Solar 101

A brief introduction to the solar resource, photovoltaic science and its history

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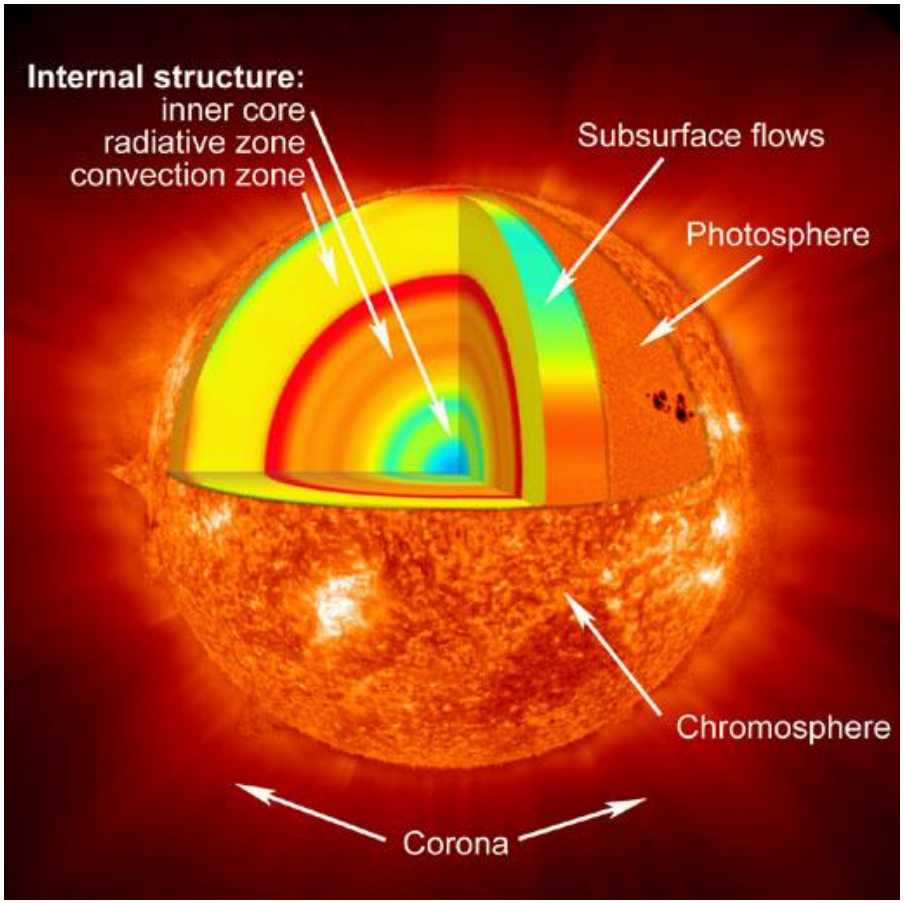
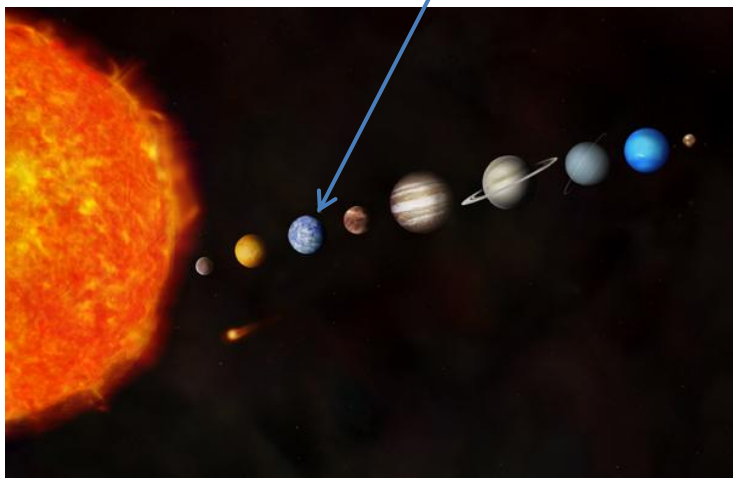
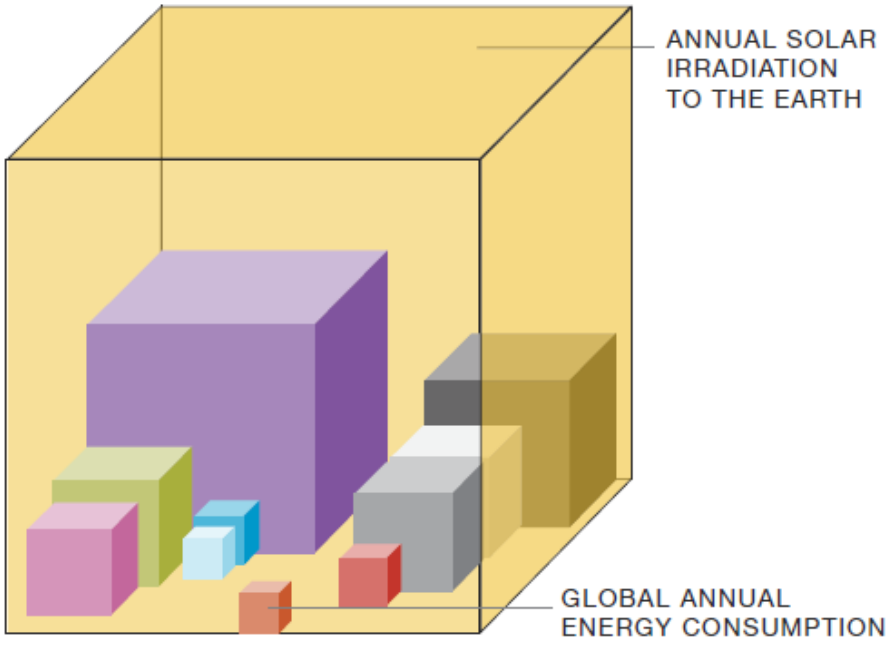
Our Sun





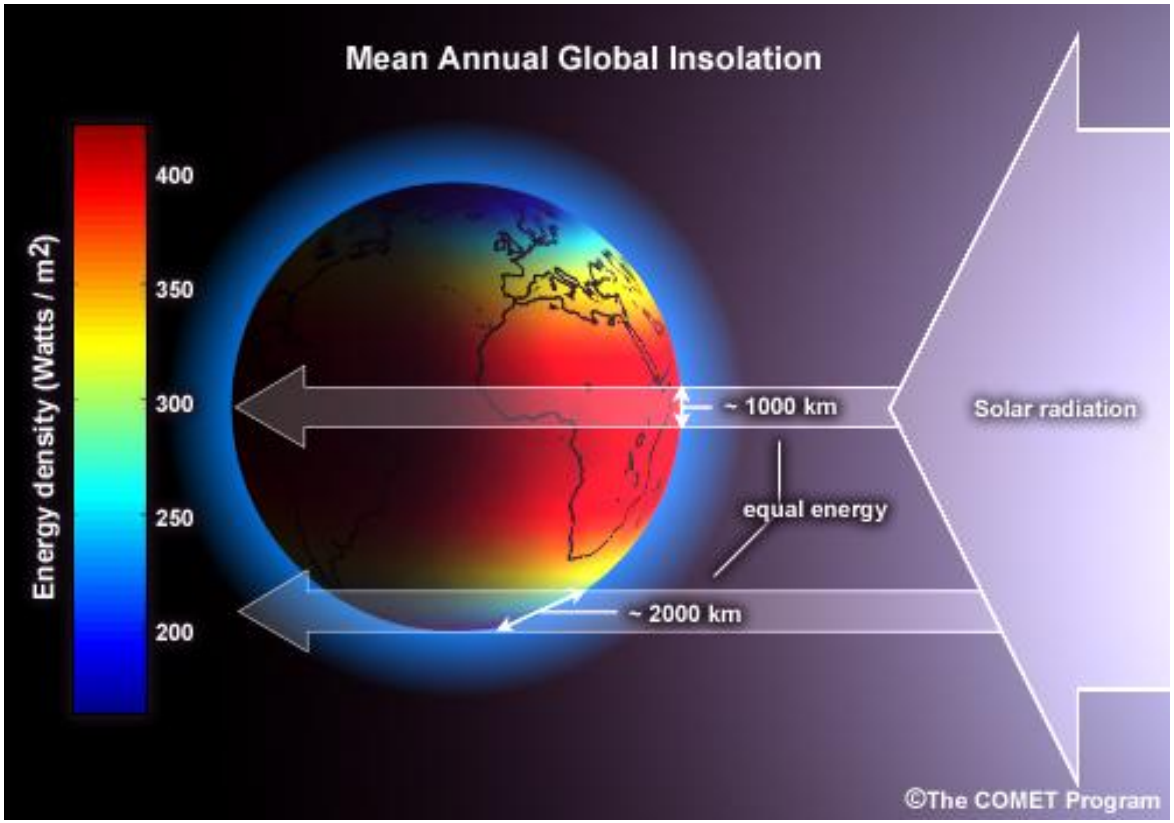
The Sun, a star amongst celestial bodies, is actually a star at the center of our universe. It provides the energy that supports life on our planet.

Solar Resource



The Sun's provides more energy to our planet than for which we have the need.

Solar Resource



How we use the Sun's potential energy can be classified in two ways:

- Passive

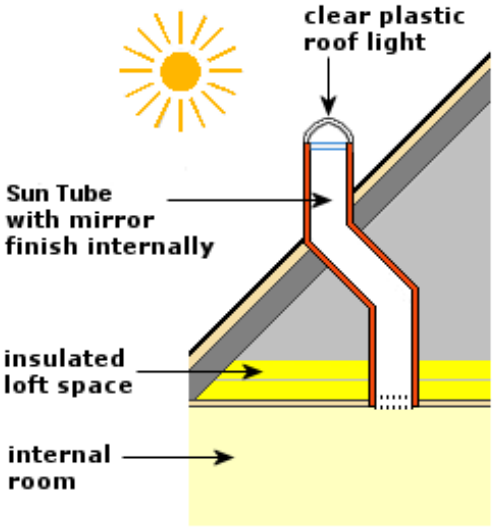
or

- Active

Passive Solar

Longwood Gardens' (PA) 30,000-square-foot, state-of-the-art Production **Greenhouse** Facility is the perfect marriage of beauty and brawn. High-tech systems power the 378' by 80' range of nine greenhouses, making it possible to produce exquisite plants year round under all conditions

Directing Natural Daylight into our homes.



SUN TUBE LIGHT

Using the sun to heat water for a shower or a swim…

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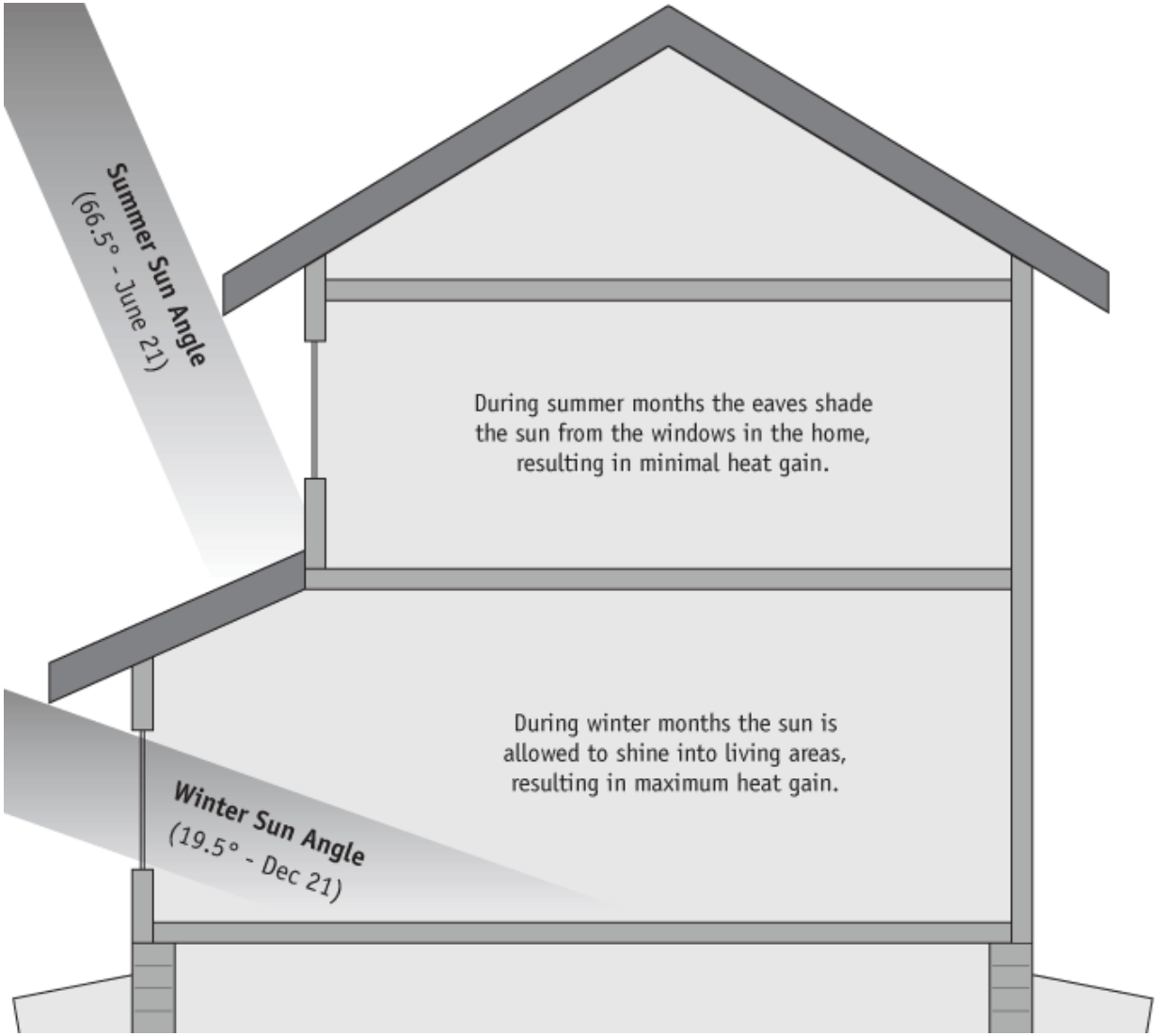
Designing a house for passive solar



Active Solar

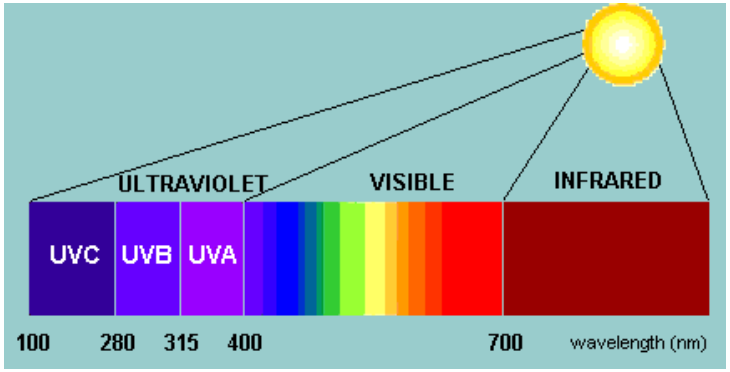
CSP – Concentrating the suns power to create steam or melt salt for thermal storage

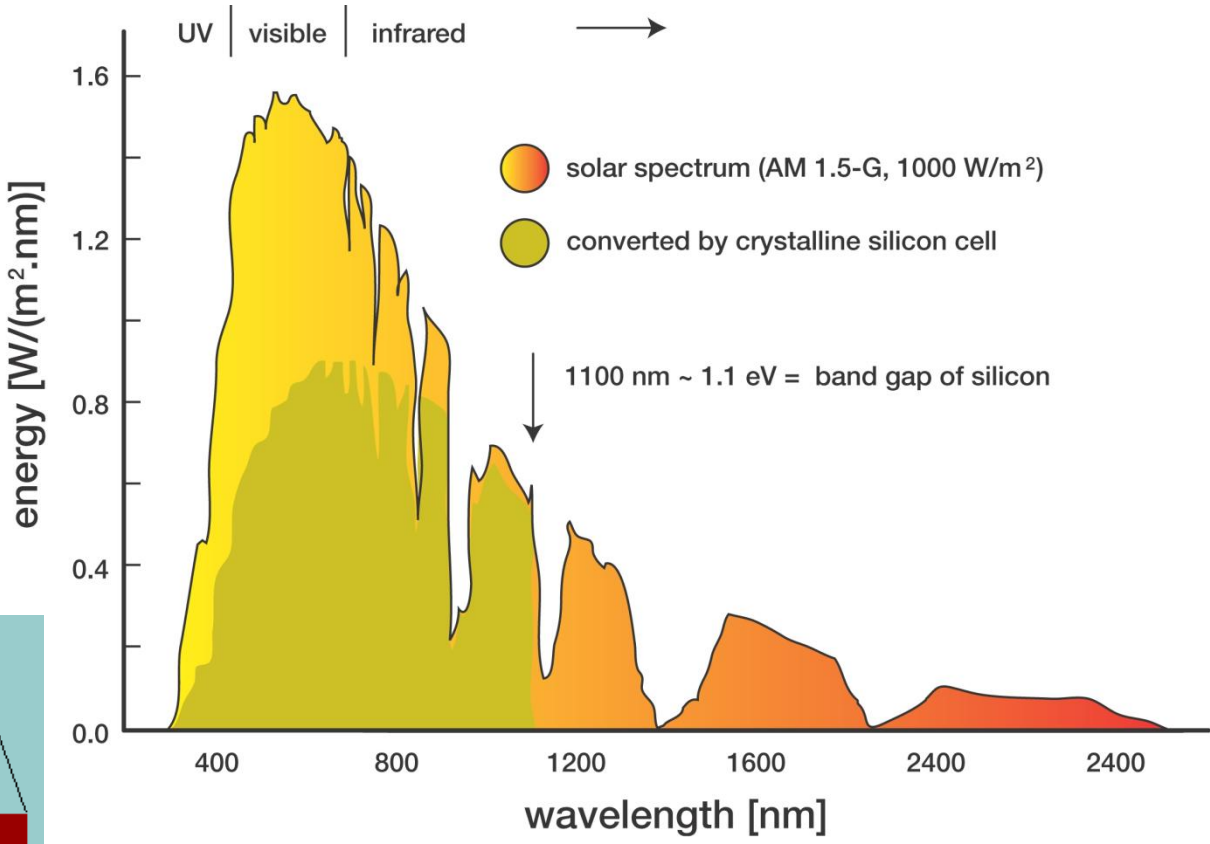
Solar PV – Converting the sunlight to electricity

Useful Terms

Photon
- a basic unit (or *quantum*) of electromagnetic (or light) energy or radiation.

Light
- electromagnetic wavelengths of energy





AIP Physics Teachers Conference Proceedings.
http://www.vicphysics.org/events/stav2005.html, 2005.

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Visible Light Spectrum

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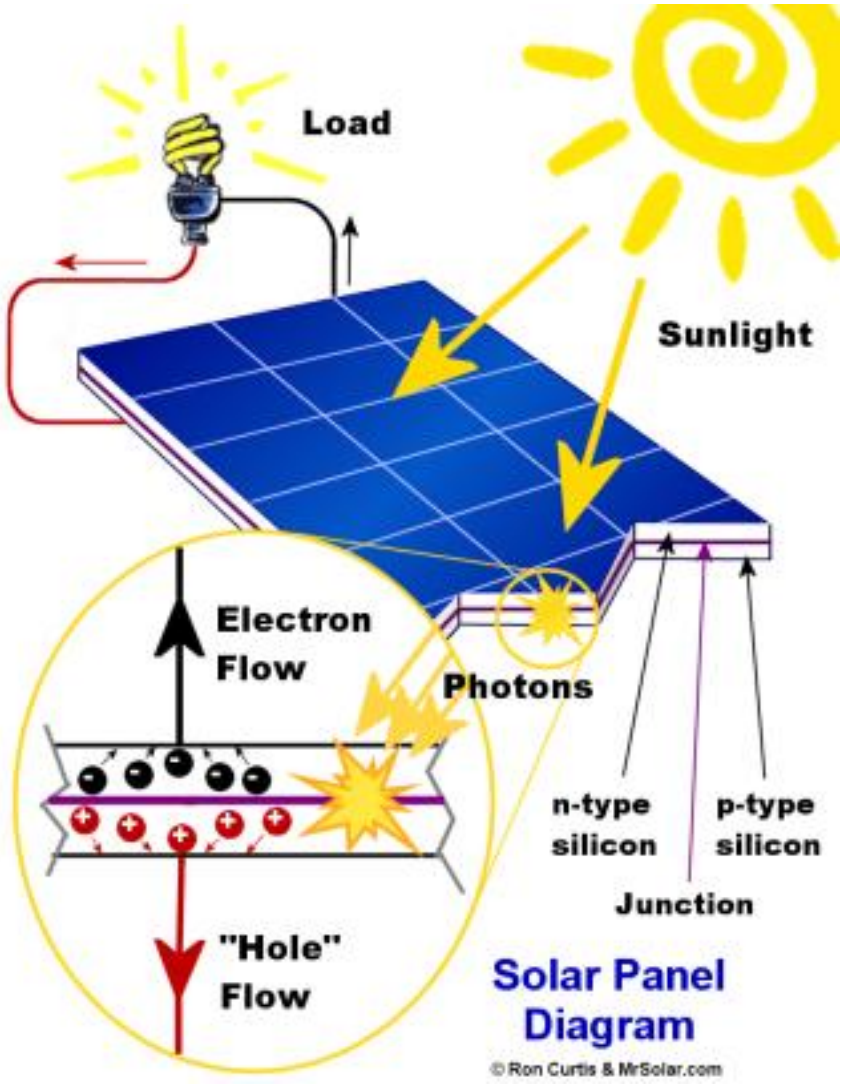
Solar 101

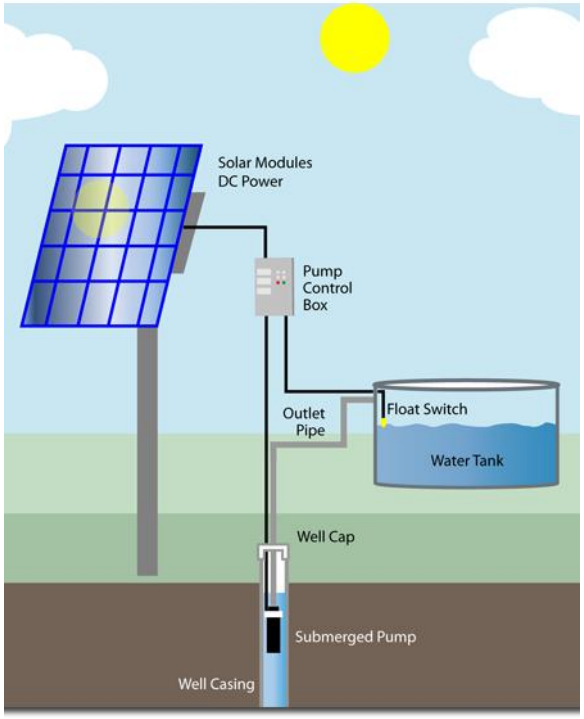
How PV works and how it is applied

How PV Works

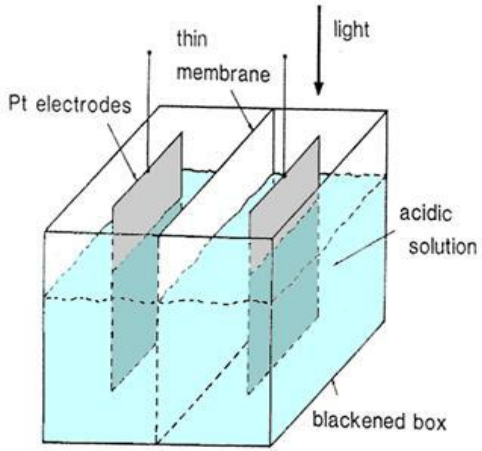


The PV cell absorbs the photon. This extra energy excites the electrons in the cell and causes them to flow.

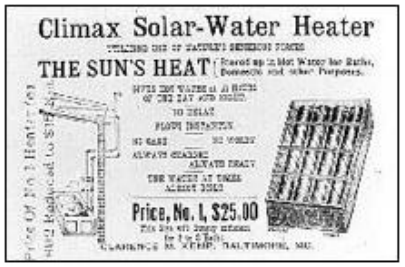
This flow of electrons is in the form of direct current and is what we refer to as electricity.



Fun Facts



Niagara Science Museum

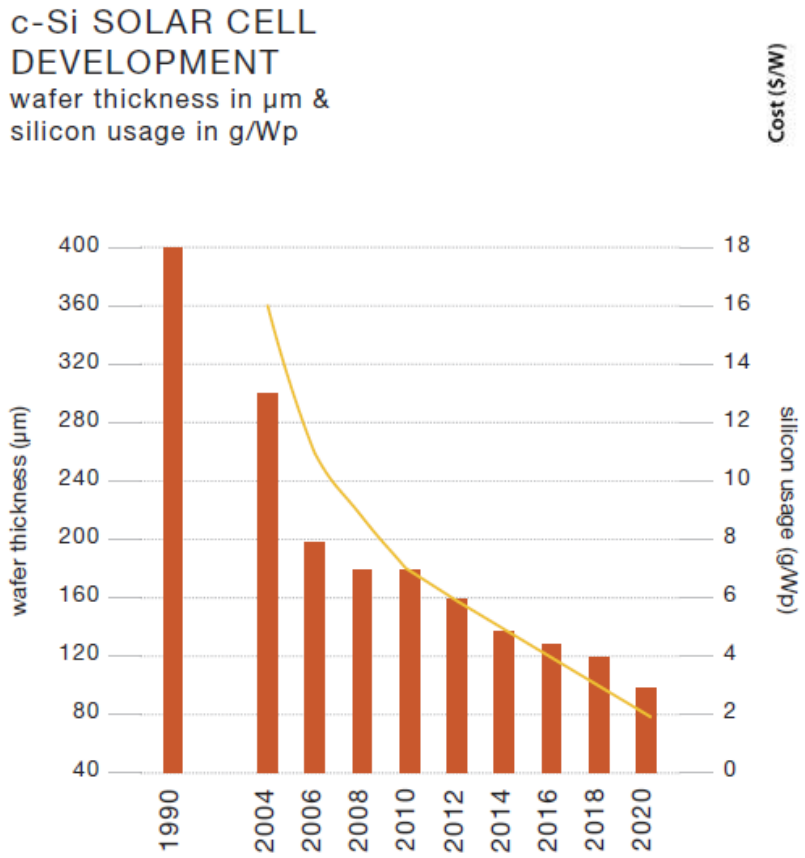


1891 The first commercial solar water heater was invented by Clarence Kemp in Baltimore, MD. Kemp called the water heater the Climax Solar-Water Heater, and marketed it to men whose wives had “gone off with their maids to summer at some resort.”

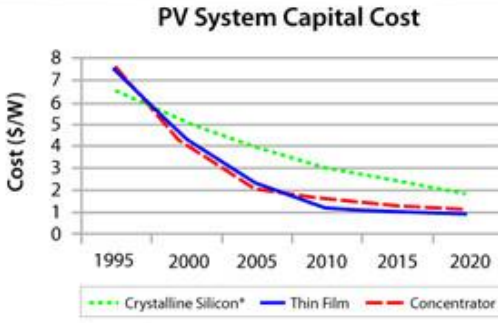
Edmund Becquerel discovered the Photovoltaic Effect in 1839

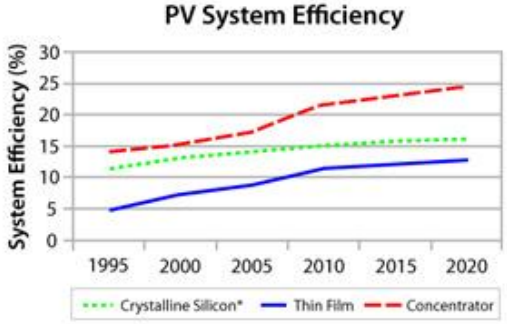
Vanguard 1 Satellite with 0.5W PV Cell

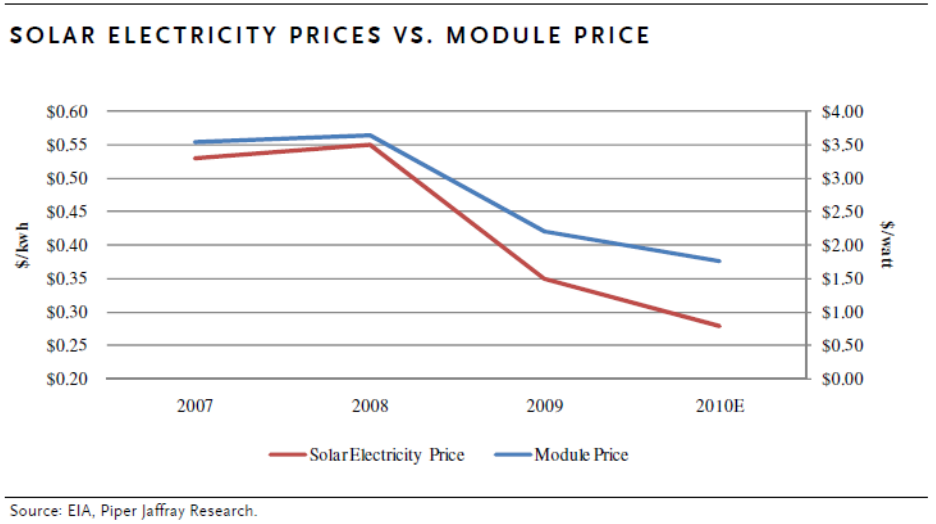
Cost & Efficiency



source: EU PV Technology Platform Strategic Research Agenda, C-Si Roadmap ITPV, EPIA roadmap 2004.



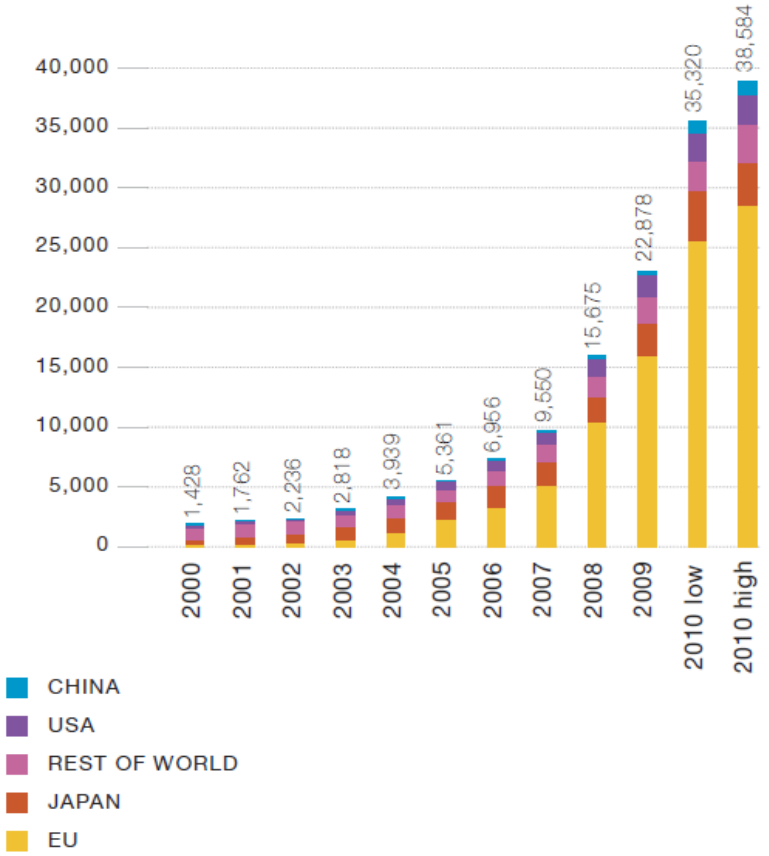




Source: U. S. Department of Energy, Energy Efficiency and Renewable Energy

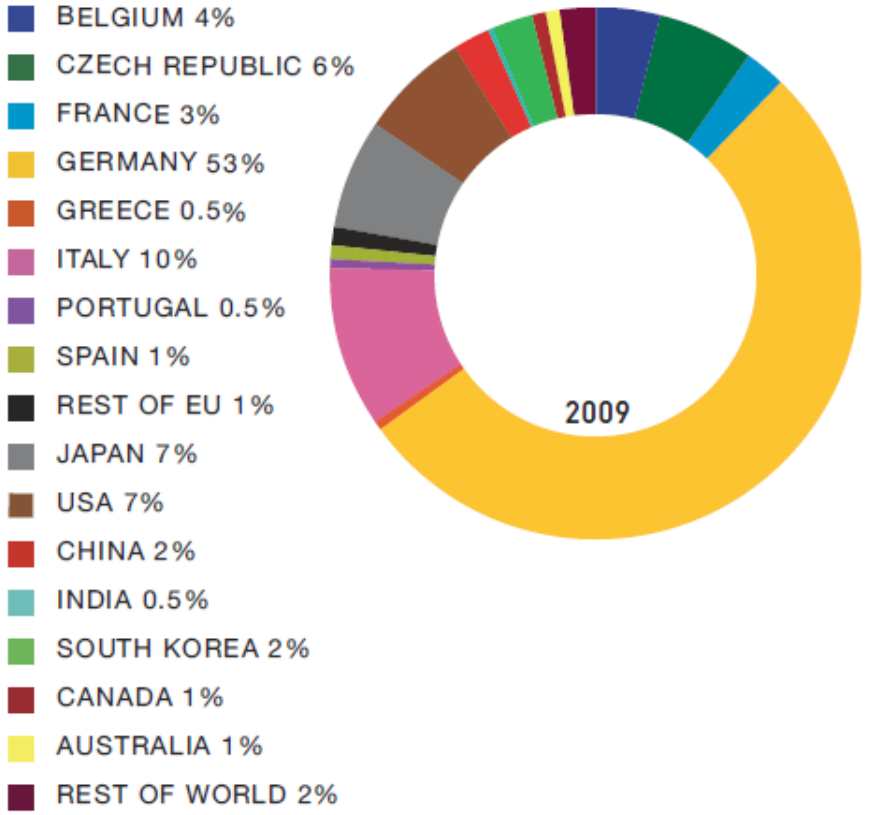
PV Global Capacity

GLOBAL EVOLUTION
OF PV INSTALLED CAPACITY
MW



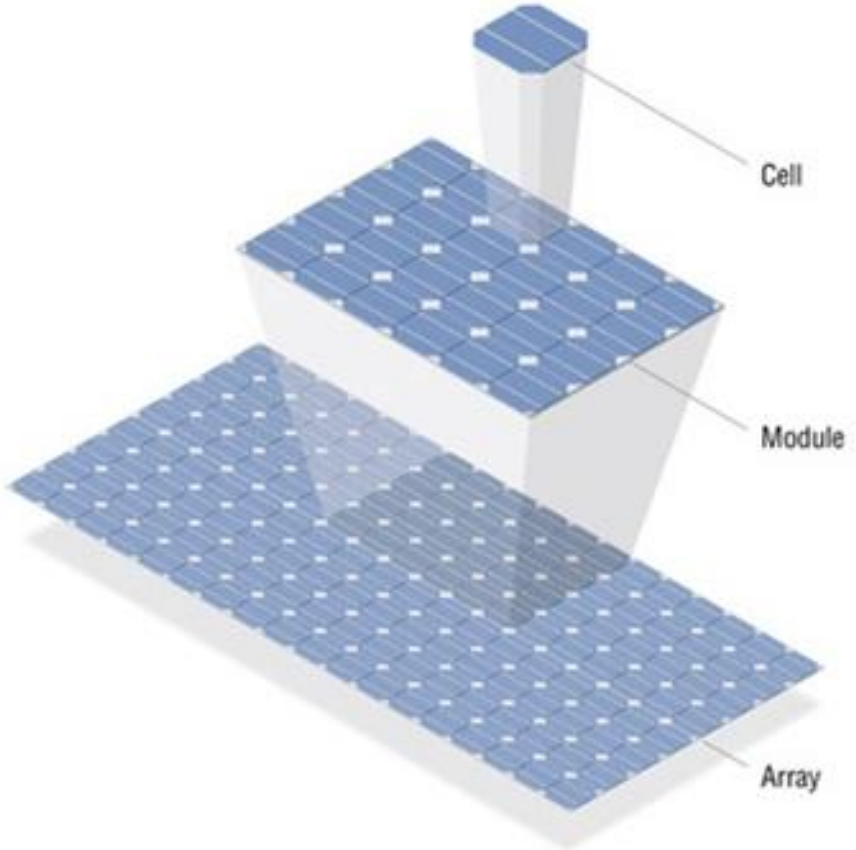
source: Global Market Outlook for Photovoltaics until 2014, EPIA, May 2010.

THE WORLD PV
MARKET IN 2009



source: EPIA.

Using PV



Group of PV cells is a Module
Group of PV modules is a Panel
Group of PV panels is an Array

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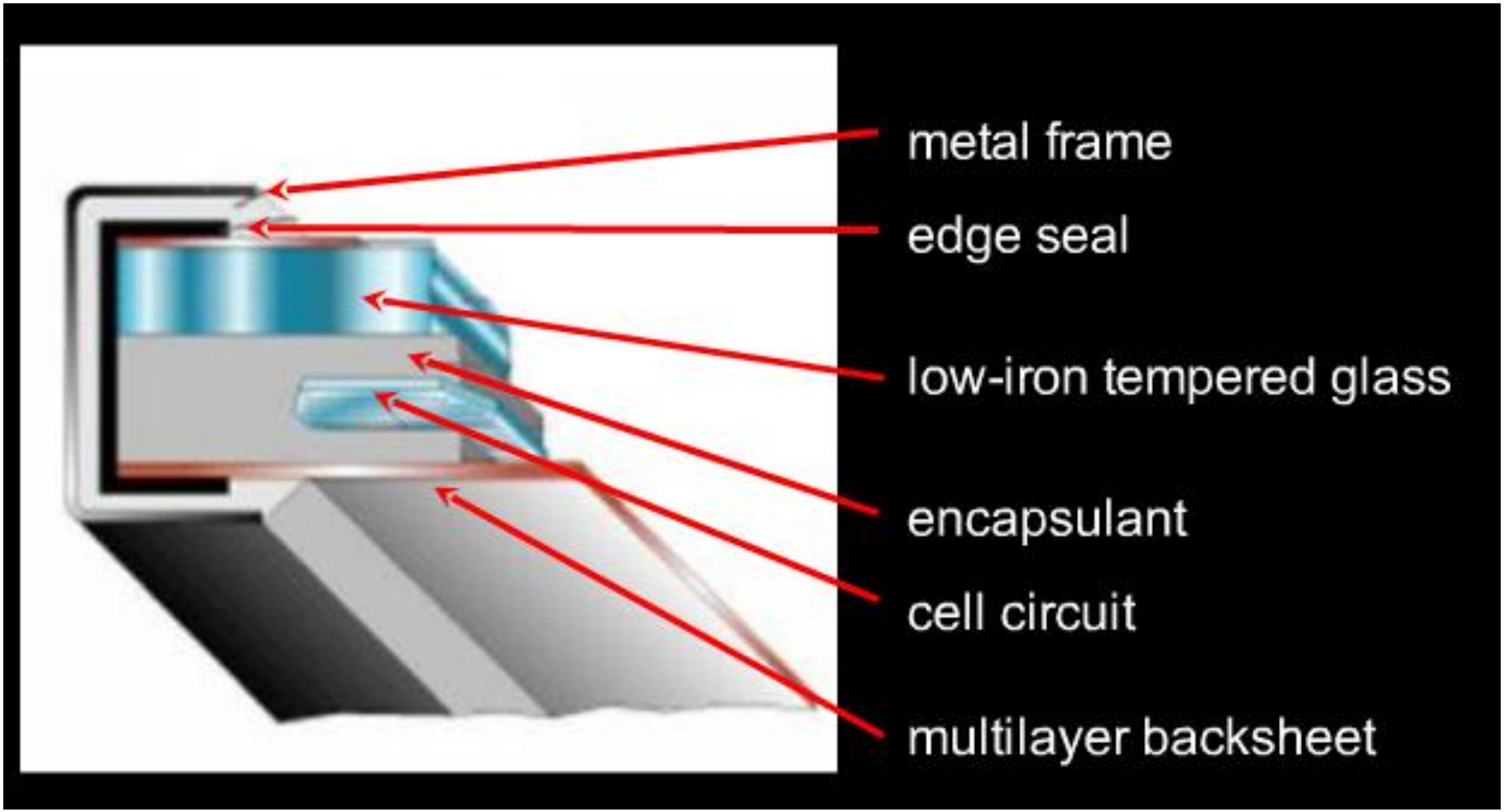
Module Composition



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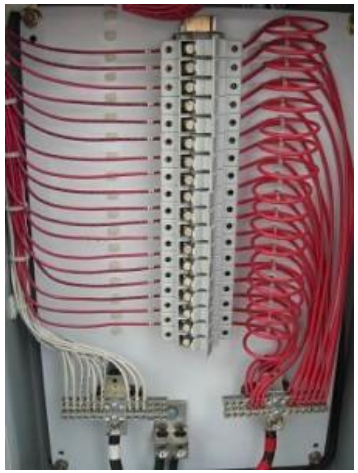
Applications

System Components



More Useful Terms

Irradiance or Radiation

- the rate of solar radiation falling on an area at a moment in time – kW/m2

Irradiation or Insolation

- the amount of solar energy over time
- kWh/m2/day

Production or Output or Generation (Annual)

- kWh/kWp
- MWh/MW-AC

Capacity Factor

- ratio of the actual output of a power plant over a period of time to its potential output

Capacity Factor

- ratio of the actual output of a power plant over a period of time to its potential output

Performance Ratio

- ratio of the actual yield (output) to the target or expected generation

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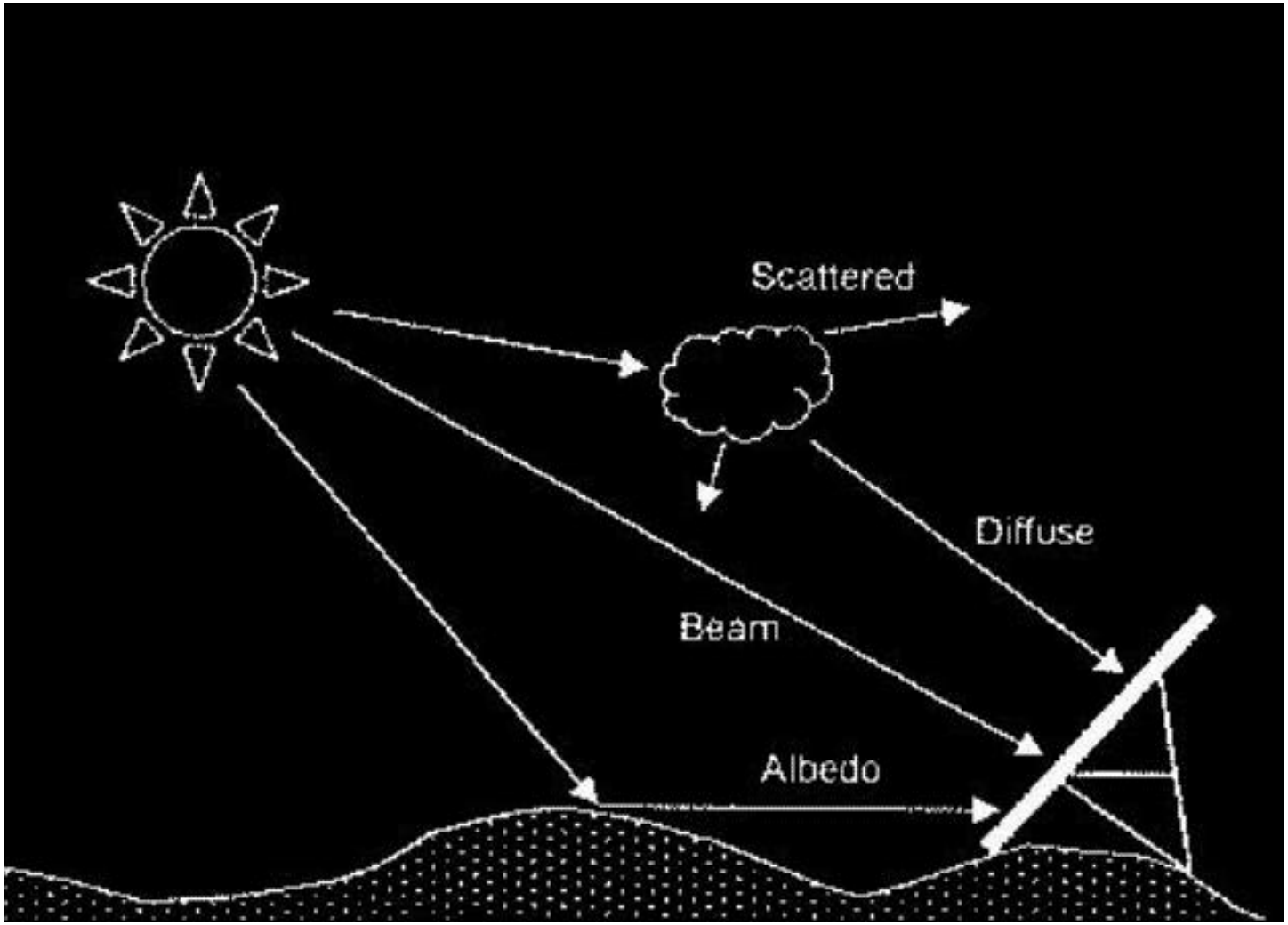
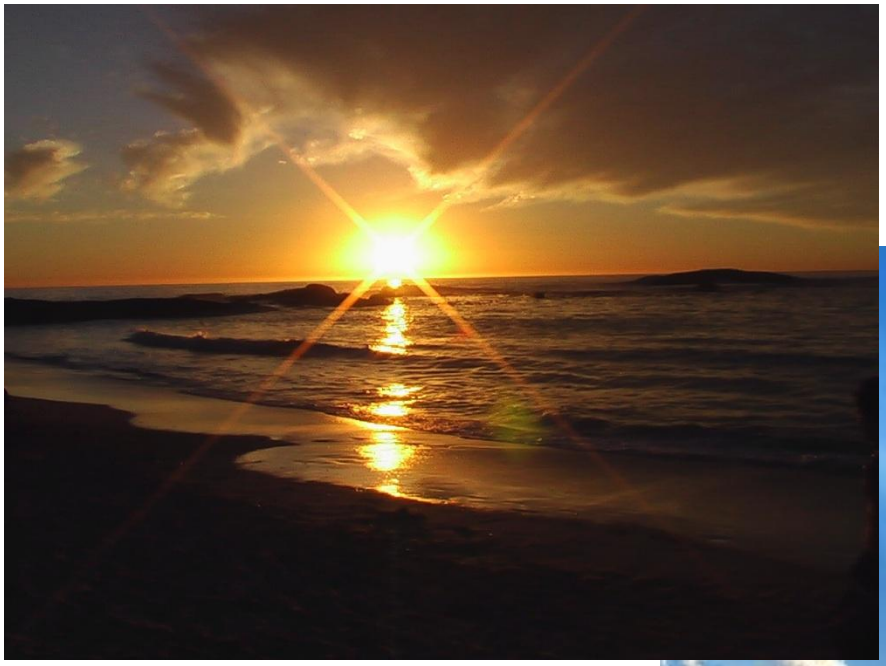


Solar 101

The Case for Solar

PV isn’t perfect…



Solar energy doesn’t reach the earth’s surface on an exact schedule. Weather place a large role in PV generation estimating.

Sunsets are beautiful but we cannot generate electricity through PV at night.

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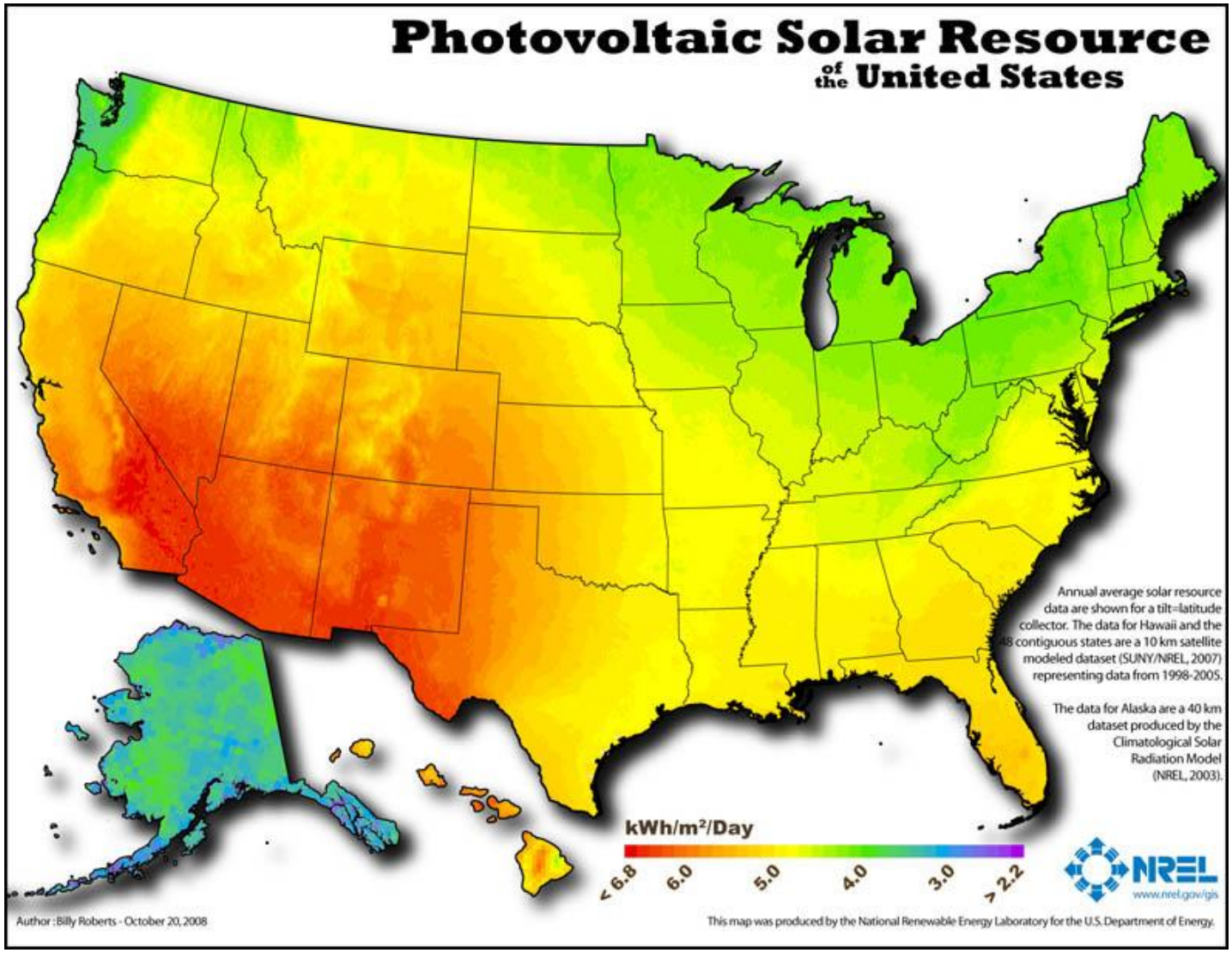
Variable Resource



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Predicting Solar Output

PVWatts

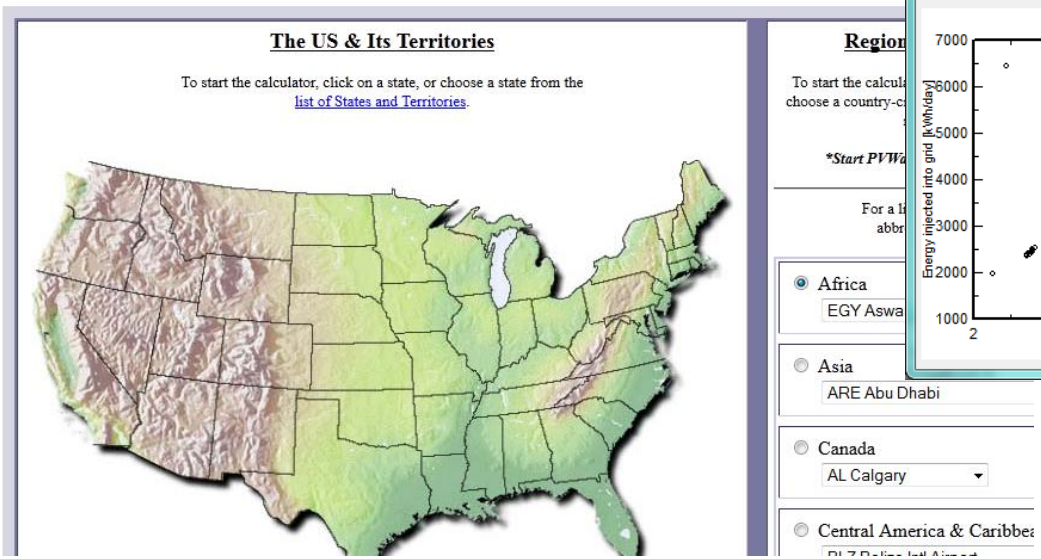
A Performance Calculator for Grid-Connected PV Systems

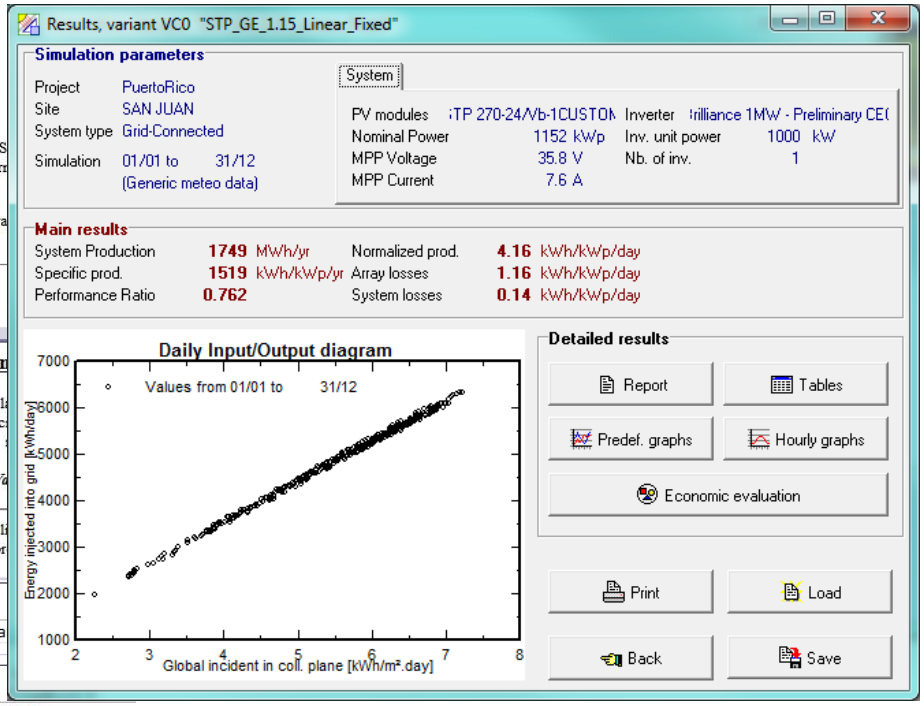
A new map-based interface for PVWatts has been released. This new version combines capabilities from both version 1 (below) and a gridded monthly data set; this updated interface is available at PVWatts. The interface below has been retained for the near future.

Version 1

PVWatts v. 1 can be used for locations accessible through links on the map below, or through a text list for U.S. sites; or for sites outside the US lists by region. Researchers at the National Renewable Energy Laboratory developed PVWATTS to permit non-experts to quickly obtain perfor for grid-connected PV systems.

Also available is an option to output hourly performance data. This option can be run after the inital calculation, and outputs the data in a separa window. Instructions for saving the output to a text file can be accessed through the "Help" link at the top of the hourly output page.





Why Solar?

No Fossil Fuels

- Once a PV System is installed it produces “clean” electricity. It uses sunlight as its fuel so it is completely renewable and does not produce harmful emissions.

Simplicity

- PV systems have no moving parts and do not require continuous maintenance. They can also be deployed to almost any area in the world.

Longevity

- Solar modules have long warranties and have been proven to Last for more than 40 years. As long as the sun continues to shine, a PV system will unobtrusively produce green electricity.

Safety

- Because there is no fuel, there is no danger in working with harmful chemicals or highly flammable and combustible materials.

Recyleability

- PV systems use basic materials such as silicon, copper, steel and aluminum. They can have a very low environmental impact and can be reused or recycled at the end of their useful life.