**Fully Electric Cars**

These are cars that move using a large electric battery powering an electric motor. They do not take any petrol. Sometimes called Battery Electric Vehicles (BEVs), they produce no exhaust, which is far kinder to the environment – petrol and diesel transport produce 20% of New Zealand’s greenhouse gases. 80% of New Zealand electricity is generated by rain (hydro dams), geothermal, and wind, so the source of the car’s fuel is environmentally friendly, and cheap (it does not need to be purchased from overseas as oil does). A 2015 government study shows electric cars also have environmental benefits versus petrol cars when the full lifecycle of manufacture, use, and disposal are assessed, and that the ingredients like lithium in batteries, aren’t scarce. Having no exhaust, fully electric cars produce no poisonous carbon monoxide fumes.

Electric cars have no clutch or gears, and accelerate more quickly and smoothly, in a “sporty” way, when compared to typical petrol cars. A fully electric engine has fewer moving parts, no spark plugs or engine oil, and requires less maintenance than a petrol equivalent. Such cars are extremely quiet and reduce noise pollution. Travelling down hills or braking recharges the batteries, and is known as regenerative braking. The motor uses no energy when the car is still.

Electric cars are safe, reliable, manufactured by large brands, and are beginning to be sold in high volume overseas. Norway, with a similar population and size to New Zealand, has about 70,000 fully electric cars, and they now account for more than 20% of all new car purchases.

Affordable electric cars have a shorter range (120-140km) than petrol cars because to have a car with a very high capacity battery (offering 400km+ range) is expensive. Battery prices are dropping every year which will lead to long range fully electric cars becoming affordable. On average New Zealand drivers travel 28km per day, and electric cars can be charged at home overnight and be ‘full’ in the morning, so affordable electric cars remain practical for most daily journeys. The range of a car is dependent on the style of driving: you can drive less distance at highway speeds or up hills than you can on flat urban residential speeds, due to engine loads and wind resistance. The dashboard will analyse the remaining capacity of your battery and show an estimate of how many kilometres you can drive.

In New Zealand, the most commonly purchased fully electric car is the Nissan Leaf, which is highest selling fully electric car globally. Small numbers of compact Mitsubishi i-MiEv and full sized, long-range, high performance cars by Tesla Motors almost make up the remainder of the emerging New Zealand market of fully electric cars. Internationally, other makes and models are available in full electric: for example VW Golf, Ford Focus, Kia Soul, Fiat 500, and Renault Zoe.

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PLUG-IN HYBRIDS

These are cars that have both an electric and petrol motor. These cars are sometimes abbreviated as PHEVs (Plug-in Hybrid Electric Vehicles).

The electric battery can be recharged at home or wherever you find an electrical socket, and the fuel tank can be filled up at petrol stations. The purpose of this is to allow you to drive short distances electrically, at low cost and without pollution, and long distances using petrol, avoiding the need to recharge frequently for long trips. These vehicles also have regenerative braking, which captures energy that would be wasted as braking heat. They cost somewhere in the middle between affordable (short range) and expensive (long range) fully electric cars. The drawback of plug-in hybrids is a more complicated engine requiring maintenance, the petrol refueling costs, air pollution, and noise of a petrol engine. Depending on the model, the petrol engine either turns the wheels, or recharges the batteries (which in turn powers the wheels).

The most purchased vehicle in this category in New Zealand is currently the Mitsubishi Outlander SUV. The BMW i3 hatchback (over 100km electric range) and the Audi A3 e-tron hatchback (under 30km) are other cars available new in New Zealand.

TRADITIONAL HYBRIDS NO LONGER COUNT

Cars such as the traditional Toyota Prius Hybrid found in this country over the past decade are different -- they can not be plugged into an electric socket to recharge. They can only fill up on petrol, and use the petrol motor and regenerative braking to recharge a small battery that gives a short (1-2 km) electric range. This type of car does not offer the same potential for low cost, low pollution travel.

WHAT ABOUT HYDROGEN?

A visible debate is forming about whether the long-term future of cars would use hydrogen fuel cells or stored electricity (i.e. batteries) for energy.

Hydrogen does not occur on earth naturally, and must be created, either from fossil energy resources (which would release greenhouse gases), or by using electricity. The hydrogen must then be pressurised, transported, and converted back into electricity inside the car, to power its electric motor. The car produces exhaust in the form of water (about a litre per 16km driven).

By comparison it is cleaner and more energy efficient, and only 25% of the cost, to generate electricity, send it through transmission wires, and recharge batteries in fully electric cars.

No hydrogen fuel cell electric vehicles (HFCVs) are available in New Zealand, and they are produced in very limited quantities globally.  

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7 Toyota Prius introduced a Plugin Hybrid (PHEV) model in 2009; in NZ it is rare and only available imported.
8 More information and sources about the hydrogen section: https://en.wikipedia.org/wiki/Hydrogen_vehicle#All-electric Vehicles
<table>
<thead>
<tr>
<th>Car (and whether electric or hybrid)</th>
<th>Seats</th>
<th>Electric Range</th>
<th>Battery (kWh)</th>
<th>Can fast charge?</th>
<th>Cost ($000) used - new</th>
<th># in NZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nissan Leaf (Fully electric)</td>
<td>5</td>
<td>121 km</td>
<td>24</td>
<td>Yes</td>
<td>$20 - $40</td>
<td>322</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(175 km from 2016)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitsubishi i-Miev (Fully electric)</td>
<td>4</td>
<td>100 km</td>
<td>16</td>
<td>Yes</td>
<td>$18+ (No longer available new in NZ)</td>
<td>35</td>
</tr>
<tr>
<td>Tesla Motors Model S (Fully Electric)</td>
<td>7</td>
<td>325 - 426 km</td>
<td>70-90</td>
<td>Yes</td>
<td>$130 - $150</td>
<td>21</td>
</tr>
<tr>
<td>Mitsubishi Outlander (Plug-in Hybrid)</td>
<td>5</td>
<td>40km +700 km petrol</td>
<td>12</td>
<td>Some¹¹</td>
<td>$39 - 60</td>
<td>330</td>
</tr>
<tr>
<td>BMW i3 (Hybrid NZ new; electric if imported)</td>
<td>4</td>
<td>130 km (+116 km petrol if hybrid)</td>
<td>22</td>
<td></td>
<td>$60 - $85</td>
<td>58</td>
</tr>
<tr>
<td>Audi Sportback e-tron (Plug-in Hybrid)</td>
<td>5</td>
<td>27km (+ typical petrol car range)</td>
<td>8</td>
<td>No</td>
<td>$75</td>
<td>30</td>
</tr>
</tbody>
</table>

The cars above can be purchased new in New Zealand from local dealerships, other than Tesla Motors cars, and Mitsubishi iMiev, which must be imported. Used cars freshly imported from Japan.

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⁹ Table updated December 2015. Range sourced from U.S. EPA except Outlander from mmnz.co.nz/plug-in-hybrid/options/4wd-hybrid-specifications/ and http://www.nbr.co.nz/outlander. Cost is from TradeMe and dealerships and is likely to fluctuate.


¹¹ Outlander and i3 cars support fast charging only if imported from Japan. Check the car before buying.
with low mileage (under 10,000km) can also be found on TradeMe and at a small number of car dealers (e.g. www.evimports.co.nz) in New Zealand’s larger cities and towns. Usually, the only noticeable difference when importing an electric car from Japan is that its dashboard and entertainment system will be partially in English and Japanese, and might only be able to changed by physically swapping out the dashboard component for one sourced in an English-only market.

If you buy a used car or import one, where it is also available new in New Zealand, you will gain a benefit of there being greater local expertise and servicing options.

**GO FOR A TEST DRIVE!**

The experience of test-driving an electric car is what commonly gives buyers the confidence to proceed with the purchase. You can test drive an electric car by asking a dealer, asking existing owners if they’re prepared to let you drive theirs, and, in Auckland, you can rent them by the day (see www.bluecars.nz).

**COMMUNITY GROUPS AND EVENTS**

Several events and active Facebook groups are run and organised by electric car owners, e.g.:

- **EVolocity**, the largest annual national electric vehicle event, including test drives, demonstrations, workshops, competitions between petrol and electric race cars, and a high-school competition in which teams design and build their own electric vehicles. (Last was November 2015). [www.evolocity.co.nz](http://www.evolocity.co.nz)

- **Leading the Charge**, an annual roadtrip of electric cars from the north to the south of New Zealand. (Next is April 2016) [facebook.com/LeadingTheCharge/](http://facebook.com/LeadingTheCharge/)

- **NZ EV Owners facebook group**, an online community. [facebook.com/groups/1399474043653239/](http://facebook.com/groups/1399474043653239/)

COSTS & SUBSIDIES

BUYING THE CAR

The primary expense associated with an electric car is its upfront purchase. Electric cars remain relatively expensive to purchase brand new. The main force reducing electric car costs in New Zealand is that a growing number of used cars are being imported from Japan and found in dealerships across the country.

ELECTRIC CARS CHEAPER THAN PETROL CARS WHEN YOU FACTOR RUNNING COSTS

The cost of travelling by electricity is cheaper than petrol. EECA has calculated that an electric car is equivalent 30 cents a litre, which is about 7 times cheaper than petrol. This means that over the course of even one year, an electric car owner can save a few thousand dollars, which quickly pays off the higher initial car purchase price. Electric cars also need less maintenance. EECA have released a tool for individuals and fleet managers to calculate total savings at eecabusiness.govt.nz/tools/vehicle-total-cost-of-ownership-tool/

SUBSIDIES AND FINANCIAL INCENTIVES

In many countries around the world, buyers receive discounts off the purchase price of an electric car. These are provided as subsidies by governments who are looking to reduce pollution by encouraging car owners to shift from petrol to electric cars. In some countries other incentives are also provided.

Norwegian electric car adoption

Norway, which has the greatest level of incentives, for example, about 25% off the purchase price is subsidised, and all fully electric cars can drive in bus lanes, and use toll roads and city street parking and charging stations for free. This has contributed to rapid adoption of electric cars - close to 70,000 fully electric cars (BEVs) and over 7000 charging points in little over four years. While it’s often said that the US subsidy is effectively a stimulus to (typically domestic) car companies, the Norway example shows that subsidies of electric cars can occur without a significant local car manufacturing industry.

Some countries have shown subsidies alone do not help; Denmark has similar incentives to Norway but only 4000 electric cars, with Denmark’s dependence on coal to produce electricity a possible issue. Electric cars, even if recharged from coal-generated electricity, pollute the air less than petrol cars, but this is the opposite of popular belief.

Several governments have committed to goals to have all passenger cars being zero emission, including Norway, Germany, U.K., and New York and California states (see zevalliance.org).

In New Zealand, the purchase of electric cars is unsubsidised, and there is no government target for numbers of electric cars. The one incentive provided currently is that you do not pay road user charges. Road user charges is a tax that funds a variety of roading and transport programmes where

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car owners do not use petrol. These are mostly commonly paid by diesel car owners; a small diesel car driving 10,000km a year would pay $620\textsuperscript{14} of such charges.

The road user charge exemption was introduced in 2009\textsuperscript{15} and will be reviewed in 2020\textsuperscript{16}, although other forms of incentives by the government may be introduced late 2015\textsuperscript{17}. The Green Party has proposed that businesses should receive a discount to owning electric cars through not having to pay Fringe Benefit Tax\textsuperscript{18}.

Fully electric and plug-in hybrid cars currently cost about $230 per year in vehicle licensing\textsuperscript{19}. This is about $100 more than cars which can be solely fueled by petrol. The difference is due to ACC levies. When you purchase petrol, some of that purchase pays ACC. However, when you buy electricity, you are not funding ACC, and so this is substituted with a higher "non petrol driven car" ACC vehicle license levy. Traditional hybrids, despite having batteries, gain all of their energy via petrol purchases, and use the cheaper "petrol driven car" ACC levy.\textsuperscript{20}

**Key organisations supporting electric cars**

The key New Zealand organisations who would have a natural role to do with electric cars are still in the early stages of supporting their adoption.

The New Zealand government has officially stated it is a “fan” of electric cars and expects them to be commonplace in future years\textsuperscript{21}. Ministry of Transport, New Zealand Transit Agency, EECA\textsuperscript{22}, regional and local councils, and power companies are starting to educate the public to the existence and financial savings associated with electric cars, and some are buying small numbers of electric cars for use by staff. However there is not yet highly visible or co-ordinated efforts across these organisations.

The Automobile Association has promoted electric cars in a limited capacity. No car brands have yet carried out any large scale promotions to create buyer awareness of their electric cars in New Zealand. An industry body named Drive Electric ([DriveElectric.org.nz](http://DriveElectric.org.nz)) was established in 2012.

Globally, the greatest amount of leadership in generating large-scale electric car adoption is Tesla Motors and its charismatic and detail-obsessed founder and leader Elon Musk.\textsuperscript{23}

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\textsuperscript{19} Nissan Leaf BEV, Outlander PHEV, Toyota traditional hybrid, Toyota Corolla (petrol) price checked at rightcar.govt.nz

\textsuperscript{20} [http://www.acc.co.nz/for-individuals/other-motorists/WPC137732](http://www.acc.co.nz/for-individuals/other-motorists/WPC137732)


\textsuperscript{22} At time of writing, of the organisations listed, EECA appears to have the most complete guide: [https://www.eecabusiness.govt.nz/technologies/electric-vehicles/](https://www.eecabusiness.govt.nz/technologies/electric-vehicles/)

\textsuperscript{23} [http://waitbutwhy.com/2015/06/how-tesla-will-change-your-life.html](http://waitbutwhy.com/2015/06/how-tesla-will-change-your-life.html) provides a very comprehensive look at Elon Musk and Tesla Motors, and the history and rationale of the electric car. Related articles on the same website focus on his background and spacecraft business, solar energy, and battery technology.
Charging and Batteries

A new unit of measurement

We use kilowatt-hours (kWh) not litres to measure electricity, so you’re unlikely to talk to electric car drivers about dollars per litre, and instead hear them discuss:

- cents per kWh, the cost of electricity; determines the cost of travelling and charging
- kWh per km, which explains how fast you’re draining your battery whilst driving
- kWh as a size of battery, which gives you an idea of how far you can drive (range)
- kW as a speed of charging, which gives you an idea of how quick to recharge

Depending on driving style and car, you can usually expect to travel around 5 or 6km per kWh.

Charging cables and car sockets

Your car will come with a portable cable that goes into a wall socket at one end and the car at the other, like the one pictured here:

Charging cables and equipment are known as an EVSE (Electric Vehicle Supply Equipment).

The car will have one or two sockets for cables. For example, the Nissan Leaf (pictured below) has a socket for fast charging (“CHAdeMO” socket on left) and slow charging (SAE standard “J1772”, also known as “Type 1”, socket on right). These are common standards for charging in New Zealand (and Japan and North America) for fast and slow charging.

Cars in Europe tend to use an alternative called Mennekes also known as “Type 2” for slow charging, and CHAdeMO for fast charging.

Some cars have a “combo” socket, allowing slow and fast charging from one socket. These are not yet common in New Zealand. Tesla cars have a non-standard combo socket compatible with Mennekes/Type 2 for slow charging and Tesla’s SuperChargers for fast charging, and can take cable adapters to plug into J1772/Type 1 (slow) and CHAdeMO (fast) chargers.
Slow charging
(Also known as Level 1 and 2)

Most electric car owners regularly slow-charge their cars overnight at home. A study of 8000 U.S. electric car owners showed 85% of charging was "slow charging" at home, much of the remainder at their place of employment, and the occasional recharge elsewhere during long trips.24

The regular 230 volt AC electricity in our homes, and the regular socket we use for all household appliances is what we often use to slow-charge a car. You might plug into an existing socket inside your garage, or if you park outside, you might get an electrician to fit a waterproof plug or dedicated charger outside.

Assuming you drive under 50km in a day, it should only take 3-5 hours to recharge, which would cost less than a dollar of electricity, especially if your power company has an off-peak rate of around 11 cents per kWh. This therefore is much cheaper than petrol driving.

Slow charging can occur with differently shaped (wall) sockets:

<table>
<thead>
<tr>
<th>Normal 3 pin socket (S3112)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 or 10 amp (1.8 - 2.3 kW, single phase). 10km+ / hour charging²⁵</td>
</tr>
<tr>
<td>This is what you find throughout New Zealand homes and offices. For most people, it is sufficient to charge their cars overnight during low-cost off peak hours (11pm-7am). This is probably what you already have inside your garage at home.</td>
</tr>
<tr>
<td>Your car may or may not be sold with a cable that fits this socket. If not, can purchase a portable 8 Amp EV charging cable through JuicePoint.co.nz.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>15 amp 3 pin socket (S3112)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 amp (3.4 kW, single phase). ~20km+ / hour.</td>
</tr>
<tr>
<td>Note the longer earth (bottom) slot hole. This indicates a 15 amp socket, which provides a faster charge. An electrician can quickly install a plug like this in or outside your home but will usually connect a dedicated wire back to your fusebox. The photo here shows a socket with a waterproof casing for outside use.</td>
</tr>
<tr>
<td>If you own a 6-10amp rated charging cable (with the 3 pin plug and smaller earth pin) you can plug it into a socket of this type; it will safely draw only up to the current the cable is rated for.</td>
</tr>
</tbody>
</table>

²⁴ See 0h50m on EVTV show https://www.youtube.com/watch?v=7NImTiaR1Zg and various other research papers at http://avt.inl.gov (Advanced Vehicle Testing Activity, Idaho National Laboratory, USA)

²⁵ km/hour charging on this and next page is a rough guide on the basis of 5 km per kW; you'll go a little further in flat/urban driving.
| **Blue Commando** | 16 amp (3.7 kW, single phase). ~20km+ / hour.  
These are the plugs found in most campgrounds around the country, used by campervans. If you get an adapter then this lets you recharge in many locations around the country. You can also get an electrician to fit such a socket at home, as they are well suited to repeated, prolonged use and rugged outdoor conditions, and won’t heat up as easily, reducing fire risk. One supplier of Blue Commando based equipment is [www.BlueCars.nz](http://www.BlueCars.nz). |
| --- | --- |
| **Dedicated units (EVSEs)** | 15 to 40 amp (3 - 22kW, single or three phase) ~15-110km / hour  
For around $800 or more, you can buy a dedicated wall-mounted charger. These reduce the time it takes to start and stop charging - you don’t have to grab or stow the charging cable in your car. There are several options in the market, with higher end devices able to take payment from users, able to draw much higher current, display information on your smartphone[^26], or in the future, return electricity from your car back into your home.  
The cable is permanently attached on most units. The cable has a specific plug at the end which fits into your car. This is typically a J1772 (aka “Type 1”) plug. Pay attention to get the one that your car needs.  
Because the plug is specific to electric cars, it deters others using the electrical socket, potentially useful in public locations.  
Cars have a maximum pace of charging; e.g. older Nissan Leafs can charge up to about 3 kW, so while a dedicated 6 kW charger will work, it will charge at half its ability.  
Owners of cars with large batteries benefit the most from the faster charge times, and more likely to support, the higher “speed” (kW) of dedicated chargers (Tesla cars, for example, support up to 22 kW charging in 3-phase AC.) |

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[^26]: Pictured EVSE: JuiceBox 40 by eMotorWerks, crowd-funded via Kickstarter, available via [juicepoint.co.nz](http://juicepoint.co.nz).
Fast charging
(Also known as Level 3)

These enable electric car drivers travel on long distance journeys.

Whereas a slow charger is often rated between 1.8 to 7 kW, a fast charger is typically 50 kW\textsuperscript{27} which is a significant electrical current, and will let your car travel over 250km per hour charging\textsuperscript{28}.

This type of charging equipment is expensive to purchase (tens of thousands of dollars) and requires consent with electricity lines companies to install. Therefore they will be purchased by large organisations and put in public locations where a high volume of car owners can drive to.

The most common fast-charge plug type (pictured) in New Zealand is the Japanese CHAdeMO standard, which is an abbreviated pun for “How about some tea?”. A Nissan Leaf can perform fast-charge to 80% battery in about 20 minutes, about enough time to take a tea or coffee and a convenience break. Given the short charge time, chargers make sense where a car will naturally stay for that length of time (cafes, supermarkets) and make much less sense where people park for hours (hotels, parking buildings, malls, cinemas).

Fast charging differs from slow charging also in that it uses DC (Direct Current) instead of AC (Alternating Current).

New Zealand’s first fast charger opened in 2014 in Whangarei, pictured here with a Nissan Leaf:

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\textsuperscript{27} Overseas, Tesla has “SuperChargers” that charge as high as 120kW. See teslamotors.com/supercharger

\textsuperscript{28} Assuming your battery is large enough and you travel 5km per kWh; you could go further with urban/flat driving.
Where can I charge?

Besides home, which is where the majority of charging takes places, some employers are providing slow charging sockets in places accessible to staff car parking, as this is a relatively cheap exercise. Besides that there are:

- Fast and slow chargers provided by electricity companies, currently concentrated to Whangarei, Auckland and Hamilton.
- A national network of nearly 100 fast chargers being installed by [www.charge.net.nz](http://www.charge.net.nz) enabling long distance electric car travel along state highways. The first chargers were installed in 2015 and the network is growing month to month.
- A growing number of hotels, motels and campervan grounds where you can plug in at powered car parks. These often require a Blue Commando plug.

Consult [www.plugshare.com](http://www.plugshare.com) (also available as a smartphone app) for an up to date map, as some councils, large shops, and other organisations are looking to add slow and fast charging locations. PlugShare explains whether there is a cost involved in charging at that location.

If you offer car charging to staff, customers, or the public, you should certainly list it on PlugShare. Include a description on whether it is free to anyone, free to customers, or paid, or restricted to employees, the hours of operation (hopefully 24/7!), and upload photos to promote your listing. Add signage to the physical space (e.g. “Electric car charging park”), to increase public awareness of electric cars, and to avoid petrol cars from blocking the space.
Batteries: Size, Life, Replacement

Electric car batteries weigh several hundred kilograms and sit under the seats, in the bottom of the car. This gives the cars a low centre of gravity, adding stability in cornering and accelerating.

Battery size is measured in kilowatt-hours, or kWh. A more affordable electric car tends to have a 24kWh battery whereas the high-end Tesla Motors cars have close to 100 kWh. This directly affects the range your car can drive, and the cost of the car.

It also gives an indication of how long it takes to charge a car. For example, a 24kWh battery when slow-charged at 2.4kW would theoretically take 10 hours to recharge. However in practice, it is often charged for shorter periods owing to the fact car owners tend to recharge before the battery is flat. However, note that the last 20% of a charge is slower and takes a longer time, and some heat is produced when charging the battery, which reduces the efficiency that batteries recharge.

A car battery will last many years and should last over 100,000km of driving. You can extend this by your routine being slow-charging to 80%. Routinely recharging to 100% full, and routinely fast charging will gradually reduce battery capacity. Cars come with battery warranties, but the details and conditions can vary, and may not always apply on used imports.

Some cars show battery health on the dashboard, so you can assess this when you test drive a used car. While it would be reasonable to expect some minor (perhaps 10%) loss of battery capacity in a used vehicle, you might be paying half or a third of the cost of a new car, and the range will be still be higher than an average daily drive.

Eventually the battery will benefit from being reconditioned or replaced. This market is very new in New Zealand, so the cost and options around replacement are still forming. It is possible that:

- Only some of the several hundred battery cells in the car could be replaced, with companies offering a service to replace only those that need attention.
- You might be able to buy a battery with more capacity than the car came manufactured with, because the cost of battery technology falls each year.
- The cost of replacing the battery of the same capacity will be a lot less than now. (A new Nissan Leaf battery costs little under $10,000 in 2015 through official dealerships)