There's no need to buy new: Buying a second-hand EV

What should I look for when checking out a potential second-hand EV purchase? Bryce Gaton explains the ins and outs of shopping around for a used EV.

For a BEV (battery electric vehicle), in place of the internal combustion engine (ICE) and its associated fuel, exhaust, emissions control and cooling systems are the new components of an electric drive system. (These being the main battery, electric motor, charger, charging socket/s and all the EV associated electronic controls).

Remember though, the electric propulsion parts are only roughly one third of the car: the rest of it is identical to its ICE powered predecessor. Consequently, many of the pre-purchase checks needed for a second-hand BEV remain identical to those needed for a second-hand ICE vehicle. For a PHEV (plug-in hybrid electric vehicle) or HEV (hybrid electric vehicle), these checks include all the ICE ones, plus additional EV ones.

Whilst an in-depth knowledge of either BEV or ICE systems is needed to diagnose and fault-find such systems, the average car buyer can make a reasonable assessment of their fitness.

The ZE0 Nissan Leaf is the cheapest second-hand EV readily available in Australia. Despite being up to nine years old and with short range compared to modern EVs, they still command good prices, rarely being found for less than $16,000. Many other EVs can sell for as much second-hand as they do new, such is the demand for EVs in Australia, although prices will drop once new lower-priced EVs such as the BYD Dolphin enter the Australian market.

Image: EurovisionNim/Wikipedia (CC BY-SA 4.0).

The general inspection categories for each EV type

- Checks common to ICE and EV

For an EV (be it BEV, PHEV or HEV) nothing changes in relation to the basic checks of the body, suspension, steering, brakes, tyres, interior, air conditioning (including filters), drive train (constant velocity joints, free play etc) and 12 V electrical systems. Radiators for the air conditioning and motor/controller cooling circuit still exist and need to be inspected as per normal. (Note: there may be more than one radiator for the electric motor, controller and/or battery cooling).

- Differences between ICE and BEV

The biggest changes are in what you don't need to check. For a BEV, these include the exhaust system, fuel system, gearbox, clutch (if a manual), oil levels, oil condition, air filter, spark plugs (if a petrol car), particulate filter (if a diesel), etc. Altogether, inspecting an EV can be much easier!

- Additional checks for a BEV

The additional checks for a BEV (replacing the ICE checks) are:

- Remaining main battery capacity
- Operation of charging system(s)
- Condition of charge socket(s)
- Portable EVSE—existence, condition and operation
- Operation in different driving modes (as fitted to the vehicle).

- Checking a PHEV

- All standard ICE checks
- All the BEV checks noted above
- Operation in different PHEV driving modes (as fitted to the vehicle).

- Checking a HEV

- All standard ICE checks
- Remaining main battery capacity

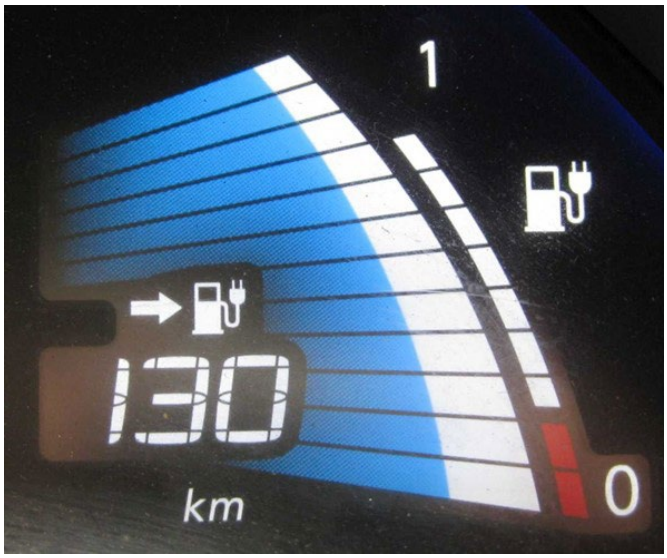

Figure 1: ZE0 Leaf dash readout.
Notes:
- Long blue/white bars: 12 = full charge.
- Short white segments: 9 of 12 showing (approximately 70% remaining battery capacity).
- 130 km = 'GOM' estimate of range. (For a ZE0/AZE0 Leaf, this is almost never correct.)

Image: B. Gaton

- Operation in different HEV driving modes (as fitted to the vehicle).

Suggested EV inspection process

- Prior to inspection day

- If a BEV or PHEV: ask the owner to charge the car to 100% before you arrive
- If the vehicle is fitted with a DC charging port: check where the nearest DC fast-charger is to where you will inspect the car. During your test drive you will need to visit this to test the DC charging system
- Read up on the specific drive mode and EV drive functions of your intended vehicle.

- On arrival

- For a BEV or PHEV: Check the dash readout shows 100% charge.
  - i If the car shows less than 100%, plug it in and see if it will reach 100%. If less than 80% and using a portable charger, try charging for half to one hour. Attempting to reach 100% from a low state of charge with a portable charger will take way too long! For a charging test, see DC charger test as described under the Test Drive step.
  - ii If a ZE0 or AZE0 Leaf, check the number of Remaining Capacity bars. (12 bars = 100%, first bar represents 15%, rest represent approximately 7.5%. 8 bars therefore represents a 37.5% decrease/62.5% remaining. See Figure 1).
- For a BEV or PHEV: check the dash readout shows the estimated range. (Ensure the air conditioning and heater are off for this check). If the car shows a significantly lower range than specified by the manufacturer (if in doubt, I suggest using the WLTP test cycle range as a guide), this may only be a sign that the car has recently been driven hard or used lots of heating or air conditioning, or it may be that the battery has reduced capacity.

- Test drive

- Turn on the car and watch for any alarms or warnings
- Set the car up for the highest possible regenerative braking level (where applicable)
- Take the car for a minimum 30 minute drive, preferably at both suburban and highway speeds.
  - i. Ensure the estimated range falls roughly in line with the kilometres travelled, especially under higher speed conditions.
    Notes:
    (a) Range versus distance travelled will fall slightly quicker if the vehicle has only been used recently for lower speed suburban trips—this is normal as most late model EVs range and economy estimates adapt to the recent use history.
    (b) Exception: the early Nissan Leaf range estimator was dubbed the 'GOM' by their owners—short for 'guess-o-meter'. For a 24 kWh battery ZE0/AZE0 Leaf, take it for a minimum drive of around 30 km to get a feeling for its range.
  - ii. After driving for a while (some EVs do not regenerative brake if the battery is 100% charged), lift off the accelerator and ensure the regenerative braking is operating—the car should slow as if it is being mildly to moderately braked. (Note: different EVs implement regenerative braking in slightly different ways—it is best to test drive several examples of the same model to ensure

An important note

If you are in any doubt about any part of the vehicle or its EV drive and charging systems, or about your ability to check them, have the vehicle checked by a qualified specialist. How to find one is discussed at the end of this article.

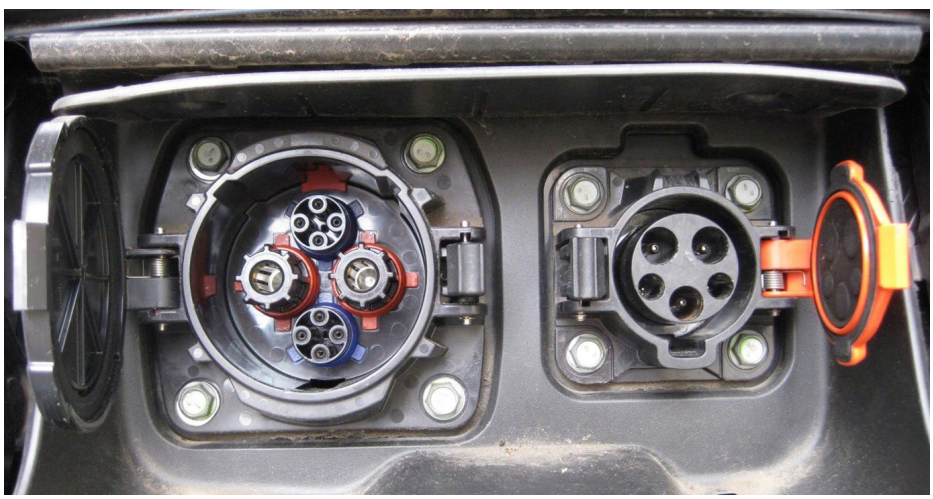

Figure 2: charging sockets in a ZE0 Leaf. Left: CHAdeMO DC charging socket. (No new EVs sold here, except the Nissan Leaf, use CHAdeMO). Main current carrying pins are the centre pair (red rings).
Right: Type 1 AC charging socket. (No longer fitted to new EVs sold in Australia). Upper two are the current carrying pins. Centre bottom is the earth pin.

Image: B. Gaton.

Figure 3: CCS2 charging socket in a Hyundai Kona. This socket is fitted to all new EVs sold here except the Nissan Leaf.
Upper three rows: Type 2 AC socket.
Note: Single phase current carrying pins are left and right pins of the second row, the centre pin is earth. If the car is capable of 11 kW or 22 kW AC, the two holes in the third row will also contain current carrying pins.
Fourth row: the two current carrying DC pins.

Image: B. Gaton.

you are comparing 'apples with apples').

iii Switch between the different driving modes and ensure they operate as specified by the manufacturer.

iv Towards the end of your test drive, pull into a DC fast-charger and have the owner take you through the process of DC charging. Allow the car to charge for five to 10 minutes to ensure the system is working and monitor the charge rate (shown in kW by the charger as well on the dashboard charging display of most EVs).

Notes:

(a) If the EV is still above 80% charged when doing this test, charging will be slower than the manufacturer's stated maximum DC charge rate for the vehicle. This is normal as DC charging rates significantly reduce after reaching 80% to protect the battery.

(b) Most DC chargers require subscription and payment. Whilst electricity is cheaper than petrol, if asked, be prepared to pay a fair price to the owner for the DC test charge. (Would you expect the owner to pay for petrol if you wanted to test the fuel filler and gauge in an ICE car?)

- On return

- Check the AC charging socket components. (See photos 2, 3 and 4).
  i. Ensure hinged covers all click into place and open/close smoothly
  ii. Ensure any rubber or plastic clip-on boots are present and undamaged
  iii. Visually ensure the charging socket electrical connections are clean and not scorched or rusty. (Under no circumstances poke any item into these sockets).
- Check the DC charging socket. If CHAdeMO this is as per i. to iii. above, or for CCS2, the lower two large pins (if CCS) as per item iii above.

  Note re the BMWi3: if you are checking a BMWi3 and the charging socket is as shown in figure 4, this vehicle cannot be DC charged except at a (very) few old DC chargers. The CCS1 socket fitted to the early BMWi3 is now only used in North America. As a result, going forward, as the last CCS1 DC chargers are updated, early BMWi3 models will not be able to be DC charged in Australia.

- Check the portable EVSE (charger) supplied with the car

All EVs sold in Australia, except the Renault Zoe, come with a portable EVSE. If considering buying a Zoe, factor in buying one if the previous owner is not selling theirs with the car.

- Visually check the portable EVSE for damage. This includes the leads and the plugs. Check the connection pins in the plugs as per the previous section. Do not perform steps below if it fails this step.
- Plug the EVSE into a power point. Does it light up?
- Plug the EVSE into the car. Does it start charging the car and its data display work?

Finding a mechanic to assess second-hand EVs

If you, like many people, find the prospect of personally assessing the condition of a prospective second-hand vehicle daunting, you do have the option of employing an experienced mechanic or a vehicle inspection service to check it for you.

In the case of the ICE (internal combustion engine) vehicle this is easy, for a wealth of knowledge has been built up over more than one hundred years of building (and breaking) them. As a result, the training and apprenticeship systems have evolved to effectively pass on vehicle repair and service knowledge to each new generation of vehicle mechanics, technicians and auto electricians. In addition, there are lots of mechanics with years of experience in servicing and repairing all makes and models that can very capably assess the condition of a used vehicle.

On the other hand, whilst EVs have been around since before the dawn of the ICE vehicle, far fewer people have worked on them in that time, meaning that EV-specific knowledge has yet to seep into general circulation. As a result, finding a mechanic that is EV trained and experienced can be difficult. This is especially so in Australia where EVs still make up less than two percent of overall new car sales.

- So who can check an EV?

As I mentioned earlier, roughly two thirds of the components of a BEV (more if it is a PHEV or HEV) are common with their ICE predecessors, so all the normal checks there still apply. For these, any competent mechanic is fine to do the checking. These include the body, suspension, brakes, steering, interior and 12 V electrical system—and, for HEVs and PHEVs—the ICE motor, fuel system and exhaust system.

However, it can be more difficult to find someone to check that new third that makes up the 'E' of an EV—the electric drive train and battery. Currently, most EV mechanics and technicians are in-house staff trained by the manufacturer on their own model vehicle(s). This means your first port of call for having an EV pre-purchase check done is through a member of the dealer network who sold that

Private imports

Dealers are very unlikely to do pre-purchase inspections of private (or 'grey') import EVs. (Private imports are vehicles that were not sold new through the Australian dealer network, instead they were imported to Australia as second-hand vehicles. In the case of EVs, these most commonly come from Japan). Dealers generally will not work on private imports as these often have options and systems not fitted to the models officially supplied for the Australian market. Given dealer data and parts systems are geared to servicing and repairing Australian delivered cars, it is not hard to understand why they don't want the headache of working out what may, or may not, fit or apply to a private import, let alone provide a warranty on such work.

model car in the first instance.

Outside of the dealer networks, some manufacturer-trained mechanics may have moved on to set up an independent workshop. Unfortunately, EVs (in particular BEVs) have not been around long enough for there to be a lot of these 'escapees', with the ones that do exist generally only being found by word-of-mouth, web research and/or asking around the EV community through the various online EV model forums.

For the general non-dealer mechanic or auto electrician, there are some elective EV training units in automotive apprenticeship qualifications (with more to come)—and some enterprising mechanical and auto electrical workshops have already had their apprentices do these units (as well as retrained their staff). Again, such EV technicians can be hard to find and will likely require research and/or asking around to discover one locally.

Questions to ask of a non-dealer EV mechanic include:

- whether all their staff are qualified mechanics
- what EV training have their EV experts done
- how much experience they have had with the EV model you are asking them to inspect.

A third option is to employ a specialist vehicle inspection service. All the state Auto Associations (RACV, NRMA, RACT, RACQ, etc) offer this service, along with a number of private businesses.

For these businesses, check with them about what level of detail they will cover on the specific condition of the EV components of an EV. For instance, it is possible with On-Board Diagnostic (OBD) scanners, as well as a number of apps, to download a fair amount of detail on the battery condition of many EV models. Therefore, you should in particular ask how much information about the battery condition will be in the report—plus how they gathered that data.

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Figure 4: CCS1 Charging socket
Found here only in early BMWi3. Upper section is a Type 1 AC socket. Lower two pins are the DC pins, as per the CCS2 socket. This socket is incompatible with Australian DC chargers.