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A Novel Implementation of Mppt Algorithm Based Modeling, Simulation and Sizing of Photovoltaic / Fuel Cell

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ABSTRACT

This paper presents a method to operate a grid connected hybrid system. The hybrid system composed of a Pho- to voltaic (PV) array and a Proton exchange membrane fuel cell (PEMFC) is considered. The PV array normally uses a maximum power point tracking (MPPT) technique to continuously deliver the highest power to the load when variations in irradiation and temperature occur, which make it become an uncontrollable source. In coordination with PEMFC, the hybrid system output power becomes controllable. Two operation modes, the unit-power control (UPC) mode and the feeder-flow control (FFC) mode, can be applied to the hybrid system. The coordination of two control modes, the coordination of the PV array and the PEMFC in the hybrid system, and the determination of reference parameters are presented. The proposed operating strategy with a flexible operation mode change always operates the PV array at maximum output power and the PEMFC in its high efficiency performance band, thus improving the performance of system operation, en- hancing system stability, and decreasing the number of operating mode changes.

Index Terms— Distributed generation, fuel cell, hybrid system, micro grid, photovoltaic, power management.

INTRODUCTION

Renewable energy is currently widely used. One of these resources is solar energy. The photovoltaic (PV) array normally uses a maximum power point tracking (MPPT) technique to continuously deliver the highest power to the load when there are variations in irradiation and temperature. The disadvantage of PV energy is that the PV output power depends on weather conditions and cell temperature, making it an uncontrollable source. Furthermore, it is not available during the night. In order to overcome these inherent drawbacks, alternative sources, such as PEMFC, should be installed in the hybrid system. By changing the FC output power, the hybrid source output becomes controllable. However, PEMFC, in its turn, works only at a high efficiency within a specific power range . The hybrid system can either be connected to the main grid or work autonomously with respect to the grid-connected mode or islanded mode, respectively. In the grid-connected mode, the hybrid source is connected to the main grid at the point of common coupling (PCC) to deliver power to the load. When load demand changes, the power supplied by the main grid and hybrid system must be properly changed. The power delivered from the main grid and PV array as well as PEMFC must be coordinated to meet load demand. The hybrid source has two control modes: 1) unit-power control (UPC) mode and feeder-flow control (FFC) mode. In the UPC mode, variations of

load demand are compensated by the main grid because the hybrid source output is regulated to reference power. Therefore, the reference value of the hybrid source output must be determined. In the FFC mode, the feeder flow is regulated to a constant, the extra load demand is picked up by the hybrid source, and, hence, the feeder reference power must be known. The proposed operating strategy is to coordinate the two control modes and determine the reference values of the UPC mode and FFC mode so that all constraints are satisfied. This operating strategy will minimize the number of operating mode changes, improve performance of the system operation, and enhance system stability.

DISTRIBUTED GENERATION:

Distributed generation, also called on-site generation, dispersed generation, embedded generation, decentralized generation, decentralized energy or distributed energy generates electricity from many small energy sources. Currently, industrial countries generate most of their electricity in large centralized facilities, such as fossil fuel (coal, gas powered) nuclear or hydropower plants. These plants have excellent economies of scale, but usually transmit electricity long distances and negatively affect the environment. Most plants are built this way due to a number of economic, health & safety, logistical. For example, coal power plants are built away from cities to prevent their heavy air pollution from affecting the populace. In addition, such plants are often built near collieries to minimize the cost of transporting coal. Hydroelectric plants are by their nature limited to operating at sites with sufficient water flow. Most power plants are often considered to be too far away for their waste heat to be used for heating buildings. Distributed generation is another approach. It reduces the amount of energy lost in transmitting electricity because the electricity is generated very near where it is used, perhaps even in the same building. This also reduces the size and number of power lines that must be constructed. Typical distributed power sources in a Feed-in Tariff (FIT) scheme have low maintenance, low pollution and high efficiencies. In the past, these traits required dedicated operating engineers and large complex plants to reduce pollution. However, modern embedded systems can provide these traits with automated operation and renewables, such as sunlight, wind and geothermal. This reduces the size of power plant that can show a profit .

Creating the Photovoltaic Cell

As seen in the science behind PV, a photovoltaic cell is created when a positively charged (P-type) layer of silicon is placed against a negatively charged (N-type) layer of silicon to create a diode and this diode is connected in a circuit via metal conductors on the top and bottom of the silicon sandwich. An actual PV cell includes these elements with an anti-reflective coating to accept more sunlight into the silicon sandwich.

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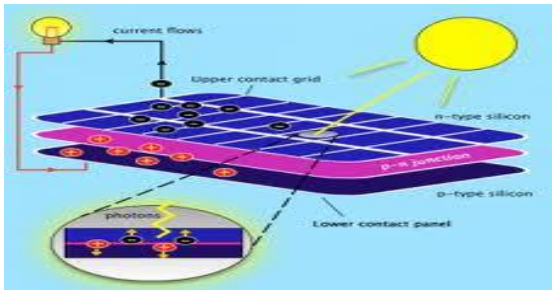

The photovoltaic cell, a sandwich of two semiconductor materials. The cell reacts to solar energy and produces an electrical charge. Metal conductor strips that run along the top layer of silicon. These strips capture the electrons freed when solar energy hits the cell and concentrate them into a current. Another metal panel, attached to the bottom layer of silicon, feeds electrons back into the cell An anti-reflective coating placed on top of or directly adhered to the silicon sandwich. This sheet reduces the amount of sunlight reflected off the glass allowing more sunlight to hit the cell and increasing the panel's efficiency.

MAXIMUM POWER POINT TRACKING MPPT

Maximum power point tracking (MPPT) is a technique that grid connected inverters, solar battery chargers and similar devices use to get the maximum possible power from one or more photovoltaic devices, typically solar panels,[1] though optical power transmission systems can benefit from similar technology.[2] Solar cells have a complex relationship between solar irradiation, temperature and total resistance that produces a non-linear output efficiency which can be analyzed based on the I-V curve. It is the purpose of the MPPT system to sample the output of the cells and apply the proper resistance (load) to obtain maximum power for any given environmental conditions.[citation needed] MPPT devices are typically integrated into an electric power converter system that provides voltage or current conversion, filtering, and regulation for driving various loads, including power grids, batteries, or motors.

Classification

Controllers usually follow one of three types of strategies to optimize the power output of an array. Maximum power point trackers may implement different algorithms and switch between them based on the operating conditions of the array.[5]

Perturb and observe

In this method the controller adjusts the voltage by a small amount from the array and measures power; if the power increases, further adjustments in that direction are tried until power no longer increases. This is called the perturb and observe method and is most common, although this method can result in oscillations of power output.[6][7] It is referred to as a hill climbing method, because it depends on the rise of the curve of power against voltage below the maximum power point, and the fall above that point.[8] Perturb and observe is the most commonly used MPPT method due to its ease of implementation.[6] Perturb and observe method may result in top-level efficiency, provided that a proper predictive and adaptive hill climbing strategy is adopted.[9]

How MPPT Charge Controllers Work

The MPPT process will raise the current while lowering the voltage. This can be done through a process called DC to DC

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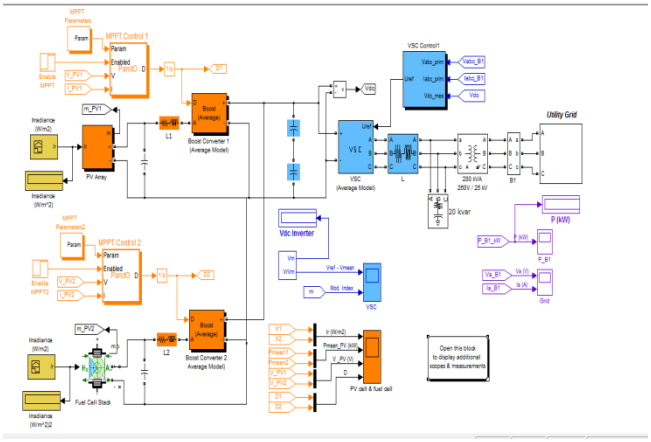
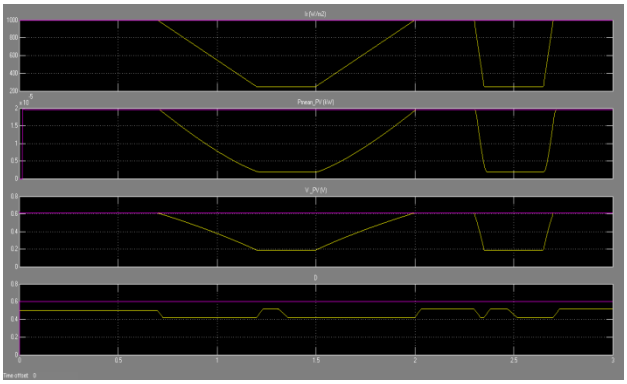
conversion. The reason this works is because we can exchange current and voltage and yet have the same amount of power (Watts). Example: 100 Volts at 1 amp = 100 Watts; 10 volts at 10 amps = 100 Watts; 1 volt at 100 amps = 100 Watts. Notice the voltage is lowered as the current is raised yet it produces the same power. (for more on this, study Ohms Law) MPPT circuits use this process to lower the voltage close to the battery voltage while raising the current. As long as the voltage reaching the MPPT controller is higher than the battery voltage by about 5% or more, then the MPPT output current will be higher than the input. With the PV module described above, we have the potential of 240 Watts of power. With the MPPT controller connected to this module, the DC converter can output over 16 amps while regulating the voltage to 14.4. (16.7 X 14.4 = 240 watts).

MPPT placement

Traditional solar inverters perform MPPT for an entire array as a whole. In such systems the same current, dictated by the inverter, flows through all panels in the string. Because different panels have different IV curves and different MPPs (due to manufacturing tolerance, partial shading,[16] etc.) this architecture means some panels will be performing below their MPP, resulting in the loss of energy.[1] Some companies (see power optimizer) are now placing peak power point converters into individual panels, allowing each to operate at peak efficiency despite uneven shading, soiling or electrical mismatch.Data suggests having one inverter with one MPPT for a project that has east and west-facing modules presents no disadvantages when compared to having two inverters or one inverter with more than one MPPT."Efficient East-West Oriented PV Systems with One MPP Tracker," Dietmar Staudacher, 2011

MODELLING DESIGN





CONCLUSION

The fused multi input rectifier stage also allows maximum power point tracking (MPPT) to be used to extract power from the wind and sunlight when it is available. The PV panel rotates automatically based on the sun irradiance during the day while at night; the system is in ‘sleep’ mode in order to reduce

the energy consumption. The boost converter always provides a higher output voltage than its input. VSC provided the quality output from hybrid souses is fed to the grid efficiently. A complete model simulating the proposed hybrid generation system including the wind, solar and fuel cell system is done using Matlab/Simulink. The MPPT control system has been developed for both the wind and solar energy sources. The simulation results showed satisfactory performance of the hybrid system. PIC.

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