

Hybrid Power Generation Using Solar, Wind and Micro Hydel

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Abstract – Hydel, solar, wind energies are the fastest growing renewable sources of energy. The electricity requirement of the world is increasing at an alarming rate due to industrial growth, increased and extensive use of electrical gadgets. The proposed system involves three types of power generations using solar, wind, and Hydel systems. The battery which is used can be recharged with the two generation inputs like solar and wind turbine. From this energy the water pump can be controlled using inverter design. From this water flow we can restore the energy generation through Hydel turbine set up. The battery is connected to the inverter. This inverter is used to convert the 12volt DC to the 230 Volt AC. This 230 volt AC voltage is used to activate the loads like water pump. Here we are also using conventional battery charger unit to recharge the battery. In this project we are using wind blade set up, Hydel based turbine set up, solar panel setup, geared dc motor Reverse polarity preventer cum polarity corrector, AC ripples neutralizer, unidirectional current controller.

Index Terms – Hybrid power, solar, wind, micro hydel, inverter.

1. INTRODUCTION

Several renewable sources have been through a good development in the last decades. Therefore, their combination would apparently provide a good uninterrupted power system. Different renewable generators would complement each other. However, a lot of requirements have to be considered first. It is important to understand all the factors that influence its behavior, in order to get the best of it. The most important factors are location, time and user needs (power). Location associates information about climate, energy sources availability and environment conditions. This information is very important to decide what kind of renewable generators can be chosen [1]. Again the rapidly increasing costs of power line extensions and fossil fuel, combined with the desire to reduce carbon dioxide emissions pushed the development of hybrid power system suited for remote locations. Hybrid power systems are designed for the generation and use of electrical power. They are independent of a large, centralized electricity grid and incorporate more

than one type of power source. They may range in size from relatively large island grids to individual household power supplies. In general a hybrid system might contain alternating current (AC) diesel generators, an AC distribution system, a DC distribution system, loads, renewable power sources, energy storage, power converters, rotary converters, coupled diesel system, dump loads, load management options or a supervisory control system.[2]- [3]. One important aspect of wind turbine applications, especially in industrial environment is that wind turbine generates electricity without creating pollution. In addition the generation of electricity using wind turbines is well suited for isolated places with no connections to the outside grid [4]. Systems with hydroelectric generation can use the free stored hydro energy in the system reservoirs to meet demand, thus avoiding fuel expenses with thermal units [5]. This paper presents several aspects that must be taken into consideration at conception and exploitation level of a hybrid system. This hybrid power system has two renewable energy resources, the wind power and the hydropower. Voltage and frequency control has done by the exciter and the governor. A careful selection of the governor parameters can produce a stable and satisfactory operation of the system and respond according to load changes. The analysis includes the performance characteristic of all the generators connected to this system. This model is used to study the different characteristics of power and field voltage. The hybrid power system which is designed based on PSCAD software is representing a sustainable and powerful technological solution to increase access to modern electricity services in rural areas and beyond

2. PROPOSED PROJECT

A new hybrid power plant to be built in Turkey will combine a traditional gas-fired steam turbine with solar thermal power and wind power, according to GE. It's a step toward integrating renewable sources into the traditional power grid, using steam and mirrors. The solar component is a field of sun-tracking mirrors that will focus sunlight on a tower to

produce steam, which will be fed into the steam turbine to increase the plant's output. A small wind farm connected to the plant will provide another 22 megawatts of power. The plant will produce 522 megawatts in total, with 450 of that coming from the natural gas plant, so its renewable portfolio is not exactly robust. But the real gain may be in the ease with which wind and solar are being added to the power grid. Instead of localized solar arrays, or distant behemoth wind farms, the renewable sources are being added to a traditional-style power plant. The varying systems can share a control center as well as connections to the grid, which can make them cheaper and easier to integrate. GE says it can cut the cost of a solar thermal system in half, according to Technology Review. The natural gas component also smooths out the variability problems inherent in wind energy. When it's not blowing, natural gas will generate steam to spin the turbines. The solar thermal technology comes from a small company called eSolar, which uses thousands of small, pre-fabricated mirrors called heliostats to reflect sunlight toward a receiver, which uses the heat to generate steam. Algorithms automatically track and focus the sun's rays, according to a news release from GE. The gas turbine is a new design GE unveiled it last month and the company says the plant will be 69 percent efficient, more than double the efficiency rate of other natural gas power plants. The technology is designed for countries that use 50 hertz electricity, Technology Review points out the US uses 60 hertz, so it's not clear whether this could work on our soil. GE is set to break ground later this year and the plant should be operational by 2015, the company says. In the present work we are combining the three renewable energy sources i.e. solar, wind and Hydel energy unlike the hybrid power plant which is under construction in turkey is combining solar, wind and natural gas as a sources for generation of the power. But instead of using the natural gas we are using Hydel energy source.



Figure 1 solar field aerial view a field of mirrors at esolar sierra sun tower power plant in California forms the GE

3. PROPOSED MODELLING

The block diagrams of the present work and design aspect of independent modules are considered. The block diagram is as shown below

HYBRID POWER GENERATION USING SOLAR, WIND AND MICRO HYDEL

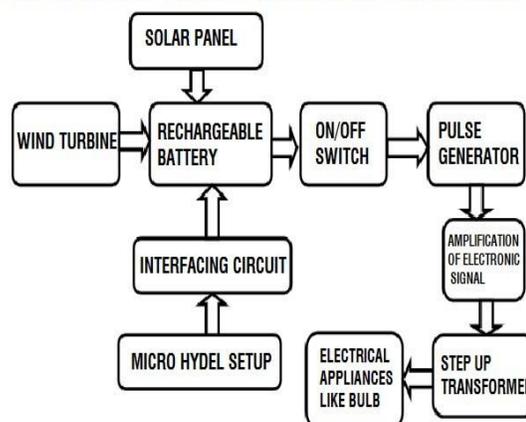


Figure 2 Block diagram of the hybrid power generation using solar, wind and micro hydel

3.1 Micro Hydel Blade Setup

It describes the development of a simplified turbine unit to produce power in a low head micro Hydel power installation. To be appropriate for remote areas and developing countries, a micro Hydel system needs to be simple in design. There are good turbine designs for medium to high heads but traditional designs for heads under about 10m, i.e., the cross flow turbine and waterwheel, are slow running, requiring substantial speed increase to drive an AC generator. Propeller turbines have a higher running speed but are normally too complicated for micro hydro installations.

In the present work a suitable micro turbine blade setup was developed. The effect of flat blades and optimum turbine blade and guide vane angles has been determined. The large hub diameter is an important compromise. A scale down model of this turbine was developed from different micro turbine models. It is predicted that the scale down model of micro turbine, with a blade tip diameter of 0.04m, will produce maximum of 6W at 2400 RPM from a head of 1.85m and the power generated by this micro turbine is about ~3W this is enough to light up an LED of 3V.



Figure 3 Micro Hydel Setup

3.2 Wind Turbine Setup

Wind turbine blades are shaped to generate the maximum power from the wind at the minimum cost. Primarily the design is driven by the aerodynamic requirements, but economics mean that the blade shape is a compromise to keep the cost of construction reasonable. In particular, the blade tends to be thicker than the aerodynamic optimum close to the root, where the stresses due to bending are greatest. The blade design process starts with a “best guess” compromise between aerodynamic and structural efficiency. The choice of materials and manufacturing process will also have an influence on how thin (hence aerodynamically ideal) the blade can be built. For instance, prepreg carbon fibre is stiffer and stronger than infused glass fibre. The chosen aerodynamic shape gives rise to loads, which are fed into the structural design. Problems identified at this stage can then be used to modify the shape if necessary and recalculate the aerodynamic performance. Just like an aeroplane wing, wind turbine blades work by generating lift due to their shape. The more curved side generates low air pressures while high pressure air pushes on the other side of the aerofoil. The net result is a lift force perpendicular to the direction of flow of the air. The lift force increases as the blade is turned to present itself at a greater angle to the wind. This is called the angle of attack. At very large angles of attack the blade “stalls” and the lift decreases again. So there is an optimum angle of attack to generate the maximum lift.

In this project we have constructed horizontal axis wind turbine (HAWT) setup. Figures are shown below:



Figure 4 Wind Turbine Blade Setup

3.3 Solar Panel Setup

A solar cell or photovoltaic cell is a device that converts solar energy into electricity by the photovoltaic effect. Sometimes the term solar cell is reserved for devices intended specifically to capture energy from sunlight, while the term photovoltaic cell is used when the source is unspecified. Assemblies of cells are used to make solar panel, solar modules, or photovoltaic arrays. Photovoltaic is the field of technology and research related to the application of solar cells for solar energy. Solar cell efficiencies vary from 6% for amorphous silicon-based solar cells to 40.7% with multiple-junction research lab cells and 42.8% with multiple dies assembled into a hybrid package. Solar cell energy conversion efficiencies for commercially available multi crystalline Si solar cells are around 14-19%.

Solar cells can also be applied to other electronics devices to make it self-power sustainable in the sun. There are solar cell phone chargers, solar bike light and solar camping lanterns that people can adopt for daily use.



Figure 5 Solar Panel Setup

3.4 working of the scale down model

This project makes use of three alternative sources of energy (solar energy, wind energy and Hydel energy) for generating the power i.e. Hybrid based power generation. The energy derived from all the three sources of energy is stored in the storage battery in the form of a DC Current. The electricity generated by the solar panel is stored during the day with the help of storage batteries which gives us only direct current (DC) and the electricity generated from wind and Hydel is also direct current (DC). But to operate electrical devices we need alternating current (AC). Therefore we need to convert DC to AC before using any appliances. The conversion of the DC to AC is done by using the Inverter circuit which is explained below:

INVERTER CIRCUIT USING CD 4047

CD 4047 is used for generating the 100 Hz pulses and four 2N3055 transistors for driving the load. The IC1 CD4047 wired a stable multi vibrator produces two 180 degree out of

phase 100 Hz pulse trains. These pulse trains are pre amplified by the two TIP122 transistors. The out puts of the TIP 122 transistors are amplified by four 2N3055 transistors (two transistors for each half cycle) to drive the inverter transformer. The 220V AC will be available at the secondary of the transformer.



Figure 6 Prototype of the hybrid power generation using solar wind and micro hydel

4. RESULTS AND DISCUSSIONS

The scale down working model of the hybrid power generation using solar energy, wind energy and micro hydel was designed such that to deliver power to switch on the loads like water pump and electrical appliances like bulb etc. The dynamo uses electromagnetic principles to convert mechanical rotation into direct current (DC) using wind energy. The system generates electrical power as non-conventional method by wind energy power using wind turbine set up. We also use solar energy and Hydel energy to charge the battery. The power output obtained after the successful implementation of all the alternative source of energy system in the project is approximately equal to ~36W and it is enough to light up the florescent bulb of ~20 W powers.

5. CONCLUSION

In this project, we have implemented power generation by hybrid by combining solar, wind and micro Hydel. We have demonstrated the possibility of generating useful non conventional power generation for connecting to electrical loads. There are some advantages and also there some disadvantages. The application includes industries, streetlights in a continuous mode by the hybrid combination. There are growing applications in agricultural sector, water pumping, security solar fencing...etc.

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