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HYBRID ENERGY STORAGE SYSTEM USING BATTERY AND SUPERCAPACITOR FOR SOLAR ENERGY UTILIZATION

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INTRODUCTION

In the time of changing global landscape, energy has become a prior focus of the all leaders of the world and technical community. There always been a great interest and primary focus for developing and refining more efficient energy storage devices. One of the device, the supercapacitor, has matured significantly over the last following time period and it has emerged with the potential to facilitate major advances in energy storage system. Supercapacitors, which is also known as ultracapacitors or electrochemical capacitors, utilize high surface area electrode materials and thin electrolytic dielectrics to achieve capacitances more of magnitude larger than conventional capacitors. In doing so, supercapacitors are able to attain greater energy densities while still maintaining the characteristic high power density of conventional capacitors.

SUPERCAPACITOR& BATTERY

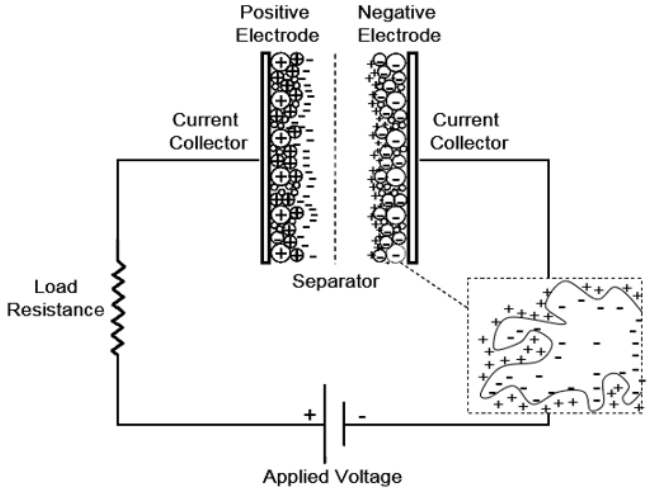
A new technology, the supercapacitors, has emerged with the potential to enable major advances in energy storage. Supercapacitors are governed by the same fundamental and mathematical equations as same as conventional capacitors, but utilize higher surface area electrodes and thinner dielectrics to achieve greater capacitances. This features allows for energy densities greater than conventional capacitors and power densities greater than batteries. Batteries have a limitation in their maximum deliverable power because of its slow chemical process required to release their energy and its low energy density.

SUPERCAPACITOR

A capacitor is a passive two terminal electrical component used to store energy in electrical field in it. When there is potential difference across the conductor, a static electrical field develop across the dielectric, it cause positive charge on one plate and negative charge on second plate so energy is stored in electrostatic field.

"A supercapacitors is an electrochemical capacitor that has an unusually high energy density when compare to common capacitor technically supercapacitors are known as electrochemical double layer capacitor or "EDLC". The electric double layer differs from conventional capacitor as it has the dielectric that is nanometre thin, which also contributes to creating high capacitance."

When we implement the renewable energy generation, the maximum power point tracking (MPPT) is integrated. But when the matter comes to implementation of adjoint with existing electrical power network, the fluctuation of power flow from these sources happens. As an assurance of power quality in system where line impedance being significantly resistive and the level of power injection is very high, energy storage system must be applied. Although .this is not cost-effective solution. In this paper supercapacitor energy storage are proposed for peak power unit in the concept of Demand side management in proper working condition. As a result, the impact of power fluctuation from renewable energy sources can be mitigated.



[Fig.01] Schematic of EDLC

For the conceptual electronic design engineers, one more important supercapacitor characteristics include high power densities and very long lifetimes including the number of charge cycles. This is a distinct advantage over batteries.[1] These all characteristics complements many more new applications characterized by widely varying energy requirements such as with smartphones and other smart electronics. In these applications, they can be used to extend battery life and performance cycle with better efficiency. Supercapacitors are also displacing both conventional capacitors and batteries in many mature applications.

Supercapacitors

- Physical Charge Storage
- Higher Power Density,
- Faster ‣ Millions of charge/discharge cycles
- No maintenance
- Broad temperature range (-30 C° to 65+ C°)
- Cycle efficiency can be above 95% ‣ Lower internal resistance energy Storage Device SUPERCAPACITOR has 1,000,000+ Times the Capacitance of “Regular” Capacitors

Batteries

- Chemical Charge Storage
- Lower Power Density, Slower
- Thousands of charge/discharge cycles
- More Maintenance
- limited temperature range

HYBRID STORAGE SYSTEM MODEL

1. PV module [Power generation]

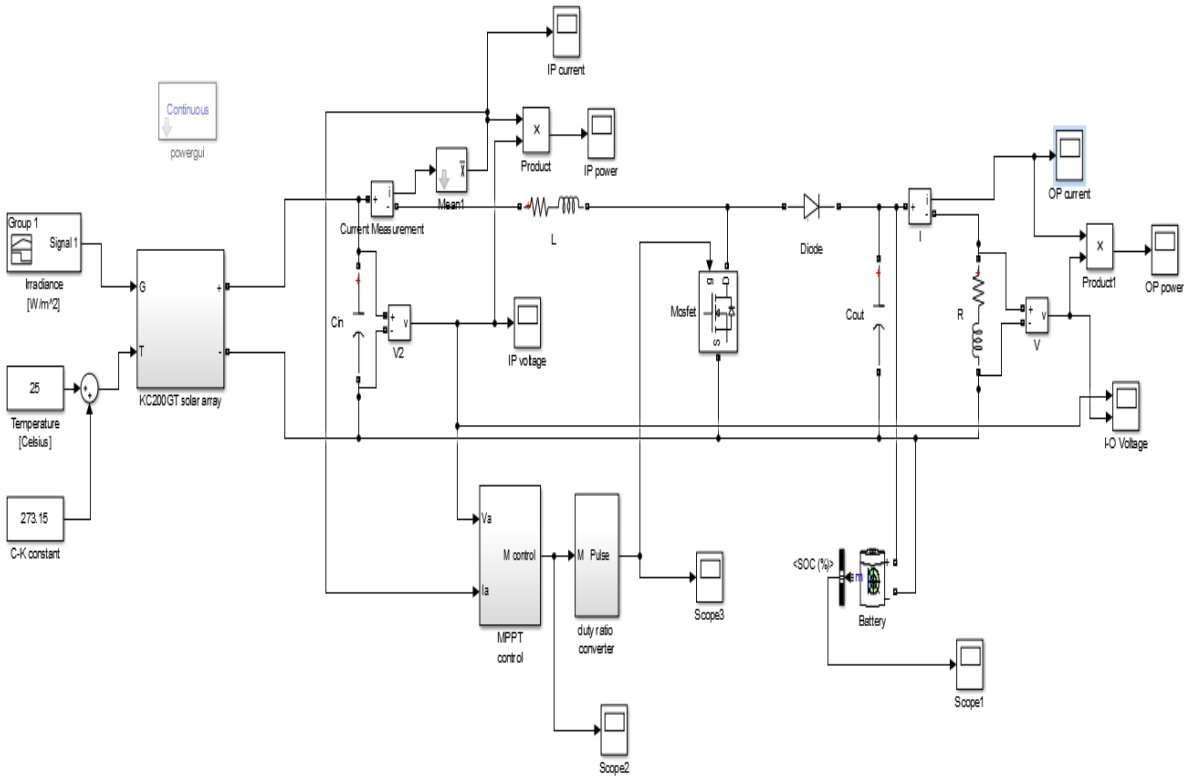
   Modeling of PV system for the power generation and getting the current and power characteristics for different temperature change and different irradiation level change.

2. PV module and converter [Power supply]

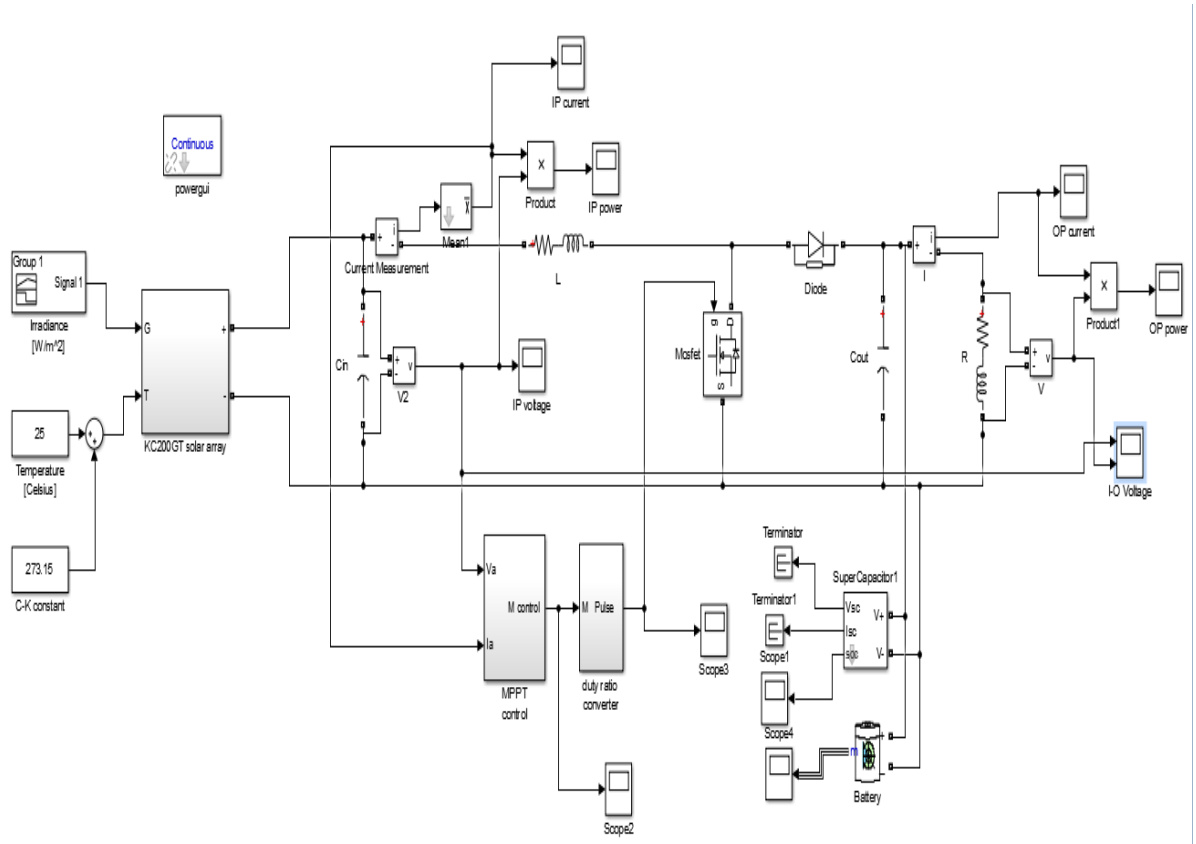
   Addition of converter to the PV module and getting the input –output characteristics for voltage level required for hybrid storage system.

3. Parallel operation of battery and supercapacitor [Hybrid storage system]

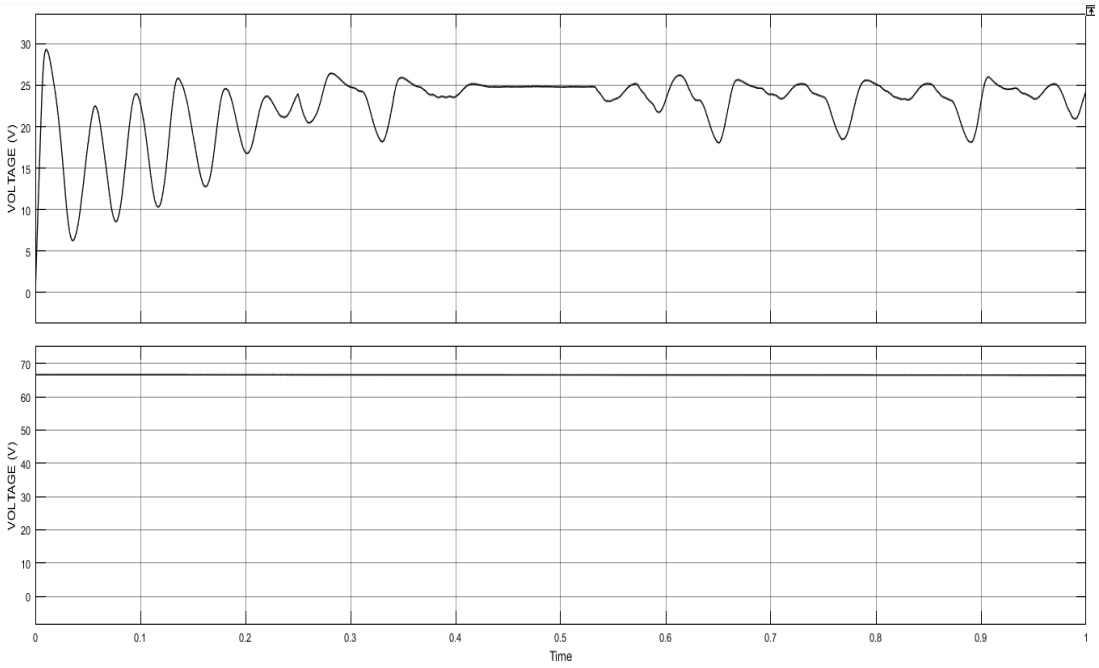
   Modeling & Simulation of Hybrid energy storage system and defining the different characteristics compare to conventional storage system.



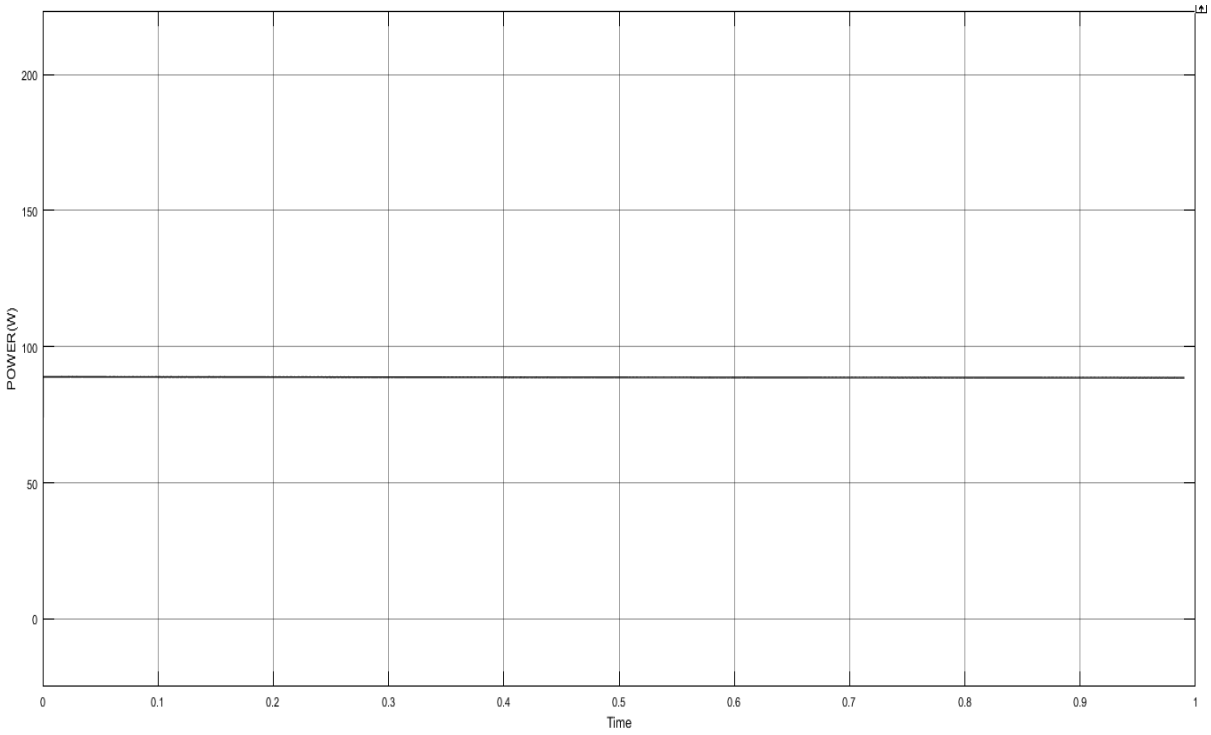
Storage system only with battery



Storage system with battery & Supercapacitor Simulation model



Input and output voltage



Output power

ADVANTAGES

- Very high rates of charge and discharge
- "Fill-in" power for wind and smart-grid system
- Grid-stability
- Power quality for composite load
- High cycle efficiency (up to 95%)
- Little degradation over hundreds of thousand cycles
- Low toxicity materials used as compare to battery and common capacitor – environment friendly

- The results show that the hybrid storage system can achieve higher specific power than the battery storage system.

CONCLUSION

By using the Hybrid storage system including supercapacitor and battery in place of conventional storage system, the voltage fluctuation and the voltage drop, starting impact of current for various load is to be mitigate and the utilization of solar energy smoother and also the efficiency level of solar cell can be increased.

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