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# REVIEW OF OPTIMIZATION OF AC-DC HYBRID MICRO-GRID

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**Abstract**
Demand for energy has increased tremendously throughout the world due to increase numerous of loads, equipments and automation of every manual activities. These also have been high growth in population, industries and manufacturing units whose demand need to meet. Such a hike in load demand has moved mankind on the erg of critical stage of energy crisis as the generation of power throughout the sector mostly depends on conventional source of energy. This high consumption of fuel and demand of power is also a reason to blame upon for hike in fuel cost thereby the per unit Power production cost. In past few decades Renewable energy has emerged as boon for the crisis, it is one of the most important alternative energy sources. Renewable energy sources are environmental friendly, economically competitive with conventional power generation. Growth in manufacturing and newer high efficiency power converters and semiconductor devices has made the use of Renewable energy resources like Wind and solar power generation economically feasible also But renewable energy alone does not prove to be solution due to low energy conversion ratio and high initial construction cost**.**

## Introduction

Renewable and alternative energy distributed generation (DG) sources, energy storage, and combined heat and power (CHP) are very promising technologies which can help reduce undesired emissions and fossil fuel dependence, and improve energy efficiency and reliability. While DG technologies are able to operate on their own, higher efficiency can be obtained by incorporating energy storage and CHP (when possible) as a hybrid system [1].
The intermittent nature of renewable energy generation sources, such as photovoltaic (PV) and wind power generation, has effects on the stability of the grid and availability of power [2]. One way to increase the benefits of those technologies and mitigate their negative impacts is to use access and capacity-oriented energy storage. Access-oriented energy storage uses fast-acting energy storage technologies, such as a super capacitor or flywheel, to respond quickly to the rapid changes in generation and load. Currently, some studies have focused on optimizing PV/wind/diesel hybrid energy systems so that the capacity of wind system, PV array arrangements, number of diesel generators, and storage battery are optimally selected [2]–[6].

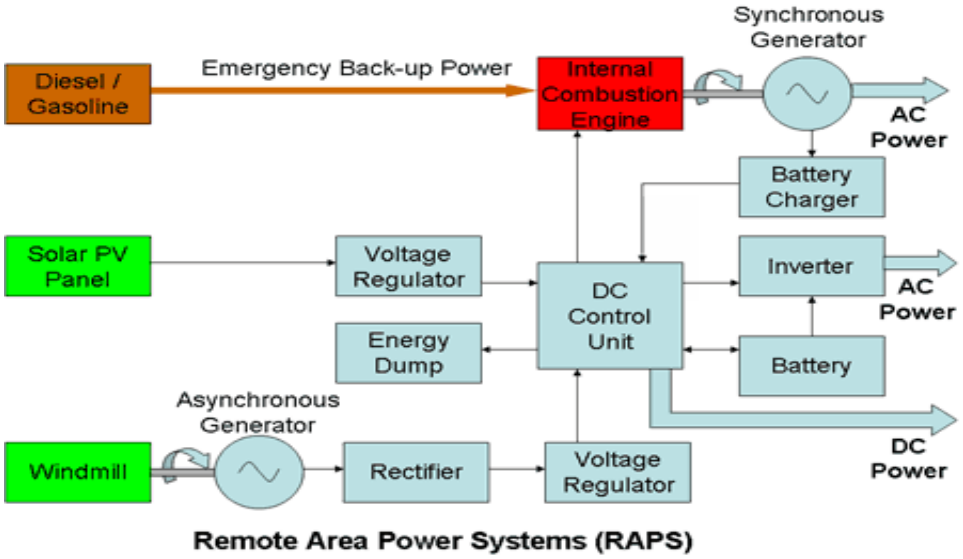


**Figure 1: Remote Power System**

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**Literature review**

To get the continuous power from renewable energy sources hybrid system installation is increasing day by day, which can provide the reliable power. Lot of researchers has suggested different ways of optimization of hybrid system, interfacing of hybrid system with grid etc. Here the brief note of the work which has been already presented in the subject area is presented by Siddique, A R M et al.

Siddique, A R M et al. [7] Planned that energy economical renewable energy based mostly Base System for an isolated location, like Saint Martin's Island. Saint Martin's island is one amongst the foremost lovely holidaymaker's island in People's Republic of Bangladesh wherever grid connected electrical system for the residents and for the communication system won't be doable to launch even in future. The residential shoppers use diesel, fuel and wood to cope through their energy requirements.

Mohamed El Badawe et al. [8] counsel that Telecommunication towers settled in remote locations area unit usually hopped-up victimization diesel generators and batteries. However, diesel generators need higher maintenance price and for remote sites this price are going to be additionally high because of the extra oil transportation price. Maximizing the employment of renewable energy is helpful in reducing the diesel generation price. This work describes the enhancement of a hybrid system to provide power for a telecommunication tower settled in Mulling, Labrador. This micogrid composed of diesel generator, wind, solar and battery bank. Hybrid improvement Model for electrical Renewable (HOMER) software system was used for the size and sensitivity analysis which is performed so as to get the optimum setup enhancement of hybrid renewable energy system.

S. M. Hakimi et al. [9] hereby, a completely unique intelligent methodology is applied to the matter of filler during a hybrid facility such the demand of dominion is met. Its study is performed for Kahnouj space in south-east Iran. It's to say that there are several similar regions round the world with this typical scenario that may be distended. The system contains fuel cells, some wind units, some electrolyses, a reformer, Associate in Nursing anaerobic reactor, and a few chemical element tanks. The system is assumed to be complete associate in Nursing uses the biomass as an offered energy resource. System prices involve investments, operation, maintenance and replacement. Costs are all empirical and parts are offered for commercially available units. During this study, the analysis is done on load growth and differing types of load profile for the considered system. During this study in village, four varieties of load among hundreds exist, like residential, agricultural, industrial, and official

**Hybrid System And Its Importance**

Hybrid System and its Importance in Hybrid technology has developed and upgraded in the resent years but the effectiveness and advantages of renewable energy source are unchallenged. Hybrid systems are used in many houses of rural as well urban areas. Since hybrid system is more economical than single renewable energy system hence many island installed hybrid system which is also called microgrid. The main function of hybrid system including solar, wind and storage battery system is shown in fig. 2.

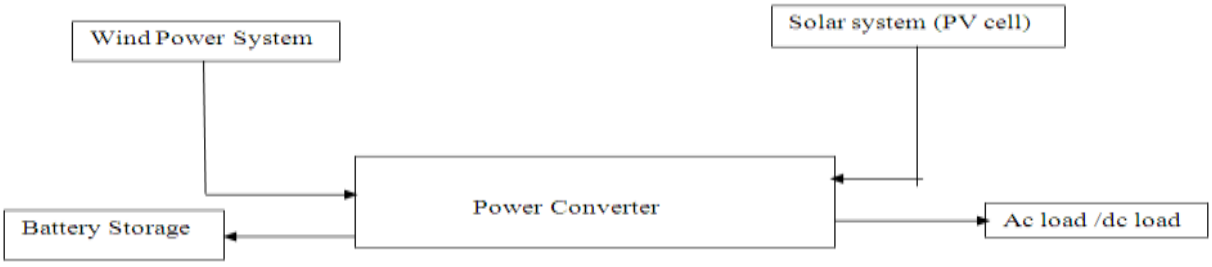


**Figure 2: Schematic diagram of hybrid system**

In hybrid wind power generate AC power whereas Photovoltaic cells produce DC power, thereby Power Electronics based Power convertors are used in this system for conversion from AC to DC or DC to AC for different loads and battery charging application.

This specific hybrid system shown in fig. 31 has many benefits such as:

- Solar and wind power obtained by nature so no need of fuel for the operation of wind and solar power so it is free of cost.
- Since solar and wind system does not induced any type toxic gages so do not pollute the environment.
- Solar power can be induced during the day and wind power can be obtained on day as well as night so the need of power can be fulfilled by combination of both systems.

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**Advantages of the Hybrid Systems**

***a. Improved Economics***

Hybrid power systems contain PV cell array and storage batteries to support the expected load profile and a diesel generator that runs to charge the batteries also used to provide power during bad weather conditions. This means that hybrid power systems are cheaper to run compared to the conventional stand-alone systems.

***b. Lower initial Cost***

A hybrid systems consisting of a diesel engine generator, wind generator system and PV cell modules cost less than a PV stand-alone system to equal size.

***c. Increased Reliability***

Hybrid system consist more than one sources so it always ready to supply power to load. So hybrid system is reliable than single source system.

***d. Design Flexibility***

Hybrid systems are very flexible in terms of design as it contains more than one power sources. System designers strive the best load mix between connected systems.

**Photovoltaic Array**

The photovoltaic cells structure of solar cell is quite simple. It has 6 different layers of materials as shown in fig. 3.3. First layer of the cell is a black cover glass surface which helps in absorption of photon efficiently and provides protection of the cell from the atmosphere elements. Second layer is an antireflective coating which helps to reduce the reflection losses from the photons to less than 5%.

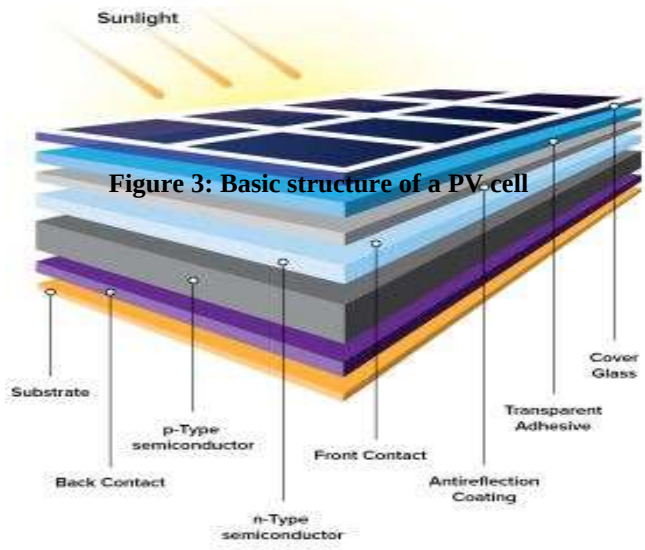


**Figure 3: Basic structure of a PV cell**

Semiconductors p-n junction forward operation type

Semiconductors p-n junction forward operation type The photovoltaic cells is a combination of 2 semiconductors p-n junction forward based operation, both layer p and n are made of crystalline silicon. The n-type semiconductor is created when the material have five valance of electron like phosphorus is added in silicon material. In the crystal silicon atoms are replaced by atoms of phosphorus which has higher valence band. So we can say that an n-type semiconductor is being created which has a surplus of free electrons in its valence band. Similarly a p-type layer is formed when some of the atoms of the Si silicon are replaced by atoms with lower valence like boron called holes. Combination of p and n type semiconductor material create a p-n junction, while an electric field is set up in depletion region.

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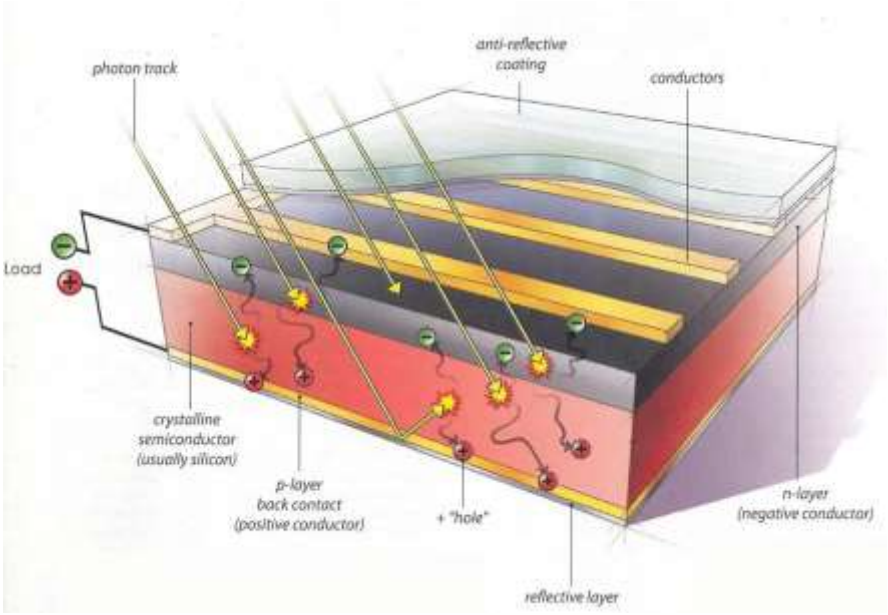


**Figure 4: Operation of a p-n junction PV cell**

**Main Cell Types**

Silicon is widely used in the industry for the construction of the p-n junction PV cell. The main source of silicon is SiO2 which is finding inside the sand. The final product of silicon is characterized by high purity 99.99%. The photovoltaic cells of silicon are distinguished in four categories and it depending on the structure of the basic material from which they are made.

These are classified as follows:

A. **Single-Crystal Silicon**

The basic material used for the construction of single crystal silicon is mono-crystalline silicon. In order to make them first silicon is purified then melted, and crystallized into ingots. The ingots are sliced into thin wafers for the preparation of individual cells. The efficiency of a single crystal silicon cell is low and it oscillates between 13-16%. The manufacturing cost of this type crystal is high and has a dark blue.

B. **Polycrystalline Silicon**

The Polycrystalline Silicon cell is relatively large in size and it can be easily formed into a square shape. It can virtually eliminate any inactive area between cells. The efficiency of Polycrystalline Silicon obtained between 10-14%. It is characterized by lower cost silicon and has light blue.

1.1 **Ribbon Silicon**:

Ribbon silicon type crystal used for the manufacturing of photovoltaic cells is made by producing a ribbon from the molten crystal silicon instead of an ingot. Its efficiency is around 13%. It is very expensive with a limited industrial production.

**1.1.1 Advantages of PV Cell Systems**

Photovoltaic modules can easily install in the isolated areas. Since the electrical power produce by PV cell by using Sun light so it is very economic and free from environmental pollution. PV cell advantages are follows:

- The maintenance cost of PV cell is very low.
- Operation cost of PV cell is almost zero, because they do not required any fuel for the production of electrical power.

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- Not much variability in their efficiency and more reliable results.
- Noise effects in the PV cell are zero during their operation.
- It is work on the principal of conservation of energy.
- PV cell is free from environmental emissions.

## WIND ENERGY SYSTEM

### *The Wind*

The Wind energy can be converted into useful form of energy by conservation law of energy. It can be converted in electrical power, wind mill used to convert wind power into mech. power, wind pumps to pump the water or drainage sails to propel ships etc by using wind turbine generating system. For the production of electrical power in large amount many numbers of wind farms consist of many units of wind turbines are connected to each other's and these are connected to the electric grid or transmission network. For any new construction, wind generation for electricity proves to be cheaper than other conventional methods.

For the supply of power to the isolated system, small wind farms installed near to the location. Service companies buy surplus electricity produced by small domestic wind turbines system. Offshore winds is steadier, stronger and have less visual impact than on land farms, but construction and maintenance costs of offshore wind systems are considerably higher.

Wind power, as an alternative to fossil fuels because,

- It is Surplus
- Its reusable
- Widely distributed
- Clean
- No greenhouse gas emissions during operation.

The effects on the environment are generally less problematic than other power sources.

### *Classification of Wind Turbine*

Wind machines, which used to harvest wind energy, are called wind turbines. Wind Turbines has been classified as per orientation of their axes with respect to the direction of the wind on their blade. Among the modern wind turbines, these can be categorized basically as: A. Horizontal axis and B. Vertical axis turbines.

### A. *Horizontal Axis Wind Turbines*

Axis of horizontal wind turbine is oriented so as to get it parallel to the ground and winds direction, but in some of models it is also seen that axis of turbine is vertical to the winds direction. Which is also known as head on and cross-wind type respectively. If the operation of turbine is such a way that it's blade is in front of the wind then its called up-wind or if blade is behind the wind then it is called down-wind. They have many types of construction and varying number of blades. Majority of wind turbines used all over the world is horizontal axis, which is about 90%

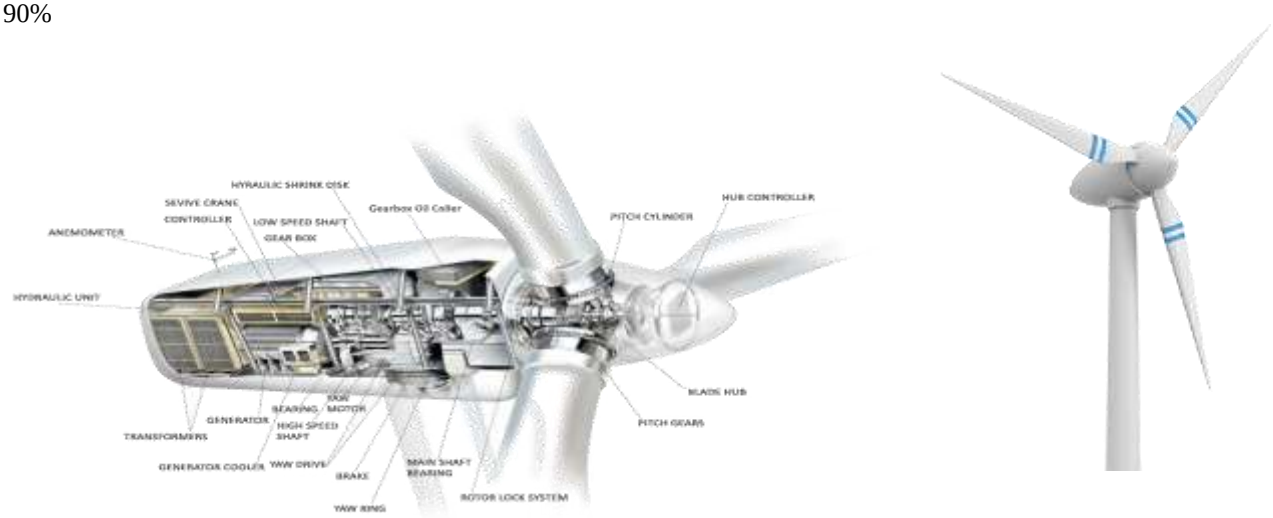


**Figure 5: The horizontal axis wind turbine**

### B. *Vertical Axis Wind Turbines*

It is a omni directional turbine i.e. it supports wind from all the direction for rotation of the blade which is placed vertically, there may not be any need of repositioning the rotor when there is variation in wind direction. Another major fact is that its construction is simple and space saving.

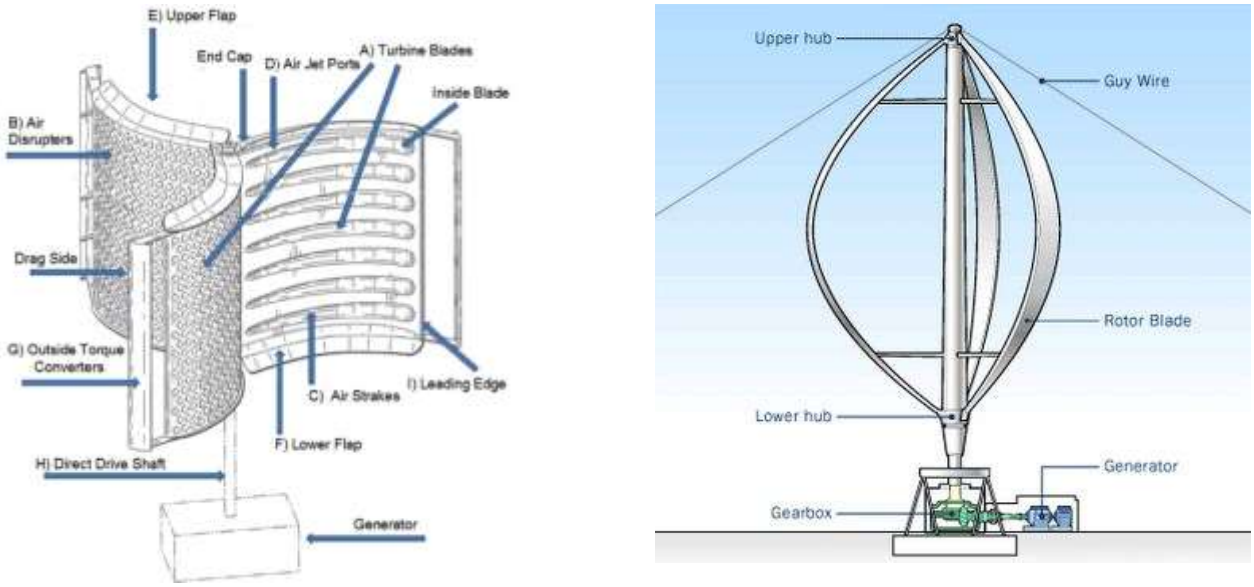


**Figure 6: (a) Savonius-type vertical axis turbine (b) Darrieus-type vertical axis turbine**

The turbine found most commonly are savonius which is omni directional type and wind tracking system is preserved. The turbine named Darrieus is very common in the market. They hold about 2-3% of the winds world's trade. Fig 6 shows a vertical axis wind turbine. Aerodynamic efficiency of these turbines is quite good for percentage of energy conversion. It is also independent of the winds direction i.e. they are Omni directional. They have low manufacturing cost and controlling mechanism is also simple.

**Conclusion**

For this work the Homer V3.4.2 has been successfully employed to optimize the combination of sources of PV array, Wind turbine and diesel generator to get to optimized value of operational cost along with meeting the load demand. The conclusion of presented work is mentioned below.

The monthly average production electricity by PV array production is 32.87% of of total generation and that of wind turbine generated power Nominal of complete system. The optimization results the best optimal combination of energy system components. Total NPC-$2826075, COE $0.301and operating cost, The payback time of complete system is about 25 years.

As discussed and proposed model in this thesis proves to be most economic and viable solution to cope through power issue by using renewable power generation sources of wind and PV which proves to b more economic too over the conventional power sources.

**Reference**

[1]. M. H. Nehrir, C. Wang, K. Strunz, H. Aki, R. Ramakumar, J. Bing, Z. Miao, and Z. Salameh, 'A Review of Hybrid Renewable/Alternative Energy Systems for Electric Power Generation: Configurations, Control, and Applications', *Sustainable Energy, IEEE Transactions on*, vol. 2, no. 4. pp. 392–403, 2011.

[2]. A. Kashefi Kaviani, G. H. Riahy, and S. H. M. Kouhsari, 'Optimal design of a reliable hydrogen-based stand-alone wind/PV generating system, considering component outages', *Renew. Energy*, vol. 34, no. 11, pp. 2380–2390, Nov. 2009.

[3]. J. L. Bernal-Agustín, R. Dufo-López, and D. M. Rivas-ascaso, 'Design of isolated hybrid systems minimizing costs and pollutant emissions', *Renew. Energy*, vol. 31, no. 14, pp. 2227–2244, Nov. 2006.

[4]. R. Dufo-López, J. L. Bernal-Agustín, J. M. Yusta-Loyo, J. A. Domínguez-Navarro, I. J. Ramírez-Rosado, J. Lujano, and I. Aso, 'Multi-objective optimization minimizing cost and life cycle emissions of stand-

alone PV–wind–diesel systems with batteries storage', *Appl. Energy*, vol. 88, no. 11, pp. 4033–4041, Nov. 2011.

[5]. M. A. Elhadidy and S. M. Shaahid, 'Parametric study of hybrid (wind + solar + diesel) power generating systems', *Renew. Energy*, vol. 21, no. 2, pp. 129–139, Oct. 2000.

[6]. S. M. Hakimi, S. M. Moghaddas-Tafreshi, and H. HassanzadehFard, 'Optimal sizing of reliable hybrid renewable energy system considered various load types', *J. Renew. Sustain. Energy*, vol. 3, no. 6, 2011.

[7]. M. Badawe, T. Iqbal, and M. George, 'Optimal Sizing and Modeling of a Hybrid Energy System for a Remote Telecommunication Facility', *IEEE Newfoundl. Labrador Sect.*, vol. 21, 2011.

[8]. Kaiser, M S and A. R. M. Siddique, 'Optimal Hybrid Option Analysis for a Remote Location in Bangladesh', *Int. J. Adv. Renew. ENERGY Res.*, vol. 2, no. 2, pp. 777–784, 2013.

[9]. T. Khatib, A. Mohamed, K. Sopian, and M. Mahmoud, 'Optimal sizing of building integrated hybrid PV/diesel generator system for zero load rejection for Malaysia', *Energy Build.*, vol. 43, no. 12, pp. 3430–3435, Dec. 2011.