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Hybrid Generation Power System for Domestic Applications

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ABSTRACT

This work presents the plan and model of the control strategy for the interconnection of the hybrid energy system able to regulating this load's voltage and controlling the energy generation with the energy options. The control strategy contains controlling the energy generated through each energy source, in a hierarchical mode using sliding/dropping mode control, while consuming consideration elements that have an impact on each electrical power source and transform the energy generated in order to suitable circumstances for lower power and domestic programs. The cross alternative energy system consists of photovoltaic cellular material, fuel cellular material and battery packs. A numerical equation in order to estimate the perfect voltage involving photovoltaic systems for virtually every solar irradiance and temperature circumstances is suggested. Simulations of a single or a lot more systems interconnected towards the load with the entire proposed control scheme, under different ecological and weight conditions, usually are introduced to indicate this efficiency with the procedure.

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1. INTRODUCTION

Using alternative as well as renewable energies to satisfy the strength demand may be rising through the last years. The requirement of designing a cleaner energy to reduce the greenhouse gases that creates environmental issues like global warming, a loss of the cost on the materials used to develop this kind of technologies as well as the increment in the price tag on the fossil fuel among others, are a few of the reasons which are pushing this kind of increment [1, 2, 3]. Of all alternative strength systems, photovoltaic cells (technology which generates a power on the sun while using photovoltaic effect), wind generators (technology which generates electric power with the kinetic energy on the wind) as well as fuel cells (technology which generates electric power by this chemical reaction of two reactants) are being among the most popular. The ability generated through photovoltaic or solar cells, wind generators and energy cells, beside dependent upon factors while solar irradiation as well as temperature for solar cells, wind speed for turbine and energy flow pertaining to fuel cells, depends greatly within the load valuations. These elements affect this system's productivity power, generating unregulated voltages as well as power lack of [4]. Since all of us cannot control many of these factors, alternative strength systems are often composed of a couple of systems in orders that one system to compensate the various other. The usage of renewable strength system has some issues. One is which the interconnection of more than one of most of these systems to your load, without a proper command strategy, may result in power high quality and stability problems [5, 6, 7]. As a result of that, the control method must be developed to regulate and supervise the electricity distribution on the hybrid system in order to supply the demanded capacity to the insert while preserving stability, legislations and quality on the power within the system. The other problem is that on the three pointed out alternative strength technologies, this wind as well as photovoltaic are generally intermittent strength sources. Their strength generation depends upon factors which might be variable and is not controlled causing

fluctuations within the maximum strength they can provide. This generates situations in which enough power is not generated to help satisfy this demand. For this kind of reason we are going to restrict our own alternative strength hybrid system to get composed of one intermittent option energy engineering, photovoltaic, the controllable non intermittent option energy engineering, fuel cells, and an energy storage system, batteries. This perform presents the structure, simulation as well as implementation of your control method, based in sliding setting control, for this interconnection of more than one alternative strength system, constructed from photovoltaic cells, fuel cells and power packs for strength storage, pertaining to residential as well as low strength applications considering different elements that has effects on each engineering while achieving high strength efficiencies as well as voltage legislations. Simulations of unique configuration of systems constructed from more than one energy methods interconnected while using the controller, under different conditions and pertaining to different arrangements are presented to indicate the efficacy on the method.

2. PROBLEM STATEMENT

Some sort of control strategy for the interconnection of one or more technologies plays an essential part inside implementation of hybrid methods. Stand-alone applications demand a control system able to generating the demanded power constantly to satisfy the load demand. These handle strategies ought to operate properly under dynamic operating circumstances, have a good reaction to load changes and help the power administration. Different handle strategies continue to be designed and also implemented and also successful final results have been obtained. Examples of control strategies that's been used in the past are: fuzzy logic[8, 9], sliding mode control[10, 11], neural network[12, 13, 14], pid control[15], hierarchical control[16], predictive control[16, 17], hereditary algorithms [18], and so forth. Even nevertheless these handle strategies exhibited good proficiency, stability and were able to control the power generation, some of them contained innovative mathematics, their adaptability to be able to changes throughout the functioning points are generally debatable, had too many assumptions that most likely are not valid or even don't consider important factors that could affect the device. In this specific document, we found a dynamic control strategy able to controlling the power age group of one or more alternative strength system, able to adapting to be able to environmental variants and obvious that may be adapted to any power technique. A number of simulations of the control approach are presented to exhibit the adaptability that it control approach exhibit.

3. OBJECTIVES

The key objective just for this research is usually to design as well as implement a new control tactic, using a new sliding mode-based manage law, for any hybrid choice power system consisting of photovoltaic tissues, fuel tissues and battery power. The controller must manage to managing the actual energy creation, energy quality and distribution of the energy that is generated by the system and to change it to your suitable condition so it can be used pertaining to residential as well as low electrical power applications. The controller must have the ability to operate nicely under diverse loads circumstances and under different managing and the environmental conditions. The system must always be simulated as well as the outcomes must indicate the predicted behavior as well as improvement described within the theory.

3.1. Solar Power

Solar panels are the medium to convert solar power into the electrical power. Solar panels can convert the energy directly or heat the water with the induced energy. PV (Photo-voltaic) cells are made up from semiconductor structures as in the computer technologies. Sun beam is absorbed with this material and electrons are emitted from the atoms that they are bounded. This release activates a current. Photovoltaic is known as the process between beam absorbed and the electricity induced. With a common principle and individual components, solar power is converted into the electric power. Solar batteries are produced by waffling p-n semiconductors. A current-volt characteristic of the PV in the darkness is very similar to that of divot. Under beam, electron flow and current occurs. In closed-loop, PV current passes through the external load. While in open-loop, the current completes the circuit through the p-n diot structure [4]. Solar batteries can be represented with an equivalent circuit of a current source, a resistor and a diot in parallel, and an external load-resistor [5], as seen in Figure

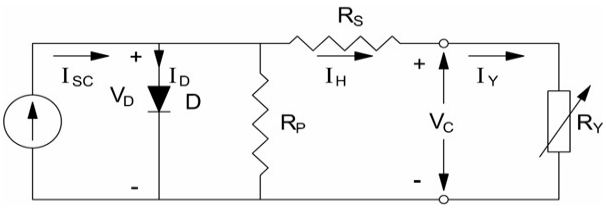

Figure 1. An equivalent circuit of a current source

It is possible to insert AC-DC converter, charger, accumulator, extra power source, and controller depending on the design differences in operational and functional specifications [6]. Solar system could be categorized into two types:

Line-independent systems: These are established in absence of line electricity to provide electricity. Since the current in these systems are DC and it must be also available overnight, energy is stored in accumulators, DC-Batteries. In case of AC-Supply requirements for the appliances, it is possible to use DC-AC invertor [6].

Line-dependent systems: These systems do not need DCBatteries, since the energy is served to the demand with the help of an invertor. Line electricity is being switched in use in case of insufficient sun beam [6].

3.2. Wind Power

Wind turbines are used to convert the wind power into electric power. Electric generator inside the turbine converts the mechanical power into the electric power. Wind turbine systems are available ranging from 50W to 2-3 MW. The energy production by wind turbines depends on the wind velocity acting on the turbine. Wind power is used to feed both energy production and consumption demand, and transmission lines in the rural areas. Wind turbines can be classified with respect to the physical features (dimensions, axes, number of blade), generated power and so on. For example, wind turbines with respect to axis structure: horizontal rotor plane located turbines, turbines with vertical or horizontal spinning directions with respect to the wind. Turbines with blade numbers: 3-blade, 2-blade and 1- blade turbines. On the other hand, power production capacity based classification has four subclasses [7].

- Small Power Systems
- Moderate Power Systems
- Big Power Systems
- Megawatt Turbines

3.3. Design and Implementation of Domestic Solar-Wind Hybrid Energy System

Hybrid systems are the ones that use more than one energy resources. Integration of systems (wind and solar) has more influence in terms of electric power production. Such systems are called as “hybrid systems”. Hybrid solar-wind applications are implemented in the field, where all-year energy is to be consumed without any chance for an interrupt. It is possible to have any combination of energy resources to supply the energy demand in the hybrid systems, such as oil, solar and wind. This project is similar with solar power panel and wind turbine power. Differently, it is only anadd-on in the system. Photovoltaic solar panels and small wind turbines depend on climate and weather conditions. Therefore, neither solar nor wind power is sufficient alone. A number of renewable energy expert claims to have a satisfactory hybrid energy resource if both wind and solar power are integrated within a unique body. In the summer time, when sun beams are strong enough, wind velocity is relatively small. In the winter time, when sunny days are relatively shorter, wind velocity is high on the contrast. Efficiency of these renewable systems show also differences through the year. In other words, it is needed to support these two systems with each other to sustain the continuity of the energy production in the system.

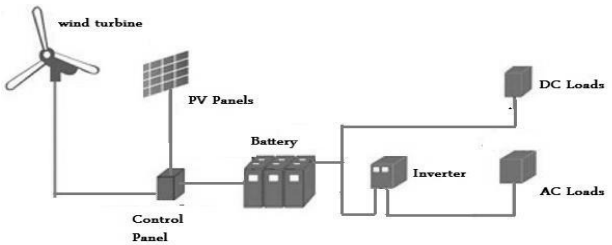

Figure 2. The energy production in the system

In the realized system, a portion of the required energy for an ordinary home has been obtained from electricity that is obtained from the wind and solar power. Experimental setup for the domestic hybrid system consists of a low power wind turbine and two PV panel. Depending on the environmental conditions, required energy for the system can be supplied either separately from the wind or solar systems or using these two resources at the same time is in show Figure. Control unit decides which source to use for charging the battery with respect to condition of the incoming energy.

Wind turbine first converts the kinetic energy to mechanical energy and then converts it to the electricity. The wind turbine in the system consists of tower, alternator, speed converters (gear box), and propeller. And a picture of the constructed hybrid System

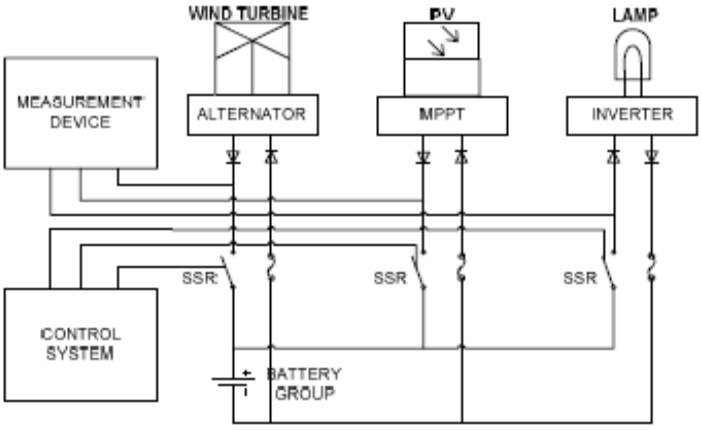

Figure 3. The constructed hybrid System

3.4. Charge Controller

The charge controller is an electronic circuitry which monitors the solar and wind input and generates control for the charging. It is discussed in detail in this section. Charge controller works on electronic circuits and masters the system functioning. The charge controller is connected to both solar and wind inputs. It senses the voltage level from solar panel and wind generator. Then as per the algorithm defined it selects the suitable resource that is either solar PV or wind turbine to store the charge. The batteries used in the system are 12V batteries so we need at least 13-14 volts system input to charge them continuously. A solar panel is normally rated for 12 volt output but the peak open circuited voltage for the panel goes around 20-21 volts. The output of the same solar panel drops to 17-18 volts when connected to load. Similarly the output of the wind turbine also changes with the change in the wind speed which occurs frequently. So a charge controller has to control these changes also. The algorithm followed by the charge controller used in this system is as follows:

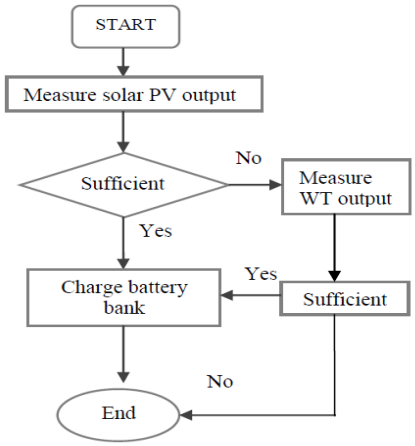

Figure 4. The algorithm followed by the charge controller

4. SYSTEM COSTING

The system costing is based on the price of various items that are available at the time of the installation. However the price may be different for different locations and working conditions.

Table1. Solar-wind hybrid System installation costing

Serial no.	Item	Cost (in Rs.)
1.	Solar panel	9,000
2.	Wind Generator/Motor	4,500
3.	Charge controller	600
4.	Wind Turbine assembly	800
5.	Panel mounting	300
	Total	15,200

5. RESULTS & DISCUSSIONS

Simulation types of photovoltaic solar cells, fuel solar cells, batteries in addition to dc/dc converters were helpful to analyze their behaviors any time interconnected like a hybrid alternate power system also to facilitate the particular developing connected with control ways of manage the ability generation of these power options while regulating the strain voltage. Each power source is attached to the weight through dc/dc converters that, by managing their work cycle, control the ability generated.

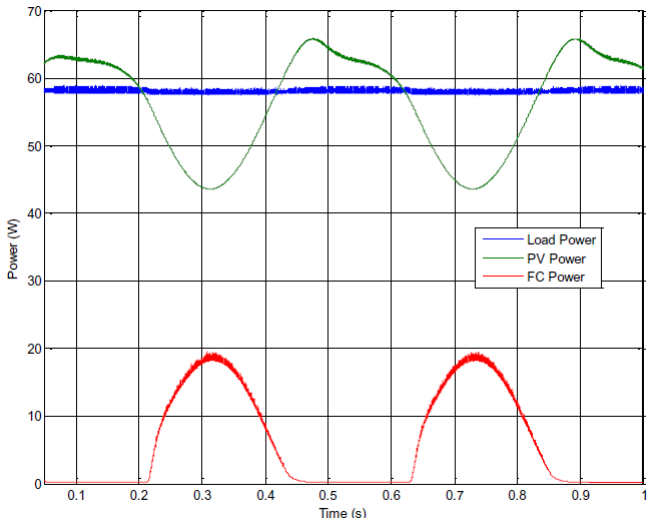

Figure 5. Power Dynamics for a Controlled and Uncontrolled System

The sun irradiance accomplishing the photo voltaic cell and also the temperature of the cell may be modified so that it can recreate different environmental conditions including daily prices of sun irradiation in addition to temperature ranges. The weight was some sort of variable resistive weight arranged in their normal way that's would power our bodies to operate at just about every proposed operation mode. This kind of operation methods were attained applying the particular designed command strategy determined by sliding manner control.

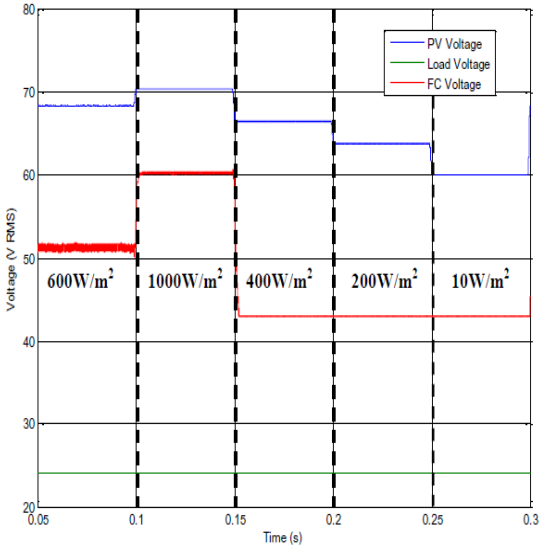

Figure 6. Load Voltages (RMS) Dynamics for Three Systems

The principal system looks after regulating the particular voltage even though the other systems supplies extra power to help the leading system accomplishes its target. The operation modes are now being controlled by simply measuring voltages within the system and also the controller determines the right operation mode with the system. Simulations demonstrated validated the power of our own proposed system to function well under static in addition to dynamics environmental and weight conditions. Environmentally friendly conditions were varied inside typical prices to reproduce realistic circumstances. Load circumstances were different to simulate changes within the load's strength demand.

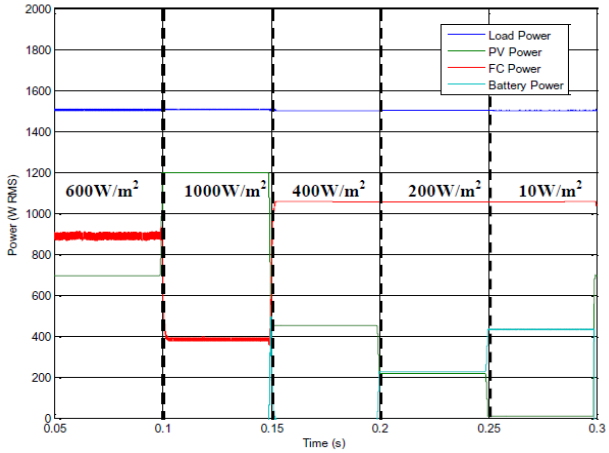

Figure 7. Power (RMS) Dynamics for Three Systems

The command law implemented with the photovoltaic tweaked itself to follow the optimal voltage blackberry curve and drive the PHOTOVOLTAIC voltage to follow the particular curve any time maximum strength mode ended up being required. Your control legal guidelines implemented with the auxiliaries systems adjusted themselves towards changes within the primary method. Advantages within the power age group and voltage legislations were seen whenever a photovoltaic cell phone was connected straight away to the load and when it ended up being connected via our controller towards load. The ability generated through the proposed method was higher and steady when operating within the maximum strength mode and also the load ended up being varying even though the power connected with the out of control system ended up being lower in addition to varying as the load varies. When operating in voltage legislations mode, the load's voltage with the controlled method was regulated with a fixed levels while the particular load's voltage of the uncontrolled method was falling at just about every variation of the load.

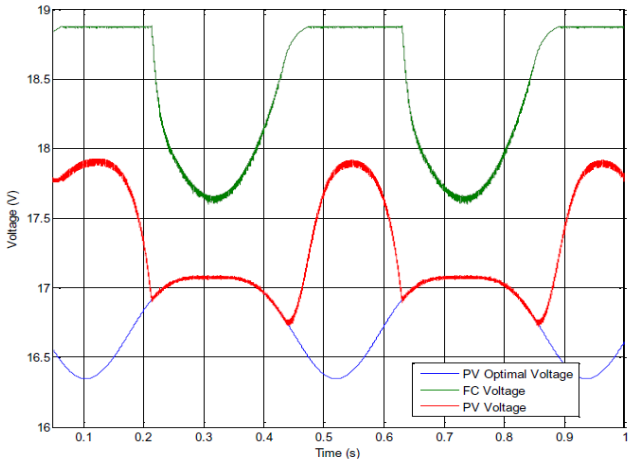

Figure 8. Optimal Voltage, PV and FC Voltage Dynamics for Simulation Conditions

6. FUTURE WORK

These can be done for future works: This implementation of a dynamical energy cell model that takes into account factors that affects the power output from the system like the internal pressures from the reactants in addition to the cell's heat range. This model employed for this operates was some sort of model that assumes continual pressures in addition to constant temperature. Using some sort of model that takes into account those factors would offer a more sensible behavior from the system. Simulations employing different type of loads. In this work, weight used for simulation was highly resistive. Loads for example inductive in addition to capacitive load ought to be tested to investigate the system's conduct. Actual implementation from the system. Simply simulations were drawn in consideration just for this work. A few experimental results ought to be obtained to be able to experimentally validate the manage strategy.

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