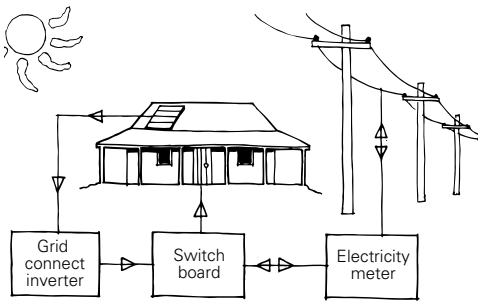
# Batteries and inverters

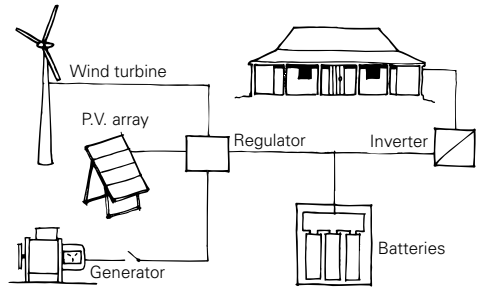
**Batteries and inverters are required to turn renewable energy sources into electricity. A complete renewable energy system has a number of components, as discussed below.**

Grid connected systems require an inverter and metering system. Battery banks can be installed if back up supply is required.




Grid connected system.

Stand-alone systems include a battery bank, inverter, battery charger and a fuel generator set (genset) if required.




Grid connected system.

Each system will require a specific regulator/ controller.

A complete system will include the necessary switches, circuit breakers and fuses to ensure that the system is electrically safe and to allow for major items of equipment to be isolated for maintenance purposes.

Installation of battery banks and inverters is similar whether the charging source is photovoltaics, wind, or micro hydro.

The exact layout will vary depending on the equipment configuration and space available.

## BATTERY BANKS

### Battery types

Lead-acid batteries are used most often in renewable energy systems. Less common are nickel-cadmium batteries which last longer but are much more expensive.

Most batteries are composed of a number of cells. For example a car battery is 12 volt, but is supplied as one unit (monoblock), that comprises 5 x 2 volt cells. In stand-alone power systems the battery banks are supplied as either 12V, 24V, 48V or 120V. These batteries could be supplied as monoblock (12V or 6V) batteries but are generally supplied as individual 2V cells. A 12V battery bank will consist of 6 x 2V cells, and so on.

**Battery banks can be designed to provide many days energy requirement with no input from the charging source.**

Lead-acid batteries can be supplied as either wet batteries, as used in cars, or valve regulated batteries commonly called “sealed” or “gel” batteries. Wet batteries are most commonly used in renewable electricity systems.


A battery bank

The life of a battery bank is affected by the average daily depth of discharge, (D.O.D.). If the battery bank capacity is large enough to keep the D.O.D. low, the battery life should be at least ten years. Battery manufacturers will provide information on the cycle life of the battery compared to D.O.D.

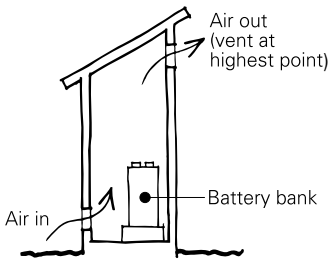
A good quality 12V battery bank will cost from $1000 to $3000 depending on the capacity. A 24V bank will cost from $2000 to $6000.

### Battery installation

Batteries emit a corrosive and explosive mixture of hydrogen and oxygen gas during the final stages of charging. This can ignite if exposed to a flame or spark.

**Batteries must be installed in a well-ventilated environment, preferably in an appropriately designed structure away from the house.**

Because the gases rise, ventilation design must permit air to enter below the batteries and exit the room at the highest point.




Ventilation can be achieved naturally or by installing fans and electrical vents. The amount of ventilation required depends on the number of battery cells and the charging current. A large battery bank using large charging currents needs more ventilation.

Do not install electronic components above a battery bank because of the risk of explosion and the possibility of component corrosion.

Install batteries in a drip tray to trap any spilled acid. Alternatively, wash any spillage to a sump and then neutralise it with bi-carbonate of soda (baking soda).

Batteries should be mounted on stands to keep them clear of the ground. If the batteries are ground mounted they should be thermally insulated from the ground temperature. They should not be installed directly onto concrete, as concrete will cool to ground temperature, causing the electrolyte to stratify. This is detrimental to a battery's long-term life and performance. Low electrolyte temperatures also reduce the capacity of a battery.

Batteries must not be installed where they will be exposed to direct sunlight, as high temperatures may cause electrodes to buckle.

The typical area required for the installation of a battery bank is:

| | |
|---|---|
| 12V | 1.4m x 0.3m or 0.7m x 0.6m |
| 24V | 1.4m x 0.6m |
| 48V | 2.8m x 0.6m |

The batteries can be as high as 700mm, and if installed in a box it must have a removable lid or at least 500mm clearance above them to allow access for a hygrometer to check the charge level.

Access to the battery room or container should be limited to responsible people trained in system maintenance and shut down procedures.

Safety signs are required in accordance with Australian Standards.

The installation must include a switch/fuse near the batteries to enable the bank to be electrically isolated from the rest of the system.

## Battery maintenance

Battery maintenance includes keeping terminals clean and tight and ensuring the electrolyte is kept above minimum levels. Use only distilled water when topping up the electrolyte level.

Batteries are dangerous items and must be treated cautiously. There are three main dangers with batteries:

> Explosion or fire from the battery gases.

> Short-circuiting the terminals.

> Acid burns from wet, lead-acid batteries.

Ensure that when working with batteries you do not short across the battery terminals. Under Australian Standards the terminals must be covered (shrouded) to prevent accidental shorting.

Wet, lead-acid batteries contain a fluid electrolyte that contains sulphuric acid. This can cause serious burns to the skin and eyes. Always wear protective clothing and eye protection. If "acid" is spilt it must be diluted with water and neutralised with sodium bi-carbonate. These should be readily accessible and stored near the battery bank.

Batteries need specific charge regimes that include equalisation charging. The system designer will explain this process. The equalisation charge will either be controlled by the system or require the owner to connect a generator and battery charger. Specific gravity readings are the best method to determine the charge level. A safe method for performing this will be explained by the system designer.

System owners should read and fully understand the manufacturer's manual for their battery bank.

## Battery disposal

Batteries contain lead and acid that are harmful to the environment. When a battery bank is being replaced the old batteries should be disposed of at a battery recycling station or other suitable site.

## INVERTER INSTALLATION

**Inverters are commonly a part of battery based and grid connected systems.**

Inverters convert DC power from batteries or solar modules into 240V AC (single phase) or 415V AC (three phase) power. Inverters are complex electronic devices and must be installed in dust free environments.

Inverters can be either wall or shelf mounted. They are heavy - a 5kW unit will measure 600 by 600 by 400mm and weigh 60kg.

Inverters become very warm or hot when operating at large power outputs and need suitable ventilation and cooling air-flow. Insects often like to nest in the heat dissipation vents. To prevent this, inverters should be carefully sited and regularly checked.

Inverters must not be installed in direct sunlight.

Inverters should be readily accessible in case they need to be electrically isolated in an emergency.

A 1.2kW inverter will cost about $2200 and a 2.2kW unit about $3000.

Lightning can damage inverters. The risk should be assessed by the designer and appropriate protection installed if required.

**Only a suitably trained and qualified person may undertake AC hard wiring to an inverter.**

## Grid connected systems

Grid connected inverters convert power from solar modules, wind or micro hydro into AC power that feeds into the grid.

On the DC side, the grid inverter is connected directly to the renewable charging source - generally PV.

The AC output of the inverter interconnects with the building switchboard in accordance with regulations.

The inverter can be installed in any suitable location between the renewable energy source and the switchboard.

## Battery based systems

The DC currents in the battery leads between the inverter and battery can be very large. To avoid problems due to overheating and voltage drop, these must be sized accordingly and should be kept to a minimum length. Situate the inverter as close as possible to the battery bank.

The battery charger can be a separate unit or be incorporated within a combined inverter/charger. The inverter supplies 240V AC power from the battery bank. When the generator starts, the inverter passes the load to the generator and becomes a battery charger.

A 3kW combined inverter/charger will cost around $6000.

Each battery charging source requires a regulator/ controller to prevent overcharging the batteries. These can be manual or automatic. In automatic controls the generator is started when the batteries reach a low charge level or the load is greater than the maximum power output of the inverter. In manual controls the state of battery charge must be regularly monitored.

## Battery charger installation

If the stand alone power system installation includes a separate battery charger, it should be treated in a similar manner to the inverter. Chargers are generally no larger than 400 by 400 by 600mm and weigh up to 40kg.

The charger must be installed close to the batteries and can be floor or shelf mounted. The input power to the charger must be a generator-only power point.

## GENERATOR INSTALLATION

The generator should be installed in a separate room or enclosure. If installed in the same room as the rest of the system it should be located as far away from other components as possible. This helps prevent excessive heating and contamination from a malfunctioning exhaust.

Sufficient space should be allowed around the generator for maintenance.

Generators are noisy, so locate and design the enclosure to minimise noise.

The generator fuel must be kept in an approved container in a safe location.

**ADDITIONAL KEY REFERENCES**

The Australian Renewable Energy Website www.renewable.greenhouse.gov.au/

Markvart T, Ed. (2000). *Solar Electricity*, 2nd edition, John Wiley and Sons.

Sustainable Energy Industry Association website www.seia.com.au for a register of accredited designers/installers.

**Principal authors:**
**Geoff Stapleton, Global Sustainable Energy Solutions and Geoff Milne**

**Contributing author:**
**Chris Riedy**