BREATHING NEW LIFE INTO THE REVA G-WIZ: A simple guide into converting a g-wiz from lead acid to lithium. (UPDATED EDIT: 3rd November 2020)

Converting a Reva G-wiz from lead acid to lithium might sound like a daunting prospect but in truth it is a very simple, straight forward and almost 'plug and play' scenario. It does require a little tinkering and DIY basic electronic skills but anyone can achieve this at a reasonable cost depending on what kind of range you are seeking to gain out of your G-wiz.

I (Richard), have built a Reva G-wiz with long range in mind and using recycled lithium-ion cells I have gained almost five times the capacity of the original lead acid packs whilst halving the total weight. This ensures a practical range of up to 150 miles on a single charge! Coupled with a Type 2 plug conversion and fast chargers, I am able to gain an extra 35 miles per hour of charge from any Type 2 charge port and if you stick to pod point, many of them are free – I have yet to spend a penny charging whilst on the road!

For videos and information on my own conversion please visit: www.richardmawby.com and you will find a link to my youtube channel.

THE BASIC PRINCIPLE:

1. Remove old lead acid batteries, water pipes, leads and the little 6v battery monitoring cables that lead to a small box beside the controller under the rear seat.
2. Remove large discharge cables, but make note of where the positive and negative terminals are. Make sure that you keep the cylindrical 400 amp fuse that is attached to the negative cable and install it when reconnecting the batteries (although you can possibly use the original battery leads that came with the G-wiz).
3. Leave the 12v converter plugged in to the on board charger (you need this to power the dash), but remove the green, red and black 240v wiring. This you can wire up to your own lithium charger so that you can continue to use the original charge socket on the outside of the car for home charging.
4. Install your own batteries wiring up negative and positive to the right terminals.
5. Install your own charger and wire up the charge wires to the positive and negative terminals directly to the battery. You will see a 'contactor' or 'solenoid' switch that activates when you turn the key. If you attach the charge wires after the contactor you will not be able to deliver charge to your batteries so make sure that you wire the positive before this contactor. (I put my chargers in the boot space but behind the seats in the footwell might also work as long as they can receive plenty of ventilation depending on the amp rating of your charger).
6. WITH THE AC MOTOR: The ems (the little box that the 6v battery cables are plugged into), can be completely unplugged and removed otherwise it will show up with warning lights on the dash, and it will also limit your range on lithium and cut power at 48v (flat for lead acid) – but lithium can run down to 45v safely. Disconnecting this deactivates your 12v cooling fans that you can access by taking the rear bumper off. This is not a problem in moderate climates, but if you have a G-Wiz in a hotter country or drive with boost on a lot for hill climbing you might consider rewiring the 12v fans to a switch that you can activate when you need the extra cooling.
7. Provided all connections are secure and you have checked all the wiring – turn the key and off you go.

STEP ONE – What range do you desire?

Before you can plug your batteries into the G-Wiz, there is a little pre-planning involved. The hardest part of this journey is in deciding what kind of batteries, and what kind of range you would like to experience from the car.

From real world testing, the expected range is between 30 and 35 miles per 100ah of capacity installed (this was tested in the DC – the AC motor is likely to produce around 35-40 miles per 100ah of capacity). There are other factors to consider such as road conditions, type of driving and weather, but as an approximation the above figures are quite close.

Decide what range you would feel most comfortable with before proceeding onto what kind of battery you would like to install.

For example: If you require a range of 100 miles: 100 ÷ 35 = 2.85 x 100 = 285

This means that you require a minimum 285 ah to achieve the desired range. For this scenario I would install 300 ah of battery power at 48v.

STEP TWO – Battery chemistry, current and battery management

The Reva G-Wiz uses a 48v Curtis controller and a 48v 4.8 nominal - 13kw (approx.) peak rated motor. Using these figures we can understand that continuous current draw is likely to be around 100 – 150 amps and peak current draw is likely to be around 270 amps. However the Curtis controller is rated at 400 amps (DC) and 350 amps (AC) which means that at very short periods we may face a burst of these high end figures.

Taking this into account we will need to build a battery pack that can cope with the peak current draw otherwise the pack will be dangerous as it will run outside of its rated parameters.

Understanding this, there are two main lithium battery chemistries to look at.

1. Lithium-ion
2. LiFePo4

Lithium-ion will provide you with the highest density of energy which will result in the ability to pack the most range into the same space under the seats of the G-wiz. The advantages of this is that you will have a battery bank capable of up to 250 miles of range per charge depending on what kind of cell you use. Whilst this kind of cell is great for higher range, if you only require a range of the original G-Wiz batteries 100-150ah of lithium-ion may not be suitable to cope with the peak discharge of up to 400 amps.

LiFePo4 will provide you with a longer life and a safer chemistry at the expense of a lower density of energy which means that for the same weight you will experience less range – perhaps 100 miles tops building the cells from scratch in a certain way – but most LiFePo4 cells available and easy to install will give you up to a 70 mile range. This chemistry can cope with a higher discharge rate at lower degradation at a high current so it would be suitable for smaller packs of 100ah of capacity.

One disadvantage with LiFePo4 is that many 48v packs charge up to 58v. On the Reva G-wiz, the DC to DC converter does not work over 56v which means you have no 12v dash until the voltage is brought down to the desired level. This will shorten your overall range a little.

Not all cells are equal. Take note of the 'C' rating on any cells you wish to use for your batteries.

1C = A max discharge of 100% of the capacity stated on the cell. (a 1000 mah cell at 1C can discharge at 1000 mah)

This rating varies per cell and if you want to stay well within its capacity, I would use the 'nominal' discharge rating for gaining the longest life out of the cells. Lithium cells lose capacity the higher you push them, so staying well below the rating will ensure that you can gain the most capacity from the cell.

BMS! – Don't forget to ensure that you fit an adequate battery management system to your battery packs. This will keep your cells balanced and also protect the cells in the event that you run the pack too low or overcharge the pack which is where most of the damage can happen if not take care to monitor. The easiest way to achieve this is to build 48v modules with individual BMS's rated at 35-45 amps and then wire these in parallel to increase the amperage/capacity/range. Use COMMON PORT when sourcing your BMSs as this enables you to charge and discharge from the same wires which is essential for regen and charging to work without getting too complicated.

If you are using EV modules from existing electric cars then you may be able to buy simpBMS, link found in resources section at the bottom of the article.

FUSE YOUR PACKS – with an adequate fuse rating based on what your BMSs and your packs can handle, this will ensure that should any packs shut down and divert all the power to one pack then it will only blow a fuse. I found this out the hard way when I ran the bank too low and melted a BMS – it could have been worse.

FIRE PROOF and PROTECT – your packs using an adequate material that like G10 that is fire resistant and will give you enough time to exit the car should you experience an accident where one of the packs are punctured or a malfunction occurs. Secure your packs in the battery trays to prevent vibration and movement as this is one sure way to loosen up the internal spot welds or cause a short.

CHARGING: Ensure that you purchase a good lithium charger to suit your needs. A 48v lithium-ion battery charges up to 54.6v whilst most LiFePo4 charge up to 58v. By selecting the right charger you can ensure that you will never overcharge your battery.

You could alternatively use the original charger with some modification. There is a pinout on the files section on the website and the facebook group which displays what you need in order to modify the charger's voltage and its current. Please bear in mind that this is not a 'walk away and forget' solution. You MUST keep an eye on the charge and turn it off as soon as it reaches desired voltage or the charger will float the lithium batteries which is not ideal. John Schofield in the facebook group is working on a solution for this using some software and in the future there may be a way to use the original charger to charge lithium cells to 100% SOC.

Do NOT purchase a charger that will charge your batteries too fast. Just like the C rating for discharge, there will be a recommendation for charging too. Whilst I 'fast charge' my packs I am still only putting 6 amps into each 27 ah pack which will not hurt them (they have a much higher peak rating) but because of the size of the bank I am able to charge at 108 amps (6kw) from any Type 2 charge post which gives me 35 miles added range per hour of charging.

There is no need to fully charge lithium batteries every time; they have no memory effect like lead acid. You can however hurt them by 100% cycles from full charge to flat and lithium batteries can have their lives prolonged considerably by only using 80% down to 30% and staying within these parameters. It is good to fully charge once in a while to give your packs a chance to balance. This is why building a pack 'over capacity' for your needs is always a good option so that you are never always cycling at 100% DOD (depth of discharge).

Lithium batteries are very robust and you can discharge them in most weather conditions. However you must make sure that they do not get too hot as this can severely impact their lifespan. This is why building your packs over capacity is a good idea so that your current draw rarely generates enough heat to be concerned about.

Discharging in winter is fine in all temperatures, but if your climate drops below freezing make sure that you bring the batteries up to temperature before charging – as this is the only other way you can damage your cells when it comes to temperature.

STEP THREE – What is your budget?

Brand new lithium based cells can be quite expensive – however they are very reliable and maintenance free compared to lead acid and can last just as long, if not longer when taken care of and not pushed beyond their limits.

The cheapest and most cost effective way to achieve a larger range is to use recycled but fully tested lithium-ion cells. This can cost you 1/3 of the price of brand new cells but unless you have the testing equipment to weed out the cells that cannot cope with a minimum of 5 amp discharge then I would avoid this – this is for the advanced battery builder. See resources at the end of this article to contact Billy Milburn who can build you packs using these cells, fully protected with G10 for as low as £300 per pack (may not be true to 2020 as the sources of the cells used in my conversion are no longer guaranteed).

Using this method I would recommend a minimum of 8 packs which would give you approximately 216 ah of capacity and a range of up to 75 miles. Any less and I would not use recycled cells unless I can find some that have a higher discharge capability.

UPDATE 3rd November 2020:

It has been almost two years since I converted my G-wiz and since then I am on my 3rd/4th conversion. With the knowledge gained I can safely say that given the abundance of used battery modules out there you can quite easily build yourself a lithium conversion at potentially less than what it costs to put a new set of lead acid in the car!

Please see the resources for some companies that will have batteries and components on the shelf which may cost a little more than sourcing them yourself but they will be guaranteed to work. The batteries I recommend the most are:

Mercedes Tesla cells from Zero-EV – You can fit 4 (up to 80 mile range) of these modules under the seats in the G-Wiz with a little modification by cutting the angle struts under the seats. You can fit 2 (up to 40 mile range) with no modification but because the car will be so light be prepared to modify the suspension if the drive is either unstable or to not risk breaking the shocks due to hardly any load on them. The total charge of the Mercedes tesla cells is in a 14s configuration at 58v. A nice feature with these modules is the fact that you can wire up water cooling and put an inline heater to ensure the batteries stay warm when charging in the winter months. You can also add cooling to two modules as it may push it at peak currents and this will allow you to maintain optimal temperatures when in operation. These modules are also compatible with simpBMS which whilst costly will ensure that you prolong the life of your cells by keeping them balanced.

Nissan Leaf modules - You will need at least 14 of these (the singular modules from the gen1 leafs). These should be wired in parallel and then series. You can alternatively go for the double modules found in the link and 8 modules will be ideal. Bear in mind they are wired in series within each module so you will need to wire 4 in series first and then 2 strings in parallel. This will give you a total charged voltage of 67.2v which is perfect for the DC car (I'm not sure if the AC will take 67v and no one has dared to try yet so stick to 14 gen1 modules easily found on ebay or other places). The old charger with a simple 5v voltage regulator is a cheap way to charge the latter configuration as it will end at 66.5v.

Other batteries that might work – The main consideration when looking for modules is the voltage and the peak discharge current capability to ensure that you have the right voltage to power the car (DC 40-80v with modification to overvoltage on the controller and 40-55v without / AC 36-60v) and its continuous and peak discharge capacity are greater or the same as what the G-Wiz demands (read further above for those figures). There are a few more modules on both secondlife ev batteries and Zero-EV that will function in a G-Wiz such as the Yuasa cells out of an outlander and the BMW i3 modules that whilst have a lower operating voltage still fall within the working parameters of both controllers in the AC and the DC cars. The plus with the BMW i3 module is that you can drop it straight into the car after removing the EMS, it is already compatible with simpBMS but the downside is that the top speed whilst driving will be much slower than using higher voltage configurations. This is fine for city driving, but not for main roads.

These days it could cost you as little as £1000 or less for the battery packs. Including a good lithium charger and Type 2 compatibility, I would recommend having a budget of up to £3000 although you could convert a car for much less than £1500 especially if you make use of the simple modification to the on board charger.

With the Type 2 compatibility a car with a range of 75 can travel up to 150 miles comfortably in one day! (75 mile commute to work – charge and drive back). The investment will be worthwhile if done correctly.

HAPPY BUILDING: BUT IF YOU STRUGGLE WITH ANYTHING AT ALL BE SURE TO CONTACT US IN THE FRIENDLY FACEBOOK GROUP AND FEEL FREE TO ASK RICHARD ANY QUESTIONS AS HE IS HAPPY TO ADVISE WHERE POSSIBLE.

RESOURCES:

Billy Milburn – Lithium-ion battery pack builder - £300 per pack (he may no longer be able to offer at the price stated here as it has been a while since my original car was converted) - billym1967@msn.com

Battery charger (please note to specify what voltage and amps you require as these chargers are set up to accommodate your battery needs). You can also find some great chargers at a very cheap price on alibaba - https://eauto.si/metron-shop/product/type2cee-3x16a-3-phase-carrier-case-copy/

ZERO-EV – Many EV resources including the Mercedes tesla modules - https://zero-ev.co.uk/product-category/battery-modules/

Secondlife EV Batteries – another great resource for EV parts and modules - https://www.secondlife-evbatteries.com/ev-batteries.html

SimpBMS documentation - https://github.com/tomdebree/SimpBMS

SimpBMS to buy (you can pre-select configurations already set for certain modules on the drop down menu. I also believe you can buy this BMS from Zero-EV pre-set for the Mercedes cells. It is not listed on their store but do enquire) - https://www.secondlife-evbatteries.com/bms.html

Ev shop EU – another great resource which also has CANBUS chargers which will be compatible with the simpBMS, they will not work without CANBUS so only purchase with a suitable BMS - https://evshop.eu/en/

Type 2 socket/leads - http://www.evbitz.uk/EVBitz.uk/Type_2_Male_Plug.html

Richard's youtube documenting his own conversion (playlist) - https://www.youtube.com/watch?v=R9gUVL1gMBw&list=PLjal5hJ9ubTv_UniU4MInaejrke8fkDun&index=3

Playlist 2 – converting the Yellow Wiz (Most recent conversion) – this series will document me getting a new motor fitted to the car too which will give it a much faster acceleration and top speed! (seeing as the DC motor on this car unfortunately is a little damaged from previous owners and my testing with higher field map brought out the problem). - https://www.youtube.com/playlist?list=PLjal5hJ9ubTuBWz9ML8pvD12rwGo58FSk

Reva G-wiz Mercedes Tesla module conversion - https://youtu.be/6mA9IGXL8mg