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# Novel slow switching technique for efficient solar energy harnessing for off grid photovoltaic systems

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Electricity consumers in remote areas where the grid connection is not available rely on diesel generators or off grid photovoltaic (PV) systems. These PV systems uses battery banks as backup energy storage. Those battery banks are charged by using a battery charge controller connected to a PV array. Because of the recent advances in solar charge controllers, they can reach maximum of 90% charging efficiency, where 10% will be unutilized. Since the efficiency of conventional solar panels lies around 20-25% which is relatively low as compared to other energy generation methods, it is important to utilize as much energy as possible produced by the solar panels. Also, when driving loads, energy stored in the battery bank again goes through a converter or inverter by wasting considerable amount of useful energy. Hence, the purpose of this study is to minimize the energy loss of the charging process of the battery bank while using the energy produced by the PV array in an effective manner. In previous publications, it was introduced a novel way of using supercapacitors (SCs) in an off grid PV system. When charging an empty capacitor in parallel with a source, 50% of energy is wasted irrespective of the value of total loop resistance. In contrast, by connecting a SC bank in series with a typical solar charge controller, it was shown that the energy loss of the combined system is less than the energy loss of parallelly connected SC bank and the battery bank in their individual systems. Experimentally, it has been shown that a 9% increment in overall charging efficiency of the combined system when a charge controller having 80% of efficiency is used to charge the battery bank in typical off grid PV system. The present study introduces a possible method of utilizing the energy stored in SC bank in an effective manner using an intelligent electronic switching scheme. The proposed method uses a second SC bank along with the existing one along with a smart electronic switching circuitry which is able to switch each SC bank between charging or discharging stages when necessary. When one SC bank is in its charging state, the other SC bank will be in its discharging state through a proper load. After that, when the first SC bank is fully charged or the second SC bank is fully discharged, positions of each SC bank is swapped so that the second SC bank will start its charging process while the first SC bank is now discharging through the load. This way both charging and discharging of SC bank can be done efficiently while charging the battery bank in the system by the same manner.

**Keywords:** Off grid photovoltaic system, Charging efficiency, Supercapacitor, Charge controller