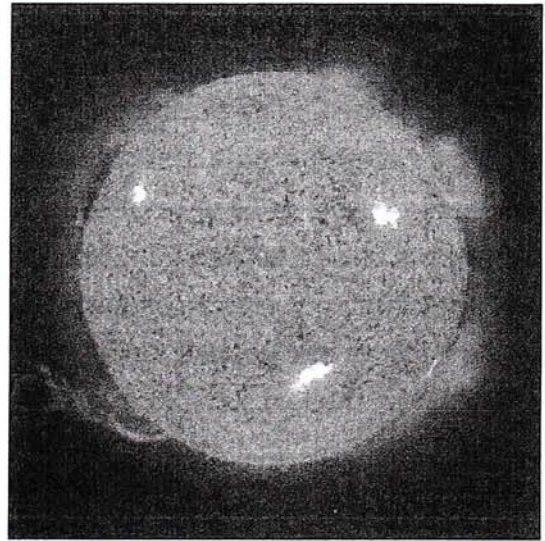


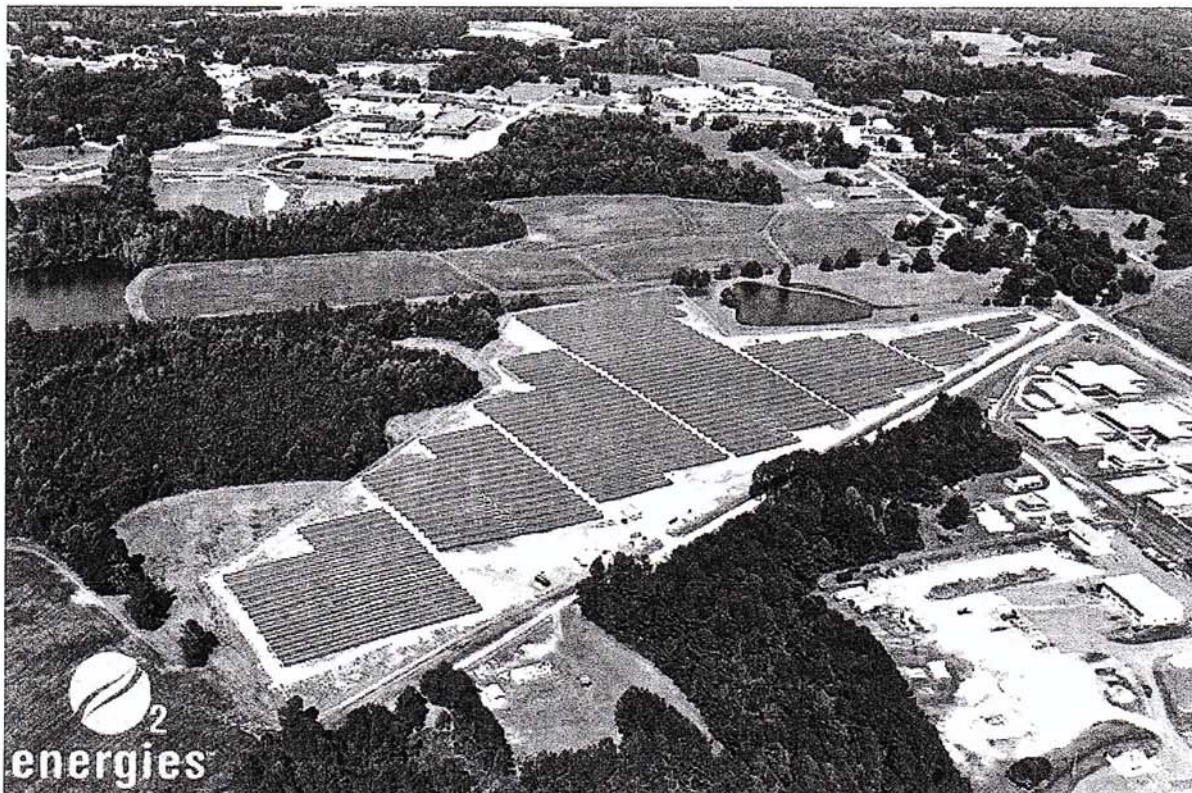
## Solar Energy Basics

The sun has produced energy for billions of years. Solar energy is the sun's rays (solar radiation) that reach the Earth. This energy can be converted into other forms of energy, such as heat and electricity. Radiant energy from the sun has powered life on Earth for many millions of years.



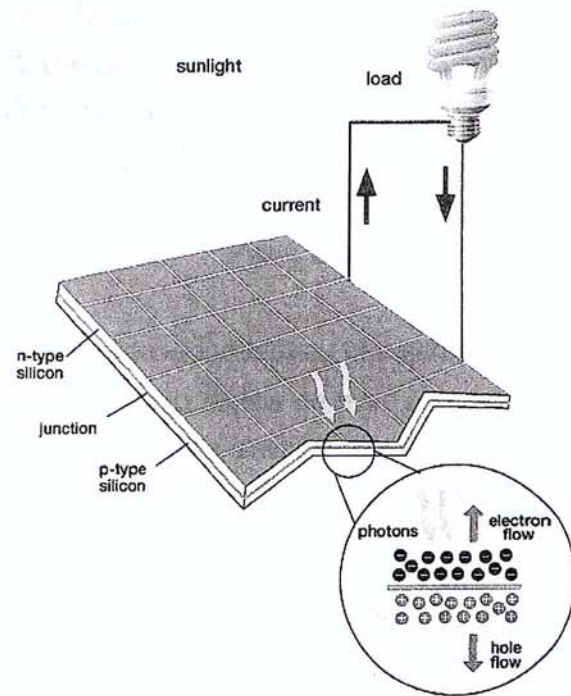
Albert Einstein has told us that light contains Photons. Photons have no weight or mass but when the photons in Sunlight hit pure silicon, electrons are released. This is called the Photovoltaic Effect.

**Photovoltaic Power** is electricity that is generated when sunlight is changed directly into electricity. Individual Photovoltaic (PV) cells are grouped into solar modules and solar modules are grouped into arrays. Solar power from PV can be used in a wide range of applications ranging from single small cells that charge a calculator, your mobile phone, or solar modules that can power your home, business or school. Large solar arrays are called solar farms which generate large amounts of power that is "fed" into the electrical grid used by many homes, businesses and school that are connected to the electrical grid. Solar Farms are large solar power plants covering many acres.



## The flow of electricity

When the electrons leave their position, holes are formed. When many electrons, each carrying a negative charge, travel toward the front surface of the cell, the resulting imbalance of charge between the cell's front and back surfaces creates a voltage potential like the negative and positive terminals of a battery. When the two surfaces are connected through an external load, such as an appliance, electricity flows.



## Weather affects photovoltaics

The performance of a photovoltaic array is dependent upon sunlight. Climate conditions (such as clouds or fog) have a significant effect on the amount of solar energy received by a photovoltaic array and, in turn, its performance. The efficiency of most commercially available photovoltaic modules in converting sunlight to electricity ranges from 10% to 20%. Researchers around the world are trying to achieve efficiencies up to 50%.

## Commercial applications of photovoltaic systems

The success of PV in outer space first generated commercial applications for this technology. The simplest photovoltaic systems power many of the small calculators and wrist watches used every day. More complicated systems provide electricity to pump water, power communications equipment, and provide electricity to our homes. In North Carolina, Solar Farms are becoming an inexpensive and clean source of power.

Some advantages of photovoltaic systems are:

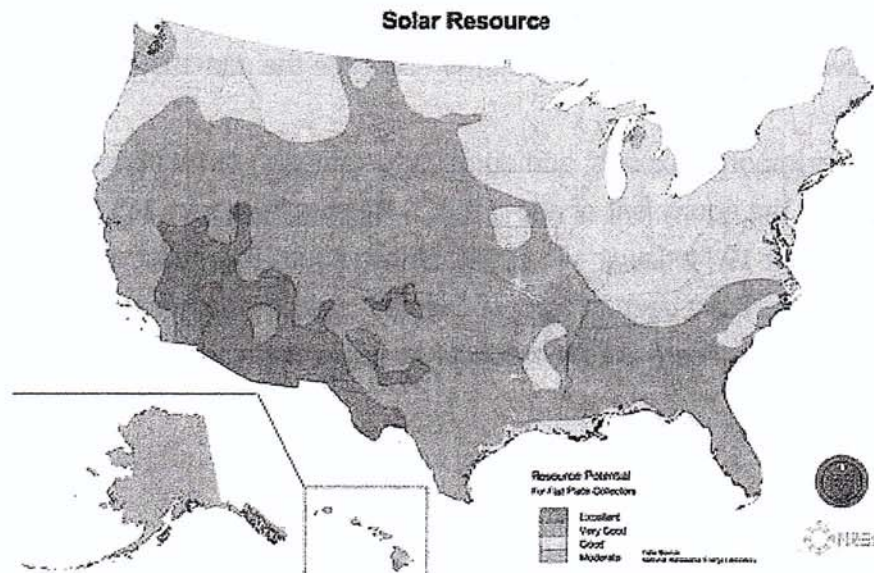
1. Conversion from sunlight to electricity is direct, so bulky mechanical generator systems are unnecessary.
2. PV arrays can be installed quickly and in any size.
3. The environmental impact is minimal, requiring no water for system cooling and generating no by-products.

## Where Solar is Found

Solar energy is sunshine. The highest intensity sunlight is found in the desert but there is more than enough sunshine throughout the United States to generate electricity from the Sun.

The amount of solar energy that the earth receives each day is many times greater than the total amount of energy consumed around the world.

However, solar energy is a variable and intermittent energy source. The amount and intensity of sunlight varies by location, and weather and climate conditions affect its availability on a daily and seasonal basis.



## More Detailed Study

Sunlight is composed of photons, or particles of solar energy. These photons contain various amounts of energy corresponding to the different wavelengths of the solar spectrum.

When photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity. When enough sunlight (energy) is absorbed by the material (a semiconductor), electrons are dislodged from the material's atoms. Special treatment of the material surface during manufacturing makes the front surface of the cell more receptive to free electrons, so the electrons naturally migrate to the surface.

Photovoltaic cells, like batteries, generate direct current (DC), which is generally used for small loads (electronic equipment). When DC from photovoltaic cells is used for commercial applications or sold to electric utilities using the electric grid, it must be converted to alternating current (AC) using inverters, solid state devices that convert DC power to AC.

#### History of the photovoltaic cell

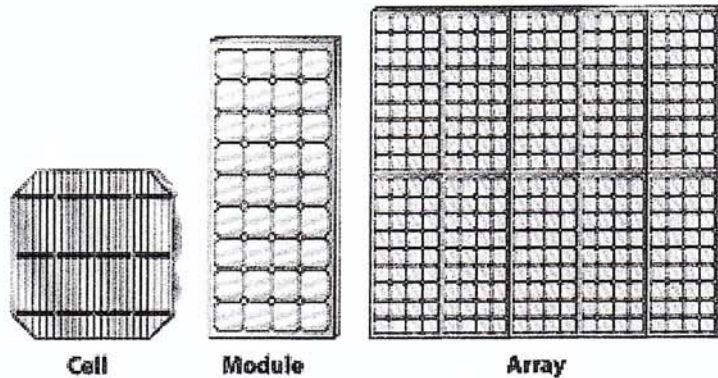
The first practical PV cell was developed in 1954 by Bell Telephone researchers examining the sensitivity of a properly prepared silicon wafer to sunlight. Beginning in the late 1950s, PV cells were used to power U.S. space satellites. PV cells were next widely used for small consumer electronics like calculators and watches and to provide electricity in remote or "off-grid" locations where there were no electric power lines. Technology advances and government financial incentives have helped to greatly expand PV use since the mid-1990s.

U.S. shipments (includes imports, exports, and domestic shipments) of PV panels (modules) by U.S. industry in 2012 was the equivalent of about 4,655 Megawatts, about 245 times greater than the shipments of about 19 Megawatts in 1994<sup>1</sup>. Since about 2004, most of the PV panels installed in the United States have been in "grid-connected" systems on homes, buildings, and central-station power facilities. There are PV products available that can replace conventional roofing materials.

## What you need to know before visiting the Rockwell Solar Farm?

What is a PV Cell? How much power does one solar cell produce?

What is a PV Module? How many watts does the average 60 cell solar module produce?



What is a PV Array?

What is DC power, give an example of a device that produces DC power (besides solar)?

What is AC power?

What is a Watt?

What is a Kilowatt, Megawatt, Gigawatt, Terawatt?

What is a Kilowatt hour?

How many Kilowatt hours does your home use a year?

How many kilowatt hours does the United States consumer every year?

How much does your family pay for a Kilowatt hour?

What is your average monthly electricity bill?

How many average homes would 1,500,000 kWh power every year?

What are the main benefits of solar energy?

What are the limitations of solar energy?