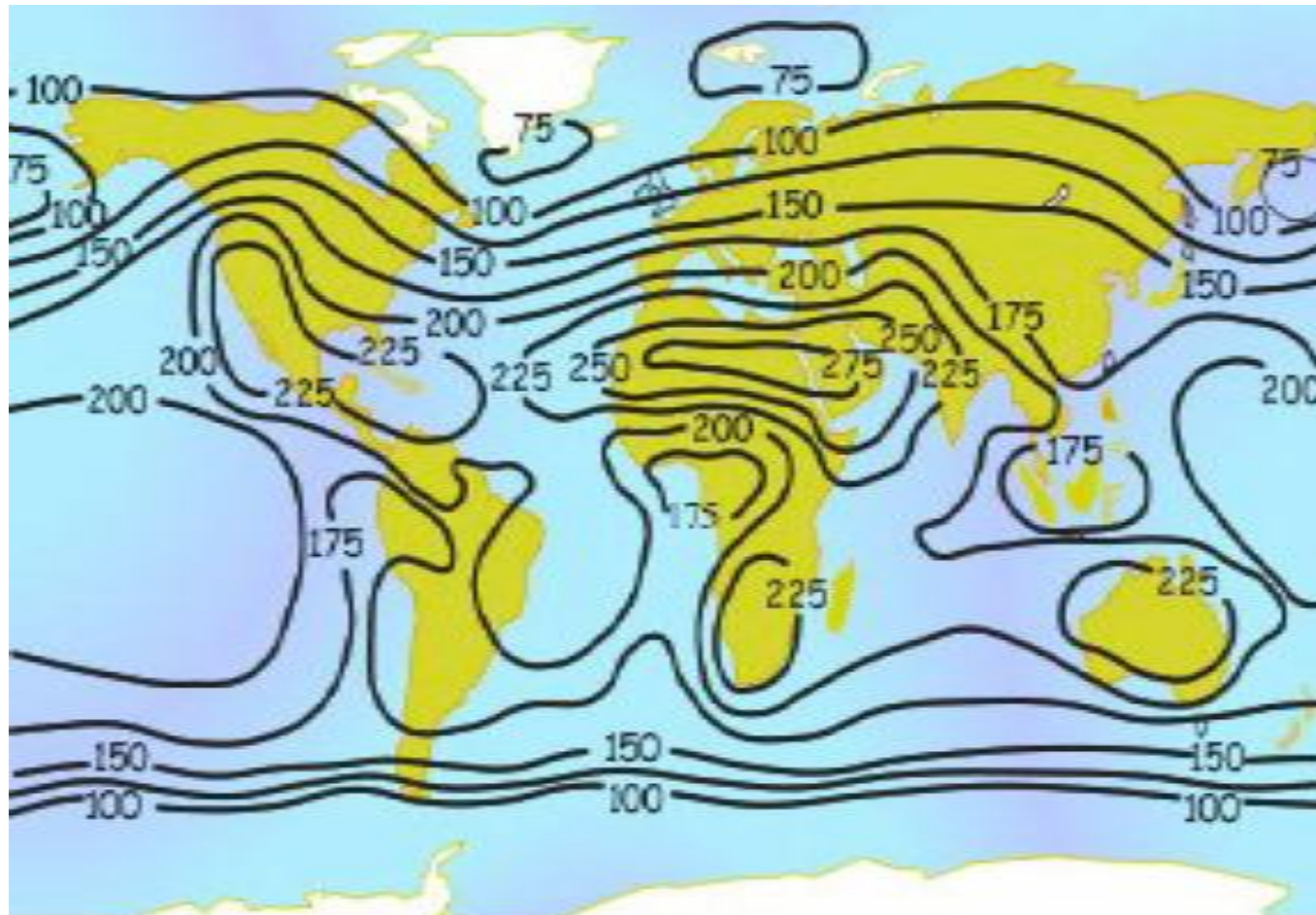


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SOLAR ENERGY

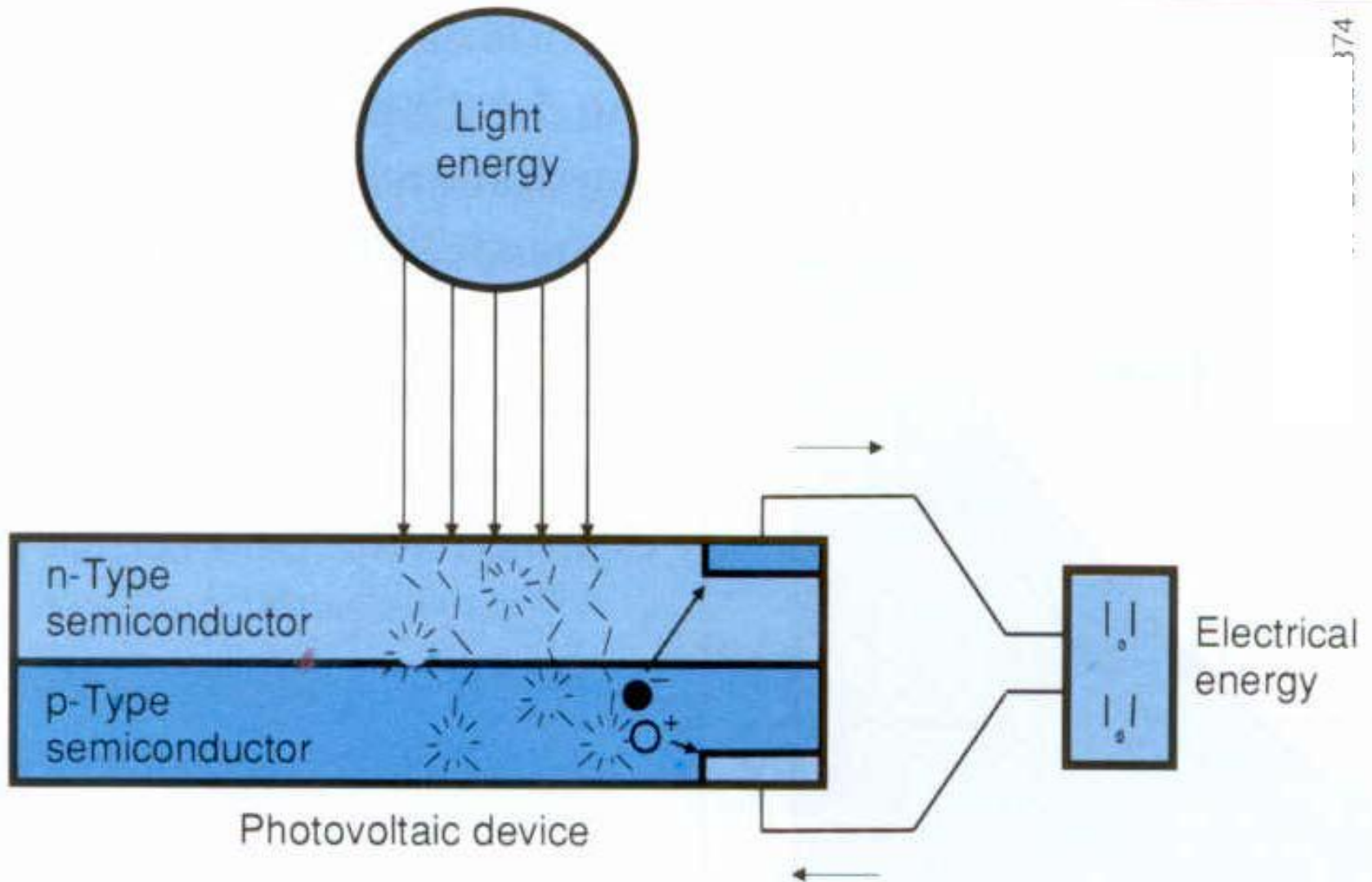


Solar Energy Levels on the Earth Surface



24 hour/365 day mean solar radiation received at the surface, in W/m^2 . It oscillates between a maximum of 275 W/m^2 in the deserts of the Middle East, to a low of 75 W/m^2 for misty isles in the Arctic.

Electricity from the Sun Using Photovoltaic Panels



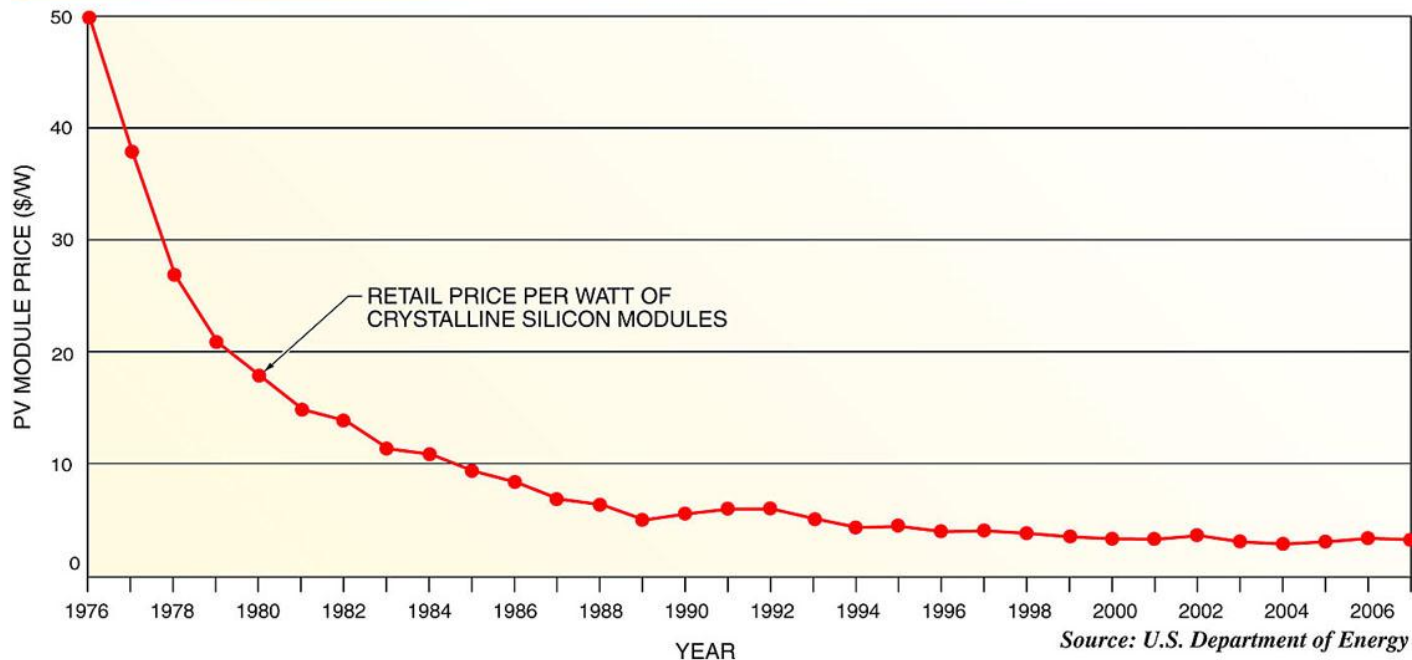
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What Happen in the Solar Cell

- **Photons in sunlight hit the solar panel and are absorbed by semiconducting materials, such as silicon—creating a dc V-I source to extract energy from.**
- **An array of solar panels converts solar energy into a usable amount of DC electricity.**
- **Power Electronics Inverters convert the DC to mains AC to supply loads or feed the grid**

How Expensive PV Systems Are

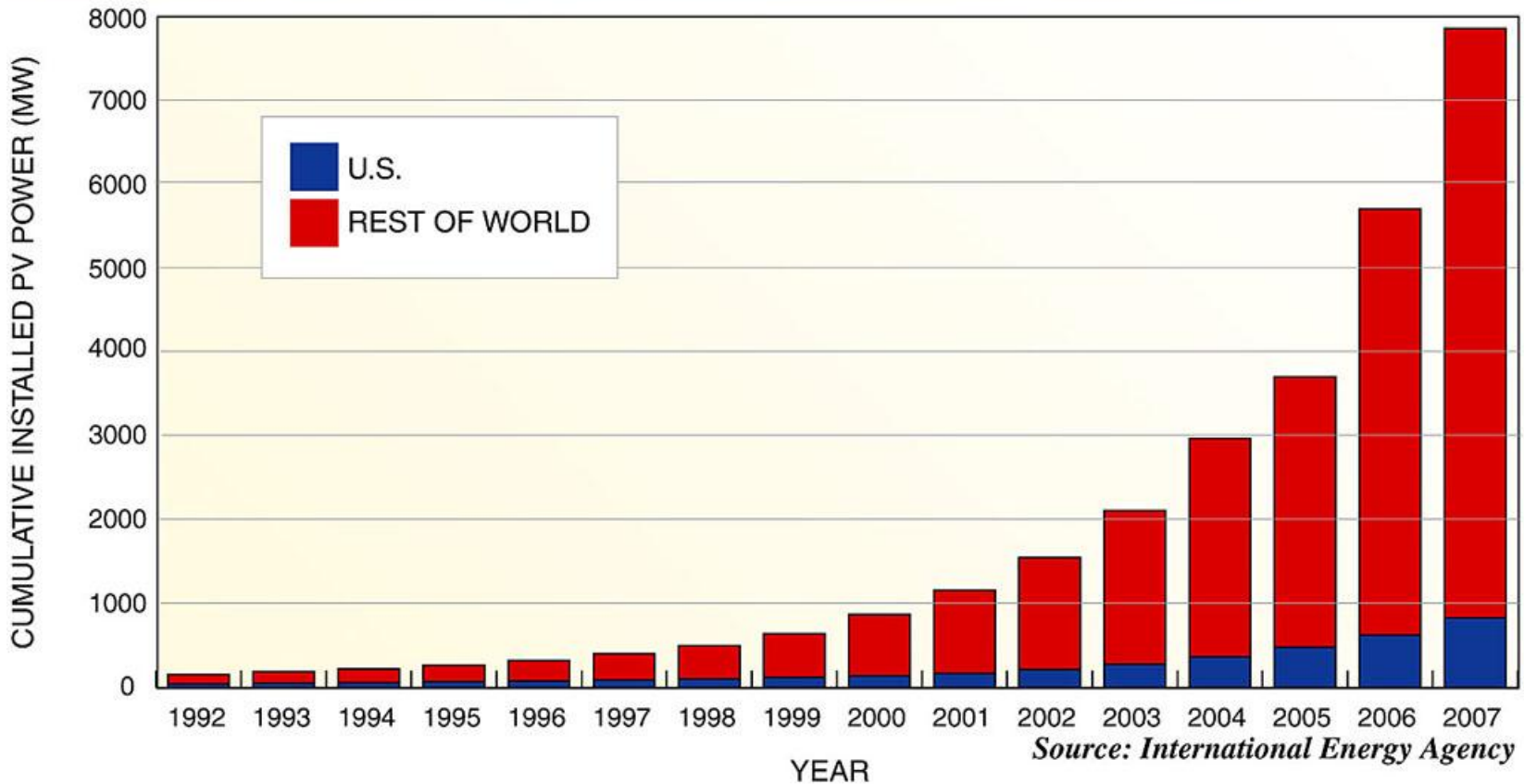
 Retail Module Prices



Decades of development and manufacturing improvements have decreased the price per watt for PV systems.

How Fast Solar Systems are Growing?

Module Installation



Production and installation of PV systems is growing rapidly.

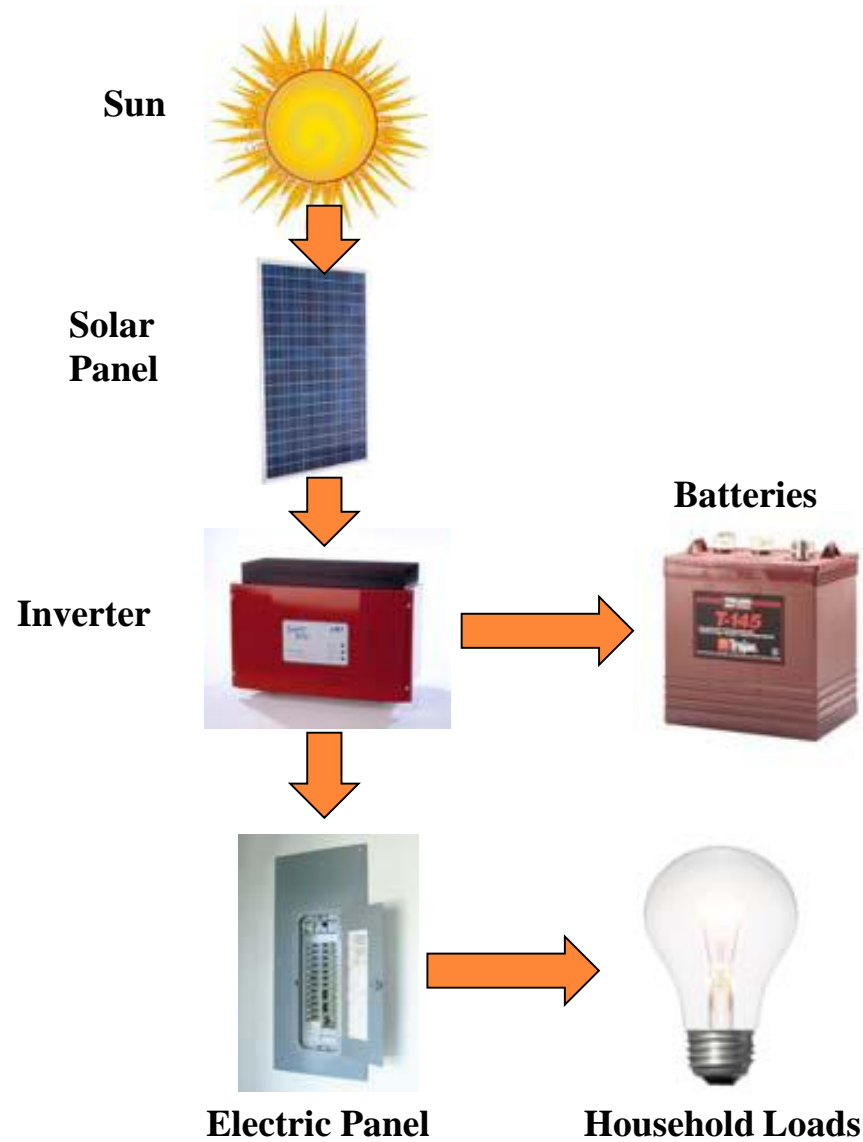
Solar System Configurations

Depending on the arrangement of system components, solar systems can be:

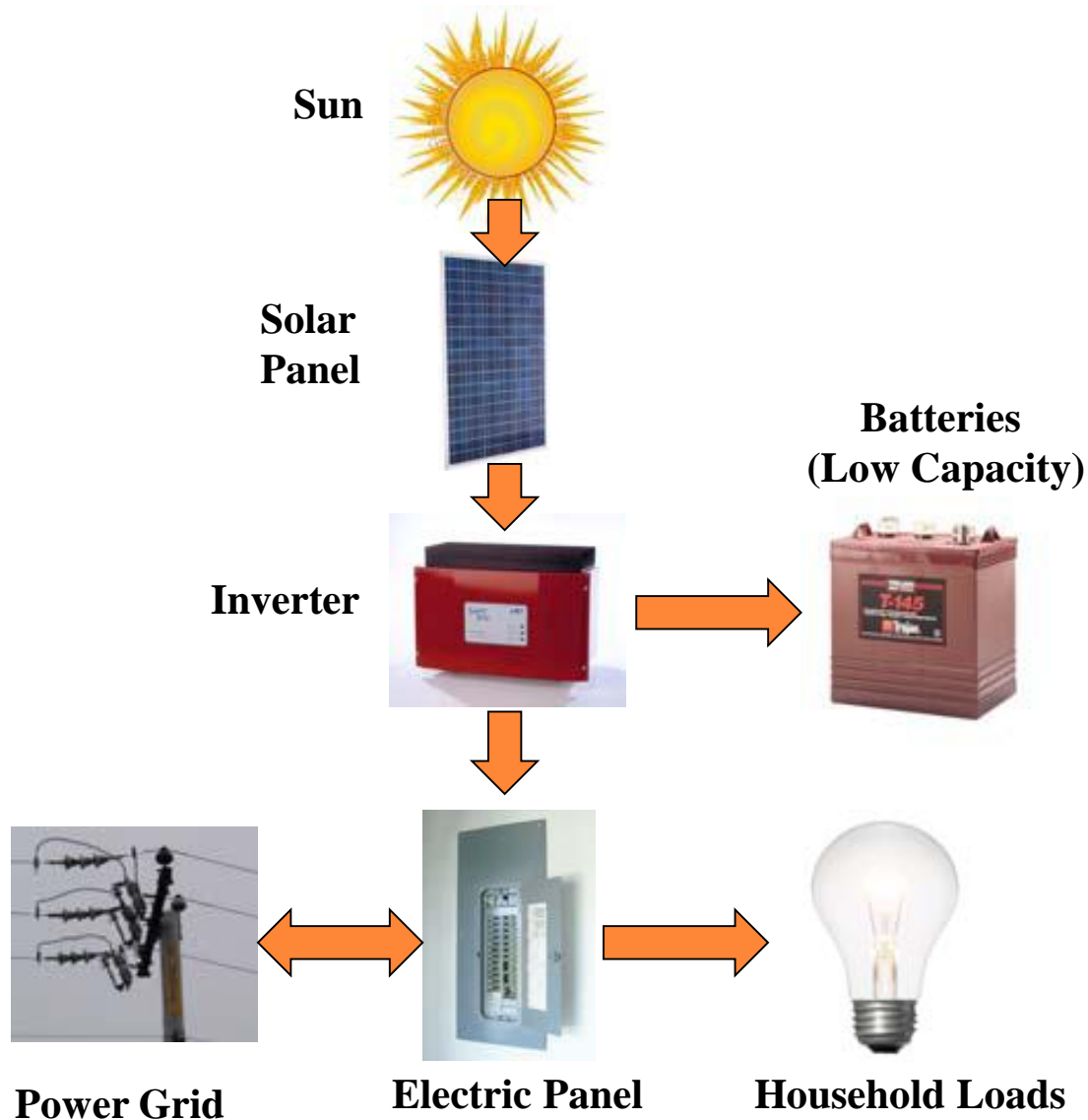
➤ *Stand-Alone Systems*

➤ **Grid-Connected Systems**

Construction of Solar Systems – Stand Alone System

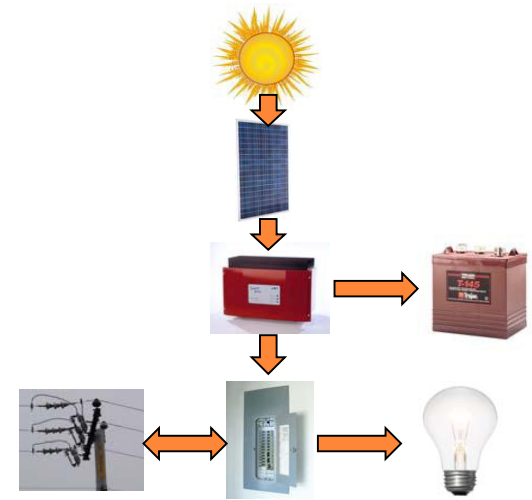


Construction of Solar Systems – Grid-Connected System



Construction of Solar Systems – Grid-Connected System

The grid-connected photovoltaic power system, is an electricity generating solar PV system that is connected to the utility grid, making it possible to import/export power from/to utility. A grid-connected PV system consist of solar panels, inverters, a power conditioning unit and grid connection equipment. These systems range from small residential rooftop systems to large utility-scale solar power stations. Unlike off-grid systems, a grid-connected system rarely includes batteries, as they are heavy & expensive. When conditions are right, the grid-connected PV system supplies the excess power to the utility grid.



Solar System Configurations

❖ *Stand-alone Systems:*

- Systems meet all electrical need of installation
- No connection to conventional power grid
- Goal = Installation is Self Sufficient

❖ **Grid-Connected Systems:**

- System meets some or all of electrical demand
- Requires connection to power grid
- Goal = Minimum Import from grid

Stand Alone System – The Merits

□ *Advantages:*

- ✓ Suitable for remote locations
- ✓ Alternative source during power failures

□ *Disadvantages:*

- ✓ Requires much more powerful system
- ✓ Designed for worst-case scenario
- ✓ Must produce more power than average consumption
- ✓ Significantly more expensive
- ✓ Could run out of power in bad weather conditions

Grid-Connected System – The Merits

Advantages:

- **System does not have to cover all electrical needs at all times**
- **Requires less surface area for panels and no batteries**
- **Less expensive**
- **Needs small battery bank**

Disadvantages:

- **Does not prevent extended grid power failures**

SOLAR POWER PLANTS

- The technologies being developed for solar power are:-

- *Solar Power Towers*

The solar power tower technology involves capturing solar radiation using a set of dual-axis mirrors (heliostats) that track the sun, and concentrate the reflected sunlight onto the receivers or receivers located on the top of the tower. The heat raises the temperature of a thermal fluid which is then used to generate steam to drive a steam turbine and generator.

SOLAR POWER TOWERS



SOLAR POWER PLANTS

➤ *Parabolic trough*

In a parabolic trough plant, a set of parabolic-shaped mirrors is set on a structure so they can track the movement of the sun and concentrate solar radiation onto a receiving tube. Inside the tube, a heat-absorbing fluid flows and reaches high temperatures. This fluid transfers the thermal energy into steam that is driven by a turbine to generate electricity.

Thermal Storage - the heat absorbing fluid allows the power to be dispatched, thus continuing plant operation under cloud cover or at night.

PARABOLIC TROUGH



Tube containing heat absorbing fluid

Parabolic reflector