# Modeling of a Lithium-ion Battery-Photovoltaic Solar Cell Hybrid System

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Many renewable forms of energy (ie. wind, solar, etc.) are intermittent in nature, which causes major problems when attempting to implement these types of energy into the electric grid [1]. Consumers demand an uninterrupted supply of power which requires constant generation sources. Although the amount of sunlight available in a given area is unpredictable, we can level the generation of an intermittent energy supply by coupling generation devices with energy storage systems (see Figure 1). At times of peak generation, part of the energy obtained can be transferred to a storage device, where it can be released during periods of low or no generation. This storage and release pattern can level the amount of renewable energy to provide a continuous source of power.

Our study specifically investigates the coupled system of a p-n homojunction silicon solar cell and a Li-ion battery (see Figure 2). We model the combined system to study the effects on the system parameters and operating conditions caused by the coupling of the two systems. A electrochemical and transport based lithium ion battery model [2-5] and a 1-D continuum model of a p-n homojunction silicon solar cell [6-7] were validated independently and then coupled to use synchronized current and voltage conditions throughout the combined circuit. This hybrid system is then solved as a single, simultaneous system to obtain battery and cell characteristics through charging (generation) and discharging (no generation) cycles. The combined system will study the ability of the Li-ion battery to function efficiently as an energy storage device for solar generation.

By solving both systems connected in circuit simultaneously we can study the effects each system has on each other dynamically. A simple circuit is considered which connects the battery and solar cell without any external voltage or current regulators. The voltage and current throughout the system are determined through the combined properties of the battery and solar cell.

By obtaining results for a small hybrid system, we can better understand how the individual systems work in tandem and affect each other's conditions. Future work will include optimizing the hybrid structure at the systems level as well as studying large scale systems that could be used for an entire solar farm.

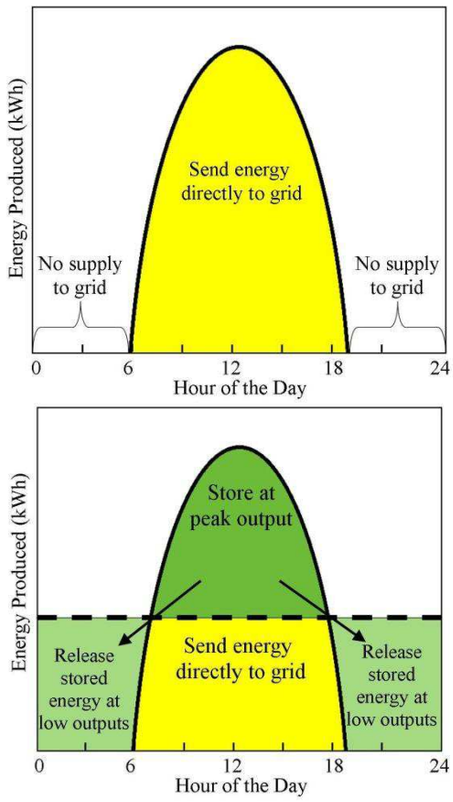


Figure 1:(Top) Without energy storage generation is intermittent. (Bottom) With energy storage source become effectively a constant generator.

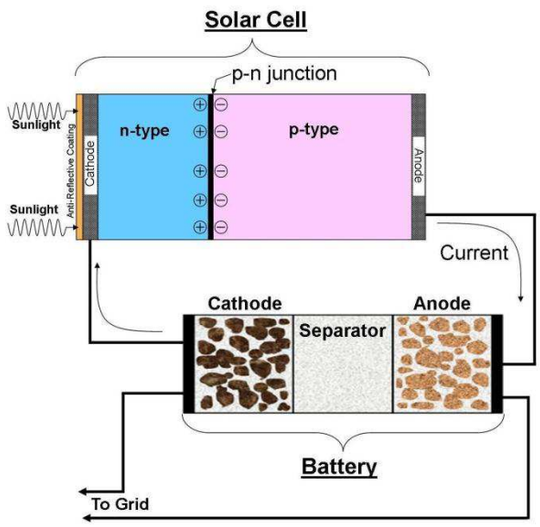


Figure 2: Battery-Solar Cell Hybrid System Schematic

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