

Implementation of Hybrid Generation Power System in Pakistan

Qazi Waqar Ali, Muhammad Aamir, Arshad Nawaz, Zaki Udin, Shahid Ullah

Sarhad University of Science & Information Technology, Peshawar Pakistan

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ABSTRACT

A solar-wind hybrid power generation system has been presented here. The application based system illustrated in this paper is designed on the basis of the solar and wind data for Pakistan. The power generated by the system is intended for domestic use. The most common source of unconventional power in homes is battery based UPS (Uninterrupted power supply) inverter. The UPS inverter charges the battery with conventional grid power. This system will charge the battery of UPS inverter by using only wind and solar power, which will make the system cost effective and more reliable. The reason for using both solar and wind is that recent studies have proven that combined system can be more productive and consistent and other thing is that neither of them can be used for continuous power generation. In the system illustrated in this paper the solar-wind system provides power periodically which is controlled by electronic methods and a microcontroller is used to monitor the power from both the inputs. The switching action is provided from the microcontroller to the battery charging based on the power received from solar photovoltaic panel and wind generators. In this paper, an efficient system has been presented comprising of solar panel, wind generator, charge controller and charge storage unit (battery). Solar panel is selected as the main input and the wind resource will be used only in the absence of the solar photovoltaic (PV) output.

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Corresponding Author:

Qazi Waqar Ali,
Sarhad University of Science & Information Technology,
Peshawar Pakistan,
Email: engr_qazi@yahoo.com

1. INTRODUCTION

In the recent times the need for energy has increased globally. The electrical energy has now become the base for almost everything. This has made us to increase our energy production which in turn has put extra pressure on our non-renewable resources. The other way is to generate energy by using renewable resources of energy. The renewable resources like hydro power are being utilized to generate power but these projects take years to complete and there are lots of other factors involved which discourages these projects. The more suitable form of renewable energy in the modern era is the solar energy. The solar energy can be utilized in many ways. The two of the most basic uses of sun light to make electrical energy are:

- ✓ Solar Photovoltaic.
- ✓ Solar Thermal.

Solar photovoltaic is a system to convert light energy (photons) into electrical energy. Solar thermal means to use the heat energy of the sun to generate electrical energy thermally. The solar water heaters and steam based solar turbine are the systems where solar thermal technique is used. The paper presented here is based on the solar photovoltaic systems. The solar photovoltaic has given us the chance to become producer of easy and clean energy. The solar systems can be installed on a small house or a big industry. The solar panel uses the solar irradiance to generate electrical energy. A solar panel uses energy of the incident photons

on its surface to generate electrical charge. The solar panel consists of small silicon cells. The cell output voltage for a single cell is of the order of 0.7V (under open circuited conditions) which cannot be utilized for power generation. These cells are placed in series-parallel combinations to get usable voltage. The other renewable energy resource is the wind energy. The wind energy is utilized by converting the kinetic energy of wind in to rotational motion by using a wind turbine. This rotational motion is converted into usable electrical energy. For this purpose a wind generator has been used which contains a wind turbine and an alternator. The systems with only solar or wind generation are productive but there are problems linked with both of them. The solar power is not available for 24 hours and wind is not continuous all the time. So a hybrid system containing solar and wind has been designed to overcome these shortcomings. A system has been designed in this paper which utilizes both solar and wind power generation systems. Recent researches in the field of renewable resources shows that the solar and wind hybrid power generation system can work with increased outputs and increased practicality [6]. The block diagram of this system has been shown below

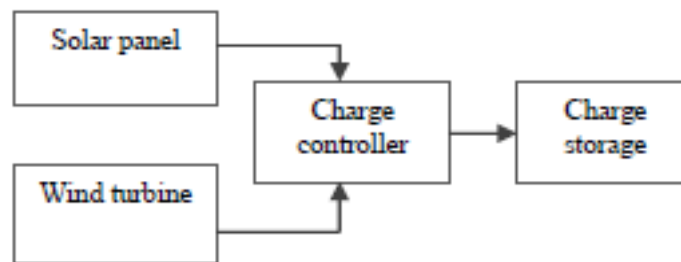


Figure 1. Blok diagram of the solar wind hybrid system

2. OBJECTIVES

The rising environmental pollution, limited fossil fuels and natural gas reserves and the unfriendliness of their use for electric power production is resulting in growing interests in the utilization of renewable sources of producing electrical energy. The emerging green technologies like photovoltaic and wind turbine generator technologies is creating opportunities for generating electric power in an harmless manner throughout the world.

Estimates by the World Bank claim that as much as 40 percent of the world population still lives in villages and rural areas are not tied to utility grids. A more feasible way of providing electricity to such rural areas is by using the new renewable technologies rather investing in transmission infrastructure to connect them to the main utility power grids. For the villages farther than 3 KM from the nearest transmission line, it is usually economically more convenient to use a hybrid based stand alone system.

Solar radiation and wind speed are having complementary profiles among the unpredictable and randomly behaving renewable energy sources. Stand alone hybrid system usually take advantages of this particular characteristics combing photo voltaic panel and wind mills in conjunction with a diesel power backup generator. However diesel generator demands fuel supply then their use in isolated as can be troublesome and, in comparison with renewable energy source, uneconomical. In some application they can be avoided by including in the system adequate energy devices like battery bank. Since storage cost in all represent the major economic restraint, usually PV and wind systems are appropriately sized to minimize its requirements. So wind power is lower in cost than PV power approximately by a factor of five, so it often gets the main role in generation.

3. REQUIREMENT OF ALTERNATES OF ENERGY AND ITS SCOPE IN PAKISTAN

Due to the advancement in electronics almost every appliance that we use now is running on electrical energy. According to the predictions of the IEA (International Energy Agency) the natural sources (Water, Natural Gas) of electrical energy that are used most commonly for electrical energy production will be able to provide energy till 2030-35. Reacting on these facts provided by IEA many countries are taking steps to get maximum energy from other natural sources for their future use. Realizing this problem Pakistan is also taking steps to provide energy from other sources and the main concentration is on Wind and Solar technologies. Pakistan government has a goal of getting at least 7% of the total energy from these two sources by year 2030. Achieving 9700 MW from wind power is planned by year 2030. With this government

will be able to provide 7874 far-flung distant of utility grids villages of Balochistan and Sindh Provinces. Alternative Energy Development Board (AEDB) is looking for the National and International companies which are interested in producing energy from the alternate sources. AEDB has started its first phase of providing electricity to the 400 remote areas of Sindh and Balochistan within few years.

4. HYBRID POWER SYSTEM

A hybrid power system is in which the load is provided by two or more power sources. Renewable energy sources, such as solar and wind are normally combined with each other because they are the most powerful energy sources. Hybrid systems can be designed to fulfill the requirements at lowest acceptable cost, which is the key to getting market.

The energy consumption is gradually increasing and the deregulation of electricity has caused that the amount of production capacity of high power stations cannot fulfill the demand. A method to fill out the space is to make alternative energy sources e.g. wind turbine, solar panels, micro turbines and photovoltaic system. Now a day the wind turbine and solar technology is one of the most capable alternative energy technologies.

Table 1. Non Renewable and Renewable

Non-Renewable	Renewable
<ul style="list-style-type: none"> • Natural gas • Ultra supercritical Pulverized coal 	<ul style="list-style-type: none"> • Hydro • Wind
<ul style="list-style-type: none"> • Integrated coal Gasification 	<ul style="list-style-type: none"> • Solar
<ul style="list-style-type: none"> • Nuclear 	<ul style="list-style-type: none"> • Biomass
<ul style="list-style-type: none"> • Ultra clean coal combined cycle 	<ul style="list-style-type: none"> • Geothermal / hot rocks

5. ADVANTAGES OF WIND ENERGY

The most significant advantage of the wind energy is that it is produced by the source which is most unlikely to vanish as compared to other natural sources like coal, natural gas.

Wind energy is safe for the environment because it does not produce chemicals like Carbon dioxide. So it does not pollute air.

The most cost effective source of energy among the renewable energy sources is the wind energy, which costs only 4 to 6 American cents per KWH relating to the environment and location of the installation.

The most suitable place for wind turbines is farms and mostly farms are placed in countryside areas and this will also help in providing electricity in rural areas.

Wind energy is “home-grown” and green (i.e. environment friendly)

6. DISADVANTAGES

Wind power is an economical energy source but its initial cost is much greater than the initial investment of other energy sources like coal and natural gas.

Now a day’s most of home appliances are dependent on electricity so they require electricity for 24 hours, but wind energy source can not provide energy all the time because wind does not blow all the time.

A wind power source does not produce chemicals as other sources do but they produce noise pollution which is caused by the movement of its rotor blades.

7. ADVANTAGES OF SOLAR ENERGY

Solar cells convert the solar radiation directly into the electricity using photovoltaic effect without going through a thermal process.

Deserts and remote areas are ideal place for the solar power generation because they provide maximum solar power and the space for the solar panels. So this will help in providing the electricity to the rural areas of Pakistan.

Solar cells are reliable, modular, durable and generally maintenance free and therefore, suitable energy in isolated and remote areas.

Solar cell are quite, compatible with almost all environment s respond instantaneously to solar radiation and have an expected lifetime of 20 or more years.

8. DISADVANTAGES

Currently, solar energy is only viable for individual household use rather than large-scale production.

In winter, there is a decrease in power generated due to the decrease in sun and there is no generation at night.

Highway Emergency Telephones are being powered using solar energy.

Keeping vaccine and medicine cold by powering refrigerators.

“Empower Consultants of New Zealand is a renewable energy specialist is working on the project in the desserts of Gawadar (Balochistan). The goal of the project is to provide approximately 30 kWh and to facilitate the poor people of that remote area.” “ The ‘prime mover’ for the project is centered on a 6 kW solar PV array, with a 10 kW inverter, large capacity (90 kWh) battery bank, 100 Amp 120 VDC solar charge controller and 7 kW backup diesel generator forming the backbone of the system”.

Solar energy does not have large scale implementation in Pakistan. Different companies are making, watches, calculators and cellular phones powered by photovoltaic cells, battery chargers, garden lights and low power photovoltaic lamps.

The Siemens Pakistan has installed microwave link repeater stations on the Lahore-Islamabad Motorway, in the Salt Range area and more than 350 emergency call boxes.

9. CURRENT SOLAR ENERGY APPLICATIONS IN PAKISTAN

Now in Pakistan different technologies are using Solar and photovoltaic technologies on small scale.

9.1. Solar Water Pumping & Home Electrification in a Balochistan, Pakistan

The main purpose of this project was to help women who are working to get water from the well and also to provide the villagers lights in the evening. This will also help villagers to save money.

This project was a low cost because most of the components installed do not require any maintenance. PV panels used have an average life of 30 years. Hand pump is expected to last about 4 years. The lights have also estimated life of about 1 year. Both photovoltaic and solar thermal technologies have great potential and application in Pakistan; however, they are not being utilized on major scale anywhere in Pakistan. On small scales the solar energy has been utilizing for more than 25 years. The following is some of the application areas of solar thermal and photovoltaic technologies.

Most efficient way to utilize solar energy is using photovoltaic cells it converts solar radiations into dc voltage.

10. CURRENT WIND ENERGY APPLICATIONS IN PAKISTAN:

AEDB installed a total of a 140 micro Wind Turbines (139 of 500 watt each and one of 10 KW) in remote village of Sindh and Balochistan Provinces to supply power to residents for household utilization. The mechanism was designed such that one turbine was utilized to electrify 5 household. Most of the turbines installed by AEDB were imported from China and a few were manufactured locally. The details in this regard are as follows:

10.1. Imported

A total of 124 micro wind turbines of 500 watt capacity were imported from China. The turbines were of (Model No. and detail). These turbines have been installed as per detail given below.

All these turbines have satisfactory results. The functionality of these turbines has been very good. Though, overall system installed in house experienced failure. Almost 60% of the turbines got drained. This happened because the dwellers utilized more power than permitted.

10.2. Locally manufactured

A total of 15 micro wind turbines 500 watt capacity were developed through local market. The generators for these turbines were imported from China. Resets of the unit were manufactured within the factory. The developer was Shah Kamal, Karachi. These turbines were installed in following locations. These turbines have not given successful results due to malfunctioning blade design. Most of these have been dismantled.

11. PAKISTAN COUNCIL FOR RENEWABLE ENERGY TECHNOLOGIES

PCRET installed a total of 134 micro wind turbines in remote villages of Sindh Province to supply power to residents for household utilization. Most of the turbines installed by PCRET were imported from China and a few were imported from China and a few were manufactured locally. The details in this regard are as follows.

11.1. Imported

In year 2002, 14 micro wind turbines (6 of 500 Watts each and 8 of 300 watts each) were imported from China. out of these , 8 were installed in coastal belt of Balochistan (3 at Dhoajee, 2 at Phore and 3 at Mata Mandar Hinglaj, Lasbella) and 6 wind turbines were installed in the coastal areas of Sindh (one at super High way Karachi, 3 at Gujjo and 2 at Kharo Chan).

In 2004, PCRET imported 116 micro wind turbines of 500 watts each and installed in remote coastal areas of Sindh and Balochistan. Through this Project, 1,430 household have been given electricity. All these turbines were also china made; PCRET has installed these turbines through its own expertise.

11.2. Local

PCRET also has made efforts to initiate local manufacturing Of 500 watts wind turbines under ToT from China and 5-10 KW wind turbines under ToT from some European countries. These turbines have passed all the laboratory tests and now are going under field testing phase, the details of private company who have been engaged by PCRET.

12. CURRENT WIND ENERGY APPLICATIONS IN PAKISTAN

Windmills are also used to provide electricity for the street lights. These types of street lights are used at Defense Housing Authority (DHA)

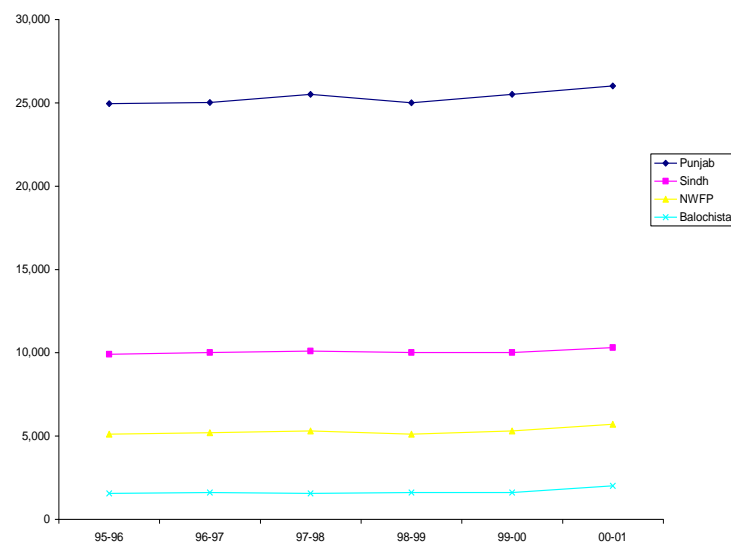


Figure 1. Defense Housing Authority (DHA)

The graph below is showing the percentage use of the electricity for the different sectors of Sindh. This graph shows that maximum consumption is in domestic sector as the electricity costs more when it is produced from the conventional sources, so there should be some concern for the production of electricity from the other natural resources.

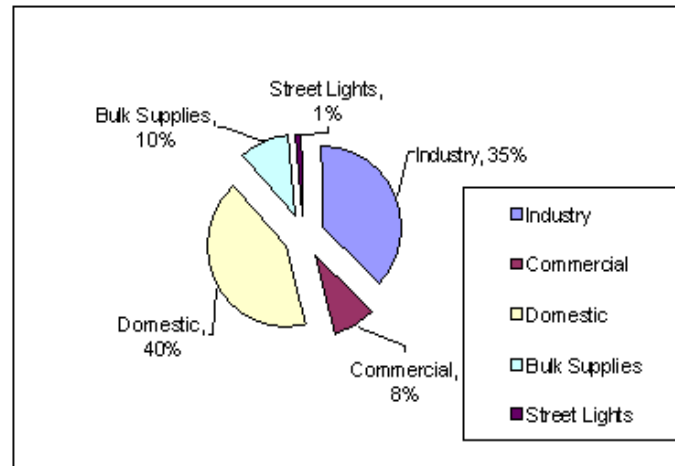


Figure 2. Electricity consumption in province of Sindh

13. PROPOSED WORK:

The main objective of the project is that it should be able to run 1 KW load at 50 Hz. We have divided this project into different phases and each phase has a specific goal.

The top level diagram of a hybrid renewable energy source is given below:

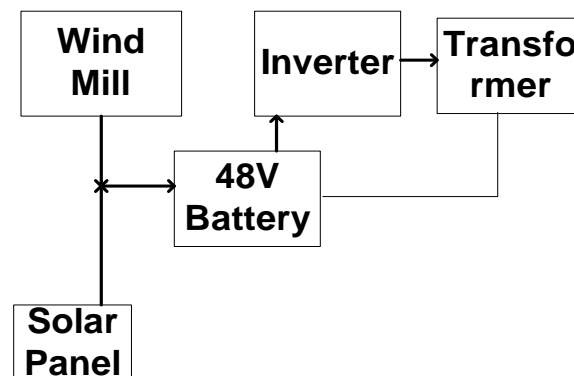


Figure 3. Block Diagram

14. FUTURE ENHANCEMENTS

14.1. Low Cost Wind Turbine Implementation

In future a low cost wind turbine can be constructed that can be connected to our system with some enhancements.

14.2. Solar Panels with Tracking System

Developing a tracking system for the solar panels which will ensure maximum energy transfer from sun.

14.3. Improving Capacity of Batteries at Low Cost

Another aspect that can be improved is the increase in capacity of batteries.

14.4. Efficient and Low cost Solar Panels

Someone can work on the solar panels so that to make them cost effective.

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