Course: Sustainable Energy Technology 1

12150310

Title: PV Technology-PV system Components – L5

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Photovoltaics Systems components

Solar Inverters:

It converts the changing direct current (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local off-grid electrical network.

I – **Standalone Inverter** (It is not required to have anti-islanding protection).

II - Grid-tie Inverter: Grid-tie inverters are designed to shut down automatically upon loss of utility supply, for safety reasons.

They should match its output with the grid voltage.

III- Intelligent hybrid inverters: manage photovoltaic array, battery storage and utility grid. All in one unit.

Solar Bidirectional Inverters:

A conventional solar inverter receives DC power from the solar panels and convert to AC power.

A bidirectional solar inverter can additionally convert AC power to DC power for battery charging (if required).

The inverter automatically detects availability of AC supply and changes operation mode from inverter to charger and charges the battery if solar power is not available.

Photovoltaics Systems –Design Examples

Design Considerations:

The factor of safety (Safety Factor)

It is employed to make sure that the PV system can handle a load current more than that planned due to addition of equipment. This is also to take into account any decrease in production due to any external conditions.

This safety factor allows the system to slightly expand.

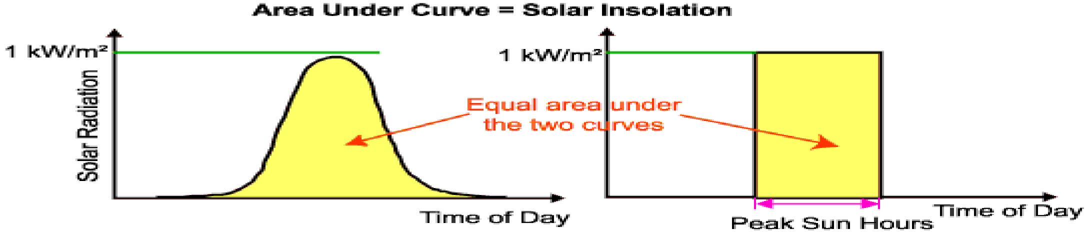
Sf = 1.15 for domestic applications whereas it may be 1.4 for critical load such as communication equipment.

The peak sun hour (PSH)

The average daily solar insolation in units of kWh/m2 per day is sometimes referred to as "peak sun hours“.

It refers to the solar insolation which a particular location would receive if the sun were shining at its maximum value for a certain number of hours.

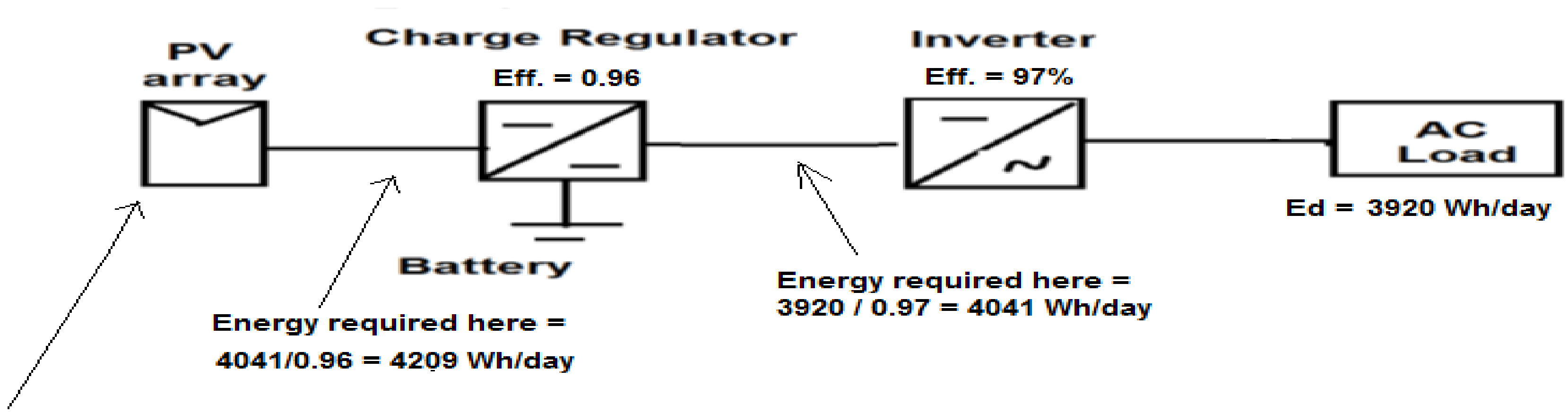
OR, it is number of hours must the sun shine at a solar intensity of 1000 W/m2 to produce the annual daily solar insulation. It is a site specific.



Photovoltaics Systems –Design Examples

Example: Design an AC decentralized PV power system to supply a load that needs 3920 Wh/day. The efficiency of the inverter, regulator and battery are 97%, 96%, 85% and considering the battery DOD is 75%. The design safety factor is 1.15 and the Peak Sun Hours for the location is 5.4 hours.

PV Sizing



$$P_{PV} = \frac{Ed * Sf}{Eff.\ Inv * Eff.\ Reg * PSH} = \frac{3920 * 1.15}{0.97 * 0.96 * 5.4} = 897\ Wp$$

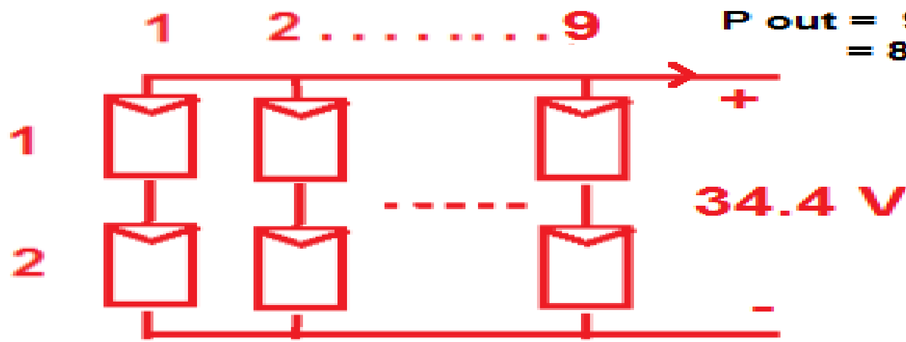
Assume that the PV module that will be used has a Vmp = 17.2 V and Imp = 2.9 A.

So, TWO PV modules should be connected in series to be able to charge the battery system at a DC bus voltage of 24 V.

The total current supplied by this PV system = Ppv / (2*Vmp) = 897 / 34.4 = 26 A

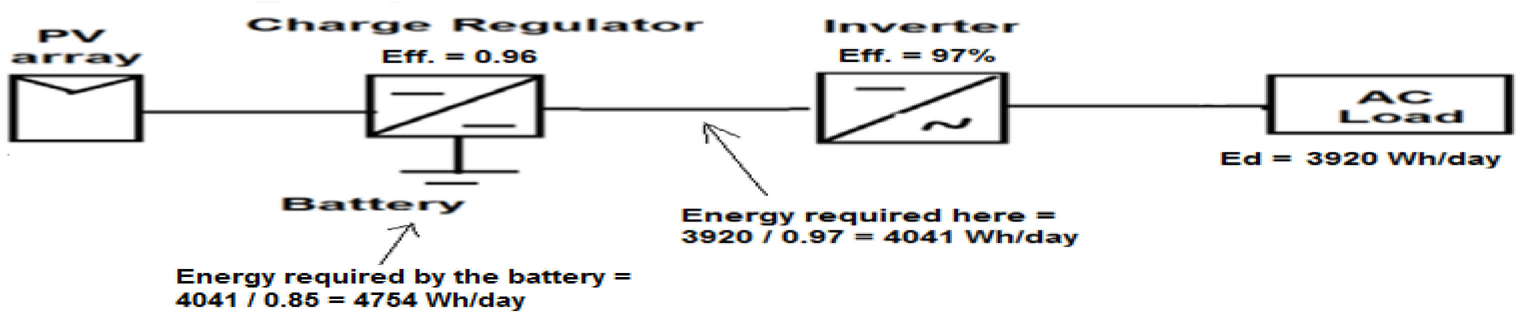
So, the number of parallel PV strings = Total PV current / current per each string = 26/2.9 = 8.96 >>>>>> = **9 STRINGS**

Photovoltaics Systems –Design Examples



P out = 9 * (34.4 *2.9)
= 897.4 W

Battery sizing:



The energy that should be stored in the battery = 4754 / DOD = 4754 / 0.75 = 6339 Wh/day

This means that the capacity of the battery to serve the load for one day = CWh = 6339 Wh.

If the battery system should be designed to supply the load for two days then CWh = 2* 6339.

In general

$$CWh = \frac{Ed * AD}{Eff.\ Inv * Eff.\ Bat * DOD} = \frac{3920 * 1}{0.97 * 0.85 * 0.75} = 6339\ Wh$$

where AD in the number of Autonomy Days

Photovoltaics Systems –Design Examples

To calculate the number of batteries in series and number of battery strings, we have to calculate the total capacity in Ah (CAh)

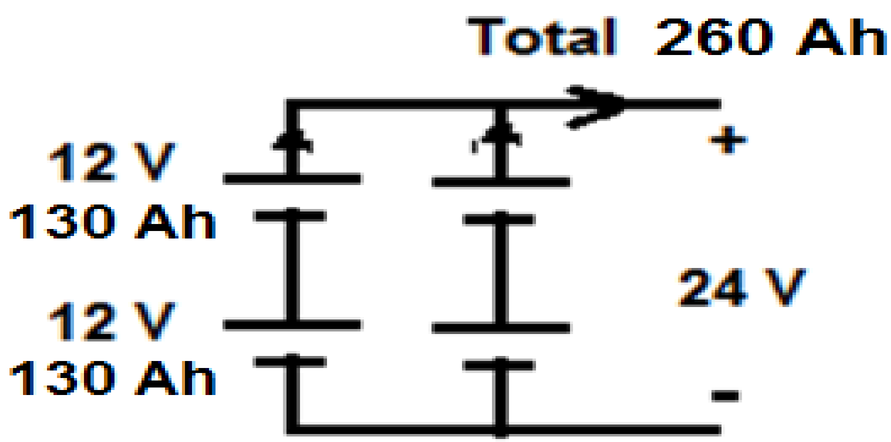
CAh = CWh / (DC bus voltage) = 6339 / 24 = 264 Ah

If we have to use batteries <u>each with 12 V and 130 Ah</u>

So, we need TWO batteries in series to construct a string.

Number of parallel strings = (CAh total)/(CAh for each string)

= 264 / 130 = 2.03 >>>>> TWO parallel strings



Assume that we need to supply the load <u>for two days</u>, then the <u>total CAh = 2 * 264 = 528 Ah</u> and in this case <u>we need FOUR strings</u>.

Photovoltaics Systems –Design Examples

Regulator Specifications:

The input voltage ------ Rated = 24 V ----- Should sustain 2*(Voc-each PV panel)

= 2*21.6 = 43.2

So, choose Vin 50 V

The output voltage ----- (2*10.8 [21.6]– 2*14.4[28.8]) >>>> (20V-30V)

So, choose Vout (20V-30V)

The input power > Ppv,

So, choose Prat = 1000 W.

Inverter Specifications:

Choose Vin (20V – 30V)

Choose Vout (210V– 230 V) ac 1-ph , 50 Hz

Choose Prat > Pconnected