Configurations of solar PV micro grid system

Solar PV microgrid systems are custom designed for their particular situation. The following factors are generally taken into account while determining the system configuration for solar microgrid system.

- Target consumer and type of electrical appliances to be operated
- Load size and daily energy demand
- Time of operation
- Correlation with load on a daily, weekly and seasonal scale
- Installed cost and maintenance costs
- User specific preferences
- Local regulations/ constraints/ benefits
- Photovoltaic only or hybrid generation

The system configuration should be chosen so as to satisfy the design criteria, to make it most cost-effective, efficient, reliable system operation and long life. Economic evaluation of different options, if required, may be carried out on the basis of life cycle costing.

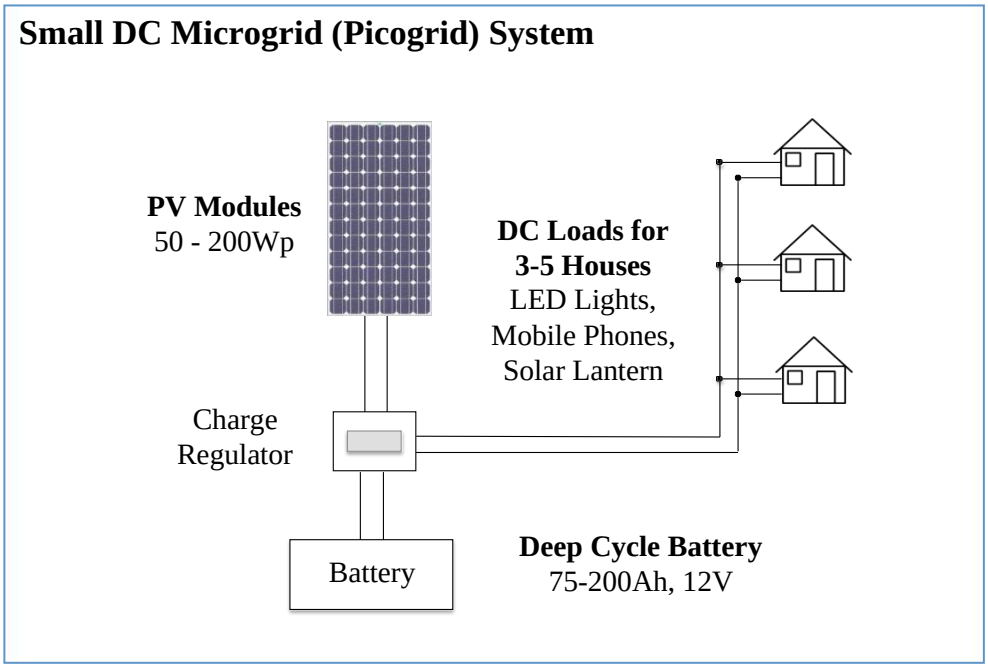
For reference purpose, we can group solar micropower or microgrid system types into five broad categories:

- Small DC microgrid (Pico-grid) system
- Large DC microgrid system
- AC Power microgrid system
- AC – DC combined microgrid system
- PV-Generator hybrid microgrid system

In the following pages typical system configurations are described.

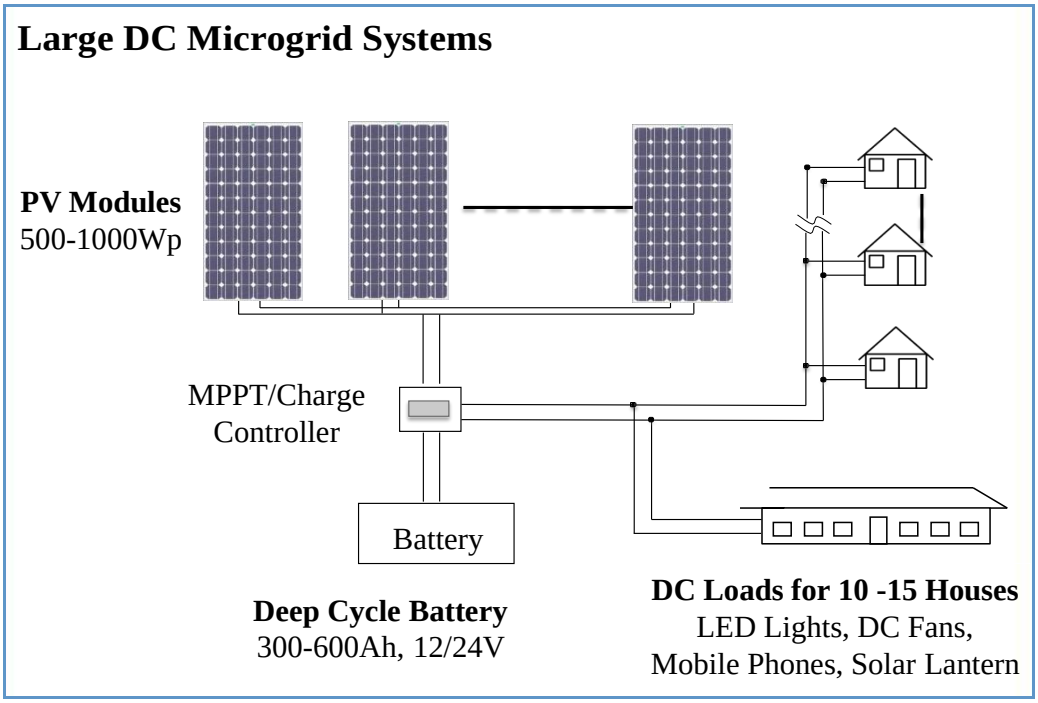
1.1 Small DC microgrid system

This configuration is similar to a solar home system shared by 3-5 houses to meet basic electricity demand for 2-3 LED lighting per house, mobile charging and charging of solar lanterns, etc. Typical battery capacity could be 75-200Ah, 12V and array capacity shall be 50-200Wp based on availability of solar radiation on the site. Generally, a typical charge regulator is used to protect the battery from deep discharge and overcharge.



1.2 Large DC microgrid system

This type of system can be designed by adding more modules and batteries. A large single charge controller or multiple charge controllers would be needed to handle the increased current from the array. If number of loads is more, a DC circuit breaker distribution box could be used. Typical array size of these types of systems may be 500 watts to few kilowatts with nominal system voltage 12, 24 or 48V based on size of the system. Similarly battery bank capacity may be of 300Ah to 600Ah.

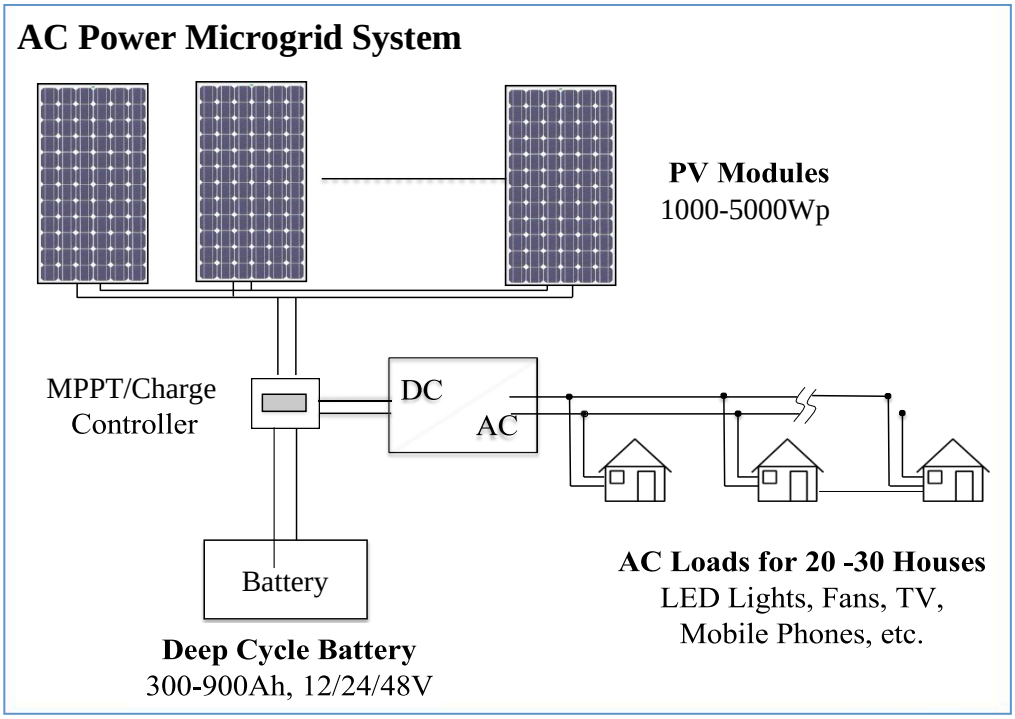


1.3 AC Power microgrid system

AC appliances can be powered by adding a DC-to-AC inverter. In general, system size more than 1000 watts can be designed for standalone AC operation. Depending on the capacity of the system and type of inverter, various types of AC appliances could be operated by this type of system.

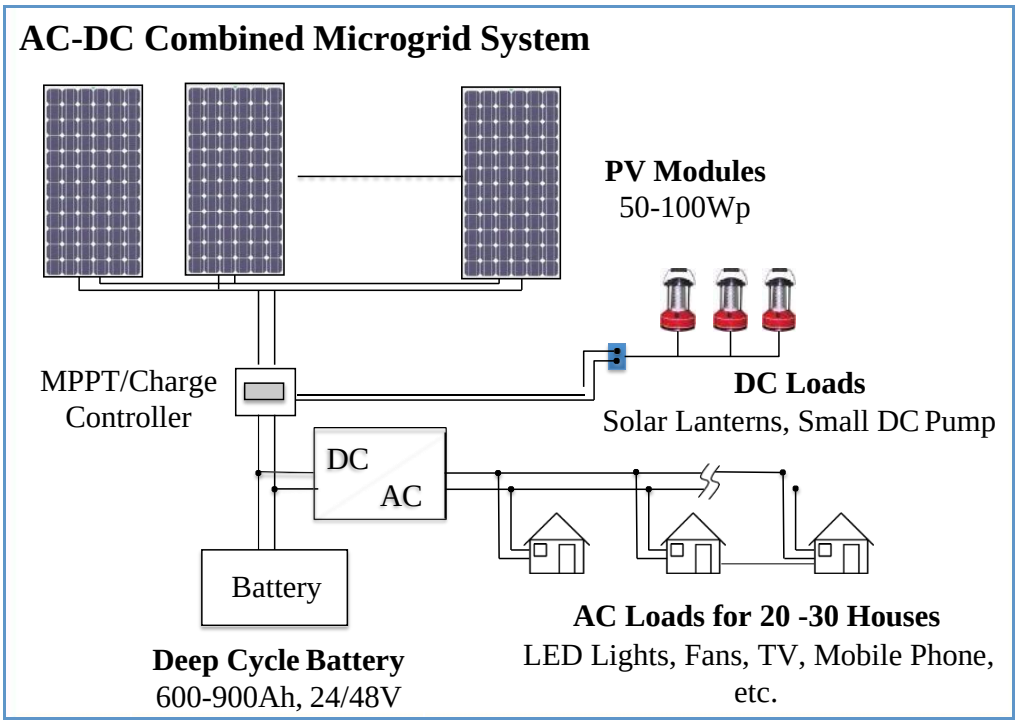
Using an AC standalone system is convenient as most of the electrical and electronic appliances available in the market run on AC. However, care has to be taken, particularly in small system for overloading of the system and inverter, as the users may not be aware of limitation of the system and they may tend to think as conventional AC system and end up discharging the complete battery capacity using the loads continuously or damage the inverter connecting loads of larger than the inverter capacity.

When low quality or inverters with square wave or modified square wave form are used, some electrical or electronic equipment may not function or even get damaged.



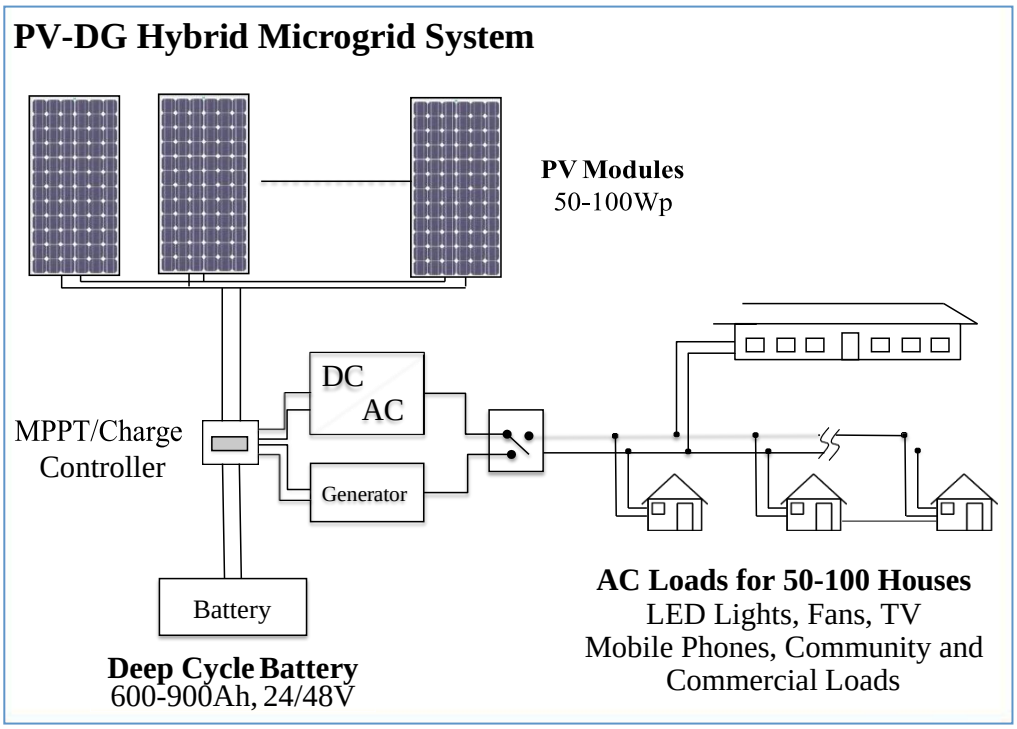
1.4 AC – DC combined microgrid system

Design and operational features of this configuration is similar to the AC power system as mentioned in the previous section. The only additional feature in this configuration is facility to use DC appliances directly from the regulator without going through the inverter. If the user has some DC loads and these are efficient, it is recommended that DC loads be used directly from the DC bus bar. This might reduce the size of the inverter and also increase overall efficiency of the system, as there is no conversion loss for DC loads.



1.5 PV-Generator hybrid microgrid system

Solar microgrid system can be integrated to other renewable energy generator such as wind turbines or micro hydro generator. A common choice is a diesel, kerosene or petrol fuel based generator. By combining a generator, the reliability of solar microgrid system can be assured with availability power during any season or weather condition during the year.



Generator AC power output can be directly connected to AC loads. A transfer switch is needed to prevent generator power from feeding backwards in the inverter. The transfer switch can be electronically operated or a manual change over switch. The generator can also be used to recharge the batteries.

1.6 Connecting microgrid system to grid

In general, solar microgrid is standalone and installed in such areas where there is no grid. As and when the main grid is extended to these areas, microgrid systems may become obsolete or have less importance due to its limited power generation capacity in comparison to the main grid. The best way to avoid such situation is to make the microgrid systems compatible to interface the main grid. A solar microgrid system can be connected to the main grid through different methods. However, such integration must be as per requirement of local grid code and provision from IEEE1547 need to be followed. Connecting microgrid system to the main grid may provide multiple benefits as below:

(i) Solar microgrids are typically designed with extra capacity to take care of energy demand during the months when solar radiation is low. If microgrid system is connected to the main grid, surplus power can be injected into the grid, which will increase capacity utilization factor of the plant.

(ii) The consumers connected to microgrid system will have more flexibility in use of electrical appliances when microgrid is connected to the main grid.

(iii) Due to availability of grid, battery capacity may be reduced or even removed if grid is reliable.