iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** V **Month of publication:** May 2017

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Hybrid Renewable Energy Systems: A Review

Pankaj Agarwal[1]
[1]Assistant Professor, Amity University Rajasthan

Abstract: Hybrid renewable energy systems (HRES) are becoming popular for remote area power generation applications due to advances in renewable energy technologies and subsequent rise in prices of petroleum products. A hybrid energy system usually consists of two or more renewable energy sources used together to provide increased system efficiency as well as greater balance in energy supply.The wind and solar energy are omnipresent, freely available, and environmental friendly. The wind energy systems may not be technically viable at all sites because of low wind speeds and being moreunpredictable than solar energy. The combined utilization of these renewable energy sources are therefore becoming increasingly attractive. Economic aspects of these renewable energy technologies are sufficiently promising to include them for rising power generation capability in developing countries. These hybrid energy systems are becoming popular in remote area power generation applications due to advancements in renewable energy technologies and substantial rise in prices of petroleum products. Research and development efforts in solar, wind, and other renewable energy technologies are required to continue for, improving their performance, establishing techniques for accurately predicting their output and reliably integrating them with other conventional generating sources. The aim of this paper is to review the current state of the design, operation and control requirement of the stand-alone PV solar–wind hybrid energy systems with conventional backup source i.e. diesel or grid. This Paper also highlights the future developments, which have the potential to increase the economic attractiveness of such systems and their acceptance by the user

I. INTRODUCTION

Hybrid renewable energy systems (HRES) are becoming popular for remote area power generation applications due to advances in renewable energy technologies and subsequent rise in prices of petroleum products. A hybrid energy system usually consists of two or more renewable energy sources used together to provide increased system efficiency as well as greater balance in energy supply. One of the most promising applications of renewable energy technology is the installation of hybrid energy systems in remote areas, where the grid extensions costly and the cost of fuel increasesdrastically with the remoteness of the location. Recent research and development in Renewable energy sources have shown excellentpotential, as a form of supplementary contribution to conventional power generation systems. Renewable energy sources, such as photovoltaic,wind energy, or small scale hydro,provide a realisticalternative to engine-driven generators for electricity generation inremote areas. It has been demonstrated that hybrid energysystems can significantly reduce the total lifecycle cost of standalonepower supplies in many situations, while at the same timeproviding a more reliable supply of electricity through the combination of energy sources.

Various hybrid energy systems have been installed inmany countries over the last decade, resulting in the development ofsystems that can competewith conventional, fuel based remote area power supplies in many applications. In India, it is difficult to electrify the remote areas of Kumoan region and the odd small villages in TehriGarwal district. It is uneconomical to provide grid power in these areas so hybrid renewable energy systems are very useful to electrify these remote villages. Various simulation programs are available,which allow the optimum sizing of hybrid energy systems.The recent state of art hybrid energy system technologicaldevelopment is the result of activities in a number of researchareas, such as

A. Advances in electrical power conversion through the availabilityof new power electronic semiconductor devices, have led toimproved efficiency, system quality and reliability.

B. Development of versatile hybrid energy system simulationsoftware; continuing advances in the manufacturing processand improve efficiency of photovoltaic modules.

C. The development of customized, automatic controllers, whichimprove the operation of hybrid energy systems and reducemaintenance requirements.

D. Development of improved, deep-cycle, lead-acid batteries forrenewable energy systems.

E. Availability of more efficient and reliable AC and DC appliances,which can recover their additional cost over their extendedoperating lifetime.

F. The task for the hybrid energy system controller is to control theinteraction of various system components and control

©IJRASET: All Rights are Reserved

powerflow within the system to provide a stable and reliable source of energy.

With the wide spread introduction of net-metering, the use of smallisolated or grid connected hybrid energy systems is expected to growtremendously in the near future. The aim of this paper is to review thecurrent state of the design and operation of hybrid energy systems, and to present future developments, which will allow a furtherexpansion of markets, both in industrialized and developingcountries.

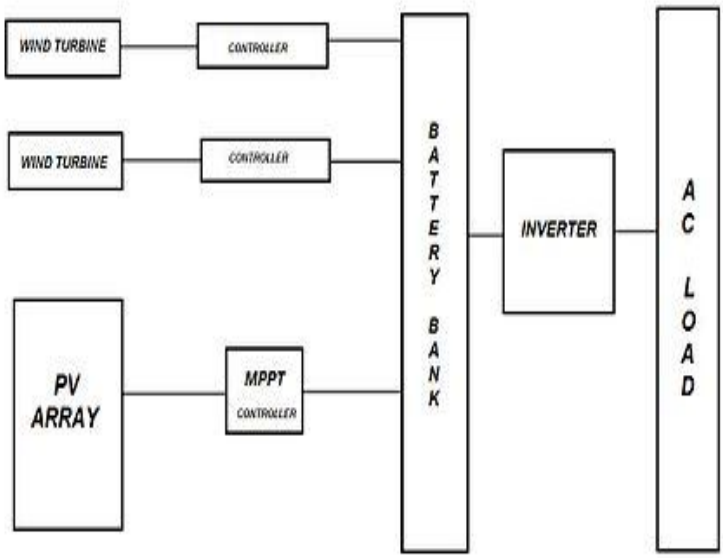


Fig.1. Block diagram of a PV/wind hybrid energy system

II. PRE-FEASIBILITY ANALYSIS OF HYBRID SYSTEM

Climatic conditions determine the availability and magnitudeof wind and solar energy at particular site. Pre-feasibility studiesare based on weather data [3] (wind speed, solar insolation) andload requirements for specific site. In order to calculate theperformance of an existing system, or to predict energyconsumption or energy generated from a system in the designstage, appropriate weather data is required. The global whetherdata could be obtained from internet and other sources likelocal metrological station. The global weather pattern is taken fromNASA surface metrological station shown in Figs. 2 and 3. In Fig. 2the red and yellow indicate high wind energy is available while theblue colors reflect lower wind energy potential zone. Fig. 3 shows the solar insolation level at different areas of the world. Wind and solar hybrid system can be designed with the help of these global weather patterns, for any location all over the world. Feasibility of hybrid PV/wind energy system strongly depends on solar radiation and wind energy potential available at the site. Various feasibility [38] and performance studies are reported to evaluate option of hybrid PV/wind energy systems [22, 50].

Photovoltaic array area, number of wind machines, and battery storage capacity play an importantrole in operation of hybrid PV/wind–diesel system while satisfyingload [1]. The objective of lightingpathway at the project site can be achieved by making use of thewind, solar and hydro energy

sources. The information about localwind, a solar and hydro energy source indicates that a feasiblehybrid energy system can be planned, modeled and designed forthe above purpose. The collected data of the various energy sourceswas analyzed in order to plan for the structure of the system. This model also allows anoptimal capacity of the hybrid energy system to be determined. Khan and Iqbal [22] discussed a primary design and pre-feasibilityanalysis of a hybrid energy system for a household in or around St.John's, Newfoundland. He collected 1-year wind speed, solarradiation and power consumption data of a house in St. John's, New found land which was used for the feasibility study of a hybridenergy system.

©IJRASET: All Rights are Reserved

Volume 5 Issue V, May 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

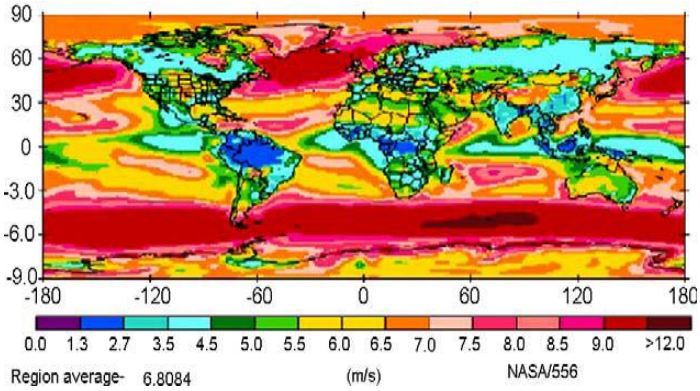


Fig.2. Global wind energy potential [75].

Wind power is one of the most efficient alternative energy sources. India is having a net potential of about 45000 MW only from 13 identified states. Wind resources can be exploited mainly in areas where wind power density is at least 400 W/m2 at 30 m above the ground. An annual mean wind power density greater than 200 W/m2 (watts per square meter) at 50-m height has been recorded at 211 wind monitoring stations, covering 13 states and union territories. India's wind power potential has been assessed at 45,000 MW. Acapacity of 15700MW has been installed. Solar power has so far played an almost non-existent role in the Indian energy mix. The grid-connected capacity in the country now stands at 481.48 MW, while the total solar energy potential has been estimated at 50,000 MW. Most parts of India have 300 – 330 sunny days in a year, which is equivalent to over 5000 trillion kWh per year. Average solar incidence stands at a robust 4 – 7 kWh/sqmtr/day.

States /UTs	Estimated potential (MW)	
	@ 50 m ($)	@ 80 m (* #$)
Andaman & Nicobar	2	365
Andhra Pradesh	5394	14497
Arunachal Pradesh*	201	236
Assam*	53	112
Bihar	-	144
Chhattisgarh*	23	314
Dieu Damn	-	4
Gujarat	10609	35071
Haryana	-	93
Himachal Pradesh *	20	64
Jharkhand	-	91
Jammu & Kashmir *	5311	5685
Karnataka	8591	13593
Kerala	790	837
Lakshadweep	16	16
Madhya Pradesh	920	2931
Maharashtra	5439	5961
Manipur*	7	56

©IJRASET: All Rights are Reserved

Volume 5 Issue V, May 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Meghalaya *	44	82
Nagaland *	3	16
Orissa	910	1384
Pondicherry	-	120
Rajasthan	5005	5050
Sikkim *	98	98
Tamil Nadu	5374	14152
Uttarakhand *	161	534
Uttar Pradesh *	137	1260
West Bengal*	22	22
Total	49130	102788

Table 1. Estimation of installable wind power potential at 80 m level

Wind potential has yet to be validated with actual measurements.
Estimation is based on meso scale modeling (Indian Wind Atlas).
As actual land assessment is not done on a conservative consideration 2 % land availability for all states except Himalayan & North eastern states, Andaman Nicobar Islands and Poor windy states has been assumed. In other area 0.5% land availability has been assumed.

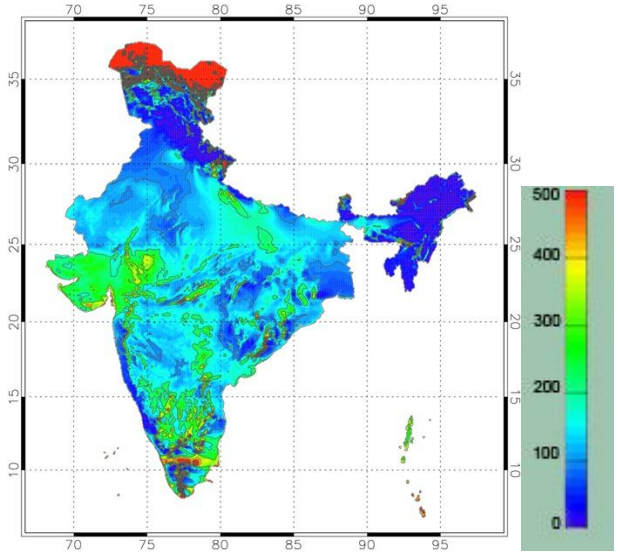


Fig3. Wind power density map at 80 m level[76]

III. UNIT SIZING AND OPTIMIZATION

After pre-feasibility study the selection of proper sizing ofequipment is made based on weather data and maximum capacity.The unit sizing of integrated power system plays an important rolein deciding the reliability and economy of the system. In thissection, study by the different researchers discussing differentmethods to determining the wind generator capacity and thenumber of PV panels and other sources and number of batteryneeded for the stand-alone system is reviewed. Using the measured data of solar and wind energy at agiven location, author employ a simple graphical construction todetermine the optimum configuration of the two generators thatsatisfies the energy demand of the user throughout the year. Kattiand Khedkar [9] develop the algorithm uses hourly average windspeed, insolation, and power demand to determine the wind/PVgeneration capacities required to meet the demand without loss ofpower supply probability (LPSP). Elhadidy and Shaahid [24–26]calculated optimum battery storage size for hybrid wind energysystem by studying an impact of variation of battery storagecapacity on hybrid power generation. Tradeoff between size

©IJRASET: All Rights are Reserved

of the storage capacity and diesel power required for the load, assuming aconstant wind power output, was also reported by the authors. In2006, Koutroulis et al. [19] presented a methodology for optimalsizing [31] of stand-alone PV/WG systems using genetic algorithms.They applied design approach of a power generationsystem, which supplies a residential household.Optimum size of hybrid PV/wind energy system can becalculated on an hourly basis [17] or on the basis of daily averagepower per month, the day of minimum PV power per month, andthe day of minimum wind power per month. Performance ofhybrid PV/wind energy system was compared on hourly basis; byfixing the capacity of wind generators, yearly loss of loadprobability (LOLP) with different capacity of PV array and batterybank were calculated. Trade off curve between the battery bank and PV array capacity for given LOLP helps to find optimum configuration at least cost. They employs a linear programming techniques [34] to minimize the average production cost ofelectricity while meeting the load requirements in a reliablemanner, and takes environmental factors into consideration bothin the design and operation phases.

Yang [8] developed a novel optimization sizing model forhybrid solar–wind power generation system. To optimize thecapacity sizes [29] of different components of hybrid solar–windpower generation systems employing a battery bank, the authorsalso calculated battery size requirements to achieve desired levelof autonomy by using system performance simulation model. Itis observed that for achieving high autonomy, a backupgenerator is required and in turn reduces battery storagecapacity. Hancock et al. [61] discussed the approach to optimizehybrid PV/wind/battery system with conventional power plantand calculated optimal system configuration on the basis of Lifecycle cost.

National Renewable Energy Laboratory (NREL)'s,Hybrid Optimization Model for Electric Renewable (HOMERversion 2.19) [73] has been used as the sizing and optimizationsoftware tool [72]. It contains a number of energy componentmodels and evaluates suitable technology options based on costand availability of resources. Analysis with HOMER requires information on resources, economic constraints, and controlmethods. It also requires inputs on component types, theirnumbers, costs, efficiency, longevity, etc. Sensitivity analysiscould be done with variables having a range of values instead of a specific number.

IV. MODELING OF HYBRID RENEWABLE ENERGY SYSTEM (HRES) COMPONENTS

Literature review reveals that over the last decades, HRES applications are growing rapidly and HRES technology has provenits competitiveness for remote area applications. It is observed that approximately 90% of studies reported are on design/economic aspects of HRES. However, fewer studies were reported on control of HRES. Utility interactive HRES [68] has yet not gained the popularity. It is expected that within the next few years HRES becomes competitive with utility grid power for wide spread distributed applications. Hence, there is a need to investigate potential and performance of PV and wind energy system to calculate level of penetration in existing networks of developed or developing countries in order to improve quality of power supply.The simulation results prove the operating principle, feasibilityand reliability of this proposed system. Solar/diesel/battery hybrid power systems [23,67] have been modeled for the electrification oftypical rural households and schools in remote areas.

V. FUTURE TRENDS FOR DESIGN AND OPERATION OF HYBRID ENERGY SYSTEM

This system can be considered for sustainable hybrid energy system, designed on two modes. One is standalone and other is grid-assisted mode. In stand-alone mode, it draws power from the wind–solar hybrid energy system. In the grid-assisted mode, when the hybrid system is unable to feed the power, it automatically takes the grid power. If the site-specific data is not available, one may use nearest meteorological station data in designing the system. The system voltage variation, the frequency, waveform and power factor at the time of grid connection, must be maintained within the limits. One can improve the power quality depending upon the local conditions. Hybrid energy flow is controlled using power electronic converters. This energy would be useful in many applications such as ship power systems, electric hybrid vehicles, telecommunication industries, rural electrification etc.

Further R&D improvements in solar PV and wind technologies will reduce the cost of renewable energy sources. The cost of conventional energy resources is increasing every year. This system is going to be economical in future. Besides the cost, the environmental benefits are likely to facilitate the widespread use and acceptance of these systems

VI. CONCLUSIONS

The hybrid energy systems are recognized as a viable alternative to grid supply or conventional, fuel-based, remote area power supplies all over the world. The review reveals that, renewable energy based low emission hybrid systems are not cost competitive

©IJRASET: All Rights are Reserved

against conventional fossil fuel power systems. However, the need for cleaner power and improvements in alternative energy technologies bear good potential for widespread use of such systems. Moreover, the rural households in industrialized and less developed countries attach high value to be liable, limited supply of electricity. Community facilities such asrural hospitals, schools, telecommunication and water pumpingstations can contribute significantly to the welfare of people andrural development. While it is recognized that technology can only be one aspect of community development, the renewable energysystems have demonstrated the potential to provide support insome of the basic infrastructure needs in remote and urban areas for different application. Although the cost reduction and technological development of hybrid energy systems in recent years has been encouraging, stillthey remain an expensive source of power. To allow the widespread application of this emerging technology, there is a need forfurther R&D improvement in solar PV and wind technologies thatcan reduce the cost of hybrid system. The cost of conventional energy resources is increasing every year, but the receding trend inthe cost of renewable energy technologies because of its widespreaduse is encouraging factor, projecting RES system an economical means of power generation in future for many standalone applications.

REFERENCES

[1] Wu JC, Liu TS. A sliding-mode approach to fuzzy control design. IEEE Transactions on Control Systems Technology 1996;4(2):141–51.
[2] Elhadidy MA, Shaahid SM. Role of hybrid (wind + diesel) power systems in meeting commercial loads. Renew Energy 2004;29(1):109–18.
[3] Yang HX, Lu L, Burnett J. Weather data and probability analysis of hybrid photovoltaic—wind power generation systems in Hong Kong. Renew Energy 2003;28(11):1813–24.
[4] Karki R, Billinton R. Reliability/cost implications of PV and wind energy utilization in small isolated power systems. IEEE Transactions on Energy Conversion 2001;16(4):368–73.
[5] Senjyu T, Hayashi D, Urasaki N, Funabashi T. Optimum configuration for renewable generating systems in residence using genetic algorithm. IEEE Transactions on Energy Conversion 2006;21(1):459–67.
[6] Tina G, Gagliano S, Raiti S. Hybrid solar/wind power system probabilistic modeling for long-term performance assessment. Science Direct Solar Energy 2006;80(9):578–88.
[7] Onar OC, Uzunoglu M, Alam MS. Dynamic modeling, design and simulation of a wind/fuel cell/ultra-capacitor-based hybrid power generation system. Journal of Power Sources 2006;161:707–22.
[8] Yang H, Lu L, Zhou W. A novel optimization sizing model for hybrid solar–wind power generation system. Solar Energy Journal 2007;81:76–84.
[9] Katti K, Khedkar MK. Alternative energy facilities based on site matching and generation unit sizing for remote area power supply. Renewable Energy 2007;32(2):1346–66.
[10] Shahirinial AH, Tafreshi SMM, Hajizadeh A,Gastaj, Moghaddamj AR. Optimal sizing of hybrid power system using genetic algorithm. IEEE Transactionb 2006;11:212–8.
[11] Deshmukha MK, Deshmukh SS. Modeling of hybrid renewable energy systems. Renewable and Sustainable Energy Reviews 2006;12(7):1–15.
[12] Valenciaga F, Puleston PF. Supervisor control for a stand-alone hybrid generation system using wind and photovoltaic energy. IEEE Transactions on Energy Conversion 2005;20(2):398–440
[13] Kolhe M, Agbossou K, Hamelin J, Bose TK. Analytical model for predicting the performance of photovoltaic array coupled with a wind turbine in a standalone renewable energy system based on hydrogen. Renewable Energy 2003;28(5):727–42
[14] El-Shatter TF, Eskander MN, El-Hagry MT. Energy flow and management of a hybrid wind/PV/fuel cell generation system. Energy Conversion and Management 2006;47:1264–80
[15] Buckeridge JS, Ding JJ. Design considerations for a sustainable hybrid energy system. IPENZ Transactions 2000;27(1):1–5
[16] Bonanno F, Consoli A, Lombardo S, Raciti A. A logistical model for performance evaluations of hybrid generation systems. IEEE Transactions on Industry Applications 1998;34(6):1397–403
[17] Kellogg WD, Nehrir MH, Venkataramanan G, Gerez V. Generation unit sizing and cost analysis for stand-alone wind photovoltaic and hybrid wind/PV systems. IEEE Transactions on Energy Conversion 1998;13(1):70–5
[18] Jain S, Agarwal V. An integrated hybrid power supply for distributed generation applications fed by non-conventional energy sources. IEEE Transactions onEnergy Conversion 2008;13(4):124–30.
[19] Koutroulis E, Kolokotsa D, Potirakis A, Kalaitzakis K. Methodology for optimal sizing of stand-alone photovoltaic/wind-generator systems using genetic algorithms. Solar Energy 2006; 80(3):1072–88
[20] Kaldellis JK, Vlachos GTh. Optimum sizing of an autonomous wind–diesel hybrid system for various representative wind-potential cases. Applied Energy b2005; 83:113–32
[21] Das D, Esmaili R, Dave Nichols LX. An optimal design of a grid connected hybrid wind/photovoltaic/fuel cell system for distributed energy production. IEEE 2005;23(5):2499–505.
[22] KhanMJ, Iqbal MT. Pre-feasibility study of stand-alone hybrid energy systems for applications in Newfoundland. Renewable Energy 2005;30(6):835–54\
[23] Nelson DB, Nehrir MH, Wan C. Unit sizing of stand-alone hybrid wind/PV/fuel cell power generation systems. IEEE Transaction 2005;134–66
[24] Shaahid SM, Elhadidy MA. Opportunities for utilization of stand-alone hybrid (photovoltaic + diesel + battery) power systems in hot climates. Renew Energy 2003;28(11):1741–53
[25] Elhadidy MA, Shaahid SM. Role of hybrid (wind + diesel) power systems in meeting commercial loads. Renewable Energy 2004;29(12):109–18
[26] Elhadidy MA, Shaahid SM. Optimal sizing of battery storage for hybrid (wind + diesel) power systems. International Journal of Renewable Energy 1999;18(1):77–86

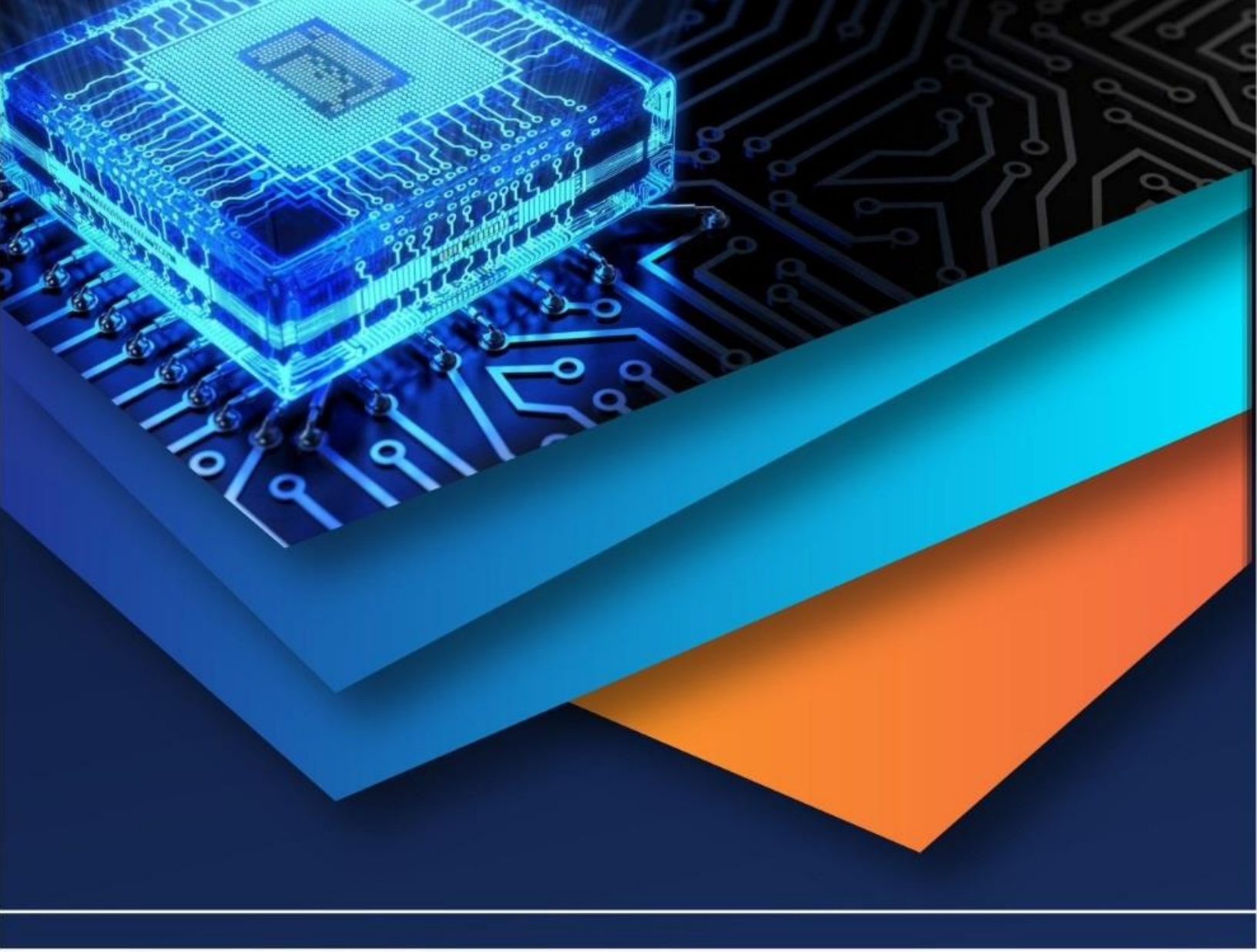
©IJRASET: All Rights are Reserved

[27] Bansal RC, Bhatti TS, Kothari DP. Automatic reactive power control of winddiesel- micro-hydro autonomus hybrid power systems using ANN tuned static var Com/pensator. IEEE Transaction 2003;14(3):182–8
[28] Bansal RC. Automatic reactive power control of wind–diesel hybrid power systems. IEEE Transaction on Industrial Electronics 2006;53(4):1116–26
[29] Seeling GCH. A combined optimization concept for the design and operation strategy of hybrid–PV energy systems. Solar Energy 1997;61(2):77–87
[30] Rahman S, Chedid R. Unit sizing and control of hybrid wind–solar power systems. IEEE 1996;12(1):79–85
[31] Capizzi G, Tina G. Long-term operation optimization of integrated generation systems by fuzzy logic-based management. Energy 2007;32:1047–54
[32] B. Beltran, T. Ahmed-Ali, M. El HachemiBenbouzid, Sliding mode power control of variable-speed wind, IEEE Transactions on Energy Conversion, 2008, on-line
[33] Borowy BS, Sa1ameh ZM. Dynamic response of a stand-alone wind energy conversation system with battery energy storage to a wind gust. IEEE Transactions on Energy Conversation 1997;12(1):73–8
[34] Protogeropoulos C, Brinkworth BJ, Marshall RH. Sizing and techno-economical optimization for hybrid solar photovoltaic/wind power systems with battery storage. International Journal of Energy Review 1997;21:465–7
[35] Giraud F, Salameh ZM. Steady-state performance of a grid-connected rooftop hybrid wind–photovoltaic power system with battery storage. IEEE Transactions on Energy Conversion 2001;16(1):1–7
[36] Meurer C, Barthels H, Brocke WA, Emonts B, Groehn HG. PHOEBUS—an autonomous supply system with renewable energy: six years of operational experience and advanced concepts. Solar Energy 1999;67:131–8
[37] Wichert B. PV-diesel hybrid energy systems for remote area power generation— a review of current practices and future developments. Sustainable Renewable Energy Review 1997;1(3):209–28.
[38] Celik AN. A simplified model for estimating the monthly performance of autonomous wind energy system with battery storage. Renew Energy 2003;28(4):561–72
[39] Bhatti TS, Al-ademi AAF, Bansal NK. Load-frequency control of isolated wind diesel–microhydro hybrid power systems. Energy 1997;22(5):461–70.
[40] Chedid RB, Karaki SH, El-Chamali C. Adaptive fuzzy control for wind–diesel weak power system. IEEE Transactions on Energy Conversion 2000;15(1):71–
[41] Koutroulis E, Kalaitzakis K, Voulgaris NC. Development of a microcontrollerbased photovoltaic maximum power poin
[42] Ai B, Yang H, Shen H, Liao X. Computer-aided design of PV/wind hybrid system. Renew Energy 2003;28(10):1491–512
[43] Markvart T. Sizing of hybrid photovoltaic–wind energy systems: solar energy. IEEE Transactions on Energy Conversion 1998;57:277–81
[44] Bhave AG. Hybrid solar–wind domestic power generating system—case study. Renew Energy 1999;17(3):355–8
[45] Yeh T-H, Wang L. A study on generator capacity for wind turbines under various tower heights and rated wind speeds using Weibull distribution, IEEE Transactions on Energy Conversion, 2008, on-line
[46] Dehbonei H, Nayar CV, Chang L. A new modular hybrid power system. In: IEEE Transaction. 2003. p. 983–90
[47] ArifujjamanMd, Tariq Iqbal M, John E, Quaicoe M, Jahangir Khan. Modeling and control of a small wind turbine. IEEE transaction 2005;778–8
[48] Celik AN. The system performance of autonomous photovoltaic–wind hybrid energy systems using synthetically generated weather data. Renewable Energy 2002;27:107–21
[49] Bakos GC. Feasibility study of a hybrid wind/hydropower system for low-cost electricity production. Applied Energy 2002;72:599–608
[50] Maskey RK, et al. Hydro based renewable hybrid power system for rural electrification. IEEE Transaction 2002;12:445–54.
[51] Jimmy Ehnberg SG, Bollenb MHJ. Reliability of a small power system using solar power and hydro. Electric Power Systems Research 2005;74:119–27
[52] Karaki HS, Chedid RB, Ramadhan R. Probabilistic performance assessment of autonomous solar–wind energy conversion system. IEEE Transactions on Energy Conversion 1999;14(3):766–72
[53] Valenciaga F, Puleston PF, Battaiotto PE, Mantz RJ. Passivity/sliding mode control of a stand-alone hybrid generation system. IEE Proceedings on Control Theory and Applications 2000;147(6, November)
[54] Ding JJ, Buckeridge JJ. Design considerations for a sustainable hybrid energy system. UNITECH Institue of Technology-IPENZ Transactions, vol. 27(1), Auckland; 2000. p. 1–5
[55] Fung CC, Rattanongphisat W, Nayar C. A simulation study on the economicaspects of hybrid energy systems for Remote Islands in Thailand. IEEE Transaction 2002;8:25–32
[56] Park SJ, Kang BB, Yoon JP, Cha 1S, Lim JY. A study on the stand-alone operating or photovoltaic wind power hybrid generation system. 35th annual IEEE power electronics specialists conference 2004;2095–9.
[57] Lund H. Renewable energy strategies for sustainable development. Energy 2007;32:912–9
[58] Ahmed NA, Miyatake M. A stand-alone hybrid generation system combining solar photovoltaic and wind turbine with simple maximum power point tracking control. IPEMC-IEEE; 2006.p 123–34
[59] Abdin S, Xu W. Control design and dynamic performance analysis of a wind turbine-induction generator unit. IEEE Conference 1998;1198–205
[60] Meyer T, Isorna F, Sauer DU, Ben J. Integrated design approach for PVHybridsystems' 3rd world conference on photovoltaic energy conversion at Osaka, Japan, 11–18 May 2003. p. 2415–18
[61] Hancock M, Outhred HR, Kaye RJ. A new method for optimization the operation of stand-alone PV hybrid power systems. In: 1994 IEEE First WCPEC; 1994.p. 1188–91
[62] Osama O, Egon O, Danny M. An online control strategy for DC coupled hybrid power systems. IEEE Power Engineering Society General Meeting 2007;108–12
[63] Yang JM, Cheng KWE, Wu J, Dong P, Wang B. The study of the energy management system based-on fuzzy control for distributed hybrid wind-solar power system. In: Proceedings of first international conference on power electronics systems and applications; 2004. p. 113–7
[64] Bhagwan Reddy J, Reddy DN. Probabilistic performance assessment of a roof top wind, solar photo voltaic hybrid energy system. RAMS IEEE 2004;654–8
[65] Reddy KN, Agarwal V. Utility interactive hybrid distributed generation scheme with compensation feature. IEEE Transactions on Energy Conversions Sep 2007;22(3):666–73.

©IJRASET: All Rights are Reserved

[66] Lew DJ, Barly CD, Flowers LT. Hybrid wind photovoltaic system for households in Inner Mongolia. In: International conference on village electrification through renewable energy; 1997.p. 123–32
[67] Schmit W. Modeling and simulation of photovoltaic hybrid energy systems optimization of sizing and control. In: IEEE conference. 2002. p. 1656–67
[68] Senjyu T, Nakaji T, Uezato K, Funabashi T. A hybrid power system using alternative energy facilities in isolated island. IEEE Transactions on Energy Conversions 2005;20(2, June):406–14
[69] El-Shater TF, Eskander M, El-HagryM.In: 36th intersociety energy conversion engineering conference; Hybrid PV/fuel cell system design and simulation 2001;112–21
[70] Chen YM, Cheng CS, Wu HC. In: Proceedings of IEEE APEC. Grid-connected hybrid PV/wind power generation system with improved dc bus voltage regulation strategy 2006;1089–94
[71] http://www.energysolutionscenter.org
[72] http://www.bergey.com/
[73] http://www.nrel.gov.com/homer
[74] http://eosweb.larc.nasa.gov/sse
[75] http://news.cnet.com/greentech
[76] Wind energy data from http://www.cwet.tn.nic.in/html/departments_ewpp.html : [accessed on 25/02/2013]

©IJRASET: All Rights are Reserved



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)