DIFFICULTY RATING: ★★☆☆☆

A blackout-proof garage
A DIY 24 volt garage door opener

In *ReNew 119*, Martin Chape described his 12 and 24 volt off-grid systems, powering his home office in WA. Here he adds a garage door opener to the system, reducing his grid power use even further.

The story thus far... In ReNew 119, *Martin Chape described how he decided to make his system as off-grid as possible when the feed-in tariff in WA dropped to 7 cents per kWh. He connected a 12 volt solar panel to a 12 volt battery bank and used this to light his home using 12 volt LED lighting. He also built a 24 volt battery system to power his home office from both wind and solar. Here, Martin describes a new addition to his system.*

I RECENTLY installed a 24 volt garage door lifter, operating from my 24 volt battery bank. This reduces my grid power use further and means my car does not get stuck in the garage if there's a blackout.

I first needed to purchase a replacement door lifter, the GDO-11v1 SecuraLift. I chose this model because it includes an option to run it from a solar kit with battery backup, and the motor and circuit board are designed to run on 24 volts DC. With a small modification it can be made to run from an external battery bank rather than the solar/battery kit.

The GDO-11v1 normally operates on 240 volts AC mains power and contains a 240 volt to 24 volt transformer which plugs into the main board. The main board includes a bridge rectifier to supply the 24 volts DC.

The modification is quite simple and involves little more than removing the 24 VAC plug in the corner of the main board and feeding your 24 VDC into that point on the board. The small white nylon plug needed is available from Jaycar Electronics, so you don't need to chop off the one coming from the transformer. This means it can easily be put back to its original form later.

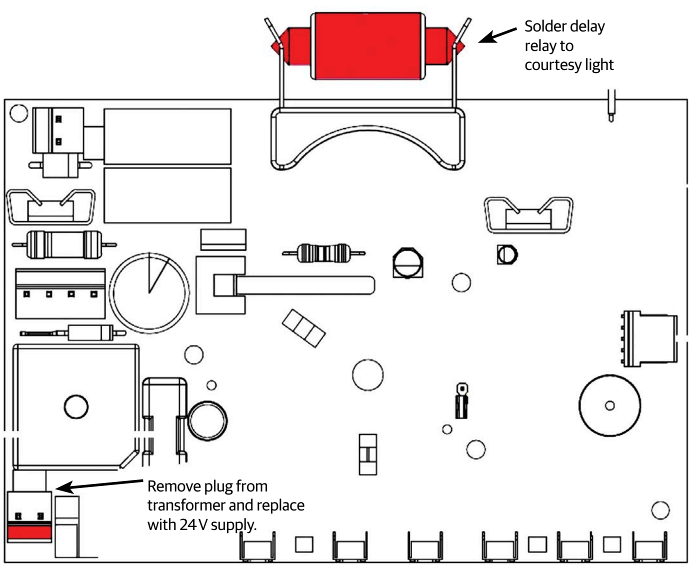
You need to provide fusing between the battery bank supply and the lifter circuit board. Polarity is not important as you are connecting to the AC side of the bridge rectifier and the diodes will direct correct polarity to the circuit board power rail.

One small problem I encountered was that the board, when it finds it's operating from 24 volts DC, reduces the time the courtesy light stays on from minutes to seconds in order to conserve the very small battery that comes with the manufacturer's solar kit.

To get around this I installed a 24 volt delay relay in a grey plastic box and wired it to the 24 volt courtesy light in the front of the unit. The courtesy light triggers the relay, which is set to stay on for several minutes and switches on several other lights running off my 24 volt battery bank.

If anyone would like more detail, I'm happy to answer queries!

Visit Martin Chape's website www.sustainabilitysolutions.net.au for updates.



↑ The conversion to the GDO-11v1 garage door lifter board is extremely simple.

↑ The converted door lifter. The grey box contains the courtesy light extender relay.

Much easier to push around
A lithium battery retrofit

When it comes to high power and high capacity for less weight, nothing beats lithium batteries. Lance Turner describes his rechargeable mower upgrade.

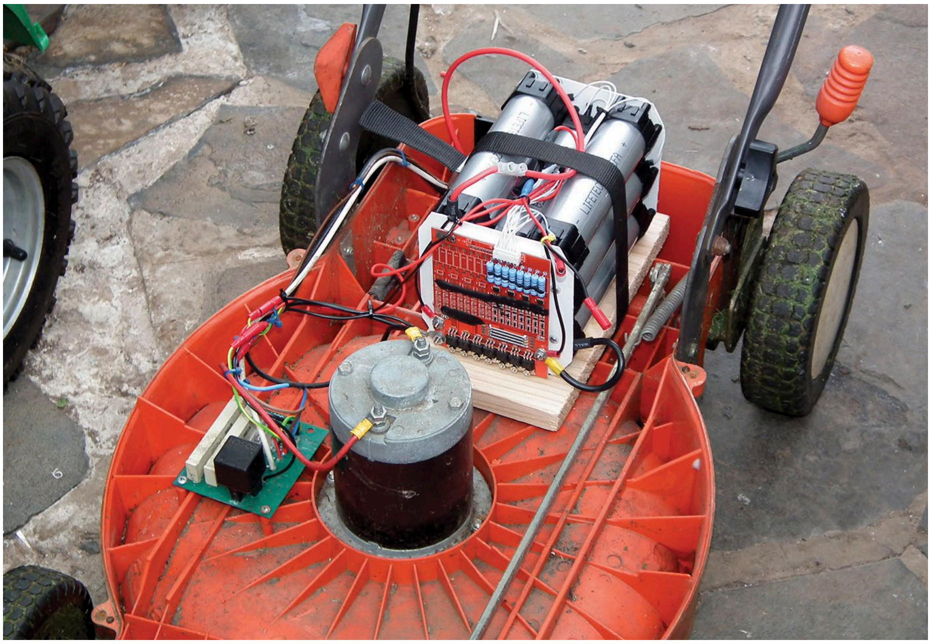
MOWING lawns is a bit of a chore but it seems hard to avoid. Unlike most people, I don't have to futz around with petrol, oil and pull starts to get my mower going, I just turn the key and off it goes.

There's a lot to be said for rechargeable electric mowers, even ancient ones like my 11-year-old Husqvarna. Despite its age, the only real maintenance it's had was a replacement set of lead-acid batteries a few years back. But like all lead-acid batteries, deep cycling means they only last a few hundred cycles at best, and these had begun struggling to give me more than 15 minutes run time. So it was time for an upgrade.

I looked around for replacements and realised that a pair of good quality 12 V, 20 Ah deep cycle lead-acid batteries were going to cost me close to $200 after shipping, so I decided to use a lithium battery pack instead.

I checked to see what was available and wasn't really happy with the standard 24 volt lithium battery packs designed for electric bikes and the like, as they were generally made from many small cells, often around 3 Ah capacity, connected in a series/parallel arrangement. I don't like batteries that contain paralleled strings of cells, even if they are all fitted with a proper battery management system, so I decided to assemble a pack myself.

There were a few options but I decided to use eight 15 Ah cells from Lithium Batteries Australia, as they have been around a long time, and are known to be robust and have very long lifespans, even when undergoing deep discharges. These cells are supplied with hexagonal end-caps that slide together to let you make a solid battery pack without the need for an external case. Copper battery linking bars and bolts are also supplied.



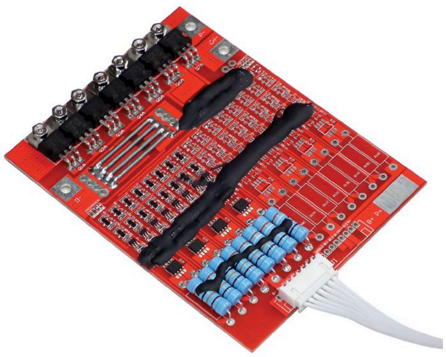
↑ The mower, minus cover, with the new battery fitted. The two bullet sockets on the right go to a volt meter mounted in the cover.

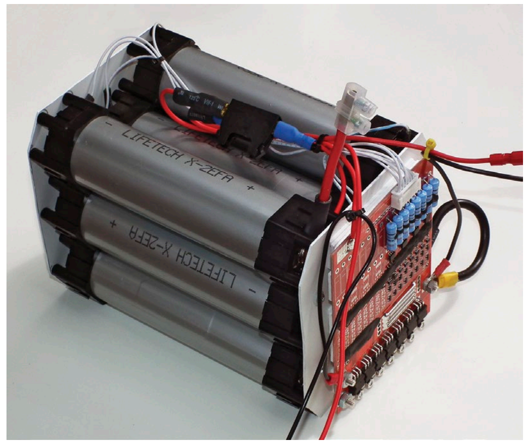
I assembled the pack in a 3–2–3 arrangement as can be seen in the photos. This gave me a pack with the closest approximation to the original battery size. Even so, the battery was longer than the original units were wide, so I had to mount the battery pack running front to back instead of side to side like the original batteries.

Battery protection

Lithium batteries, even robust units like $LiFePO_4$ batteries, need to be protected from being overcharged or over discharged, as cell voltages outside their designed range can damage the cells. To protect them you need a battery management system, or BMS. A BMS works by connecting charging control shunts across each cell, as well as providing a low voltage disconnect for the entire pack, which disconnects any load attached to the battery to prevent over discharge.

The BMS connects to the battery and has separate balance charging wires going to each of the junctions between the cells. The BMS I chose (from www.ev-power.com.au, who also have cylindrical cells similar to the Lithium Batteries Australia units) charges the batteries until one cell is fully charged or the pack





↑ From left to right: the BMS board, the assembled battery pack, and the completed battery with BMS attached and connected to the cell junctions. Note the use of a fuse between the BMS board positive and the battery, and the heavy cable between the BMS board and the battery negative, as the full load current goes through the BMS board.

reaches a trip voltage. It then stops charging the charged cells and continues feeding around 95 mA into the uncharged cells until all cells are charged. Eight power resistors on the BMS board are used to bleed off the balancing charge current from the fully charged cells.

When discharging, the entire load current goes through six paralleled power MOSFETs on the BMS board (the seventh MOSFET that can be seen in the photos controls the charge current). When the battery voltage drops below the set point, the load is disconnected.

Attaching the battery and BMS

To cover the battery terminals and provide a place to mount the BMS, I cut two end caps from some spare 2 mm thick plastic sheet, and attached these to each end of the battery via four small screws and nylon washers. These were screwed straight into the mounting posts on the cell end brackets (which are there for just this purpose).

The BMS board was mounted on a second layer of the plastic sheet on one end of the battery, spaced away from the screw heads with some thick double-sided foam tape. The BMS board itself was mounted using this same foam tape—it's a high temperature tape made for electrical work and is extremely strong.

I mounted the battery on a piece of wood for support, as the base of the mower is quite irregular. Not shown in the photo is that there is also a second smaller block of wood mounted on the BMS end of the base board. I attached long screws through both pieces of wood and into the base of the mower to prevent the board moving around. I fitted a foam rubber buffer block between the BMS board and the smaller wooden block, fitting up against the power MOSFETs. This prevents the battery sliding forward, while the mower's cover prevents it sliding backwards. It is held in place side-to-side by a tie-down strap.

I used almost all of the mower's original wiring. All I changed was to connect the charge lead from the socket on the mower handle to the BMS board so that it could control the charge current.

Warning

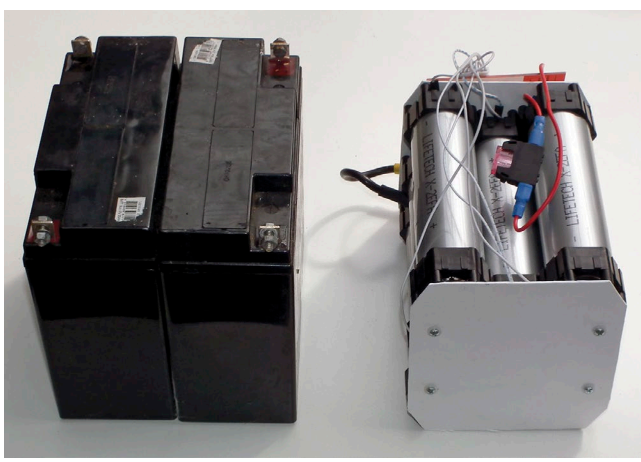
Lithium batteries can produce very high currents when shorted and may overheat and vent, or even explode or catch fire. You need to be careful when assembling lithium battery packs to ensure that you do not short any cells.

Performance

After I had reassembled the mower I gave the battery pack a full charge while monitoring voltages, and was pleased that everything seemed to be working as expected. The real test was the 'lawn' in the rear garden—a mixture of several types of grass, onion weed and various other distinctly non-grasslike plants. Previously, it had taken three to four charges of the lead-acid batteries to mow this area, so I expected to have to charge the new battery at least once during the mowing.

The reality was a pleasant surprise. The first thing I noticed was that the mower had more power, as the battery voltage didn't sag under load like the lead-acid battery did. But the amazing thing was the runtime. One charge allowed me to cut the entire area, with the mower still showing good power output and battery voltage. This would have been impossible with even brand new lead-acid batteries due to the Peukert effect (the faster you discharge them, the lower their usable capacity)—not a problem for lithium batteries.

Possibly the greatest thing about the conversion is that the mower lost so much weight with the new battery. The original lead-acid batteries weighed in at around 11.5 kg while the new $LiFePO_4$ battery weighs less than 5 kg, including the BMS. The result is a mower that's much easier to push around! ✱



← On the left are the original lead-acid batteries and on the right is the new $LiFePO_4$ battery. The new battery is not only smaller in volume, but weighs less than half the original weight while providing more power and a longer runtime.