Renewable Energy Sources

PV SYSTEMS

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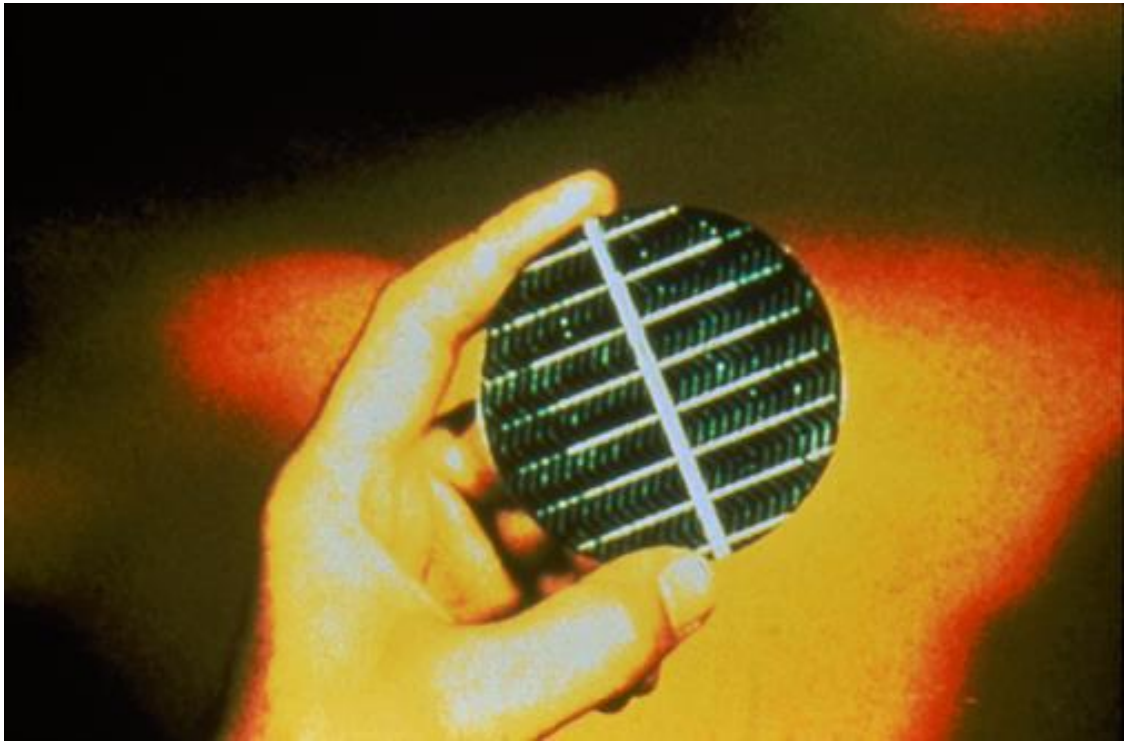
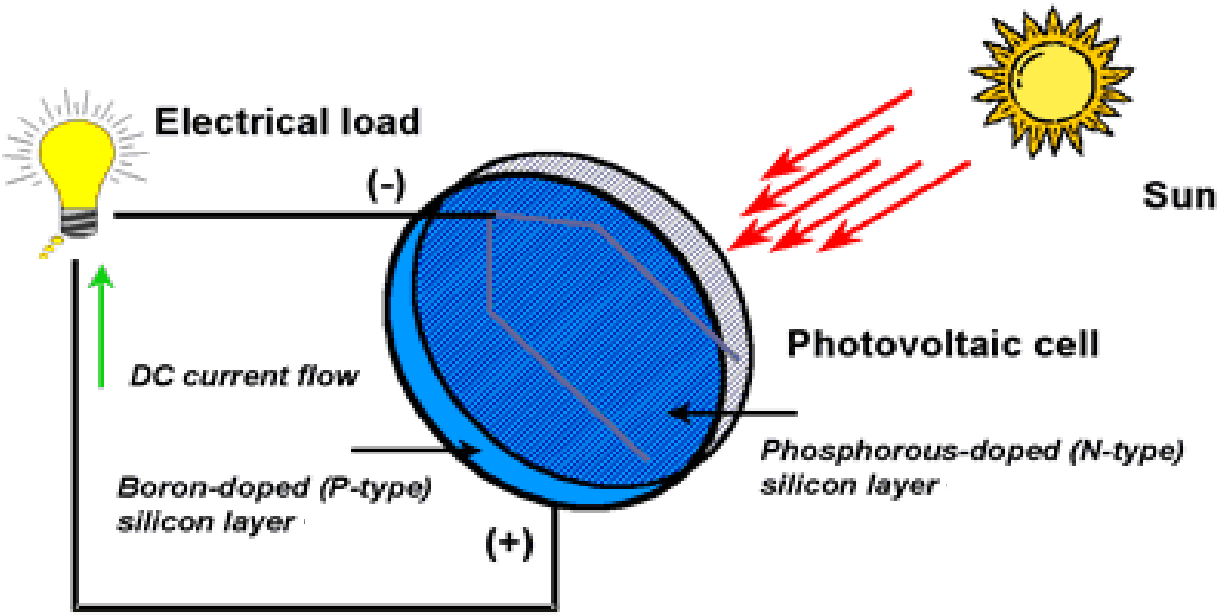
Solar Photo-voltaic (PV) Systems

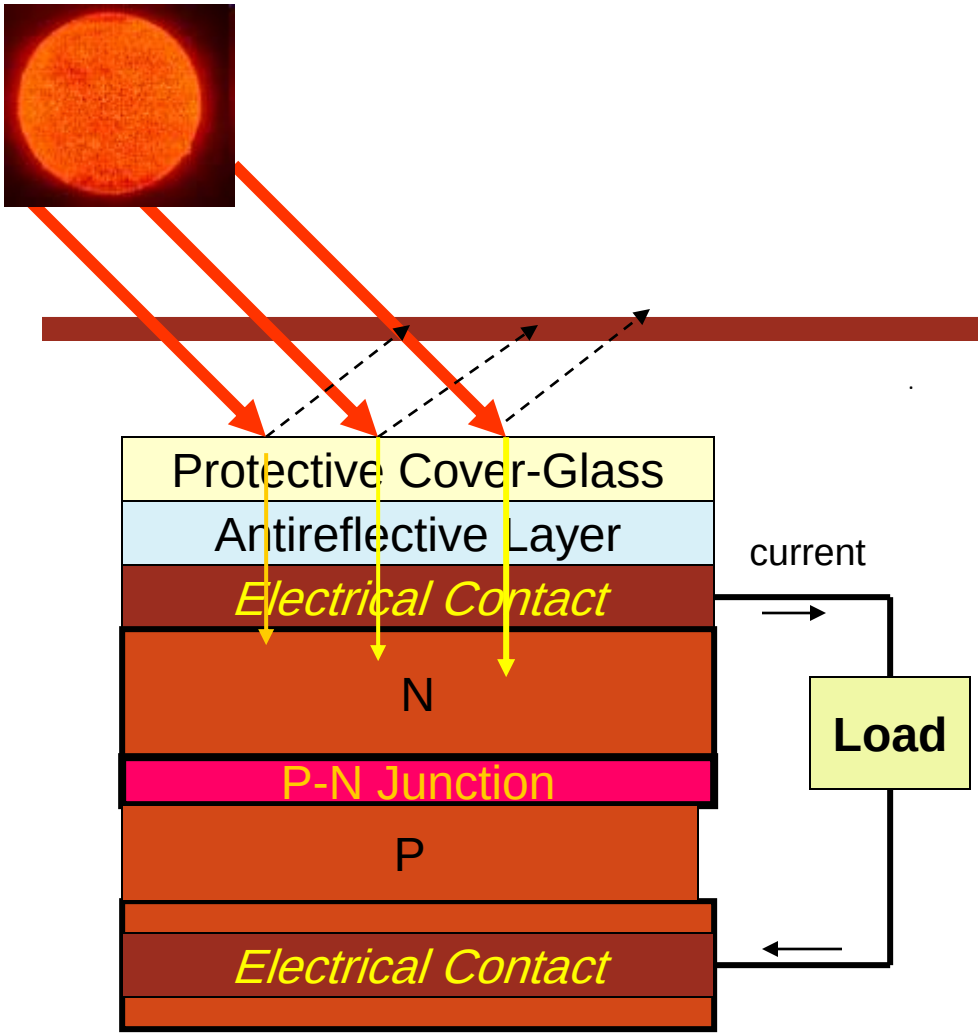


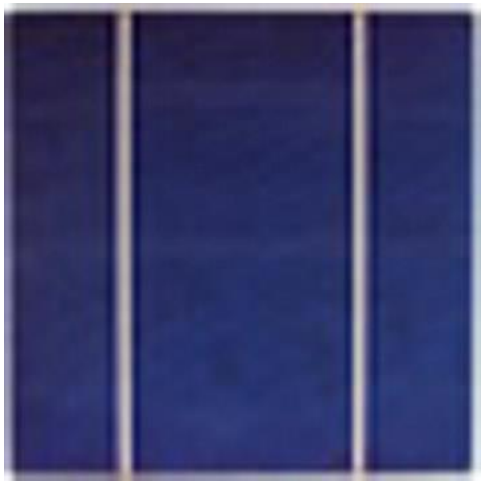
How electricity is generated through Solar Energy?

- Solar photo voltaic (SPV). Can be used to generate electricity form the sun.
- Silicon solar cells play an important role in generation of electricity.

How solar cells Generate electricity





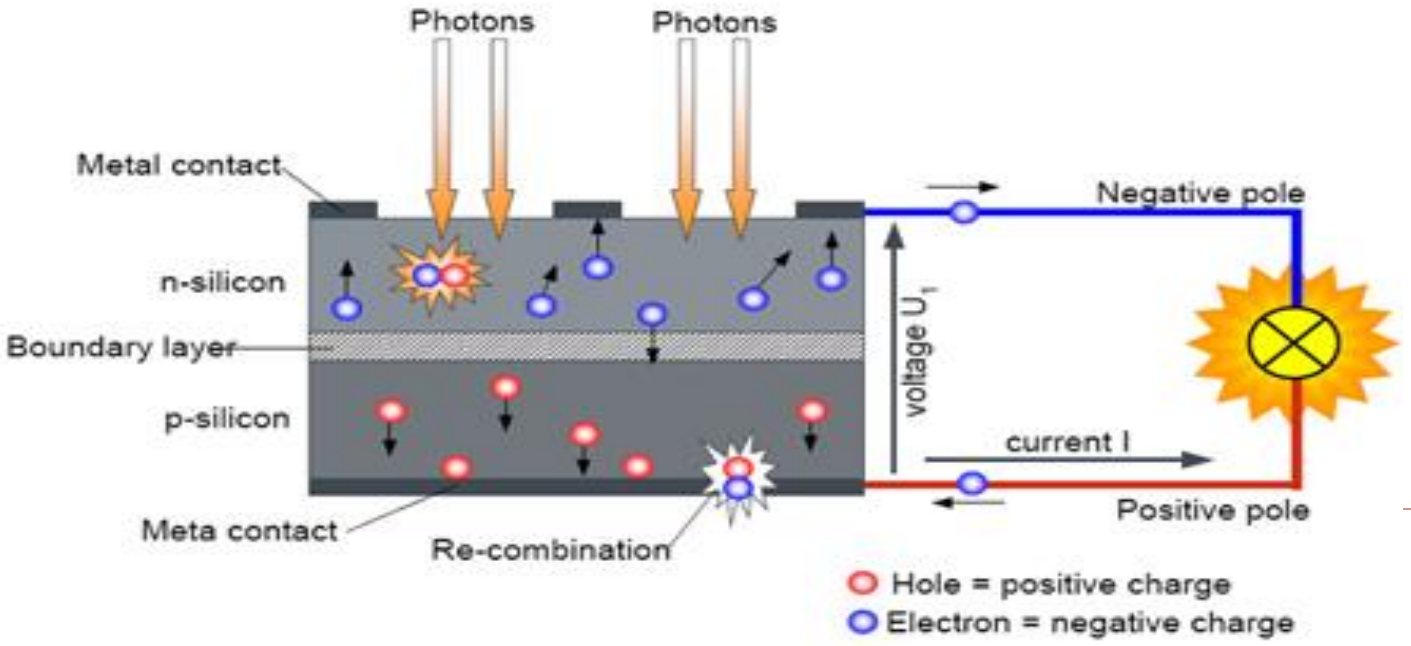


Solar Cell Schematic

The Process

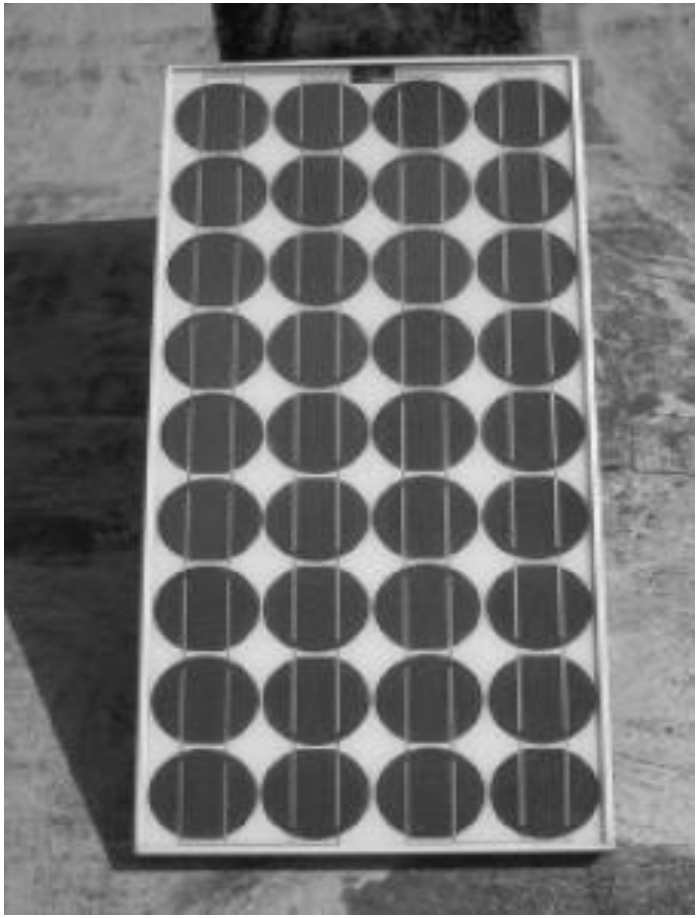
- Sunlight is made of photons, small particles of energy.
- These photons are absorbed by and pass through the material of a solar cell or solar PV panel.

- The photons 'agitate' the electrons found in the material of the photovoltaic cell.
- As they begin to move (or are dislodged), these are 'routed' into a current.
- This, technically, is electricity - the movement of electrons along a path.

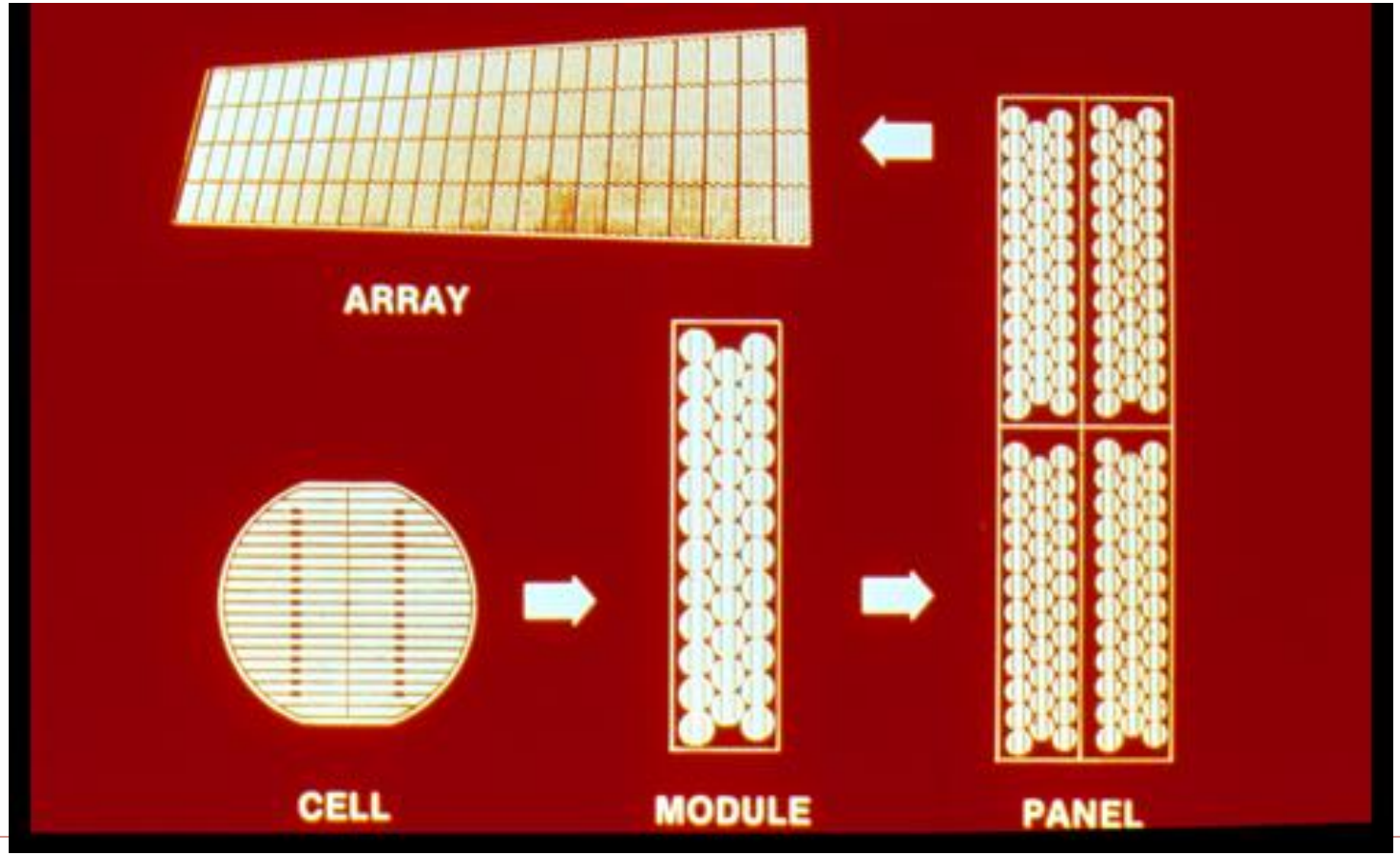


From Cells to Modules

- The open circuit voltage of a single solar solar cell is approx 0.7V.
- Much higher voltage is required for practical application.
- Solar cells are connected in series to increase its open circuit voltage.

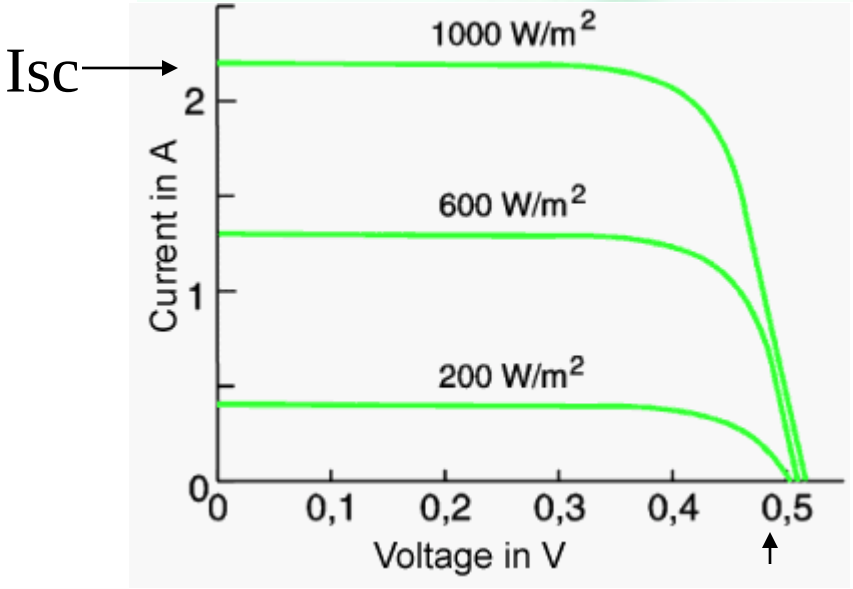


Groups of solar cells can be packaged into modules, panels and arrays to provide useful output voltages and currents to provide a specific power output.

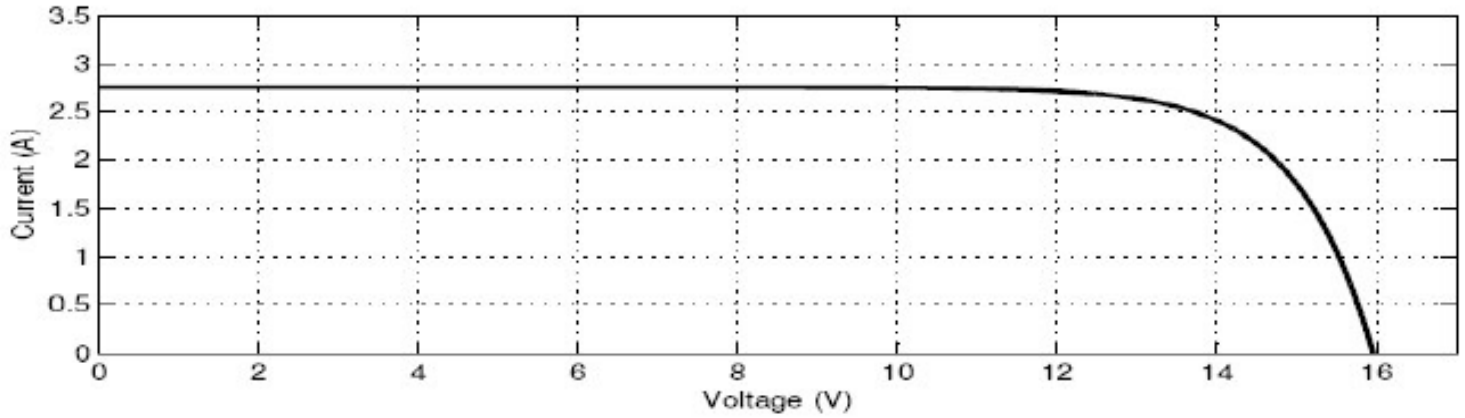


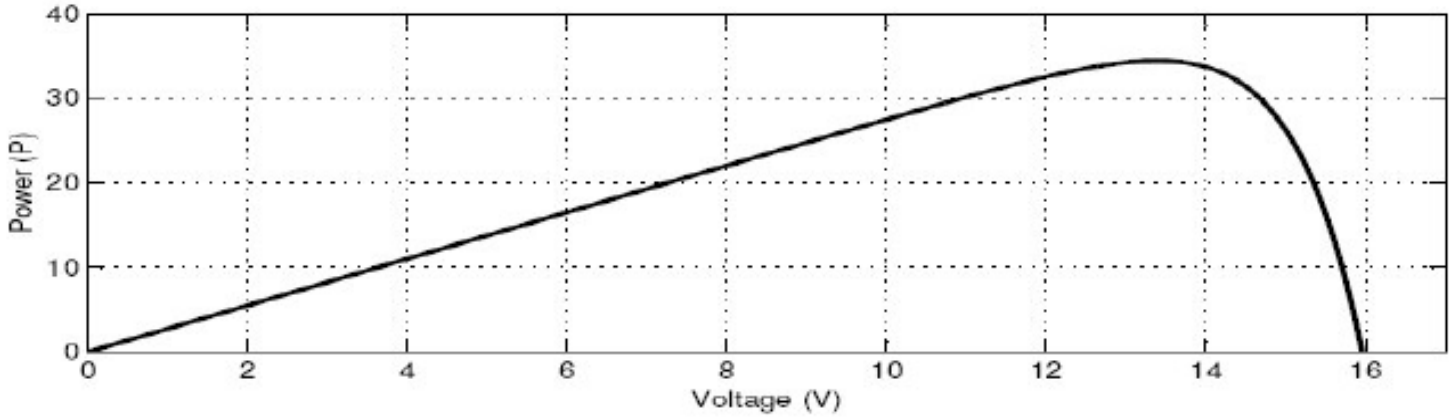
Solar cells Characteristics.

- Isc-short circuit current.
- Voc-open circuit voltage.
- Peak power.

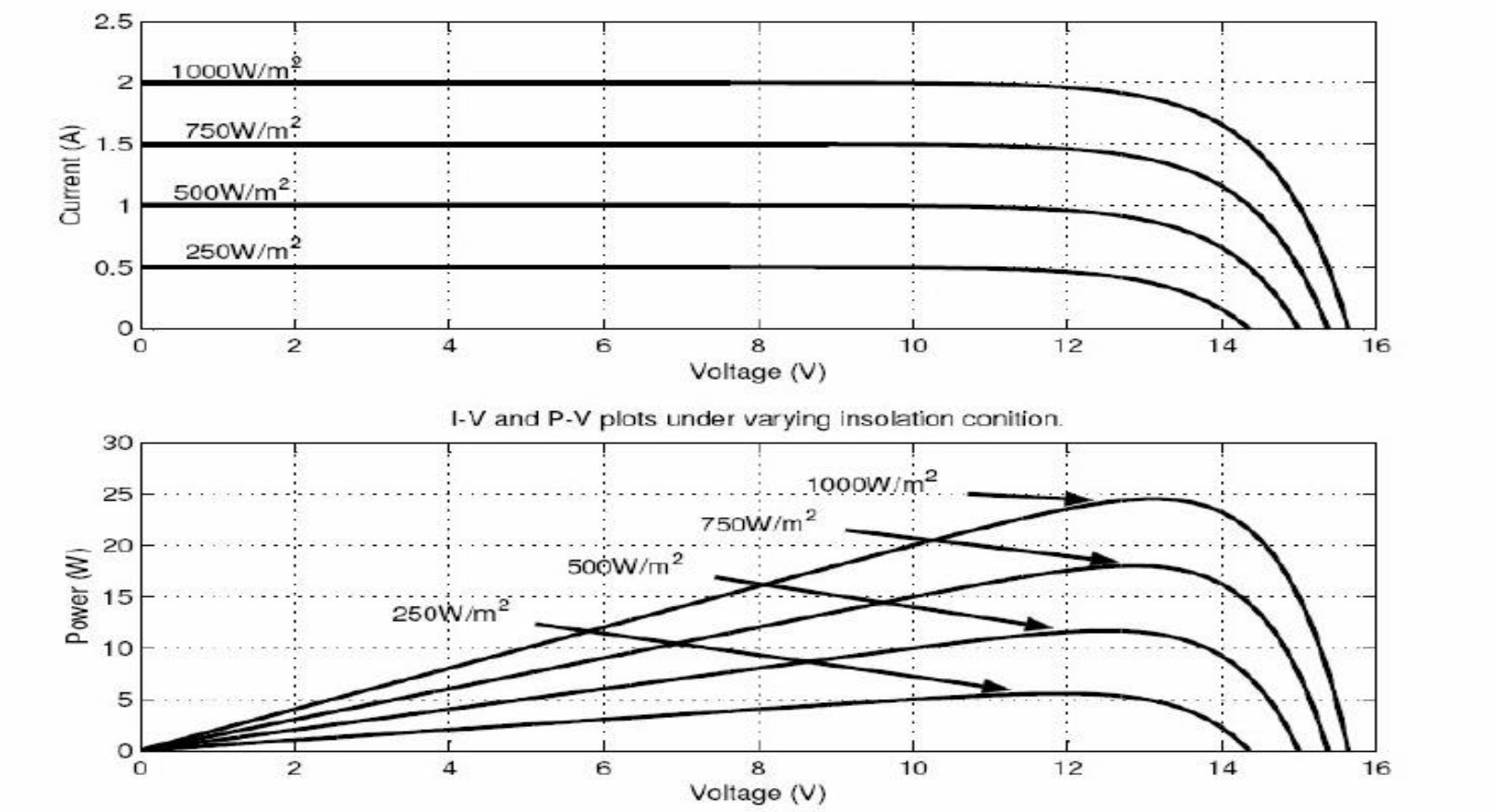


Characteristics of a typical Solar Pv Module.



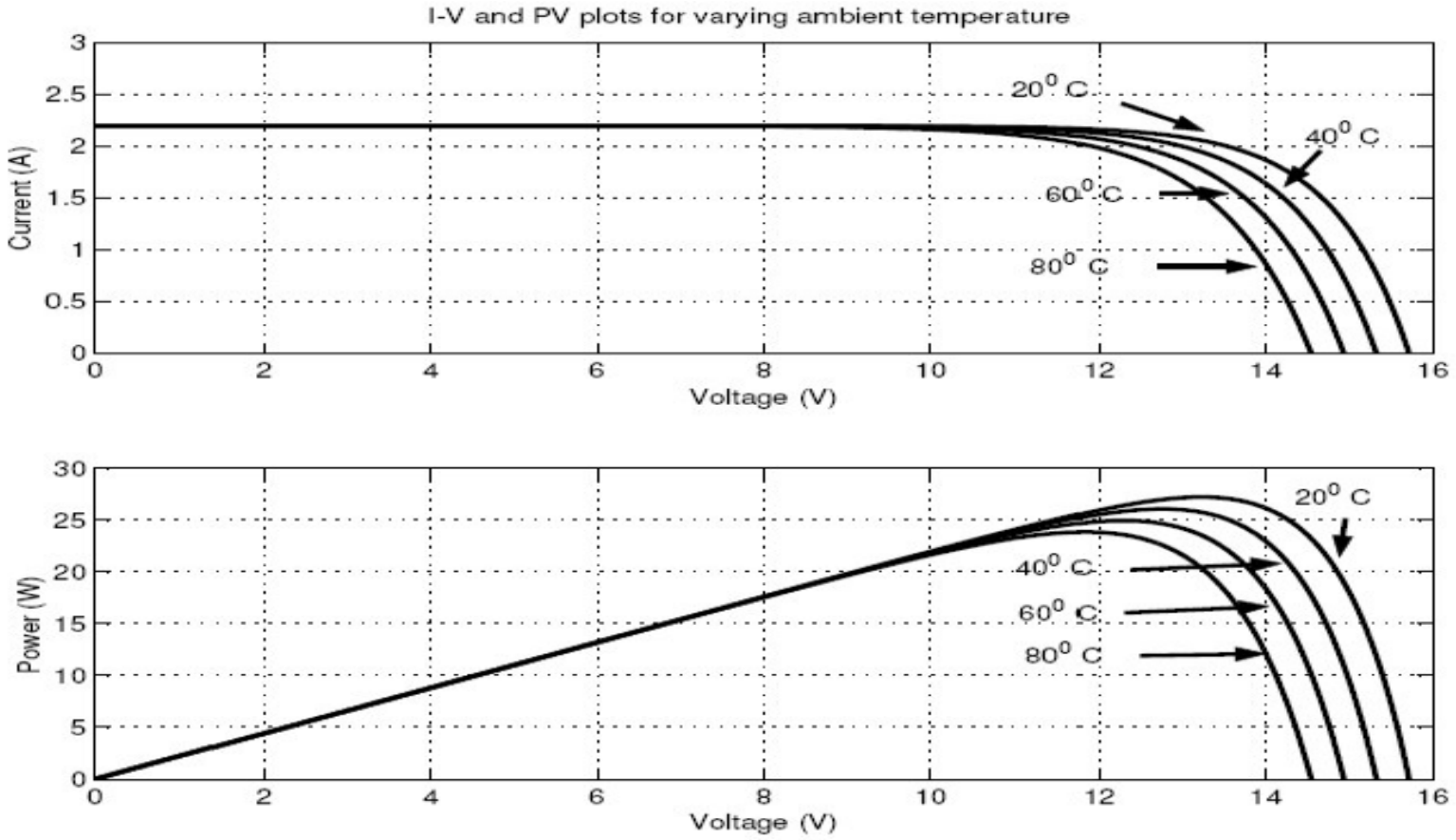


Variation of characteristics of Solar module with change in the atmospheric conditions



Variation due to insolation Change

Variation of characteristics of Solar module with change in the atmospheric conditions



Variation due to Temperature change

Conclusion from the Characteristics.

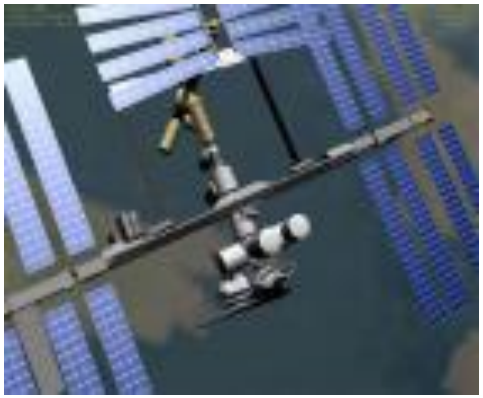
- Power of the module has only single maxima.
- Peak Power of the module changes with the change in temperature.
- Peak power of the module changes with the change in Radiation level.
- Need to track the peak power in order to maximize the utilizations of the solar module/array.

Photo-voltaic systems: Applications

Using the sun to generate electricity

Main Application Areas – Off-grid

Water Pumping



Space

Telecom

Solar Home Systems

Main Application Areas - Grid-connected

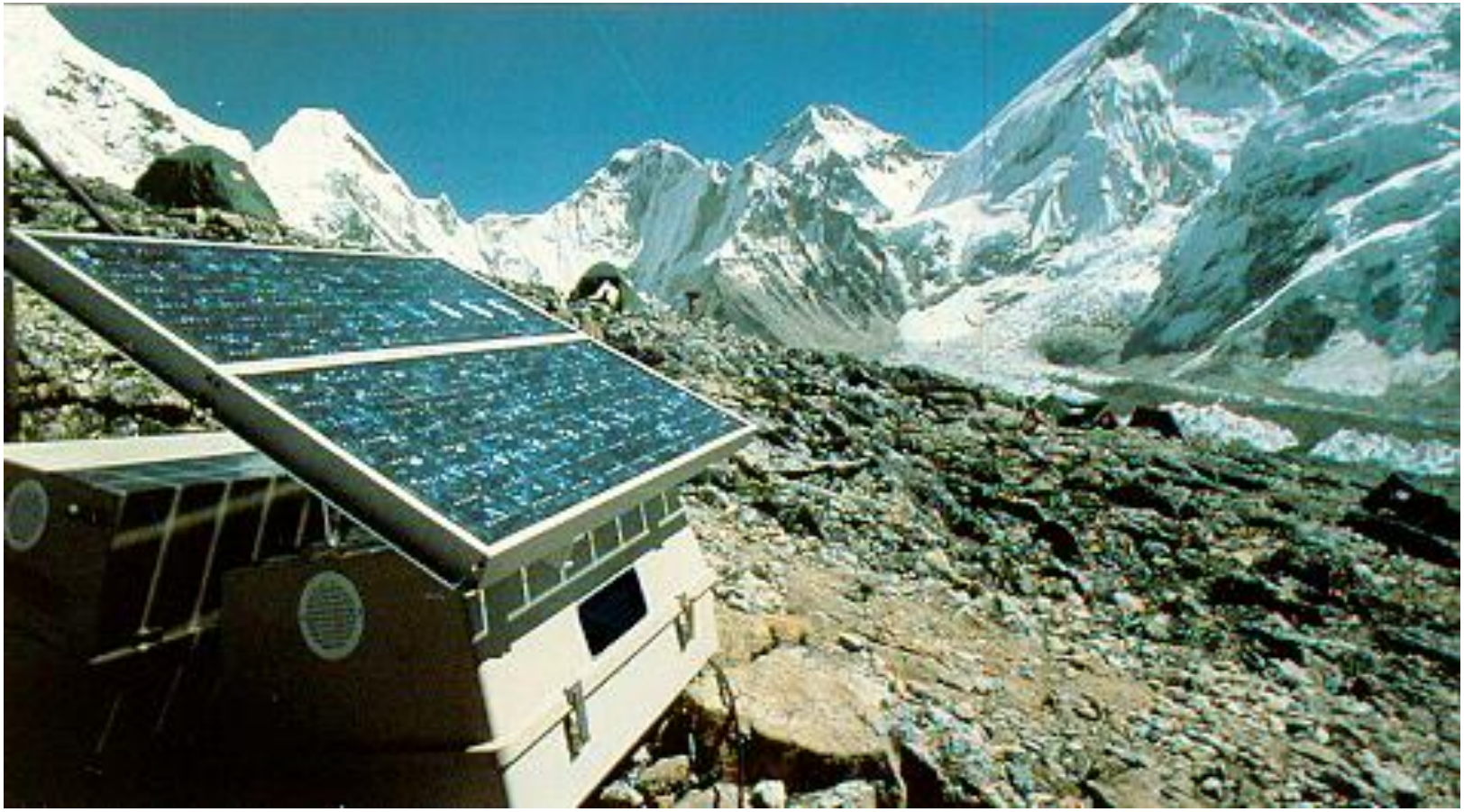
Commercial Building Systems (50 kW)

Residential Home Systems (2-8 kW)

PV Power Plants (> 100 kW)

On a planet where more than two billion people have no access to electricity, PV systems can provide power for many uses.

Photovoltaic power is ideal for remote applications where other power sources are impractical or unavailable



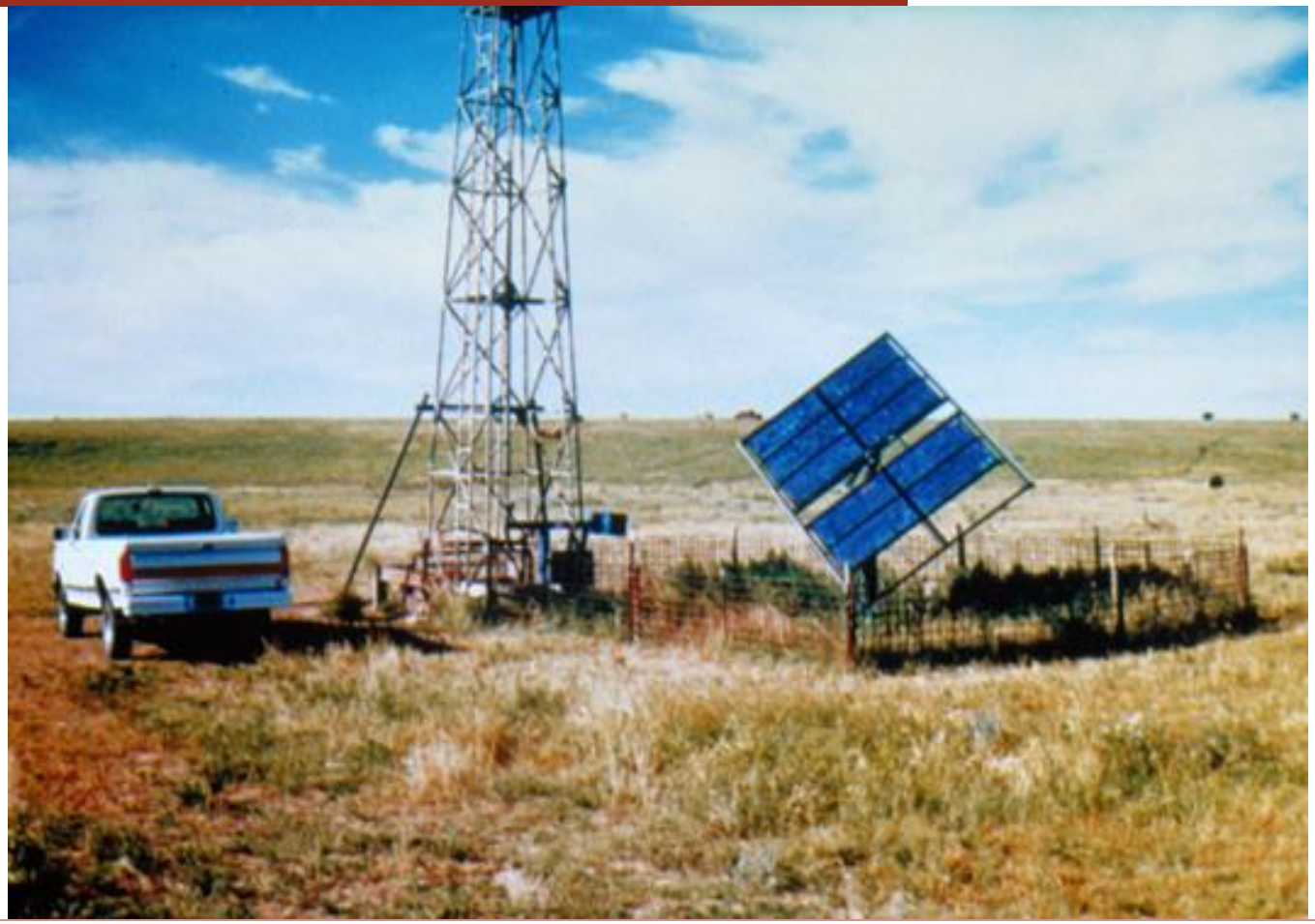
This mountain hut in a very remote area of France uses PV to generate power.

A lighthouse along the coast of Africa. Before this PV system was installed, the Lighthouse relied on bottled gas for power – a system that required constant maintenance and a permanent staff on site.

A stand-alone PV system in rural Spain. This system consists of a 900-watt PV array with inverter and batteries. More than 60 rural homes in this mountainous area have been electrified with PV.

PV power for off-shore navigational aids eliminates trips to and from shore to refill generators with fossil fuels.

Solar-powered water pumps are very efficient and cost-effective in agricultural applications

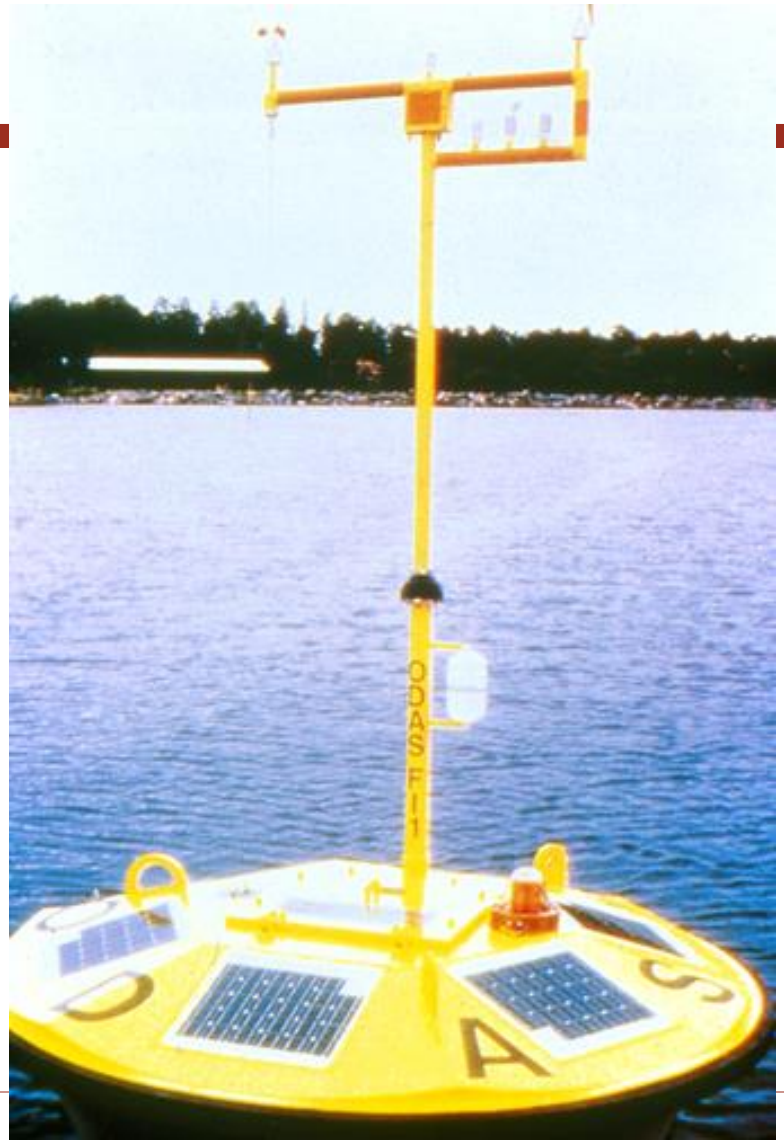


Another farm application – keeping animals where they belong, behind PV-electrified fence chargers.

PV-powered streetlights like these in a rural town help contribute to the safety, security and general standard of living in remote areas all over the world.

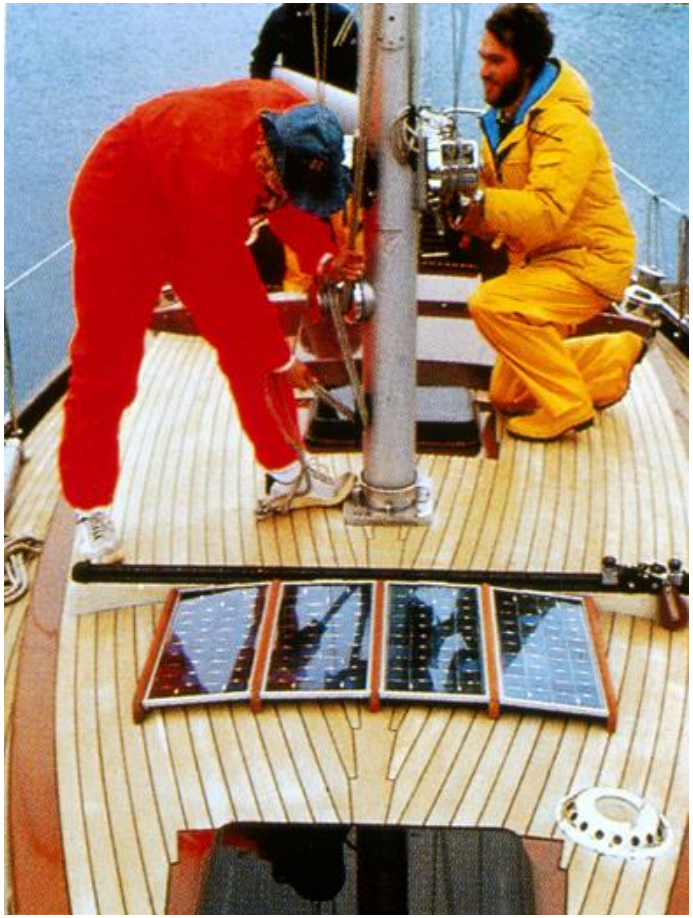
The lamp in this PV-powered insect-trap comes on automatically after sunset. It attracts insects which collide with the metal grid and drop into the receiver below.

PV applications include lighting for remote signs like this outdoor board along a highway.



Off-shore navigational aids, which require little maintenance, can withstand harsh storms, and cut down on the cost and pollution of battery replacement and disposal by using PV for power.

Highway directional signs can use PV systems to save the expense of excavation to extend electric lights to the sign as well as the cost of maintaining the electric line.



PV is an excellent source of power for battery chargers for boats, vehicles, and equipment. The solar-powered charger assures that the battery is charged and ready for use, even if the boat or vehicle has sat for a long time and the battery has discharged.

Campers can use PV in remote areas to provide power for lighting, appliances and other uses.

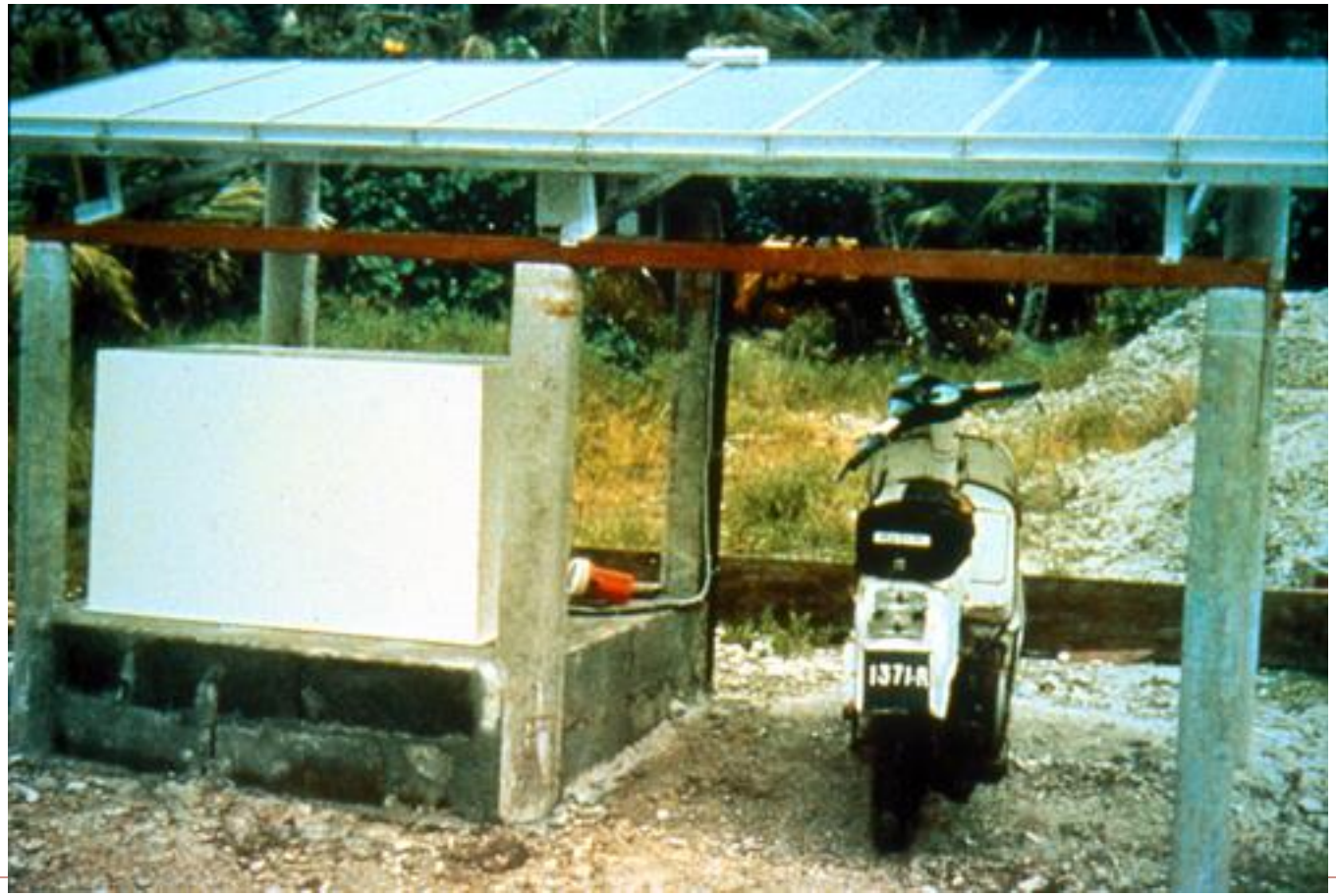
In many cases, it is more cost-effective to install a PV system than pay the costs of having the utility company extend the power lines to the home.

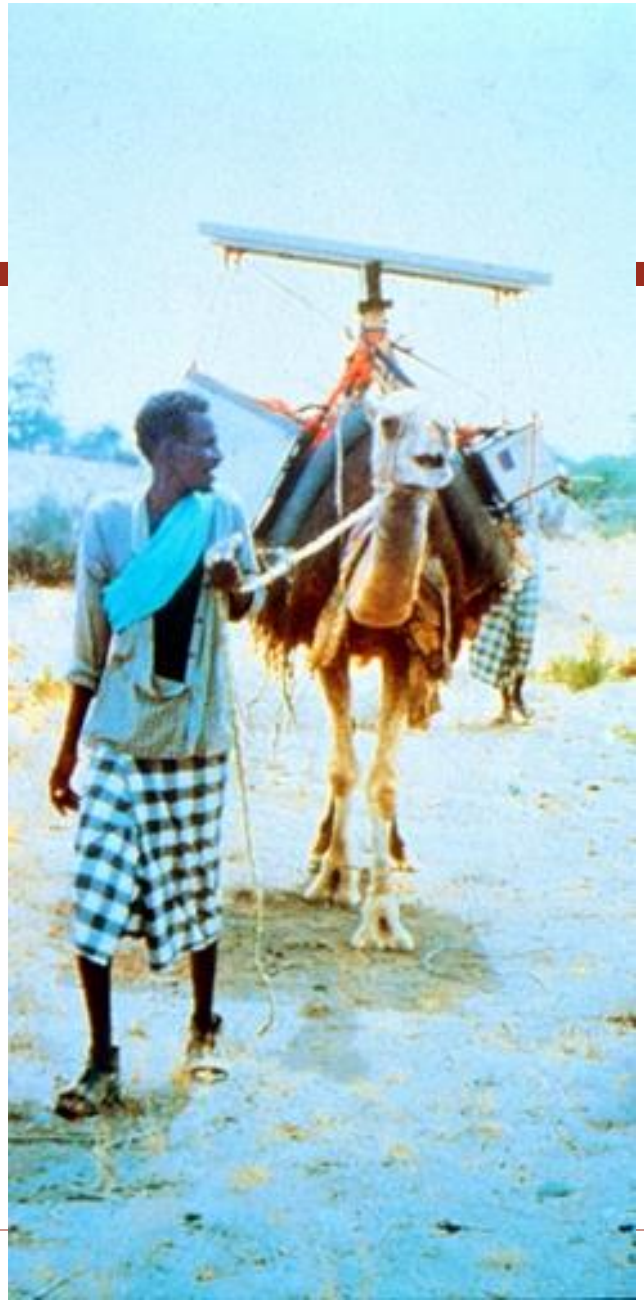
Many utility companies are turning to large PV systems to help meet peak power demand and reduce the need for building new power plants.

Around the world, there are many dramatic examples of PV systems. They include this PV-wind-diesel hybrid system in Mexico that provides village-wide power for 43 homes, three schools, two stores, a church and an auditorium.

In 1987, the Swiss government started a program to mount PV arrays on a sound barrier along a main motorway.

This photovoltaic system in the Philippines not only provides electricity to the home, but also creates a shelter for this motorcycle.





Maybe no uses are as dramatic and important as the portable PV panels and small refrigerators carried around Africa on the backs of camels.

Refrigerators like this, carried on the backs of camels and powered by PV panels, allow vaccines to be kept in good condition and transported to remote villages where medicines are needed.

A PV-powered police car in Zermatt, Switzerland.

A photovoltaic kit is used to recharge portable lamps in the Ivory Coast in Africa.

This solar panel powers a light in a bus shelter in Australia, providing security and convenience at night.

In many parts of the world, getting water is as important as getting energy. This experimental system in Palestine uses PV and wind energy in a desalination project.

Discussion Questions

- Are PV systems as efficient or economic as fossil-fueled systems?
- Is PV a viable alternative for all of our power needs? For homes? For vehicles? For other needs?
- Is PV the answer to all of the world's power needs?