Solar Power Generation for Domestic Use

Brian Sullivan

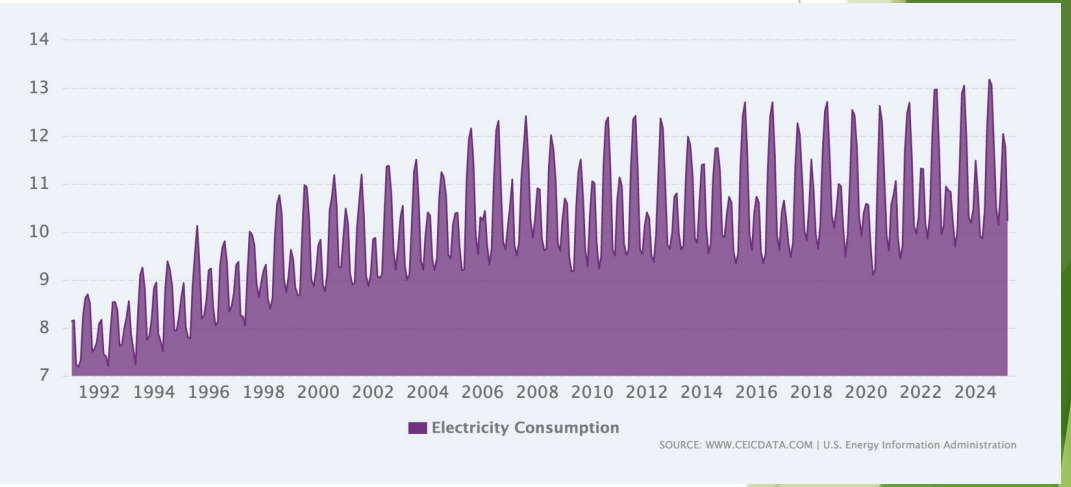
Saad Babezzine

Kodjovi Tini

Why we chose to talk about domestic solar

- Year over year , the power needs of the average American is increasing[1], and the average consumer is getting squeezed by their regional utility company to make up the difference
- Renewable energy projects at scale are not always able to match conventional methods of power generation in terms of volume, but a domestic solar set –ups have allowed the average consumer to create sustainable power on their own terms and, over time , save money.

Figure 1: graph of Kwh over time for US energy consumption from the EIA



What does a common domestic solar setup look like

- From the banks of photovoltaic cells on the roof or other structure, the dc power is passed to a dc power controller in order to charge a battery or battery bank
- This DC power is held in the batteries until it needs to be used by the homeowner.
- The direct current then passes through an inverter , becoming alternating current, in order to work with your home and the electric grid.
- Your solar system and the grid meet at the meter of your home , where under ideal circumstances your system can send excess power back to the grid.

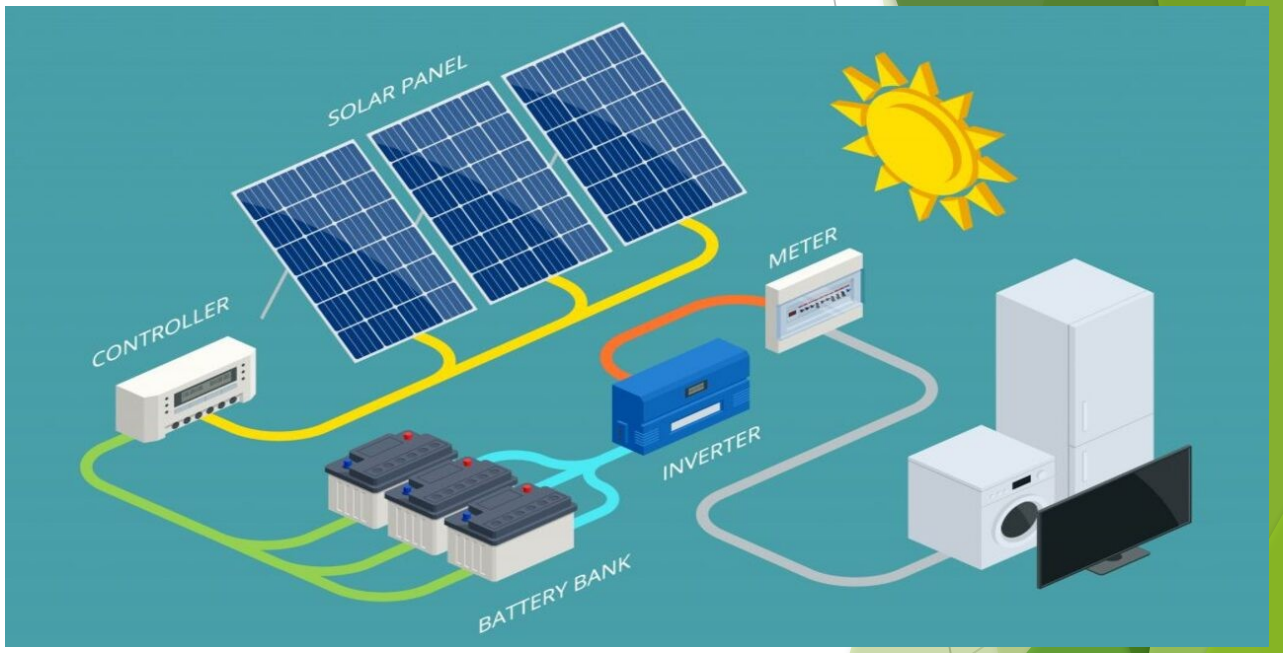


Figure 2: Exploded view of Domestic solar set-up

How does a photovoltaic cell work

- Visible, ultraviolet and infrarec light comes down as sunshine
- The photons pass a reflective coating , through to a semiconductive layer and excite the electrons in the layer
- That charge is passed upwards to the rails that carry the voltage on

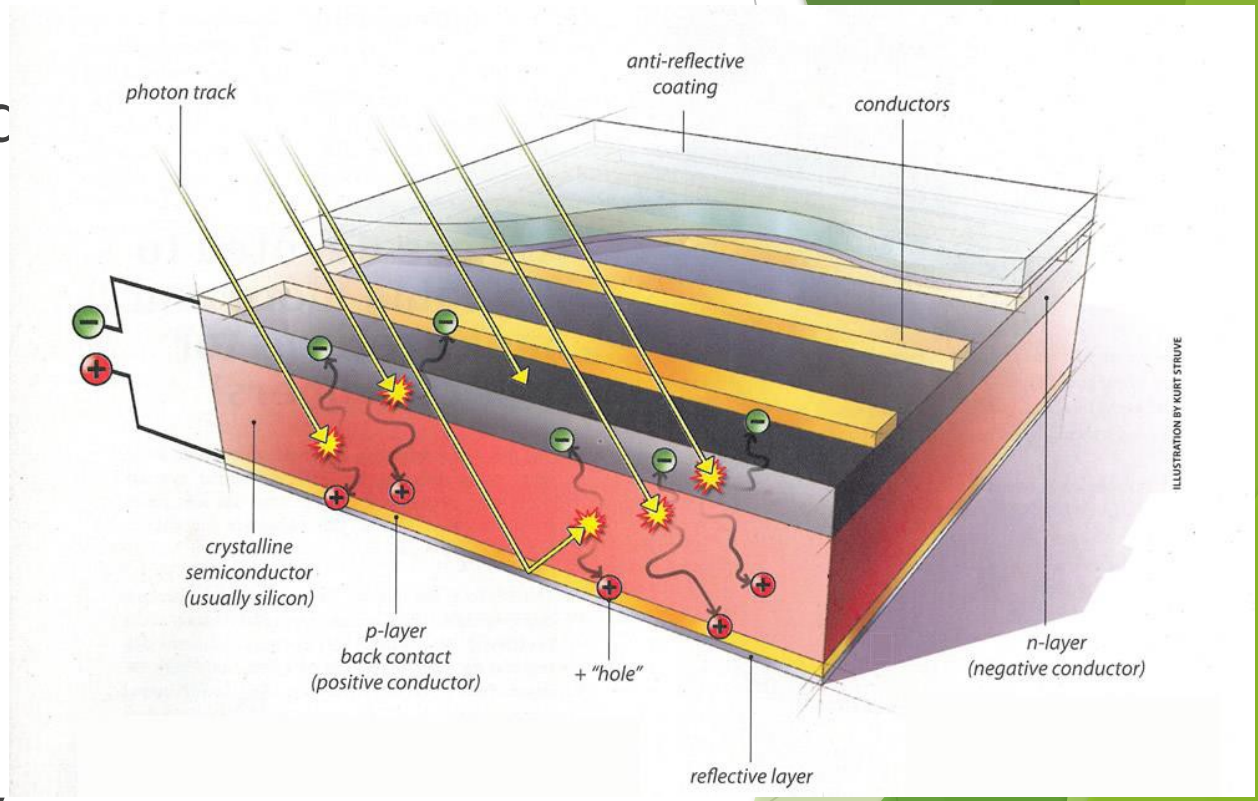


Figure 3 : Internal view of solar cell

What does an inverter do?

-Our DC voltage is combined with a switch and a pulsing signal, here a 50Hz oscillator.

-These signals are used to create an A/C waveform by consistently pulsing between a negative and positive amplitude, -110 and +110 for this example

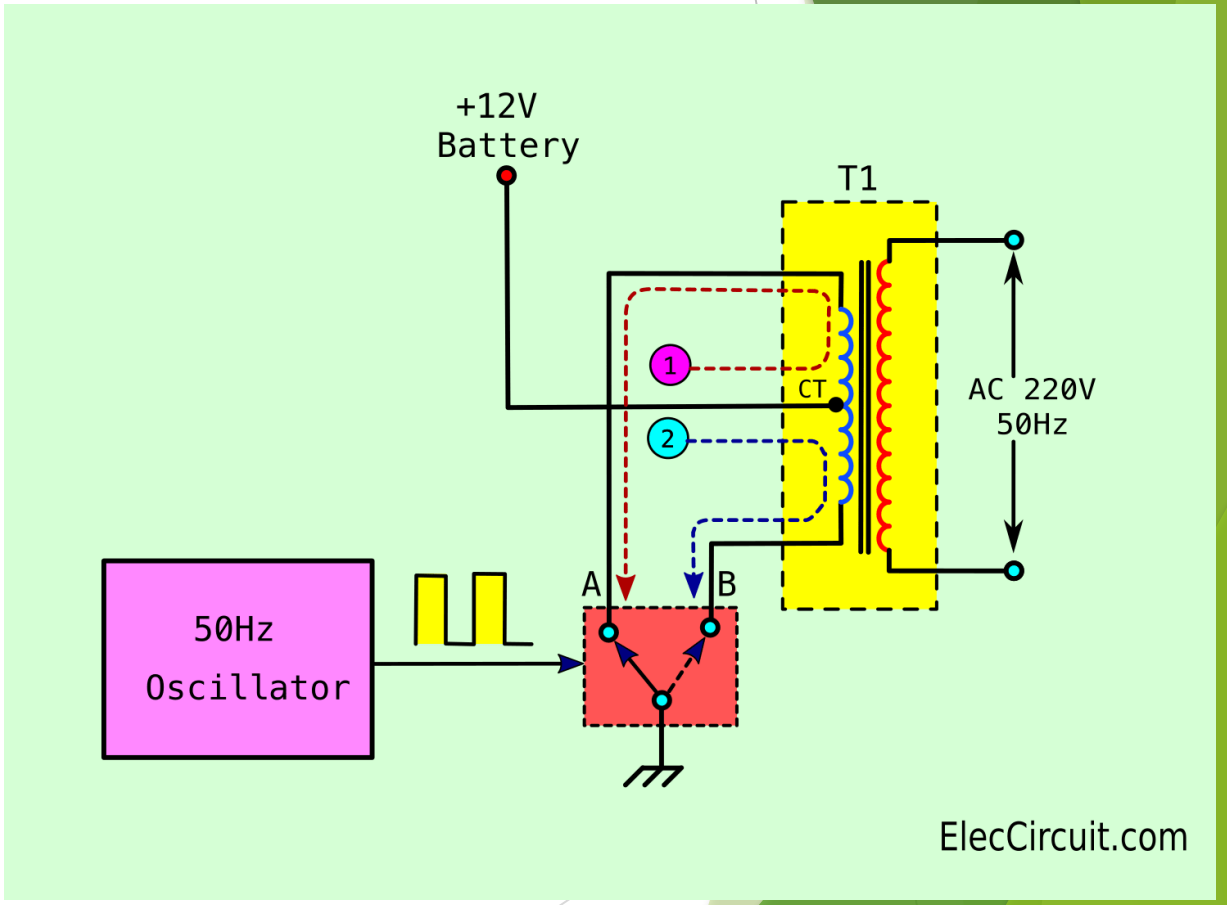


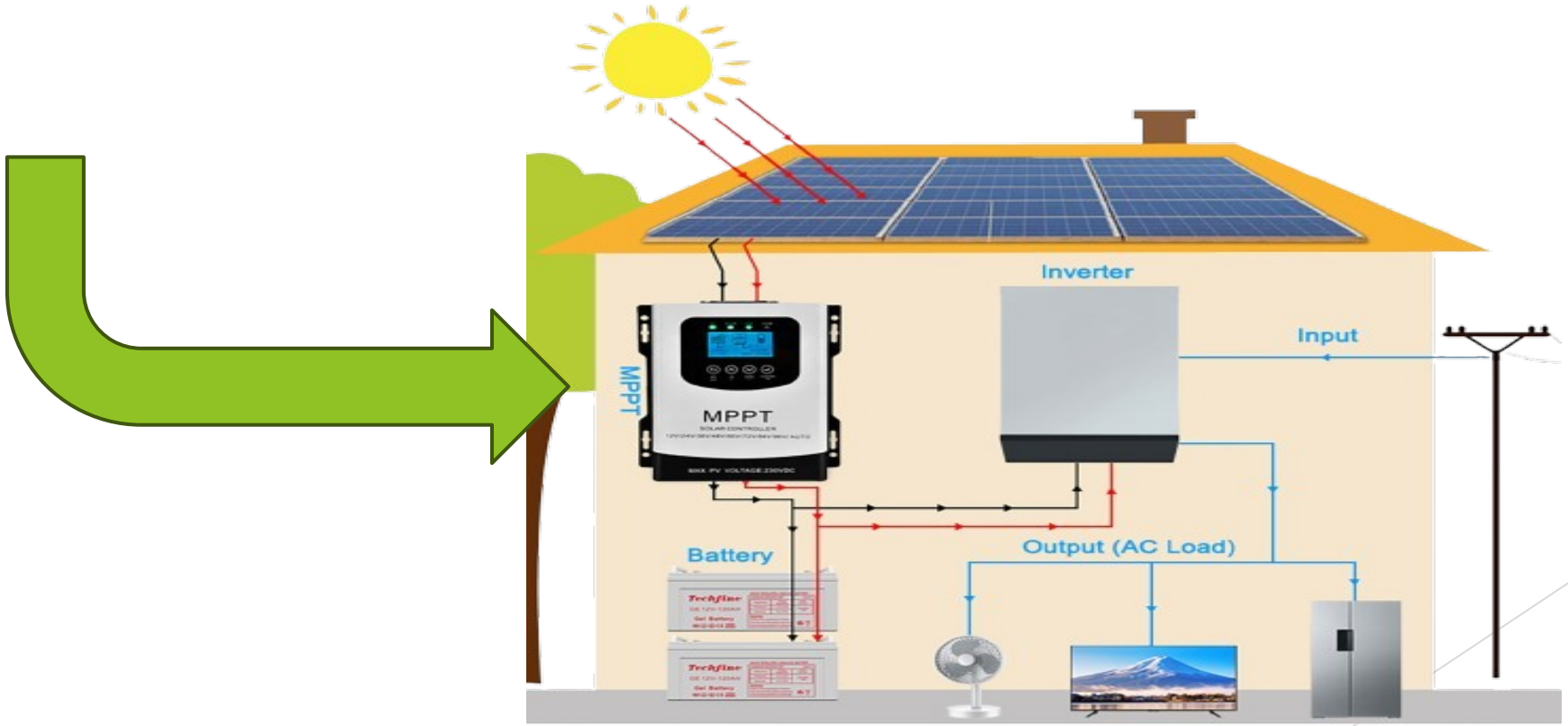
Figure 4 : Inverter diagram from 12v to 220 v AC

Battery and Control System in Solar Circuits

- → The charge controller
- → The Charge and Discharge of a Battery
- → Battery Connections — Series vs. Parallel

Charge controller

A charge controller is a small electronic device that sits between the solar panel and the battery.



Types of charge controllers:

There are two main charge controllers:

- **PWM**: Pulse Width Modulation connects the solar panel directly to the battery and switches current on/off to control voltage.
- **MPPT**: Maximum Power Point Tracking uses a DC–DC converter to adjust voltage and current to extract maximum power.

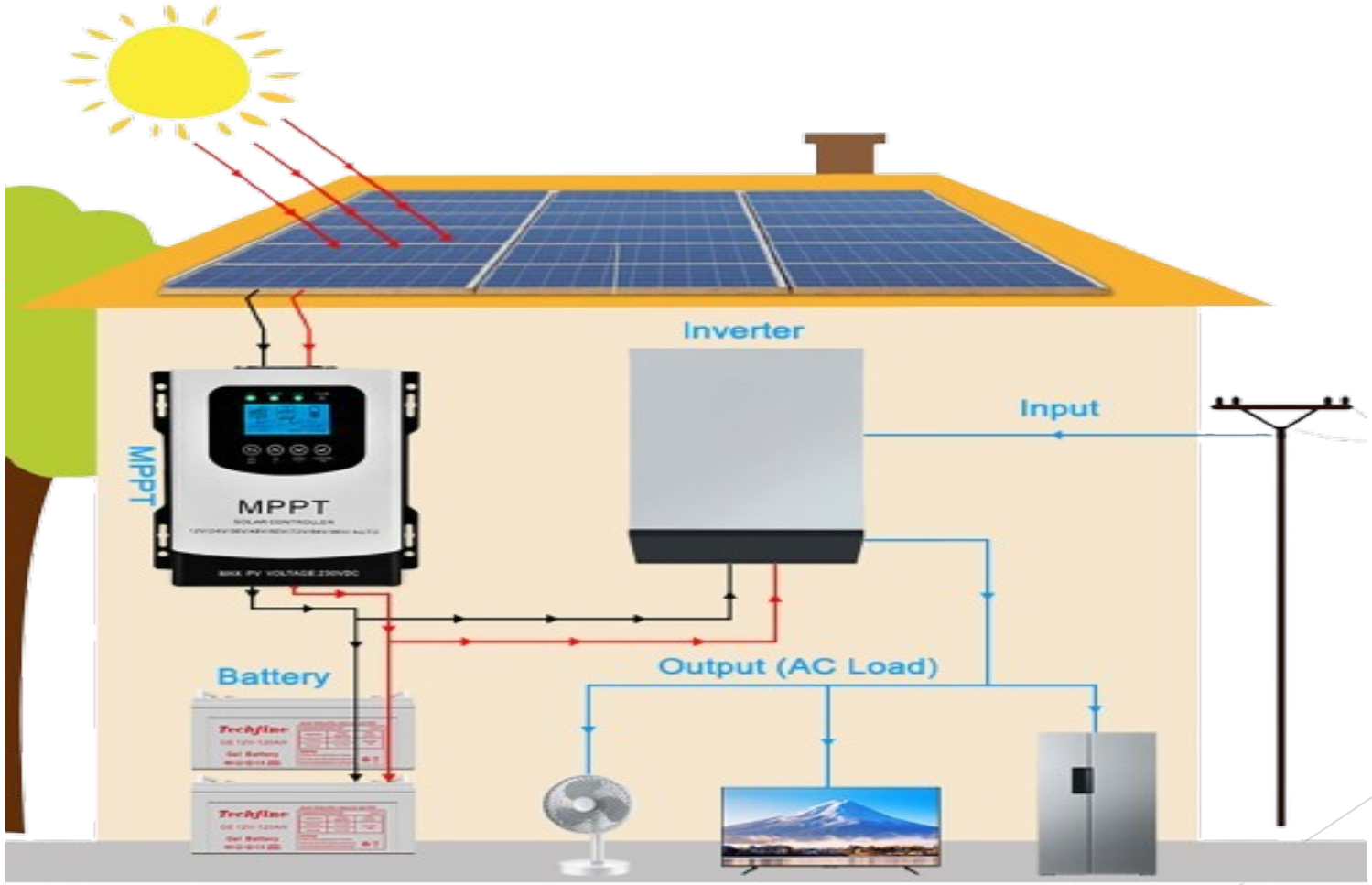
MPPT


victron energy
SmartSolar charge controller
MPPT 100 I 30
IP43

PWM


victron energy
PWM
13.0
BlueSolar PWM Charge Controller LCD-USB 12|24V|5A
PV
BATTERY1
BATTERY2

A quick setup with MPPT charge controller



The charge of a battery

- A battery stores electrical energy as chemical energy.



The charge of a battery

What happens during a battery charge?

1. The solar panel converts sunlight into DC electricity.
2. When the panel voltage is higher than the battery voltage, current flows into the battery.
3. Electrical energy is converted into chemical energy and stored inside the battery.
4. The battery voltage rises as it charges (for a 12 V battery)
5. The charge controller regulates the current to prevent overcharging.

The discharge of a battery

What happens during a battery discharge?

1. When sunlight is gone or panel voltage is lower than the battery’s, current flows out of the battery.
2. The battery converts stored chemical energy back into electrical energy.
3. This current powers the load (lights, fan, etc.).
4. The battery voltage decreases gradually during discharge.
5. The charge controller prevents deep discharge to protect battery life

Battery in Series vs. Parallel

Feature	Series connection	Parallel Connection
Connection Type	Positive (+) of one battery connected to Negative (-) of the next.	Positive (+) connected to Positive (+) , Negative (-) to Negative (-)
Voltage	Adds up Ex; 12v +12v=24v	Stays the same Ex: 12v +12v =12v
Capacity (Ah)	Stays the same	Adds up Ex: 100Ah+100Ah=200Ah
Power (Wh)	Increases because power increases	Increases because capacity increases
Use Case	When a higher system voltage is needed	When longer backup time is needed

Problems the solar system may face- Weather variations

- Cloudy or rainy weather can impact the panel output, reducing the total amount of time per day that the panels can be active
- -less sunlight slows down battery charging
- -seasonal changes impact daily energy production
- -dust and shading can lower the performance of the system

Temperature Effect on the Solar system

- Higher temperature (heat) effects (reduces) panel voltage and the battery life.
- Cold weather may slow battery charging.
- Proper ventilation improves the system performance
- Instability temperature may cause energy loss.

Maintenance

- Check wires and connections on time for corrosion
- Inspect charge controller and battery levels
- Clean panels regularly to avoid dust buildup
- Fix or replace damaged parts on time

References

[1]https://www.ceicdata.com/en/united-states/electricity-supply-and-consumption/electricity-consumption

[2]https://sites.lafayette.edu/egrs352-sp15-pv/how-do-solar-pv-panels-work/

Figure 2, Figure 3 : https://arka360.com/ros/things-needed-set-up-solar-power-home

Figure 4: https://www.eleccircuit.com/simple-working-principle-of-the-inverters/