is insufficient for a sustainable development. Integration and optimization of local alternative renewable energy sources is an optional solution of the problem. The needs of rural electricity is met by conventional approaches is limited. In economic perspective, non-conventional forms of rural electrification may least-cost, particularly where villages are some distance from each others. In this paper the renewable energy reduces the burden on electricity supply shortfalls and the urgency of costly grid extension. In this paper we will bring in some new concepts associates with renewable energy forecasting.

Energy plays a significant role in the economic and technological advancement of modern society and plays crucial role in human life standard. In hilly regions energy situation in terms of availability and demand is very different from that in the urban areas. Large parts of hilly and remotely located regions remain un-electrified.

The studies are carried out for load management during a typical rainy, winter and a summer seasons. The results with using matlab for the rainy, winter and summer seasons scenarios are present in this paper. This paper presents a how manage the load forecasting of rural areas.

Index Terms- Load Management, Load forecasting, Renewable Energy and Hybrid System

I. INTRODUCTION

Energy flows from many sources, exists in a variety of interchangeable forms, and drives all systems. It is fundamental to the quality of our lives and today, we are dependent on an abundant and uninterrupted supply of energy for living and working [2]. Due to their geographical location and the lack of critical mass, rural areas are mainly suitable for renewable energy off grid application, systems which are connected to a battery via a charge controller, which stores the electricity generated and acts as the main power supply [6]. Access to electricity is still a dream for 20% of the world's population. Most of them are about 85%, live in rural areas where the extension of utility grid is either complex or very expensive. This is due to the features of rural populations, which are remote and disperse, have small incomes and whose electric consumption is low. The International Energy Agency (IEA) foresees that if current policies do not change by 2030 there will still be 1.2 billion people without access to electricity [11].

The most of the population in India lives in villages and a large number of villages are not served by the national grid due to the high cost involved in erection and maintenance of transmission lines in comparison to low power consumption in such areas. Rapid depletion of fossil fuel resources necessitated an urgent search for alternative energy sources to fulfill the demand of present day. New and renewable energy sources are economically suitable for the remote areas. These alternative energy sources such as solar, wind, biomass, small hydro etc. have attracted energy sectors to generate power on large scale. But the above renewable energy sources alone cannot provide continuous supply of energy due to seasonal and periodic variations. The effort of doing in this direction, so that the result in a high cost of the system. In this situation, the possible solution is hybrid energy systems. These systems combine two or more renewable sources along with a back-up source as per the availability of resources and load demand in those remote areas [3].

In India a very large proportion of Indian citizens continue to live with no access to electricity and other forms of commercial energy. More than 50 percent of the population has little or no commercial energy access in their daily lives. So the daily life is affected of that peoples of remote areas are shifted from remote to the urban areas for their employment opportunities, education, and health problem etc. Renewable energy can make a substantial contribution in each area. It is only the solution of Renewable energy to the nations for satisfying their energy needs. In terms of all renewable energy categories, India is currently ranked fifth in the world with 15,691.4 MW grid-connected and 367.9 MW off-grid renewable-energy based power capacity. As on March 31, 2012, installed capacity of renewable energy based power generation was 24,503 MW, which is about 12 percent of the total installed capacity of 199,626 MW. That is possible only by major renewable energy sources and integration of these sources [12].

Many alternative energy sources including wind, PV, diesel system, and biogas, small hydro can be used to build a hybrid energy system. The major renewable energy sources used and reported are Wind, solar and biogas power generation in any remote areas. Due to the intermittent nature of wind and solar energy, stand-alone wind and PV energy systems normally require energy storage devices or some other generation sources to form a hybrid system. The storage device can be a battery bank, super capacitor bank [7]. A battery bank is also used in the system for short-time backup to supply transient power. The different energy/storage sources in the proposed system are integrated through an ac link bus. Simulation studies have been carried out to analysis of load management under seasons of rainy, winter and summer using practical load curve [7].

Renewable energy technologies avoid greenhouse emissions**,** have low operation and maintenance costs, generate employment and allow decentralized production of the rural areas. In rural areas, they are capable of electrify homes, villages, farms and small industries as well as being used for telecommunication, water supply and irrigation. The use of these technologies in rural areas reduces the need for candles, kerosene

and battery charging and higher quality of lamps than kerosene and also improving the standard of life in the rural areas. [6] The basic objectives of the development of renewable energy is ensuring energy security and reducing emissions. [6] The sustainable energy production is to be found in renewable energy sources that are clean, cheap and green [2].

For electrification of remote areas/rural electrification started shecheme of the government like Kutir Jyoti Program (KJP) , Pradhan Mantri Gramodaya Yojna (PMGY), Rajiv Gandhi Grameen Vidyutikaran Yojna, Jawaharlal Nehru National Solar Mission scheme [13]. Rajiv Gandhi Gramin Vidyutikaran Yojana (RGGVY)-The basic purpose of the Rajiv Gandhi Gramin Vidyutikaran Yojana (RGGVY) Programme is to provide 100% electrification of all villages and habitations in the country, electricity access to all households , free of cost electricity connection to BPL (Below Poverty Line) households through renewable energy sources in those unelectrified remote census villages, unelectrified hamlets of electrified census villages where grid connectivity is either not feasible or not cost effective & and electrified villages/hamlets where power availability is less than 6 hours per day averaged over the year. Jawaharlal Nehru National Solar Mission- the National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge. The basic purpose of the National Solar Mission is to establish India as a global leader in solar energy by creating the policy conditions for its diffusion across the country as quickly as possible [13].

These schemes are used for rural electrification but not sufficient to provide electricity for 24 hours. So that the solution is how to manage the load, according to demand of rural areas. This paper presents how to manage the load and forecasting of remote areas according to rainy, winter and summer seasons in yearly on the basis of data collection of remote areas. For sustainable development of rural electrification the integration of renewable energy sources (hybrid system) is needed. The results for load management are shown in this paper for remote area.

II. HYBRID SYSTEM

The performance of hybrid system is dependent on the environmental conditions, analysis is considered in the given study area to investigate the associated cost and component size. The alternative/renewable energy sources such as solar energy, wind energy and biogas power plant have the greater potential to generate power for system utilities. The abundant energy available in nature can be converted to electricity in a sustainable and clean way to supply the necessary power to remote areas for the living standards of people without access to the electricity grid. If stability is concerned with available voltage and power variation, these problems can be solved by integrating the possible renewable energy sources [1].Based on the availability and potential of renewable energies in the remote areas cluster of village consisting of a hybrid energy system wind, solar PV and biogas system along with a DG back-up, battery storage and power conditioning equipment [3].

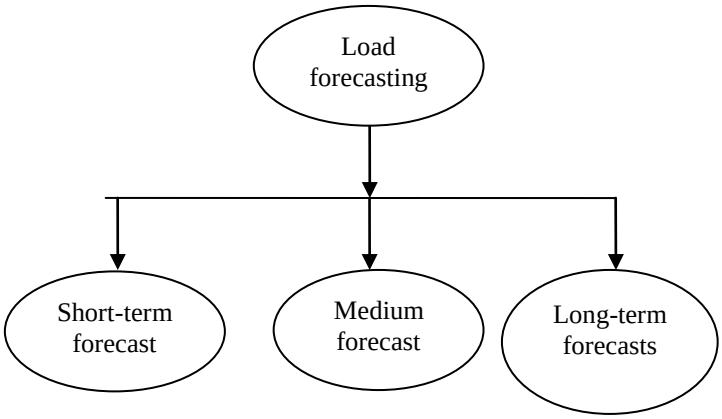
The main advantages of hybrid systems as reduced operational cost due to lower fuel consumption and low PV maintenance, improved reliability through diversifying power sources and continuous power supply, as well as increased operational life due to fewer generator operating hours. The system is environmentally friendly due to reduced emissions and noise pollution, and smoothes out seasonal weather fluctuations, resulting in improved energy services, and extended battery life [4]. The role of integrating renewable energy in hybrid energy system is primarily to save diesel fuel. The renewable energy sources commonly used in hybrid configurations are small wind turbines, photovoltaic systems and biogas. The integrated approach makes a hybrid system to be the most appropriate for isolated communities of a rural remote area [8]. For systems employing totally clean renewable energy, high capital cost is an important barrier. We can produce green power by adding different renewable energy sources to diesel generator and battery, which is also called a hybrid system. This kind of system can compromise investment cost, diesel fuel usage cost and also operation and maintenance costs [8].

The diesel generators have been the solution for decentralised electricity supply because of their low initial capital cost. Apart from environmental concerns, the diesel generator has high operating costs as a result of high consumption of fuel and high maintenance costs. The amount of power produced by renewable energy devices such as photovoltaic cells and wind turbines varies significantly on an hourly, daily and seasonal basis due to the variation in the availability of sunshine, wind and other renewable resources. This variation means that sometimes power is not available when it is required and on other occasions there is excess power [4].

III. LOAD FORECASTING

Load forecasting is very important for electric utilities in a competitive environment created by the electric industry deregulation, planning and operational decision [5]. From the perspective of the system operators and regulatory agencies, the medium term forecasting is a source of primary information for the safe and reliable operation of the system. The basic tool for determining the optimal utilization of generators and power stations, some facilities are more efficient than others.

Load forecasting is classified as-



IV. LOAD SURVEY OF RURAL AREA

The load survey of the rural areas is achieved by taking the interview of sarpanch, school teachers, members of rural area etc. The following constraints are considered during the load survey of nearby villages up to 5 to 12 km distance from each other in the district of Sehore (MP). The load survey of rural area depends on-

(1) Number of villages of rural area
(2) Number of houses of rural area
(3) Population of rural area
(4) Demand of domestic load
(5) Demand of street lighting load
(6) Demand of commercial load
(7) Demand of agriculture load
(8) Average energy consumptions
(9) Others demand.

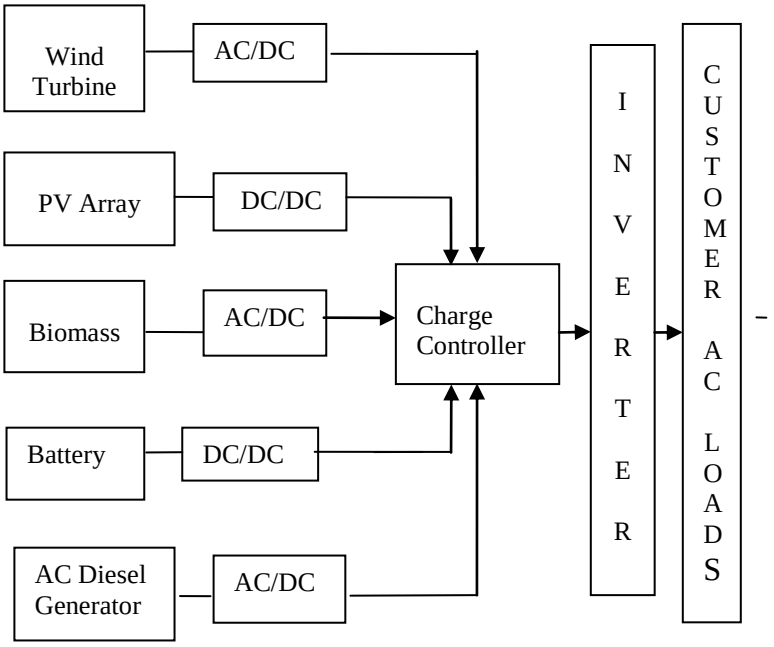
V. ENERGY DEMAND AND RESOURCES

The electrical loads of the area are classified as domestic, agricultural, commercial and street light. The domestic sector needs electricity for electrical appliances such as TV, fan, Tube light, washing machine, mixer, fridge, water heater and motor for pumping.. The agricultural load includes irrigation and motor for water pumping. The commercial load includes schools, shops, flour mill, small scale industries, and village panchayat office buildings [1].

The connected load determination of the average connected load of households in the hilly rural area, which is not yet electrified, has been made feasible by the estimation method. The expected consumption pattern of the area throughout the year has been estimated, keeping in mind demographic characteristics of the local population, land features, density of population in each village, prevailing climate and social requirements of inhabitants. For load estimation in that rural area has been a great help in determining the load requirement for this rural hilly area [3].

VI. OVERALL POWER MANAGEMENT STRATEGY

An overall control strategy for power management among different energy sources in a multi-source energy system is needed.



The block diagram of overall control strategy for the proposed hybrid alternative energy system.

The power difference between the generation sources and the load demand is calculated as-

$$P_{net} = P_{wind} + P_{pv} + P_{biogas} + P_{load} \quad \text{--- (1)}$$

Where -

Pwind is the power generated by the WECS,

Ppv is the power generated by the PV energy conversion system,

Pbiogas, is the power generated by the biogas energy conversion system

Pload is the load demand.

VII. RESULTS FOR LOAD MANAGEMENT

In order to analysis of the load performance under different situations, the studies have been carried out using practical load demand data with the help of matlab depending on seasons (rainy, winter summer seasons). As discussed in this paper the system is considered to supply electric power demand of 100 houses in the any rural areas.

A typical hourly load demand for a house in the rural areas reported with survey of rural areas and study of that area. The total hourly load demand profile of 100 houses over 24 h is shown in the form of load curve of rainy, winter and summer season.

The studies are carried out for load management during a typical rainy, winter day and a summer day. The results with the help of matlab for the rainy, winter and summer season's scenarios are shown in the fig. 2, fig. 3, fig. 4

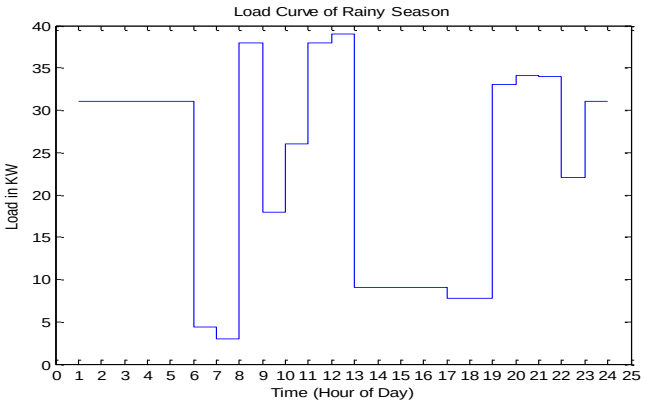


Fig. 2

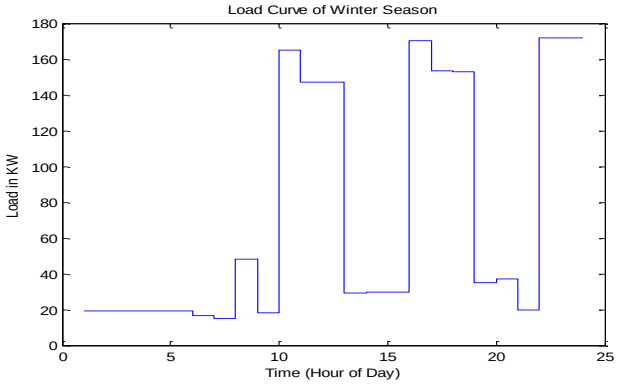


Fig. 3

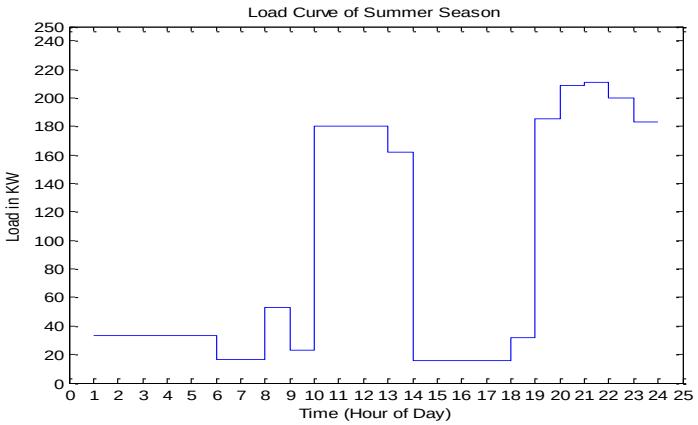


Fig. 4

The studies are carried out for load management during a typical rainy, winter and a summer season after adjustment of the load. The results with the help of matlab for the rainy, winter and summer season are shown in the fig. 5, fig. 6, fig. 7.

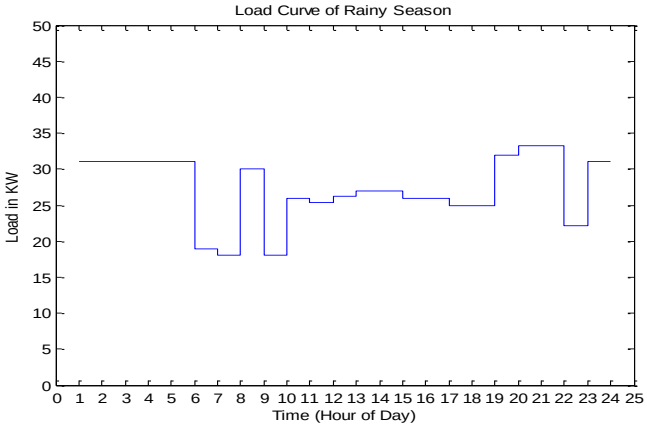


Fig. 5

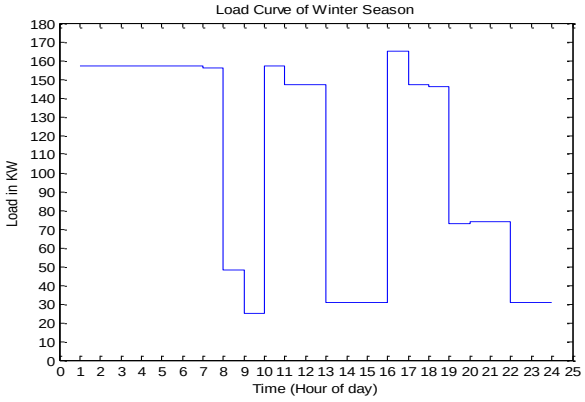


Fig. 6

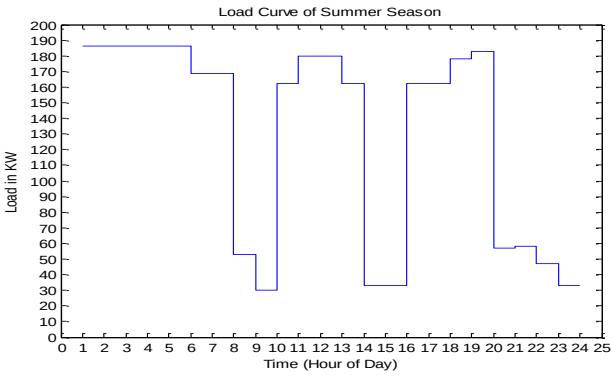


Fig. 7

The studies are carried out for load management during a typical rainy, winter and a summer season after distribution of agriculture loads in weekly. Agriculture load for rainy season is considered zero. So that the results with the help of matlab for the winter and summer season are shown in the fig. 8, fig. 9, fig. 10, fig. 11.

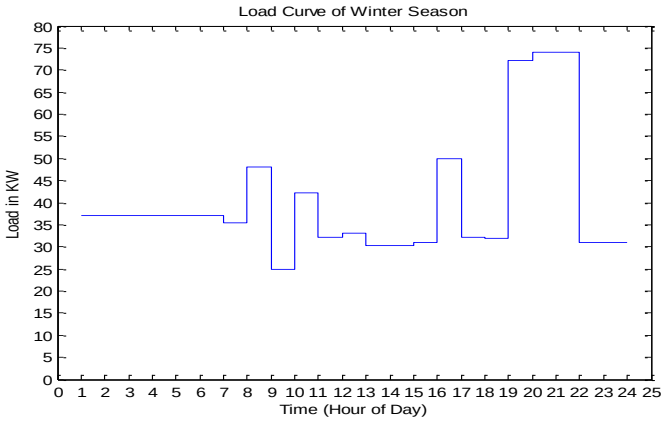


Fig. 8

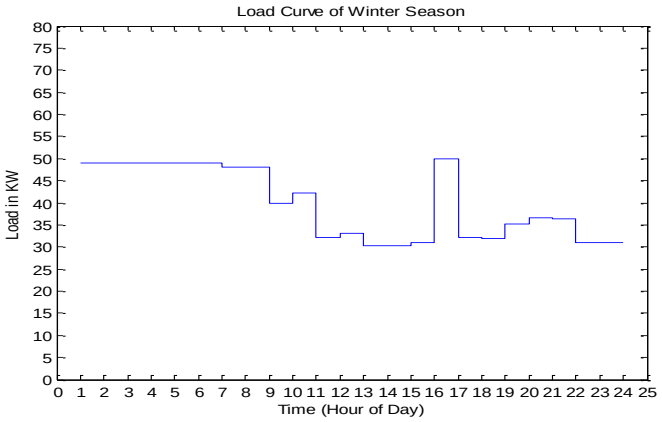


Fig. 9

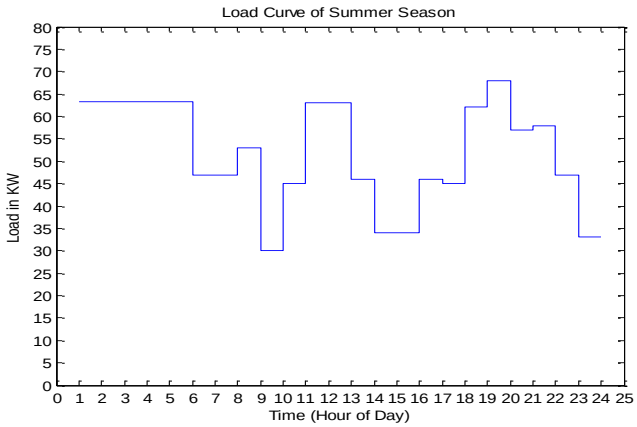


Fig. 10

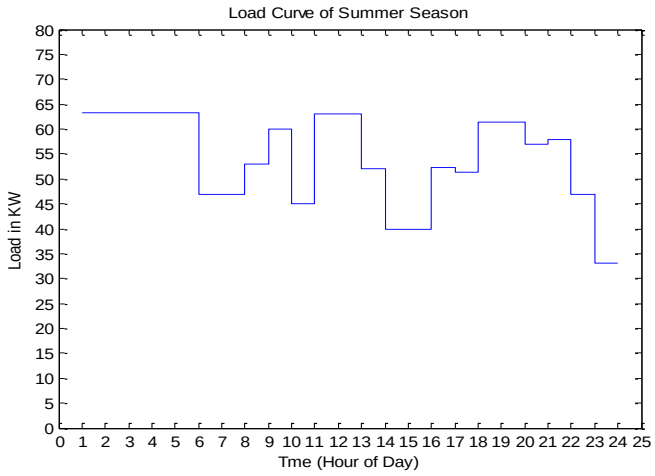


Fig. 11

VIII. CONCLUSION

In this paper, an ac-linked stand-alone Wind/PV/Biogas alternative energy system is proposed. The wind, PV generation and biogas systems are the main power generation devices in any rural areas.

The model of the hybrid system has been discussed in this paper. The studies have been carried out to verify the load performance under different scenarios using matlab the practical load curve profile in the remote areas. The results, with the help of matlab to given for a rainy, winter and a summer seasons scenario, show the effectiveness of the overall load management strategy and the feasibility of the proposed hybrid alternative energy system.

REFERENCES

[1] Deepak Kumar Lal, Bibhuti Bhusan Dash, and A. K. Akella " Optimization of PV/Wind/Micro-Hydro/Diesel Hybrid Power System in HOMER for the Study Area", International Journal on Electrical Engineering and Informatics , Volume 3, Number 3, Aug. 2011, pp. 307-325.

[2] Dr. M. M. Qurashi & Engr. Tajammul Hussain, "Renewable Energy Technologies for Developing Countries Now and to 2023"

[3] A. Rajoriya & E. Fernandez, "Sustainable energy generation using hybrid energy system for remote hilly rural area in India", International Journal of Sustainable Engineering, Vol. 3, No. 3, Sept. 2010, pp. 219–227.

[4] Henerica Tazvinga, Tawanda Hove, "A technical model for optimising PV/diesel/battery hybrid power systems", Proceedings of the 3rd Biennial Conference of the Council for Scientific & Industrial Research (CSIR): Science Real and Relevant Conference, Pretoria, South Africa, Aug. 2010, pp. 1-10.

[5] Eugene A. Feinberg, Load Forecasting, State university of New York, stony brook, Applied Mathematics for Power System, pp-269-283.

[6] Renewables Global Status Report 2006 Update REN21 published 2006, accessed 2007-05-16

[7] Caisheng Wang, and M. Hashem Nehrir, "Power Management of a Stand-Alone Wind / Photovoltaic / Fuel Cell Energy System", IEEE Transactions on Energy Conversion, Vol. 23, No. 3, Sept. 2008, pp. 957-967.

[8] A. Gupta, R. P. Saini and M. P. Sharma, "Design of an Optimal Hybrid Energy System Model for Remote Rural Area Power Generation", Proceedings of the International Conference on Electrical Engineering (ICEE), Lahore, Apr. 2007, pp. 1-6.

[9] S.N. Singh, "Electrical Load Survey & Load Forecast For A Stand Alone Small Hydropower Station", Senior Scientific Officer, AHEC, Indian Institute of Technology Roorkee, Himalayan Small Hydropower Summit (October 12-13, 2006), Dehradun, pp-301-306.

[10] Ministry of New and Renewable Energy [www.mnre.gov.in]

[11] Olatz Azurza, Iñaki Arranbide and Itziar Zubia, "Rural electrification based on renewable energies. A Review", International Conference on Renewable Energies and Power Quality (ICREPQ'12), Spain, March 2012.

[12] The Potential for Renewable Energy in India -2012 www.gyananalytics.com

[13] Vijay Modi , "Improving Electricity Services in Rural India", CGSD Working Paper No. 30, Working Papers Series Center on Globalization and Sustainable Development, The Earth

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