

Battery Storage

Battery costs have come down but they are not cheap. If you are already grid connected then batteries are unlikely to save more money than they cost unless power prices rise a lot. However, batteries will give you independence and reliable supply. Some compromise may be necessary between the amount of power you can have and the degree of independence you want.

Going completely off the grid saves the most money, especially in fixed daily connection charges (about \$500 per year and rising) but there is a larger up front cost.

A partial battery (hybrid) system can power a couple of essential circuits for a refrigerator, lights, TV and internet. Grid connection is retained for broader power needs and to export any excess solar. The battery storage required is smaller but grid connection charges continue and power bills are only partly reduced.

Your Needs

The first step is to check your power bill to find your average daily usage in kilowatt hours (kWhr/day). For an off grid system you will need battery storage that can stand daily discharge for your average use and to periodically provide two or three days of power in cloudy conditions. You can reduce the storage required by using a backup generator for extended cloudy periods and for heavy power drains like air conditioners, hot water boosters and clothes driers.

A basic partial system will require batteries for daily discharge of only 3-4 kWhr and rare 6kWhr discharge for grid blackouts of more than one day in overcast weather.

Also check your bill for your average solar output in winter. A 1.5kW solar array in a good location would be expected to produce over 4kWhr/day.

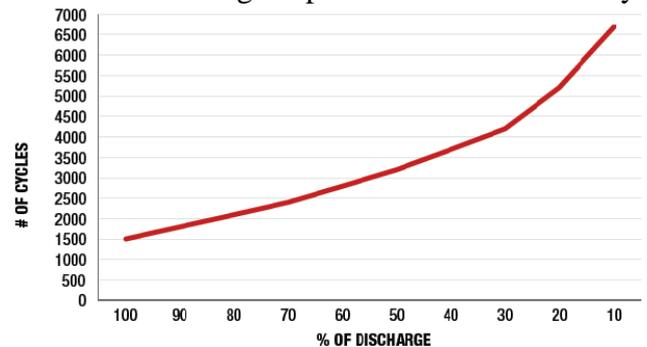
Battery Speak

Different battery chemistries have different capabilities that effect how much power you can draw and how often without dramatically shortening the life of the battery.

Until recently, battery capacity was usually stated in Amp hours for a discharge over 20 hours (or 20C). A 500Amp hour battery is therefore rated as being able to deliver 25 amps over 20 hours. To convert this to kilowatt hours (kWhr) you multiply by the voltage of the battery and divide by 1000 eg 500Ahr @12V = 500X12/1000 or 6kWhr.

If you see 5kW/10kWhr, the 5kW refers to the maximum peak power draw and 10kWhr to total storage. A battery discharged over 100hrs (100C) will generally deliver more total power but much less if discharged over 1 hour. Discharging over 20% of total battery power is called deep discharge and dramatically shortens the life (charge cycles) of traditional lead/acid batteries. Doubling the voltage doubles the available power and reduces the size of electric cabling required.

Life versus discharge depth for a lead/acid battery



Other Costs

In addition to batteries you will need a regulator to use your solar panels for charging and maybe a new inverter to convert battery power into 240AC house power. Nearly all off grid systems will also need a backup generator, a heavy duty battery charger and fuel costs can be significant. There will also be installation costs.

Battery Types

Note: The comparisons below are based on a partial system to supply 3kWhr nightly for a minimum of 10 years. Complete off grid systems will cost 2 to 4 times more.

Lead/Acid – traditional deep cycle battery storage. Cost per kWhr increases with size and suffers from limited life under heavy discharge eg 1000 cycles at 70% discharge or 4000 cycles at 20% discharge. About \$6000 (10yr, 3kWhr daily, 15kWhr total). Maintenance may be required.

Lithium batteries – eg Powerwall, Genevo, Compact and comparatively light. Claims of long life with deep discharge (70%) not yet confirmed. The Powerwall (\$9500) requires specialised invertors and regulators (\$3,500 extra). Minimum of 2 Powerwalls recommended for off-grid application. Genevo operates at 48V in a less compact system. Around \$9000 (10yr, 3kWhr daily, 6kWhr total and includes inverter)
<http://www.genevo.com.au/technology/>

Manganese/Sodium – Aquion 7.8kWhr around \$6000 (3 stacks) at 48V. Claims 3000cycles (8yr) at 100% discharge or 12,000cycles (24yr) at 25% discharge. Non-toxic & recyclable and less temperature sensitive. No maintenance required but lower energy density ie 3 times more bulky than lead/acid. 5yrs Guarantee. Extra storage can be added in steps. Info: www.aquionenergy.com supply: www.blitzability.com.au

Zinc/Bromine – RedFlow Z-Cell, high energy density 10kWhr 48V units. Up to 100% daily discharge and may be regularly required. 10yr guarantee. Claims fully recyclable. Battery \$11,500, installed with inverter \$18,500. <http://redflow.com/products/zbm/>

Nickel/Cadmium – Highly toxic components and suffers from memory charge ie if over charged or not completely discharged before recharging then the battery power can be permanently impaired.

Useful battery Blog - <http://www.solarchoice.net.au/blog/>

Some major energy providers may offer schemes to pay off batteries over a contract period. There may be advantages such as a longer battery warranty but the aim of the scheme will be to lock you to the grid under that provider. You will have to carefully weigh the provisions of such contracts especially around future connection costs and power pricing.

DC Microgrids

Most of the cost of an off grid battery system is the extra storage required to cope with longer periods of reduced solar output in extended overcast conditions.

One type of micro-grid used by some communities is a system of underground DC power lines between a number of home battery systems. A single connection to the standard AC grid can be used to supply trickle charging that dramatically reduces the battery storage required.

A microgrid can also remove the need for a backup generator provided that heavy draw appliances are not required such as air conditioning, hot water boosters or clothes driers.

Restrictions may apply between properties with standard AC grid connections.

Battery Location

Home storage batteries contain a great deal of power and carry the risk of fire or explosion if there is a short circuit. Some battery chemistries can also produce dangerous gases or corrosive fumes. Batteries should be located in a well ventilated, vermin proof structure, outside the home. Some battery systems can be several hundred kilos in weight and should be on firm foundations but insulated from the ground to avoid internal temperature stratification.

Series or Parallel

When batteries are connected in series, positive to negative like a string, the voltages add. When batteries are connected in parallel, positive to positive, negative to negative, like a ladder, the voltage does not add but the amp hours do.

If the target is to have a 12 volt system of 600Amp hours then it would seem to be a lot cheaper to buy six, 100 Amp hour car batteries and connect in parallel. Unfortunately, slight differences between the batteries cause one to charge another. The resulting high current flows can lead to destructive heating or even a fire and the system will likely breakdown within months. It is much better to have six batteries of 2 volts, each of 600amp hour capacity (5kWhr total) connected in **series**. The Manganese/Sodium batteries are the only system we know of where stacks can be added in parallel to increase storage over time.

Solar Output

Solar power varies a lot with cloud conditions. Your battery system evens out this variability by storing power. However, to avoid frequent deep discharges that may shorten battery life it is necessary to have an average solar output larger than your average daily power use.

In a partial system (also called a hybrid) any excess solar can still be sold on the grid and shortfalls can be covered from the grid.

The Future

-Battery costs may decline over time but demand may keep prices up in the near term.

-In NSW, daily charges for grid connection have increased sixfold since 2002 and power companies are lobbying for more. 18% over the next 3 years.

-Reliability of grid power may decline without community power initiatives especially as major coal fired power is inevitably moth balled.