Photovoltaic Systems

Introduction

Currently, the most popular form of renewable energy is solar energy, or energy that is produced from the sun. The cornerstone for this industry is photovoltaic modules which are currently available from various manufacturers. There are many advantages of using photovoltaics in today's world such as high reliability and little need for maintenance, its obvious environmental value, remote location small scale applications and the relatively low cost in comparison to other types of renewable energy. The New Jersey Clean Energy Program offers rebates for installing a photovoltaic system at homes or businesses. The case study presented in this document reviews the installation of a 35 kW for their business and interconnected this system with the power grid. The business will now always have power even when the photovoltaics are non-operational.

How Photovoltaic Systems Operate

Photovoltaic cells are made up of semiconductor materials, which are materials with electrical conductivity intermediate between that of an insulator and a conductor. The most common semiconductor used today for photovoltaic cells is silicon. When light strikes the cell, the energy from the light, known as a photon, is absorbed by the electrons in the valence shell of the semiconductor. By absorbing this energy, the electron loosens and is able to flow freely forming electrical current. The process of electrons absorbing photons and leaving the current electron shell is known as the photoelectric effect. By placing metal contacts on the top and bottom of the photovoltaic cell, current can be drawn externally. This is how photovoltaic cells are used in systems that can be used to power electrical devices. Dozens of these photovoltaic cells are interconnected together in a sealed weatherproof package called a module. Multiple modules can be combined to produce more current for different size loads [1]. A diagram of a photovoltaic cell is shown Figure 1.

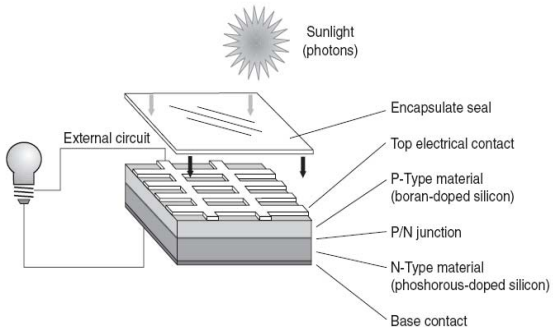

Figure 1: Diagram of a Photovoltaic Cell [1]

Applications of Photovoltaic Systems

Grid-Connected Systems

In a grid-connected system, the photovoltaics deliver dc power to a power conditioning unit (PCU) that converts dc to ac and provides the building with power. The PCU will draw power from the utility grid if the photovoltaics supply less than the immediate demand. On the other hand, the photovoltaics can send power back to the grid and spin the electric meter backwards if the photovoltaics supply more power than the immediate demand. The PCU will also assist in keeping the photovoltaics operating at the most efficient point on their Power (current by voltage) curves as certain conditions change.

Stand-Alone System

A stand-alone system is a photovoltaic system that is not connected to a utility grid and often has a battery for storage or generator for emergency power. These systems are very useful and economic in remote locations. Other alternative solutions may be generators which are often noisy and inefficient or the burning of expensive fuel. Also, power lines may even need to be extended to the nearest utility grid of the remote location which could cost thousands of dollars per mile. Stand alone systems are not ideal due to inefficiencies, including battery losses not operating at their most efficient operating point. These inefficiencies often come from mounting the array at an overly steep tilt angle to supply a more uniform amount of energy through seasons. The alternative would be picking an angle that result in the maximum possible annual energy production. A diagram of a stand alone system is shown in Figure 2 [2].

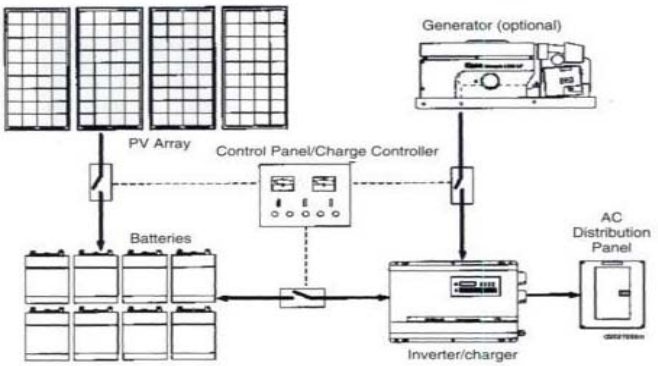

Figure 2: Diagram of a Stand-Alone System [3]

Photovoltaic Systems Coupled to Loads

Another type of photovoltaic system is one that is directly coupled to a specific load without batteries or any other power conditioning equipment. One example of this type of system is a water pumping system, in which the wires from the PV array are connected directly to the motor running a pump. When the sun shines, water is pumped. However, there is no electric storage, but potential energy can be stored in a tank of water uphill for use when needed. Such systems simple, reliable, and least costly. A diagram of such a system is shown in Figure 2.

Rebates for Photovoltaic Systems

Rebates are available for photovoltaic systems that are installed on location, including businesses and homes. There are two types of rebates available for residents of New Jersey installing photovoltaic systems. The first and largest rebate program is the CORE rebate. This is a rebate that is paid for by the New Jersey Clean Energy Program that will pay for a percentage of the installation cost. The second can still save money and this way is selling SRECs (Solar Renewable Energy Certificates). A SREC is a solar credit that is obtained after producing a megawatt of energy with the system. The price per SREC varies depending on the market and who the SREC is being sold to. Visit www.njcep.com for updates on the average price of SRECs and updates on the CORE rebate program. The current rebate prices are listed Table 1[2]. All new applications for the CORE rebate are held in queue until new funding is available.

Table 1: CORE Rebates for System Size [2]

	All Private Sector Solar PV Applications effective 09/01/06	All Public and Non-Profit Sector Solar PV Applications effective 09/01/06
0 to 10,000 watts	$3.50/watt	$4.10/watt
10,001 to 40,000 watts	$2.50/watt	$3.15/watt
40,001 to 100,000 watts	$2.25/watt	$2.50/watt
100,001 to 500,000 watts	$2.00/watt	$2.30/watt
500,001 to 700,000 watts	$1.75/watt	$1.85/watt

Case Study in Relation to Rebates

A business owner in Southern New Jersey installed a 10 kW system to cover their electrical needs. It was installed and interconnected to the grid during the fall of 2006. The total cost of the system was $77,500. Under the current CORE rebate system, a photovoltaic system of this size would receive $38,000 in CORE rebates. Annual savings from electric bills is approximately $3,900. According to the average value per SREC from the NJCEP, each SREC could be sold for around $250. This would be providing a total of $2,400 annually just from the value of the SRECs. After subtracting the CORE rebate from the initial cost, this subtotal is divided by the sum of the projected annual savings and projected sales from SRECs. This new total will be the payback period for the system. The payback period for this system would be 9.6 years.

Solar Companies

Companies such as BP, Sanyo, GE, Mitsubishi, and Kyocera are known for manufacture solar panels. These companies and the many other not mentioned make a variety of solar cells that supply various amounts of power. There are also many companies that will sell packages including the panels, the inverters, and installation costs. Some of these companies are Mesa Environmental, Solar Works, Sea Bright Solar, and many others located in New Jersey.

References

[1] Introduction to Photovoltaic Systems. Available: http://www.infinitepower.org October 17, 2006 [date accessed]
[2] Renewable Energy. Available: http://www.njcep.com October 17, 2006 [date accessed]
[3] Masters, Gilbert M. Renewable and Efficient Electric Power Systems. Wiley-Interscience, 2004