SOLAR WATER PUMP USING SUPER CAPACITOR ENERGY STORAGE SYSTEM

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ABSTRACT

There are many agriculturists who have cultivated in area far away from water source in India, thus, farmer needs to install water-pumping system to irrigate their farm area. Solar water pump system is one of system that is applied photovoltaic panel for water pump as power source. In daytime, photovoltaic panel can generate power and storage in Supercapacitor bank to be used later without concerning over weather. Another benefit from system is to reduce energy cost and environmental impact compared to traditional diesel water pump. Therefore, this paper aims to design and develop solar water pump with charger controller for batteries. Performance of solar water pump system in terms of temperature, voltage, and current have been evaluating in this study.

The variable output of renewable such as solar causes fluctuations of power flow that can adversely affect power system operation, especially at high levels of penetration. The coordination of multiple energy storage solutions can mitigate integration challenges by providing a buffer from variable renewable. This paper presents the integration of super capacitor energy storage that can then be used in combination with other energy storage solutions such as batteries to enhance the overall energy storage solution. Control algorithms are developed for the super capacitors to enhance the stability of the power system. In addition, a key parameter that is analyzed is the effective super capacitor energy rating and state of charge (SOC).

This paper has presented design and development of solar water pump. The performance of this system has been evaluated using electrical data and temperature from photovoltaic panel and energy storage device throughout the day. The results have indicated that current and voltage generated from photovoltaic panel mainly depended on solar irradiation and temperature. In energy storage part, for battery charging at constant voltage, charging current is less than current from photovoltaic panel due to power loss that occurs in equipment and copper wire. The performance analysis has shown the effectiveness of solar water pump compared to diesel engine water pump that farmer has normally used. The proposed solar water pump can be effectively employed in cultivated area located far away from water source.

Keyword

Photovoltaic System, Renewable Energy, Water Pump. Super capacitor energy storage system Monocrystalline silicon solar cells; —Battery, charge controller, Solar water pumping Energy Storage, Supercapacitor.

1. INTRODUCTION

India is an agricultural country and there is currently a major exporter of agricultural and food products with rural population mainly an agriculturist. Nowadays different irrigation systems are used to reduce the dependency of rain and mostly the existing irrigation systems are driven by electrical power and manually ON/OFF scheduling controlled .Currently, farmer mainly uses diesel engine water pump for water pumping. With rising in energy cost and environmental issue, renewable energy water pumping system has been gaining a lot of attention from government and agriculturist. Solar water pump system is one of solar power application that gains much attention from agriculturist. Pumping system operates by converting solar energy to electric energy using Monocrystaline panel. Generating electricity, then, use to drive water pump to irrigate cultivated area with an installed energy

storage system to operate water pump when there is not enough solar irradiation to generate power[1]. Supercapacitors (SC) are electrochemical capacitors with an unusually high energy density compare to common capacitors, typically thousand times greater than a high-capacity electrolytic capacitor[2].

The designed controller is shown to have very fast transient response and very small transitory voltage overshoot. It is also found that the proposed charge controller shows better PV energy capture than the on/off controller [3]. Non-reliability in availability of electricity, particularly in developing countries and in rural areas, and increase in diesel prices, it is essential to have other alternative water pumping technologies. Solar water pumping system has gained increasing popularity in this regard because it reduces dependence on electricity generated from diesel, gas or coal. Photovoltaic (PV) technology is seen as technology of the future for generation of distributed low-power electricity. Solar-powered pumps are fueled by electricity generated by PV panels or by the emitted thermal energy available from collected sunlight. Solar powered PV pumps is cost effective because of low operation and maintenance costs and is also more environmental friendly as compared to pumps powered by an internal combustion engine (ICE)[4]. The system is designed not only to provide the rated discharge of water but also to feed the surplus power to the grid[5]. This system is used in areas where electrical power is not accessible Using photovoltaic energy is one of the solution to this problem[6]. irrigation system is usually designed for ensuring the proper level of water for growing up the plants all through the season. Even when the farmers are away, these automatic irrigation systems always ensure the proper level of water in the sites [7].

1.1 SUPERCAPACITORS

Supercapacitor is a kind of electrical energy storage device. The advantages of supercapacitor are high power density, high efficiency, fast charging and discharging speed, long cycle life, wide operating temperature range and environment friendly.With such advantage of supercapacitors over other conventional capacitor and battery the combined working or individual working of it is of main interest. Supercapacitors or ultracapacitors are promising energy storage devices due to their capability to deliver high peak current and to capture a huge amount of energy in a short time with very low internal power loss. In particular, supercapacitors currently seems to be interesting device for many applications because they can supply high power for a significant amount of time and can be recharged more quickly than electrochemical batteries. In different applications, a combination of the two devices batteries and supercapacitors could be used to develop a high-efficiency storage system with a high dynamic performance. In this paper we are going to concentrate on various parameters of super capacitor [8]. The variable output of renewables such as wind and solar causes fluctuations of power flow that can adversely affect power system operation, especially at high levels of penetration. The coordination of multiple energy storage solutions can mitigate integration challenges by providing a buffer from variable renewable[9].

1.2 MONO-CRYSTALLINE SOLAR PV PANEL

The solar cell is a semiconductor device that converts solar energy into electricity. Basically, a solar cell is a p-n junction in a thin wafer of semiconductor . When a solar cell is exposed to sunlight, the photons with energy greater than the band-gap energy of the semiconductor are absorbed and create a number of electron-hole pairs proportional to the incident irradiation. These carriers are swept apart and create a photocurrent, under the influence of the internal electric fields of the p-n junction which are directly proportional to solar insolation . Crystalline silicon solar cell was one of the first to be developed and continues to be the dominant material for solar PV production in the world . The cell efficiencies for mono-crystalline silicon are found to be significantly higher than for poly-crystalline silicon. [10]. SunPower Corporation manufactures high efficiency rear-contact mono-crystalline silicon solar cells. Historically, the cells have been fabricated using methods common to the semiconductor industry, including photolithography [11].

2 FUNCTIONING OF SOLAR WATER PUMPING SYSTEM.

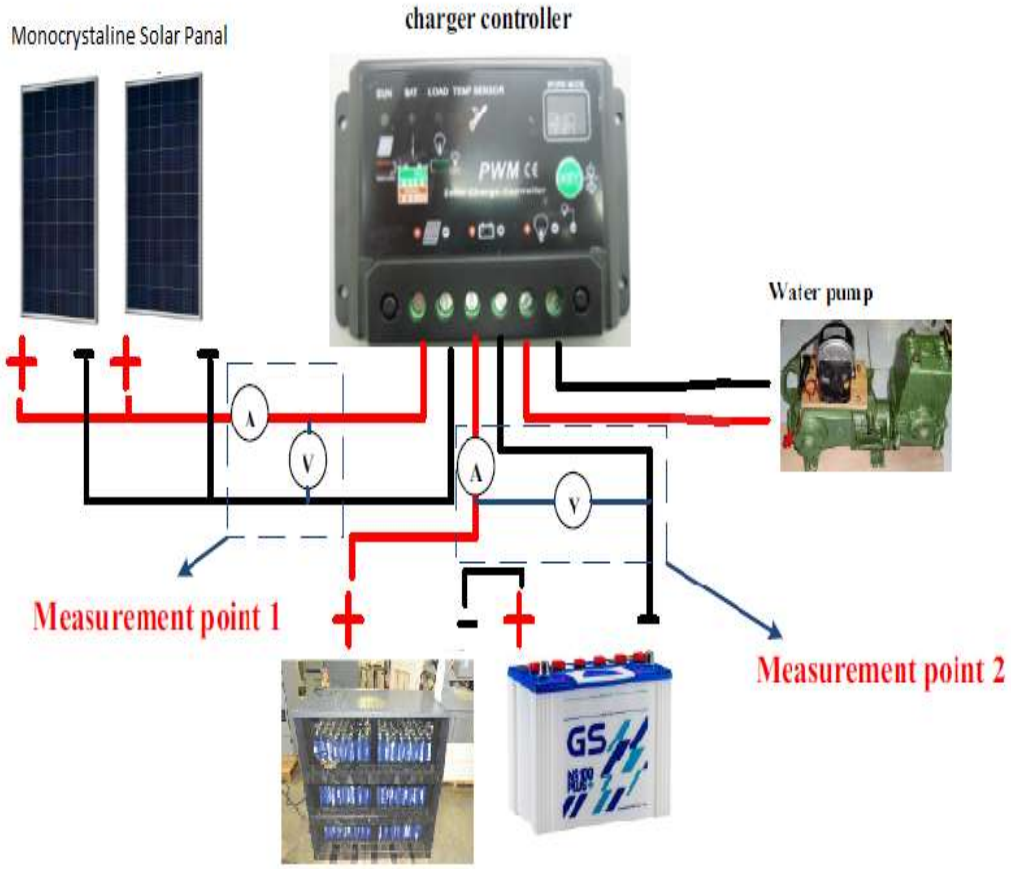

Fig -1. Diagram of solar water pump

The solar water pump system has been designed and built. It was installed on raft and floating way in irrigation canal . .solar water pump with charger control for energy storage is illustrated. The system consists of equipment as follows: monocrystaline solar panels, charger controller, supercapacitor, timer to control operating time and one DC water pump.

A monocrystaline cell is the only source of energy to drive this system. The energy will be stored in the supercapacitor through power supply. The sensors, microcontroller interface are driven by DC power. The designed charger controller is to have very fast transient response and very small transitory voltage overshoot. It is also found that the proposed charge controller shows better PV energy capture than the on/off controller. While the studied system is characterized by lower battery bank internal resistance, it has been inferred that in systems with higher nominal voltages and thus higher internal resistance and having installed battery capacity which is small compared to the PV array, the proposed controller will have significantly higher utilization factor and hence should be the preferred controller. In terms of over-voltage, both controllers were able to maintain the battery voltage at or below the thresh hold setpoint in the system considered here. In systems with very rapid on/off operations near full charge the on/off controller could risk oscillation or would have difficulty following very frequent over-voltages if built with timed on/off period. Agriculture livestock watering /crop irrigation, home garden and drip irrigation system.

3. OBJECTIVE

- Consistency in water supply.
- Constant power flow.
- Makes irrigation more efficient.
- Minimizes human interventions.
- More capable than conventional pump

4. APPLICATIONS

- Agriculture livestock watering /crop irrigation, home garden and drip irrigation system.
- Domestic portable water for remote homes, camp grounds.
- Pond water management and water transfer.
- Water supply for villages for developing world.
- where a large amount of power is needed for a relatively short time, where a very high number of charge/discharge cycles or a longer lifetime is required

5. CONCLUSIONS

The performance of proposed system has been evaluated using electrical data and temperature from Monocrystaline panel and energy storage device throughout the day. The results have indicated that current and voltage generated from Monocrystaline panel mainly depended on solar irradiation and temperature. In energy storage part, for supercapacitor charging at constant voltage, charging current is less than current from Monocrystaline panel due to power loss that occurs in equipment and copper wire. The performance analysis has shown the effectiveness of solar water pump compared to diesel engine water pump that farmer has normally used. The proposed solar water pump using supercapacitor can be effectively employed in cultivated area located far away from water source.

6. REFERENCES

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