

OFF-GRID ENERGY SYSTEMS INFORMATION

(by Peter McKernan, PM Engineering)

SYSTEM OVERVIEW

Our philosophy is that your “Off Grid” energy system should be as easy to operate as possible.

The system should be fully automatic and require the absolute minimum amount of maintenance. Compared to grid connected people; the owners of properly designed “Off Grid” solar systems should enjoy all of the luxuries they want, have greater reliability and have no energy bills.

The latest design is called “An AC Coupled Micro-Grid”.

It will have solar panels arranged in arrays. Each array will be connected to an independent input on and **AC coupled inverter**. (Like you would have on a suburban grid feed system)

This inverter will convert the DC energy from the solar panels into AC energy which will feed the backbone wiring (“Micro-Grid”).

On the same micro-grid wiring system there will be a **“Multi-mode inverter”**.

The multi-mode inverter is connected directly to your battery, generator and “Micro Grid”

It will constantly monitor the performance of your system. When your solar energy production is less than your needs it will take some of the energy from your battery, convert it to AC energy and meet that need.

When your solar production is greater than your needs the multimode inverter will convert the excess energy to DC energy and re-charge your battery.

If you have had a low sun period and your battery is discharged the multi-mode inverter will automatically start your standby generator. The energy from your generator will be distributed to your loads first and then the excess energy will be converted to DC to recharge your battery.

This design has by far the highest overall efficiency and typically provides the lowest achievable run time from the generator. All of the operations above are programmed into the multi-mode inverter and are fully automatic. The system incorporates an extensive data logging system and will produce performance graphs which can be used to fine tune the settings. Once it is adjusted to optimum performance you can ‘set and forget’ or if you like you can log into the data and watch it manage your power in real time.

DESIGN SIZING

The three most important items to size in an “Off Grid system are the solar array, the Multi-mode inverter, and the generator.

To size these items we start with your average daily energy requirements and “Load Profile”. We need to establish how much energy you need each day (Kilowatt/hours) and we need to know what the maximum power level will be (Kilowatts)

1. ENERGY (Kilo-Watt Hours/day)

Estimated energy requirements are based on a typical load assessment spread sheet and some assumptions for air-conditioning requirements

Your system should be designed to meet your needs all year round.

Estimating actual daily consumption and peak demands can be tedious and does involve a lot of guessing. Adding a spa bath, extra beer fridge or an electric hot water booster for example can make a massive difference to your daily consumption so please be aware of all the electrical appliances you wish to incorporate.

In rural locations there is usually a water pressure pump and often a transfer pump or bore pump. These typically add 1.5Kw/Hours/day each in winter and up to 8 KW/Hours in summer. These are loads which do not apply in metropolitan regions.

Experience has shown us that the average rural family needs approximately 18KW/Hours/ day in winter (assuming they use slow combustion wood heating.) They will need approximately 28 Kw/Hours/day in summer (assuming some split system air conditioning).

A couple typically uses 14KW/Hours/day in winter and 26KW/hours/day in summer.

2. MAXIMUM POWER (Kilowatts)

The maximum power level is determined by the rating of your multi-mode inverter.

You reach your maximum power level when you run many appliances at the same time or if you run large loads like arc welders and air compressors.

If there is no requirement to use an arc welder or a large air compressor then a 5KW inverter will provide sufficient peak power to meet your needs. If you will be operating large loads or if you see the need to operate many appliances simultaneously then we recommend increasing the inverter size to 7.5KW. Families that include young children are better off with a larger inverter.

One way you can flatten your consumption peaks is by having a dedicated circuit to your home that is normally only available when your batteries reach full charge and you have excess solar available. This excess can then be directed to boosting your hot water or transferring septic water for example.

STANBY GENERATOR

All “Off Grid” installations require a generator.

The perfect generator for the task should meet the following criteria.

- Diesel or bio-diesel
- Automatic (Electronic) Voltage regulation
- Automatic (Electronic) frequency control
- The “Prime” (continuous) Kilo-watt rating is 1.25 times the multimode inverter rating.
- Two wire remote start capability
- Incorporated “watchdog” to monitor coolant temperature and oil levels
- A low fuel warning float switch.
- Very very low noise level (Incorporated sound shell) 51db is excellent
- Must be installed to satisfy AS 2790 and AS 3000 standards.

Please note: to benefit from the full battery warranty, some manufacturers require that a properly sized generator is part of the installation.

SOLAR ARRAY LAYOUTS

Solar system energy production tends to commence around 9.00am each day, slowly increase to a peak at midday then recede and turn off around 6.00PM depending on the season. Unfortunately we tend to want most energy in the early mornings for breakfast and in the evenings to prepare dinner. One way we can adapt the solar array to better match our consumption is by orienting some of the panels toward the North East, and some towards the North West. This provides a flatter overall energy production and reduces the demand on the battery. If this layout is possible on your roof and it is worth considering

BATTERY

All Batteries must be housed in a dedicated battery room.

- It must comply with Australian Standards: AS 3011.2 / AS 4086.1 / AS 4509.1
- The best designs feature fully insulated walls lined with cement sheet or other non-flammable lining.
- The room will need a vent measuring 100mm X 400mm at ground level (Preferably on a southern wall) and a 100mm X 400mm vent at ceiling height (Preferably on a northern or eastern wall)
- Keeping batteries at or below 25 degrees will double the life expectancy compared to 35 degrees.
- The battery room will need a lockable door to which we will fit appropriate warning signs.

Energy storage makes up a large part of any off grid solar system. The storage options should use the best available chemistry with the longest possible service life. (some go to 20 year design life.)

When determining the quality of a battery we calculate the “**All of life Kilowatt Hours**” for the battery we take into account efficiency, maximum daily discharge, maximum permissible recharge rate and temperature degradation. We divide the cost by the final result and end up with a total cost per kilowatt hour. (It is currently around 13cents)

Other chemistries are available at a lower initial cost. If design life is not your highest priority you can try lower cost alternatives.

Occasionally your daily consumption will go beyond our predictions. To guard against this you need to choose a storage battery that is capable of recharging at a very high rate. This should be matched with a generator with a very high prime rating. This means that when the demand is unusually high you can be assured that the generator has plenty of capacity to supply all of the loads and that the batteries will recharge quickly so that the generator run time is kept to a minimum.

The operation of the generator should be entirely automatic and if you wish you can include an alarm system that will notify you when the generator is getting low on fuel. It can also be linked to an SMS system so you can monitor critical information on your mobile phone. On some

remote installations there are connections for oil pressure, coolant temperature and output voltage so the client can monitor these items as well.

WARRANTY

All workmanship should be covered by a 5 year warranty.

Your solar panels will typically come with a 25 year performance warranty as well.

ACREDITATION

Licensed Electrician

Registered Electrical

Clean Energy Council Accreditation

DESIGN SPECIFICATIONS MARROONDAH HIGHWAY TAGGERTY

Multimode inverter	Selectronic	7.5 Kilowatt
Solar Inverters X 2	ABB	9 Kilowatt (TOTAL)
Solar Panels	Trina Honey (30)	10.64 Kilowatt
Battery	Lead / gel	99 Kilowatt/Hours @80%
Solar mounting frames	DPA system	Category 3 storm rating

PERFORMANCE

The following is the estimated performance the system.

Total solar array rating		Kilowatts
Average daily energy production (allowing for system losses)	41.49	Kilowatt hours/day
Estimated average daily consumption	29	Kilowatt hours/day
Average daily winter production	22.34	Kilowatt hours/day
Estimated daily winter consumption	22	Kilowatt hours/day
Average daily summer production	95.76	Kilowatt hours/day
Estimated daily summer consumption	38	Kilowatt hours/day
Estimated generator run time (Winter)	4.2	Hours/ week