Reasons why to choose DC and/or AC coupled solar in Off-grid Power Systems

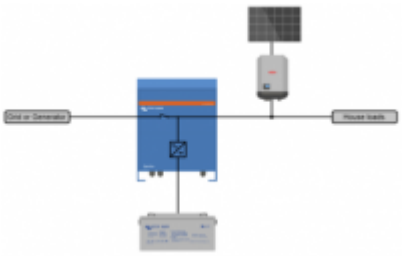
Under construction

Introduction

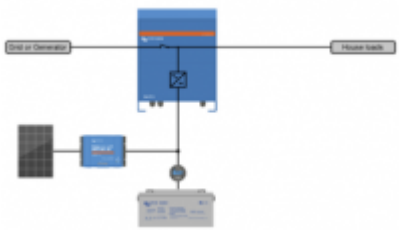
Off grid systems have traditionally used DC coupled solar. This was an easy choice because batteries are also DC.

As off-grid systems have become larger now also AC coupled solar is used. AC coupled solar systems use strings of solar panels configured in 100-600 Vdc strings going to a grid feed inverter which converts directly to 230 Vac

An AC coupled solar system looks like this:



A DC coupled solar system looks like this:



AC and DC solar compared

AC solar advantages and disadvantages

Pros:

- Less and thinner AC cabling
- PV array can be far away from the installation

Cons:

- 1.0 rule

- Programming needed
- System will not recover from low battery if there is no backup generator
- Potential clock and timer issues
- Not suitable for boats or vehicles

DC solar advantages and disadvantages

Pros:

- Better for charging batteries
- More efficient if most energy needs to be stored
- Easy to setup. Default products can be used, no programming needed
- Fail-safe in case batteries are too far discharged

Cons:

- Not so suitable for very large arrays (max voltage 250V)
- the battery will be worked harder

Advantages and disadvantages explained

DC is simpler to set up than AC

The big advantage of the DC solar system is its simplicity. It is a very ‘robust’ design that allows a very reliable and efficient charging of batteries.

DC will work the battery harder than AC

In a DC system the inverter/charger will do all the work on supplying the 240V loads. The grid-feed inverters will support the AC Loads. Very large systems will typically have large loads. AC solar inverters can support these daytime loads and increase the sustained and total kW power that the system can supply.

AC allows fro a larger solar array than DC

DC solar strings are typically much lower voltage, the wiring requirements are larger. Often only 2 or maybe up to 6 panels to a pair of 4-6 mm wires. In very large systems with 20 panels or more, this can require a lot of cable runs.If the solar array is very far away from the battery and other DC distribution, it is a lot more efficient with wire cost to run AC back, rather than low voltage DC.

DC is better for battery charging than AC

Victron DC MPPT control is very quick and very precise, much less than a second.

When the AC solar inverter MPPT is governed by a signal sent from the CCGX, and then inverted by the inverter/charger back to DC, there is additional delay and ‘chunkiness’ added to the charge profile.

Depending on the battery technology (lead acid or lithium) this can lead to other issues where the only charge supply source is the AC solar due to lack of fine current or voltage fidelity (eg inrush current and overshoot).

DC can recover from empty battery while AC can not (black start)

When a system reaches a critical low level of battery, Many of the services shut off to protect the batteries from permanent damage. One of those services is the AC output of the battery inverter. This provides the grid forming service that the AC solar inverter requires to start up. So even though there is abundant solar, if the battery inverter has shut down, it will not be able to charge the batteries.

DC Solar does not require any other components to be active, and can charge dead flat batteries and be powered from the solar panels.

This is critically important in lithium batteries, where parasitic self discharge loads can permanently destroy a battery.

Heat

Heat is the enemy of all electronic equipment. The first thing to do is use the most efficient equipment available (in-efficiency is lost to heat).

Using a solar inverter removes some of the (daytime) load from battery inverter, and means it generates less heat.