

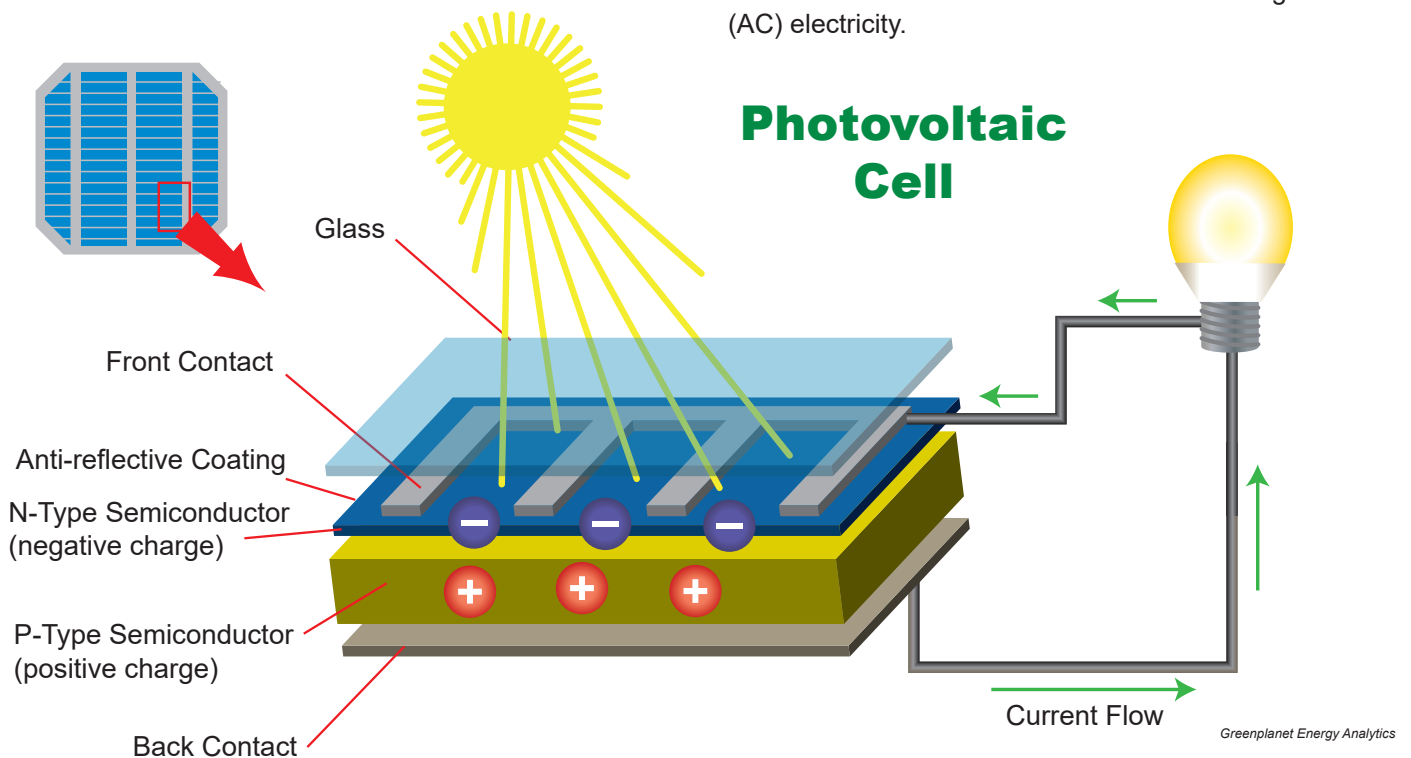
What is Light Energy?

- Unless disrupted, light travels in a straight line to Earth from our Sun.
- You are most familiar with Visible Light. It is the only part of the Electromagnetic Spectrum that you can see. However there are many other types of light.
- The Electromagnetic Spectrum is also made up of: Radiowaves, Microwaves, Infrared, UltraViolet Light, X-Rays and Gamma Rays. All of these are invisible to our eyes.
- Sunlight supplies plants with energy which they use (through the process of photosynthesis) to make food (sugar).
- Animals then eat the plants to absorb their energy.
- Sunlight delivers thermal energy that drives ocean currents, wind and on a larger scale, weather and climate systems!
- In fact, nearly all energy on Earth originates from sunlight. Powerful stuff!

Converting Sunlight Into Electricity

Solar energy is collected by technology called Solar Photovoltaics (Solar PV) or more commonly referred to as solar panels.

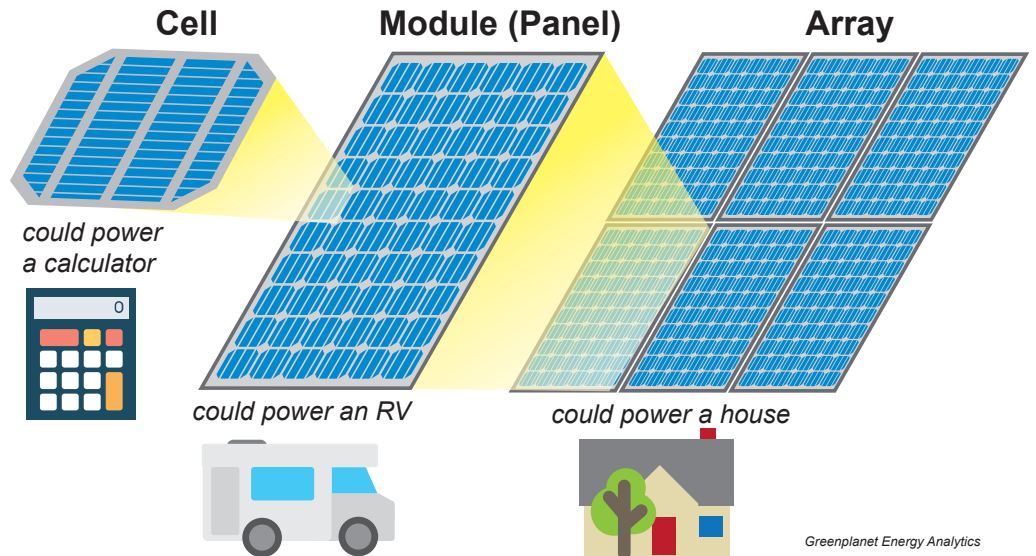
- Each individual panel is constructed of a layer of silicon cells (also called photovoltaic cells), a metal frame, a glass casing surrounded by a special film, and wiring.
 - Silicon (Si), is a nonmetallic chemical element in the carbon family. Silicon makes up 27.7 percent of Earth's crust and is found in everything from rocks to animals and plants.
 - Silicon is an excellent semi-conductor which means it is half-way between a conductor and an insulator. This makes it very useful in electronics.
- Within each solar cell is a thin wafer made from two layers of silicon. One layer is positively charged, and the other negatively charged, forming an electric field.
- When light energy from the sun strikes a photovoltaic solar cell, it energizes the cell and causes electrons to 'come loose' from atoms inside the semiconductor silicon wafer.
- Those loose electrons are set into motion by the electric field surrounding the wafer, and this motion creates an electrical current.
- Wires capture and feed this direct current (DC) electricity to a solar inverter to be converted to alternating current (AC) electricity.



Solar Cells, Panels & Arrays

Solar panels (also called a modules) consists of a group of solar cells packaged together in a metal frame. There are typically 32, 36, 48, 60, 72 or 96 solar cells in a solar panel.

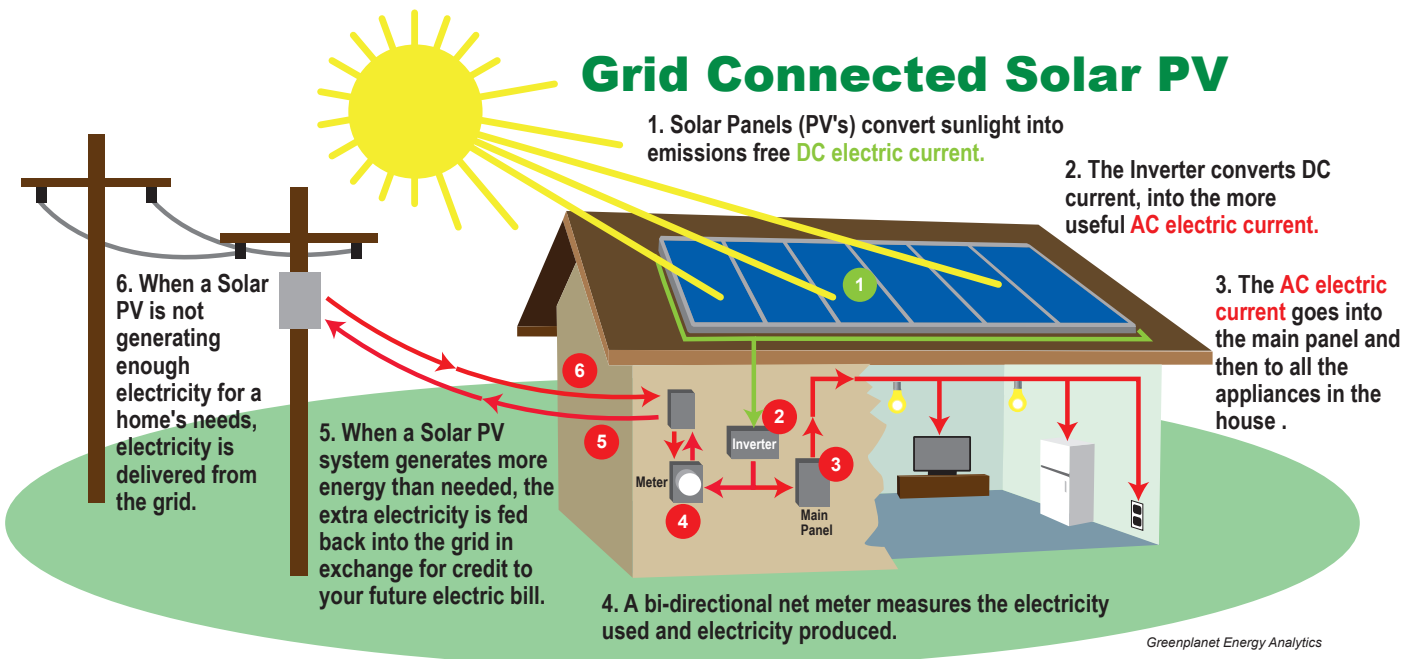
To achieve the desired voltage and current, modules are wired into groups called arrays. The flexibility of the modular PV system allows designers to create solar power systems that can meet a wide variety of electrical needs.

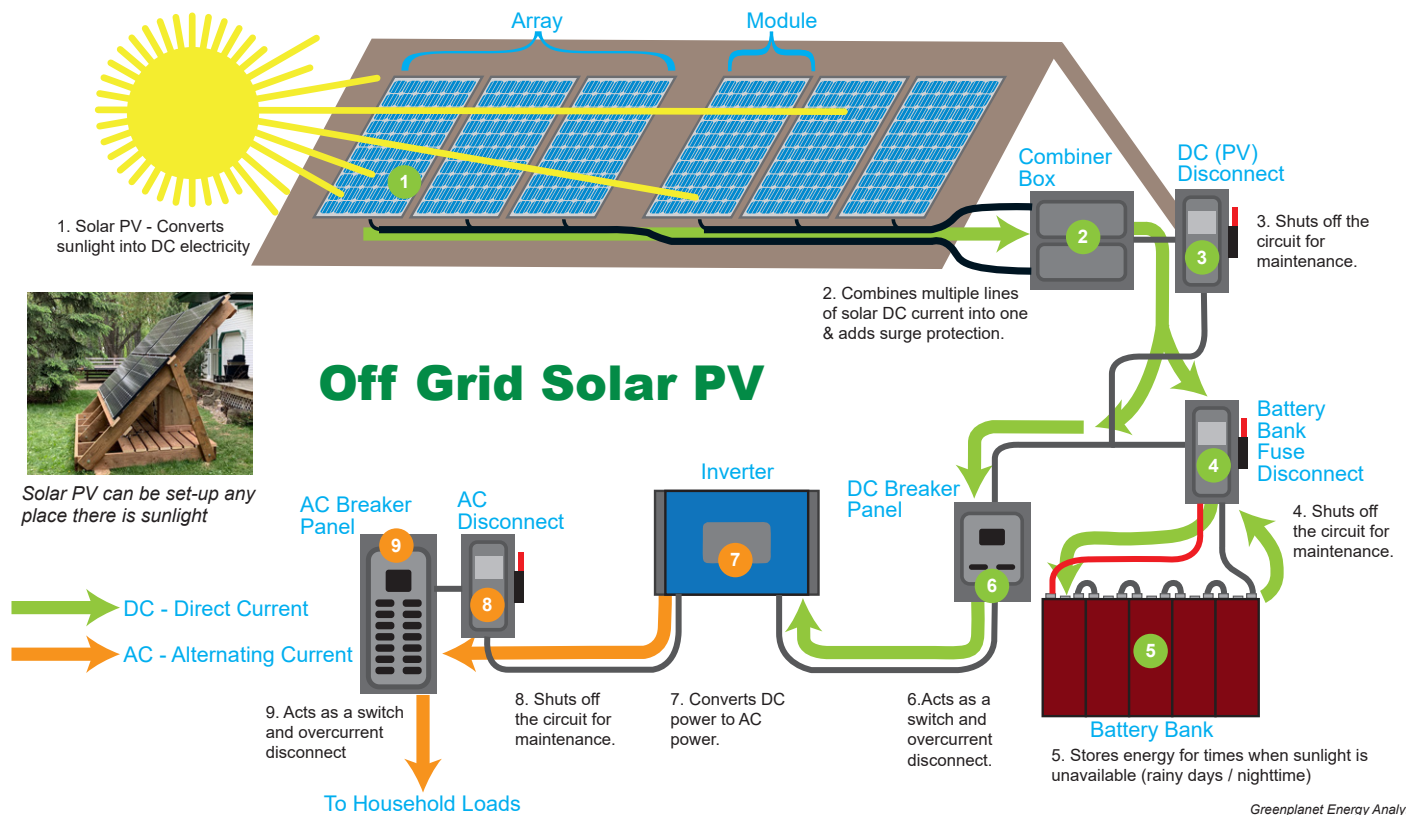


Small Scale Solar PV Systems

Grid Connected Solar

- Solar PV technology is often located on homes (roof mounted) or in an open area (ground mounted).
- The panels generate electricity to offset or supplement a home's electrical demand.
- When solar PV's are generating electricity by homeowners, it is referred to as Microgeneration.
- As a micro-generator, grid connected solar will send excess electricity into the grid in exchange for credits on their utility bill when a home is producing more electricity than it needs. This is called Net Metering.
- Grid connection ensures that homeowners have access to electricity during times that the sun is not providing enough electricity to meet a home's energy demand.





Off Grid Solar

- This system is installed when there is no access to an electrical grid connection.
- Not having access to the grid, means without batteries available, a homeowner will have no electricity when the sun is not shining.
- In some instances, homeowners will use diesel generators instead of batteries.

Utility-Scale

- Utility-scale solar refers to large scale electricity generation. These projects play the role of a power plant for our electrical grid.
- Traditionally, energy was provided to the electrical grid by coal power, wind farms, hydroelectric dams or nuclear power plants.
- More recently, solar farms have been playing a bigger role in providing electricity through the grid, and in some places a homeowner can choose to pay a premium for renewable electricity.
- Utility-scale solar farms require large, open areas of unobstructed access to sunshine.
- These facilities occasionally are accompanied by energy storage technology.



Fort Chipewyan Solar Farm under construction.

How To Make Solar PV Systems Effective

- Since Canada is located in the Northern hemisphere, Solar PV systems must always be installed to be South facing.
 - As the sun rises in the East and sets in the West, the sun does not travel between these points directly above us, but more to the South.
 - The opposite is true in the Southern hemisphere such as in a country like Australia, their solar PV systems are North facing.
- Solar PV's must be free of obstruction from direct sunlight, meaning no buildings, HVAC equipment or trees can obstruct sunlight's path to the solar PV.
- Dust, snow or debris can build up on a solar PV over time, blocking the sunlight. Keeping the panel clean will keep a solar system running efficiently.
- Solar energy is not constantly available.
 - When the sun goes down at night or the sun is not high in the sky providing direct sunlight, its efficiency decreases.
 - Solar PV's are more reliable when combined with a connection to the electrical grid or hooked up to an energy storage technology such as batteries.
 - Batteries are often Lithium Ion due to their high efficiency and capacity to be charged and depleted over extended time periods.
 - When a battery is charged and depleted, this is called a cycle. A battery's energy efficiency will deplete over time, and is connected to the amount of cycles it goes through.

Benefits of Solar PV

- You will save on energy and utility bills
- Solar PV's do not produce greenhouse gases or air pollutants while in operation.
- Solar energy systems have minimal effects on the environment.
- Solar PV's have a low operating cost as little maintenance is required once they are operational.



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Case Study: Fort Chipewyan Solar Farm

Like many northern and remote communities, Fort Chipewyan is not connected to the rest of the province's electric grid. Power is typically generated by large-scale diesel generators. Diesel is shipped into the community when the winter road is open, which is shortening each year because of climate change. To ensure there is renewable energy, energy security and energy independence in the community, a two-phase solar farm is being built in Fort Chipewyan.

Phase 1 is an ATCO-owned and operated 400kW system that is already producing power for Fort Chipewyan. Phase 2 is owned by Three Nations Energy (joint ownership by Athabasca Chipewyan First Nation, Mikisew Cree First Nation and Fort Chipewyan Métis Association) and when complete in the fall of 2020, it will be Canada's largest remote community solar farm. This will be connected to a battery system to continue to provide clean electricity when the sun isn't shining.

Project Facts and Figures

Generation Capacity

- 2.6MW (2,600 kW)

Energy Production

- 3,200 MWh/yr (25% of Fort Chipewyan's annual consumption)

Number of Panels

- 7,500 ground-mounted

Reduction in Diesel Use

- approx. 800,000 litres

Reduction in Greenhouse Gas Emissions

- 1,743 tonnes CO₂ equivalent per year

Battery Storage System

- 1.5 MWh (Mega Watt Hours) will extend ability of solar PV power to displace diesel power

Further Information

Photovoltaic System - University of Calgary

https://energyeducation.ca/encyclopedia/Photovoltaic_system

How Do Photovoltaics Work? - NASA

<https://science.nasa.gov/science-news/science-at-nasa/2002/solarcells#:~:text=Photovoltaics%20is%20the%20direct%20conversion,of%20light%20and%20release%20electrons.&text=The%20diagram%20above%20illustrates%20the,also%20called%20a%20solar%20cell.>

How Solar Panels Work - Popular Mechanics

<https://www.popularmechanics.com/technology/infrastructure/a28186403/how-solar-panels-work/>

Follow the Sun: How Solar Panels Are Evolving - CBC

<https://www.cbc.ca/news/technology/what-on-earth-solar-panels-bifacial-dual-axis-1.5643798>

Micro-generation - Alberta Government

<https://www.alberta.ca/micro-generation.aspx>

Videos

Solar Energy - Bill Nye's How Stuff Works

<https://www.youtube.com/watch?v=av24fEMhDoU>

Shining A Light On Solar Energy Myths #135 - Green Energy Futures

<https://www.greenenergyfutures.ca/episode/solar-myths>

How Do Solar Panels Work? - Richard Kom/TED Talk

<https://ed.ted.com/lessons/how-do-solar-panels-work-richard-komp>



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