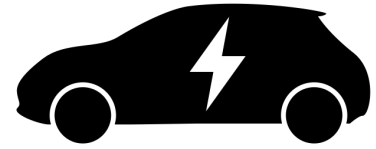


# new zealand electric car guide



By Sigurd Magnusson, Wellington, NZ. 7 November 2018. Updated monthly. Download latest from [www.electriceaven.nz](http://www.electriceaven.nz)

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## FULLY ELECTRIC CARS

These are cars that move using a large electric battery powering an electric motor. They do not take any petrol. Also called Battery Electric Vehicles (BEVs), they produce no exhaust, which is far kinder to the environment – petrol and diesel transport produce 18% of New Zealand's greenhouse gases.<sup>2</sup> 80% of New Zealand electricity is generated by rain (hydro dams), geothermal, and wind<sup>3</sup>, so the *source* of the car's fuel is environmentally friendly, and inexpensive, and produced locally (We import over a billion dollars of petrol and three billion dollars of crude oil from overseas each year<sup>4</sup> and local electricity generation is cheaper). 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.<sup>5</sup> Each year, an estimated 256 New Zealanders prematurely die from harmful diesel and other vehicle emissions<sup>6</sup> (similar to the number who die in crashes) and this would reduce by driving electric vehicles.

Electric cars have no clutch or gears, and accelerate more quickly and smoothly, in a "sporty" way, and climb hills easier than petrol cars. A fully electric motor 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 globally. Norway, with a similar population and size to New Zealand, is a global leader, with over 60% of new car sales now fully electric or plug-in hybrid (with most of the rest being plug-less hybrid).

The dashboard displays how far you can drive with remaining battery. Entry-level electric cars have a shorter range (100km+) than petrol cars. High-end cars with large batteries (500km+ range) cost more. Battery prices are dropping significantly (80% drop from 2010 to 2016<sup>7</sup>), making electric cars steadily cheaper. On average New Zealand drivers travel 28km per day<sup>8</sup>, and 95% of days within 125km<sup>5</sup>. Electric cars can be charged at home overnight and be 'full' in the morning, so affordable electric cars are practical for most daily journeys. The census shows over half of New Zealand households have two or more cars<sup>9</sup>, suggesting many could own a cheap electric car and keep a long distance fuel car.

Since 2016, electric car prices and models in NZ have improved. Electric cars here are mostly cheap, used, imported short-range Nissan Leaf hatchbacks. Increasing numbers of other makes and models are arriving, including large, long-range, high performance cars by Tesla, the global pioneer in electric cars. Most automakers are indicating timeframes by which all cars they manufacture will be partially or fully electric, e.g. Volvo by 2019<sup>10</sup>; Jaguar 2020, Mercedes 2022, Toyota/Lexus 2025<sup>11</sup>; Porsche & VW 2030<sup>12</sup>.

<sup>1</sup> This document is released under the Creative Commons Attributions license at [creativecommons.org/licenses/by/3.0/nz/](http://creativecommons.org/licenses/by/3.0/nz/)

<sup>2</sup> MfE carbon inventory May 2017 [mfe.govt.nz/publications/climate-change/new-zealands-greenhouse-gas-inventory-1990-2015](http://mfe.govt.nz/publications/climate-change/new-zealands-greenhouse-gas-inventory-1990-2015) (Report page 79)

<sup>3</sup> 2015 MBIE report [mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/energy-in-new-zealand](http://mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/energy-in-new-zealand)

<sup>4</sup> [stats.govt.nz/browse\\_for\\_stats/industry\\_sectors/imports\\_and\\_exports/OverseasMerchandiseTrade\\_HOTPFeb16.aspx](http://stats.govt.nz/browse_for_stats/industry_sectors/imports_and_exports/OverseasMerchandiseTrade_HOTPFeb16.aspx)

<sup>5</sup> EECA Life Cycle Assessment of EVs [eecca.govt.nz/assets/Resources-EECA/ev-lca-final-report-nov-2015.pdf](http://eecca.govt.nz/assets/Resources-EECA/ev-lca-final-report-nov-2015.pdf)

<sup>6</sup> NZTA links to 2012 Health and Air Pollution in New Zealand Study [hapin7.org.nz/HAPIN7%20Update\\_Vol%201%20Summary%20Report.pdf](http://hapin7.org.nz/HAPIN7%20Update_Vol%201%20Summary%20Report.pdf)

<sup>7</sup> [mckinsey.com/industries/automotive-and-assembly/our-insights/electrifying-insights-how-automakers-can-drive-electrified-vehicle-sales-and-profitability](http://mckinsey.com/industries/automotive-and-assembly/our-insights/electrifying-insights-how-automakers-can-drive-electrified-vehicle-sales-and-profitability) (Exhibit 4)

<sup>8</sup> 2010-2013 Distance per driver trends [transport.govt.nz/assets/Uploads/Research/Documents/Drivers-2014-y911-Final-v3.pdf](http://transport.govt.nz/assets/Uploads/Research/Documents/Drivers-2014-y911-Final-v3.pdf)

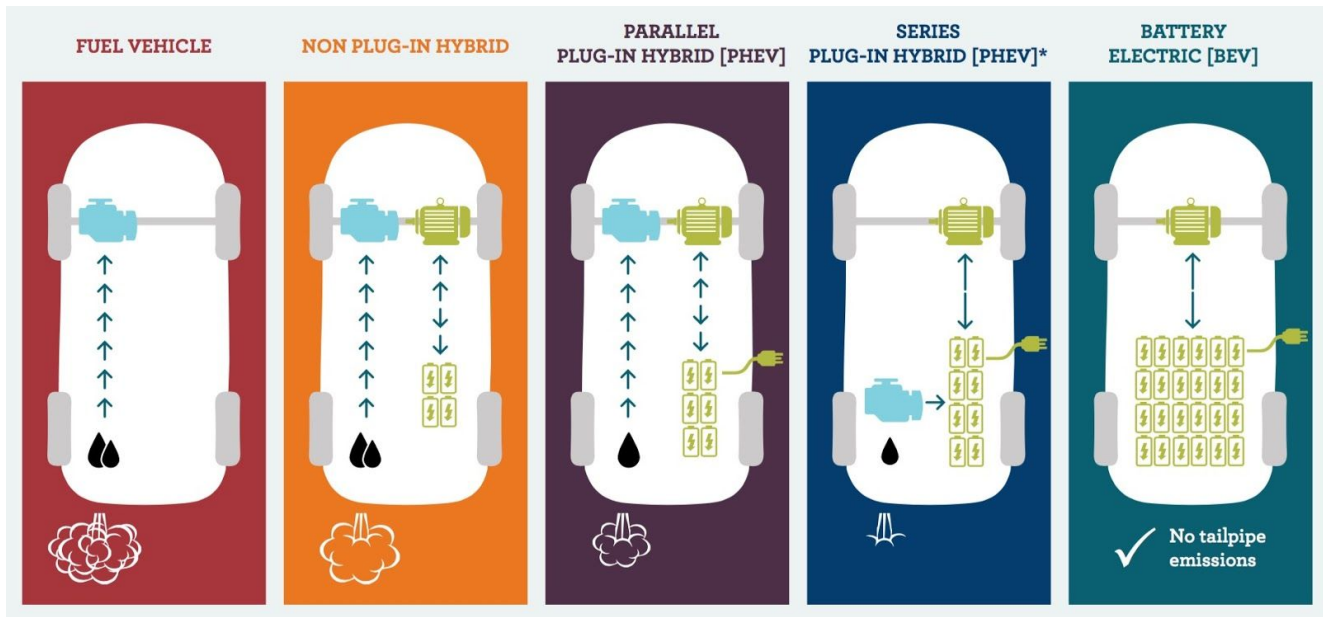
<sup>9</sup> [stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-transport-comms/number-motor-vehicles.aspx](http://stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-transport-comms/number-motor-vehicles.aspx)

<sup>10</sup> [media.volvocars.com/global/en-gh/media/pressreleases/189874/volvo-cars-announces-new-target-of-1-million-electrified-cars-sold-by-2025](http://media.volvocars.com/global/en-gh/media/pressreleases/189874/volvo-cars-announces-new-target-of-1-million-electrified-cars-sold-by-2025)

<sup>11</sup> [electrek.co/2017/12/18/toyota-electric-car-plans/](http://electrek.co/2017/12/18/toyota-electric-car-plans/) and [electrek.co/2018/04/09/porsche-ceo-only-electric-vehicles-2030/](http://electrek.co/2018/04/09/porsche-ceo-only-electric-vehicles-2030/)

<sup>12</sup> [bloomberg.com/news/articles/2017-09-11/vw-ceo-vows-to-offer-electric-version-of-all-300-models-by-2030](http://bloomberg.com/news/articles/2017-09-11/vw-ceo-vows-to-offer-electric-version-of-all-300-models-by-2030)

# TYPES OF VEHICLES



\* Some manufacturers also call this a Range-Extended Battery Electric Vehicle or REX.

## PLUG-IN HYBRID ELECTRIC VEHICLES (PHEVS)

These have both an electric and petrol motor, but with the added feature that they can be plugged in at home or wherever there is an electrical socket. This lets you drive short distances electrically, at low cost and without pollution, and long distances using fossil fuel, avoiding the need to frequently recharge. These vehicles also have regenerative braking, which captures some 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 complicated engine requiring maintenance, petrol refueling costs, air pollution, and engine noise.

The fossil fuel engine will either help the electric motor turn the wheels ("parallel PHEV") or only recharge the battery ("series PHEV") but some can do both. Most have very small batteries that don't drive far electrically. As battery prices drop, plug-in hybrids will be replaced by full battery electrics.

## WHAT WE USED TO CALL HYBRIDS NO LONGER COUNT








Cars such as the *non-plug-in* 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 engine and regenerative braking to recharge a small battery that gives a short (1-2 km) electric range. A plug-in vehicle has many more benefits.

## WHAT ABOUT HYDROGEN?

There has been an ongoing debate about whether the long-term future of cars would use hydrogen fuel cells or stored electricity (i.e. batteries). While hydrogen vehicles can recharge quickly and drive long distances, the challenge is that hydrogen is made by splitting it out of natural gas (which releases greenhouse gases) or water (which requires vast amounts of electricity) and the hydrogen then needs to be pressurised, stored, and transported, even though the vehicle still has an electric motor. Battery electric cars by contrast are safer (no explosive gas), simpler, use less energy, and it is a quarter of the cost to generate electricity, send it through the electrical grid, and recharge batteries. Hydrogen cars are not sold here, and are very limited globally.<sup>13</sup>








<sup>13</sup> More information and sources about the hydrogen section: [en.wikipedia.org/wiki/Hydrogen\\_vehicle#All-electric\\_vehicles](https://en.wikipedia.org/wiki/Hydrogen_vehicle#All-electric_vehicles). A test-drive of a hydrogen versus electric car is contrasted at [transportevolved.com/2015/08/25/first-drive-report-2016-toyota-mirai-hydrogen-fuel-cell-sedan/](https://transportevolved.com/2015/08/25/first-drive-report-2016-toyota-mirai-hydrogen-fuel-cell-sedan/). Essay by hydrogen race-car builder has published essay at [ssj3gohan.tweakblogs.net/blog/11470/why-fuel-cell-cars-dont-work-part-1](https://ssj3gohan.tweakblogs.net/blog/11470/why-fuel-cell-cars-dont-work-part-1)

# common electric cars in New Zealand<sup>14</sup>

| Car (and if battery electric or plug-in hybrid)  | Seats                        | Electric Range  | Battery (kWh)                                     | 0-100, Power   | Fast Charge                                   | Cost (\$000) used - new  | # in NZ (last month)                             |
|--|------------------------------|---|---|--|---|--|--|
| <b>Nissan Leaf</b> (Fully electric)<br>                    | 5                            | 2011-17 models:<br>117 km Gen1<br>135 km Gen2<br>172 km Gen2<br><br>2017-19 models:<br>243 km<br>~350 km (2019) | 24<br>24<br>30 note <sup>15</sup><br><br>40<br>60 | 9-10 secs<br>80kW 110hp<br><br>-<br>8 secs<br>110kW 147hp            | Yes   | \$10k - \$65k used<br><br><i>(Used imports from Japan &amp; UK are abundant. Also available new 2019.)</i> | 5617<br><br>+448<br><br>(~ 50% of all EVs in NZ) |
| <b>BMW i3</b> (Full Electric OR Plug-In Hybrid)<br>        | 4                            | 130 km Gen1<br>183 km Gen2<br>260 km Gen3<br><br>(+116 km petrol range if plugin hybrid)                        | 22<br>33<br>42<br>COMING                          | 7 secs<br><br>125kW (168hp)  | Yes   | \$40 - \$85k   | 492<br>(159 BEV)<br><br>+5                       |
| <b>Hyundai Ioniq</b> (Full Electric OR Plug-In Hybrid)<br> | 5                            | 219 km<br><br>(Or, if PHEV, then 47km electric range + hundreds of km petrol range)                             | 28<br><br>Larger battery coming 2019              | 10 secs<br><br>88 kW (118 hp)  | Yes   | \$60k  | 472<br>(413 BEV)<br><br>+10                      |
| <b>Nissan e-NV200</b> (Fully Electric)<br>                | 2, 5, or 7                   | 121 km Gen1<br>194 km Gen2  | 24<br>40  | 11 secs<br><br>80kW (110hp)  | Yes   | \$20k+<br>\$50k+<br><br><i>(Imports only.)</i>   | 311<br><br>+0                                    |
| <b>Tesla Model S</b> (Fully Electric)<br>                | 5<br>(plus 2 kids as option) | 416 km to 507 km  | 75 or 100   | 4.2 or 2.7 secs<br><i>(Ludicrous upgrade)</i><br><br>568 kW (762 hp) | Yes   | \$129k + optional upgrades<br><br><i>(Buy from NZ section of www.tesla.com)</i>                            | 288<br><br>+6                                    |
| <b>Tesla Model X</b> (Fully Electric)<br>                | 5, 6, or 7                   | 383 km or 465 km  | 75 or 100   | 5.2 or 3.1 secs<br><i>(Ludicrous upgrade)</i><br><br>568 kW (762 hp) | Yes   | \$139k+ optional upgrades<br><br><i>(Buy from NZ section of www.tesla.com)</i>                             | 238<br><br>+7                                    |
| <b>VW e-Golf</b> (Fully Electric)<br>                    | 5                            | Generation 1:<br>133 km<br><br>Generation 2:<br>201 km  | 24<br><br>36                                      | 10 secs<br><br>85kW (115 hp)   | Yes   | \$40 - 62k   | 149<br><br>+5                                    |
| <b>Renault Zoe</b> (Fully Electric)<br>                  | 5                            | Generation 1:<br>~ 140 km<br><br>Generation 2:<br>~ 280 km<br><br>(Manufacturer claim, not EPA)                 | 22<br><br>41                                      | 13.5 secs<br><br>65 kW (88hp)  | No<br><br>60 min to 80% AC recharge available | \$30k<br><br>\$40k<br><br><i>(UK import)</i>   | 102<br><br>+6                                    |

<sup>14</sup> Costs from TradeMe & [aa.co.nz/cars/buy-sell/new-cars/new-car-prices/](http://aa.co.nz/cars/buy-sell/new-cars/new-car-prices/). Electric Range is U.S. EPA from [fuelconomy.gov](http://fuelconomy.gov), unless stated otherwise.

<sup>15</sup> The 30kWh battery for the Nissan Leaf is potentially aging quicker than expected but has a software fix: [flipthefleet.org/2018/30-kwh-leafs-soh-loss/](http://flipthefleet.org/2018/30-kwh-leafs-soh-loss/)

|  |        |  |                      |                                  |                                   |   |  |
|--|--------|--|----------------------|----------------------------------|-----------------------------------|---|--|
|    | 4      | 100 km   | 16                   | 13 secs<br>49 kW (66 hp)         | Yes                               | \$12k+<br><i>(No longer sold new; import only. The Peugeot is higher spec.)</i> | 100<br>(+2)  |
|    | 5      | <a href="#">Estimated EPA 402 km</a><br><br>(A smaller range battery option exists but is not available in NZ) | 64                   | 7.6s 150kW                       | Yes                               | \$74k   | 76<br>(+39)  |
|    | 2 or 5 | Generation 1:<br>~100 km<br><br>Generation 2:<br>~150 km<br><br>(Manufacturer claim, not EPA)                  | 22<br><br>33         | 44 kW (60 hp)                    | No                                | \$75k   | 44<br>(+4)   |
|    | 5      | 150 km<br>179 km   | 27<br>30             | 11 secs<br><br>81 kW (109 hp)    | Yes                               | \$35k+<br><br><i>(Imported. Not sold new in NZ)</i>                             | 22<br>(+0)   |
|   | 3      | Estimated 150+ km  | 56                   | 100 kW                           | Yes<br><br>(slow charge optional) | ~ \$80k<br><br>(or \$75k with cab & chassis only)                               | 13<br>(+3)   |
|  | 5      | 376 km   | 90                   | 290 kW<br>4.8 secs               | Yes                               | \$160k  | <b>None</b><br><br><i>Order now for 2019 delivery.</i> |
|  | 5      | 346 km<br>418 km<br>500 km   | ~ 50<br>~ 62<br>~ 80 | 5.6 secs<br>4.5 secs<br>3.3 secs | Yes                               | USD 35k<br>USD 46k<br>USD 53k<br><br>(plus GST)                                 | <b>None</b><br><br><i>Order now for 2019 delivery.</i> |

| Medium-range Plug In Hybrids (30-100km EPA electric range):   | Low-range Plug In Hybrids (under 30km EPA electric range):   |
|---|--|
| <b>Holden Volt PHEV</b> (56km) (Sedan) <i>Rare, used, sold 2013+</i><br><b>Hyundai Ioniq PHEV</b> (47km) (Hatch) \$54k new<br><b>Kia Niro PHEV</b> (42km) (SUV) \$56k new<br><b>Mitsubishi Outlander PHEV</b> (35km) (SUV) \$32k used / \$60k new<br><b>Toyota Prius Prime</b> (40km) (Hatch) \$48k new | <b>Audi:</b> A3, Q7<br><b>BMW:</b> 225xe, 330e, 740e, X5, i8<br><b>Mini:</b> Countryman<br><b>Mercedes Benz:</b> C 350 e, GLE 500 e, S 500 e<br><b>Porsche:</b> Cayenne & Panamera e-hybrid<br><b>Toyota:</b> Plug-In Prius<br><b>Volvo:</b> XC60, XC90, S90 |

**8107 full electric + 2667 plug-in hybrid + 111 heavy electric vehicles**

**= 10885 total**

*(Includes small numbers of other makes and models, and home-conversions, and ~400 Paxster full electric buggies used by NZ Post)*

**New electric models coming between 2017 - 2020 to New Zealand:** 30 full electric + 25 plug-in hybrid models

(Source: New Zealand Motor Industry Association - Manufacturer Survey, updated mid 2017. [mia.org.nz/Documents/](http://mia.org.nz/Documents/) )



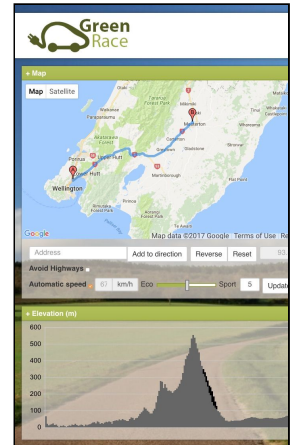
## HOW FAR CAN YOU DRIVE BEFORE RECHARGING?

Automakers and dealers advertise the distance cars can drive, however these can be exaggerated. A good information source is the “EPA Range” ([fuelconomy.gov](http://fuelconomy.gov)). The US government test-drives cars in a consistent manner to determine how far the battery lasts on a typical journey mixing highway and suburban driving. (A similar European “NEDC” and Worldwide “WLTP” electric car range test is less useful because they state long distances that can never be achieved with normal driving.)

Several situations will result in a car using up its battery before reaching the EPA range: e.g. frequent acceleration, big hill climbs, high speeds, constant aircon or heating, headwinds, towing a trailer, and an old battery. Conversely, travelling slowly or staying on flat terrain can often let you drive further than the EPA figure.

When planning road trips, talk to other owners of your car model about how mountains, headwinds, and other factors drain your battery along your specific route, and how much battery you need to confidently reach destinations. The pictured GreenRace tool at [jurassicstest.ch/GR/](http://jurassicstest.ch/GR/) can give you a rough idea.

If you run out of charge, the car will slow down to crawl and eventually stop. The AA can flat-bed tow you to a public charger so you can get back on your journey.



## EXPENSIVE UPFRONT; CHEAPER OVERALL

Electric cars are currently more expensive to buy new than fuel vehicles, largely due to high battery prices and low production volume. This is expected to change within 10 years, at which point it will be cheaper for car manufacturers to build electric cars than fuel cars.<sup>16</sup>

Travelling by electricity is cheaper than petrol: EECA calculates it is equivalent to 30 cents a litre, about 7 times cheaper than petrol.<sup>17</sup> Driven regularly, an electric car can save you a few thousand dollars a year, quickly paying off the higher car purchase price. Fewer moving parts means electric cars have less maintenance cost. See calculator: [eecabusiness.govt.nz/tools/vehicle-total-cost-of-ownership-tool/](http://eecabusiness.govt.nz/tools/vehicle-total-cost-of-ownership-tool/) The cost of electricity varies more than petrol. Recharging with electricity can be free (if your employer or a friendly business or council is paying instead of you!), low cost (overnight off-peak electricity rates are cheaper than daytime, if you select a good plan or provider), or higher cost (if you recharge during the day, or are paying to use a fast-charging station).

Assuming you commute 40km a day, you would probably need about 8 units of electricity (kWh) to recharge. At a low overnight rate of 11c per kWh this is \$0.88 a day. Overnight charging is good for the national electricity grid because it is at its lowest demand, meaning the power is likely generated with renewables, not coal and gas. If your car has a smart timer, set the ‘End charge time’ to just before 7am, so your battery (and optionally cabin) isn’t cold to drive away in, your battery isn’t full for long, and so it randomises the charge start time (makes managing electricity demand easier for the power companies).

## GLOBAL LEADERS & GOVERNMENT POLICY

Many governments are forcing automakers to sell electric cars to hit climate change and air quality goals, and in response to diesel emissions cheating. All new cars *sold* are expected to be electric from 2025 in Norway, 2030 in Germany, Netherlands and India, 2032 in Scotland, and 2040 in France and Britain<sup>18</sup>. Others have interim goals: 12% of sales in China by 2020; 22% of sales in California and New York by 2025; 20-30% of sales in Japan by 2030. Over 200 European cities have low emission zones where fuel vehicles are barred entry or pay fees (e.g. Paris, London). The US has forced VW to spend \$2B on charging stations across USA<sup>19</sup>. China is working towards 5 million charging locations by 2020<sup>20</sup>.

<sup>16</sup> Malcolm McCulloch (Oxford University, UK), [radionz.co.nz/news/national/307388/electric-cars-close-to-price-parity-conference-told](http://radionz.co.nz/news/national/307388/electric-cars-close-to-price-parity-conference-told)

<sup>17</sup> [energywise.govt.nz/on-the-road/electric-vehicles/](http://energywise.govt.nz/on-the-road/electric-vehicles/)

<sup>18</sup> [theguardian.com/politics/2017/jul/25/britain-to-ban-sale-of-all-diesel-and-petrol-cars-and-vans-from-2040](http://theguardian.com/politics/2017/jul/25/britain-to-ban-sale-of-all-diesel-and-petrol-cars-and-vans-from-2040)

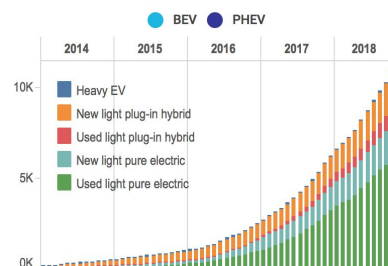
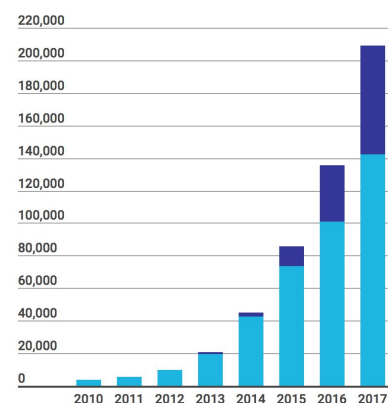
<sup>19</sup> [electrek.co/2017/02/08/vw-electric-vehicle-charging-infrastructure-dieselgate-settlement/](http://electrek.co/2017/02/08/vw-electric-vehicle-charging-infrastructure-dieselgate-settlement/)

Norway has the most incentives globally, and has a similar population, land size, and vehicle count as NZ, but higher proportion of renewable electricity. Norway charges a 'pollution' tax on fuel vehicles (up to \$40,000, based on emissions and weight) and a discount on electrics (-\$10,000). Electrics also don't pay any 25% sales tax, enjoy halved fringe benefit tax, and free use of bus lanes, toll roads, urban street parking, and charging stations. As a result, Norway has over 250,000 electric vehicles and over 10,000 charging points.

## NZ POLICIES AND GROWTH

Electric car numbers here are low but doubling per year. If all 3.8 million light vehicles went electric this will demand 17% more electricity, which can be met with renewable power stations that have consent to be built.<sup>22</sup> In 2016 the government released an electric vehicle 'package' with a stated target (a doubling of electric vehicles every year to 64,000 by 2021, about 2% of all vehicles, reaching about one in eight car sales being electric), a \$1M/year (for 5 years) nationwide education and promotion campaign, offering cash to co-fund projects that aid electric car adoption (\$3M fund pool, open every 6 months), briefly trialled electric cars driving in special vehicle lanes, and efforts to support bulk purchase, public charging infrastructure, and decision-making. In July 2017 the motor vehicle registration fee for electric (and plug in hybrid) cars reduced to ~\$75/ year, the same as the safest (and thus lowest price registration) fuel vehicles.<sup>23</sup> See [electricvehicles.govt.nz](http://electricvehicles.govt.nz).

EVs in Norway<sup>21</sup> (above) and NZ (below):



The government does not charge road user charges (RUCs) on electric vehicles. These save an electric car owner \$620 versus a small diesel car if driving 10,000km a year. This exemption began in 2009 for light vehicles, and is expected to continue until light vehicles reach 2% of the fleet. For electric vehicles over 3 tons (buses and trucks), RUC exemptions are expected 2018 through 2025. Rising petrol prices and fuel taxes (up to 9-12c/litre within 3 years across New Zealand, plus 10c/litre in Auckland from July 2018<sup>24</sup>) will increase the savings available to electric car drivers.

NZ is one of few countries in the world where it is very cheap to import used vehicles; this makes *used electrics* likewise cheap to import. Used electrics from Japan and UK are cheaper still, as their governments subsidise their purchase cost. A 2015 report on electric car policy was published by Barry Barton at University of Waikato<sup>25</sup>. It compared electric vehicle growth in different countries, and determined New Zealand would benefit from a cost-neutral "feebate" scheme, used today in France and Norway. This is where the government adds a cost to buying "dirty" cars and uses that money to reduce the cost of electric and fuel-efficient cars. The report noted NZ is one of the only countries to have no fuel efficiency standards, which makes it expensive or difficult to buy high-emission cars. The Government is to consider Productivity Commission's suggestions to bring in the feebate and efficiency standards.<sup>26</sup>

Electric vehicle adoption is supported by an industry ([DriveElectric.org.nz](http://DriveElectric.org.nz)) and owner association ([BetterNZ.org](http://BetterNZ.org)). Some large NZ firms have said they will make a third of their cars electric by 2019<sup>27</sup>. Councils have few electric cars however EECA has released a local government guide for councils<sup>28</sup>. Auckland's mayor has pledged the streets for a part of the city will be 'fossil fuel free' by 2030<sup>29</sup>

<sup>20</sup> [chinadaily.com.cn/business/motoring/2015-10/13/content\\_22170160.htm](http://chinadaily.com.cn/business/motoring/2015-10/13/content_22170160.htm)

<sup>21</sup> European policies: [icct.org/sites/default/files/publications/ICCT\\_EVpolicies-Europe-201605.pdf](http://icct.org/sites/default/files/publications/ICCT_EVpolicies-Europe-201605.pdf) Norway graph & facts: [elbil.no/english/](http://elbil.no/english/)

<sup>22</sup> Meridian Energy calculation: [http://www.nzherald.co.nz/business/news/article.cfm?c\\_id=3&objectid=11851629](http://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=11851629)

<sup>23</sup> \$18 ACC levy + \$52 NZTA licensing + admin fee: [nzta.govt.nz/vehicles/licensing-rego/vehicle-fees/licensing-fees/](http://nzta.govt.nz/vehicles/licensing-rego/vehicle-fees/licensing-fees/)

<sup>24</sup> National increase: [transport.govt.nz/assets/Uploads/Multi-Modal/Documents/Draft-GPS-2018.pdf](http://transport.govt.nz/assets/Uploads/Multi-Modal/Documents/Draft-GPS-2018.pdf) & Auckland region: [parliament.nz/52PLaw25421/](http://parliament.nz/52PLaw25421/)

<sup>25</sup> Barry Barton Paper: [waikato.ac.nz/\\_data/assets/pdf\\_file/0007/278080/Electric-Vehicle-Policy-New-Zealand-in-a-Comparative-Context.pdf](http://waikato.ac.nz/_data/assets/pdf_file/0007/278080/Electric-Vehicle-Policy-New-Zealand-in-a-Comparative-Context.pdf)

<sup>26</sup> Low Emissions Economy report: <https://www.productivity.govt.nz/inquiry-content/3254?stage=3>

<sup>27</sup> [airnewzealand.co.nz/press-release-2016-landmark-commitment-will-boost-new-zealand-ev-numbers](http://airnewzealand.co.nz/press-release-2016-landmark-commitment-will-boost-new-zealand-ev-numbers)

<sup>28</sup> [eecca.govt.nz/assets/Resources-EECA/research-publications-resources/electric-vehicles-local-government-guide.pdf](http://eecca.govt.nz/assets/Resources-EECA/research-publications-resources/electric-vehicles-local-government-guide.pdf)

<sup>29</sup> [c40.org/press\\_releases/mayors-of-12-pioneering-cities-commit-to-create-green-and-healthy-streets](http://c40.org/press_releases/mayors-of-12-pioneering-cities-commit-to-create-green-and-healthy-streets)

# CHARGING your car

## 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
- km per kWh, similar to 'miles per gallon', or how far you're driving for a unit of electricity
- kWh as a size of battery, which gives you an idea of how far you can drive (range)
- kW as a speed of charging, and, also, speed of draining your battery  
(A 30kWh battery should take around 10 hours to recharge with a 3kW charger.  
Driving at 15kW will drain a 30kWh battery in two hours.)

Depending on driving style and car, you can usually expect to travel around 5 to 7 km per kWh.

Most car charging happens overnight. A study of 8000 U.S. electric car owners showed 85% of charging was at home, much of the remainder at work, and occasionally elsewhere.<sup>30</sup>

The regular 230 volt AC electricity in our homes, and the regular socket we use for all household appliances is all you need to recharge your car, though dedicated equipment is faster and safer. The electrical safety regulator, WorkSafe, has guidelines on its website about what is required and recommended for domestic and public electric vehicle charging equipment, sockets and wiring.<sup>31</sup>

|   |  |
|---|--|
| <p><b>Normal 3 pin socket (S3112)</b><br/>8-10 amps, single phase AC 230V<br/>1.8 - 2.3 kW</p> <p><b>10km+ per hour recharging</b><br/><b>100km takes 10 hours</b><sup>32</sup></p>  | <p>This is what you find throughout New Zealand homes. For most people, it is sufficient to charge their cars overnight during low-cost off peak hours (11pm-7am). It is too slow to be very useful for daytime recharging, and won't give you much more than a 100km top-up overnight. This socket is probably what you already have inside your garage at home. If your car doesn't come with a cable fitting this socket, you can purchase a portable 8 amp unit from various sources (e.g. <a href="http://leadingthecharge.org.nz/where_to_buy_charging_equipment">leadingthecharge.org.nz/where_to_buy_charging_equipment</a>)</p> <p><i>Note: Read WorkSafe guidelines for restrictions about this socket outside of a domestic environment, and restrictions from using the 15 amp variant of this socket (which can get too hot).</i></p> |
| <p><b>Blue Commando (IEC 60309)</b><br/>16 amps, single phase AC 230V<br/>3.7 kW</p> <p><b>18km+ per hour recharging</b><br/><b>100km takes 5 hours</b></p>                          | <p>These are the plugs found in campgrounds all over the country, used by campervans. Having a connector for this socket lets you recharge in many locations around the country, and allows a higher current, faster charge. You can get an electrician to fit this socket at home. The thick metal pins are well suited to repeated, prolonged use and rugged outdoor conditions, and won't heat up as easily, reducing fire risk.</p> <p>Unless a car is parked for many hours, this is rather slow for daytime recharging, but it is a very low cost solution.</p> <p><i>Note: Read WorkSafe guidelines for restrictions about installing this socket outside of a domestic environment.</i></p>  |

<sup>30</sup> See 0h50m on EVTV show [youtube.com/watch?v=7NlmTiaR1Zg](https://www.youtube.com/watch?v=7NlmTiaR1Zg) and various other research papers at [avt.inl.gov](http://avt.inl.gov)

<sup>31</sup> [energysafety.govt.nz/legislation-policy/electricity-acts-regulations-codes/regulatory-guidance-notes/electric-vehicle-charging-safety-guidelines](http://energysafety.govt.nz/legislation-policy/electricity-acts-regulations-codes/regulatory-guidance-notes/electric-vehicle-charging-safety-guidelines)

<sup>32</sup> km/hour charging on this and next page is a on the basis of 5 km per kWh; you'll go a little further in flat/urban driving and using more efficient cars.

### Dedicated “slow” charging station

15-40 amps single phase AC 230V  
3-9kW  
**18-45km per hour recharging**  
**100km takes 2-5 hours**

**Or**

32 amps, three phase AC 415V  
22kW  
**110km per hour recharging**  
**100km takes just under an hour**



For around \$800 or more, you can buy a dedicated wall-mounted charging station<sup>33</sup>. They are safer, more robust, and charge faster compared to regular wall sockets, so are the ideal option for homes, businesses, and public locations. WorkSafe guidelines indicate standards you should look for in a product. Some take payment, have timers, are smartphone controllable, or work [well with solar](#)<sup>34</sup>.

The unit will either come with an attached cable, or just a socket. A unit with just a socket is compatible with all car types and thus is the approach recommended by NZTA for public stations. Units with attached cables are limited to specific cars (okay for home or fleets). Either way the connectors are specific to electric cars, deterring others from using them.

Cars limit the maximum pace of AC charging; e.g. older Nissan Leafs only charge up to 3.6 kW, and the newest BMW i3 charge up to 11 kW; so while a high power 22 kW charger will connect, it will charge only as fast as the car supports. On the other hand, a Renault Zoe and Tesla cars can charge at high power levels, and drivers could feel impatient using a lower power (e.g. 7kW) charger.

These units (especially 3-phase 22kW) provide fast enough speeds to suit users parked at day-time destinations (e.g. workplaces, malls), without the high cost of fast DC chargers (below).

### Fast DC Chargers

16-800 amps, 415-480V, 3 phase, inverted and supplied to car as DC

#### Medium speed: 25 kW

Adding 100km takes up to **1 hour**

#### Fast: 50 kW (Common in NZ)

Adding 100km takes **25 minutes**

#### Faster: 120 kW (Rare in NZ<sup>35</sup>)

Adding 100km takes **10 minutes**

**Ultra Fast: 400 kW (No car yet supports charging this quickly; used in NZ today by electric buses)**  
Adding 100km takes **3 minutes**<sup>36</sup>



The earlier options take hours for a car to recharge. Fast chargers by comparison take much less time, and make long distance road trips practical. They work by providing a much greater amount of electricity and by changing it into *direct current* meaning it can be fed straight into the battery. Like petrol, you can choose just to ‘top up’ your car and put in a few minutes’ worth of power.

25 minutes typically adds 100km, however much shorter recharge times will become possible when New Zealand gains higher power charging stations and cars that support them. This type of charging equipment comes in a large range of speeds and therefore costs (around \$15,000 to over \$100,000; a 50kW device is in the middle of this range.) They are purchased by organisations and put in key locations where a high volume of car owners can drive to, such as town centers, supermarkets or petrol stations, or workplace fleet car parks. They are overkill in locations where people intend to park for hours; a slower charger would be more appropriate there.

Cars usually can only be fast-charged to between 85-95% full, and the charging slows right down towards the end.

Your car will normally come with a portable cable for only *one* of the two wall-sockets pictured on the previous page, and might come with a cable to plug into a “Type 2” wall socket. Pick carefully when buying a cable, socket, or charging unit. Do not allow a car dealer to provide you with a cable for a Japanese shaped wall socket or 100V electricity; this is unsafe and not permitted.

<sup>33</sup> Pictured EVSE: Type 2 socketed wall-mounted device with an untethered cable (as per NZTA guidance)

<sup>34</sup> The Zappi electric car charger measures unused solar energy to smartly control the car charge rate [myenergi.uk/product/zappi/](https://myenergi.uk/product/zappi/)

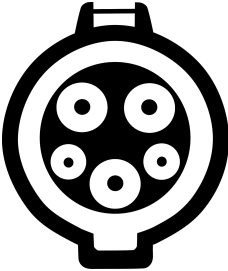
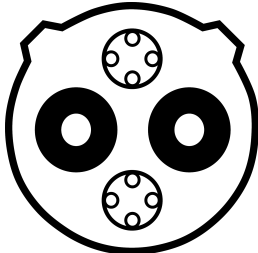
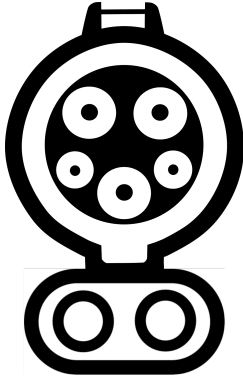
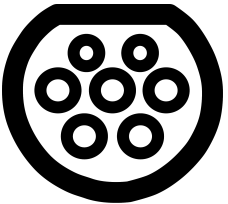
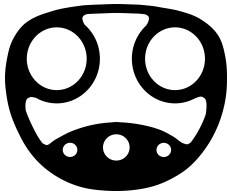
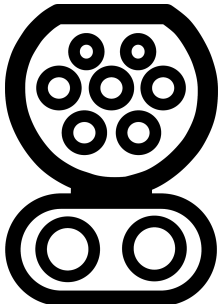
<sup>35</sup> Tesla’s SuperChargers run at 120kW and go higher still in the future. 120kW Delta DC chargers are sold in NZ by [yhipower.co.nz](https://yhipower.co.nz).

<sup>36</sup> Assuming your battery is large enough and you travel 5km per kWh; you could go further with urban/flat driving. Large vehicles such as buses and heavy trucks take considerably more electricity drive each kilometer.



# car connectors and inlets

The connector/inlet on the car is designed specifically to be durable for continuous use and to be safe. There are multiple standards based on manufacturer, country, and charging speed. The following is based on typical configuration for cars in New Zealand<sup>37</sup>:

| Slow (AC)  | Fast (DC)   | Combo (slow AC and fast DC)  |
|--|---|--|
| <p>Type 1 (“J1772”) (Japan / US)</p>  <p>Audi A3 e-tron, Q7 (historically)<br/> BMW - bought in NZ (historically)<br/> Holden Volt<br/> Kia Soul<br/> Nissan Leaf and eNV200<br/> Mitsubishi iMiev and Outlander<br/> Toyota Prius Plugin (not Prime)</p> | <p>CHAdEMO (Japan / US)</p>  <p>BMW i3 imported from Japan<br/> Kia Soul<br/> Nissan Leaf and eNV200<br/> Mitsubishi iMiev and some Outlander<br/> Tesla (with CHAdEMO cable from Tesla)</p>   | <p>Type 1 CCS (Japan / US)</p>  <p>BMW i3 bought in NZ (historically)<br/> <u>NOT supported by NZ charging stations</u></p> |
| <p>Type 2 (“Mennekes”) (Europe)</p>  <p>Audi (from 2017)<br/> BMW (from mid 2017)<br/> Hyundai Ioniq, Kona<br/> Kia Niro<br/> Renault Zoe, Kangoo<br/> Tesla (slow AC. Fast DC at SuperCharger)<br/> Toyota Prius Prime<br/> VW eGolf</p>                | <p>Tesla Supercharger (Japan/US)</p>  <p><i>This socket isn't found on Tesla cars in NZ. Here, Tesla cars use CHAdEMO (with special cable supplied by Tesla) and modified Type 2 (not CCS) for both AC and DC).</i><br/> <u>NOT supported by NZ charging stations</u></p> | <p>Type 2 CCS (Europe)</p>  <p>BMW (mid 2017 onwards)<br/> Hyundai Ioniq, Kona<br/> VW eGolf</p>                           |

NZTA issued guidelines in 2016 ([nzta.govt.nz/ev](http://nzta.govt.nz/ev)) on the socket types to install at public stations:

- **AC:** Socketed Type 2 (with drivers bringing a cable like that pictured, to fit their car).
- **DC:** CHAdEMO and Type 2 CCS (cabled), optionally supplemented with an AC Type 2 socket.



Example Type 1 (left, into car) to Type 2 (right, into wall) AC charging cable

## smarter charging in the future

- Your vehicle could power a home (“V2H”) or return power to the national grid (“V2G”) to help cover power shortages and outages, and reduce power costs. Readily available in Japan<sup>38</sup>, an early stage demonstration by Vector in Auckland is currently underway<sup>39</sup>.
- Power companies could switch your charging on and off during the night to use electricity at times of lowest cost and demand. This was successfully trialed in California with 100 cars<sup>40</sup>.
- Wireless charging (also known as induction) is available overseas (e.g. [pluglesspower.com](http://pluglesspower.com)).

<sup>37</sup> Vector diagrams for the sockets available [commons.wikimedia.org/wiki/EV\\_Charger\\_Gallery](https://commons.wikimedia.org/wiki/EV_Charger_Gallery)

<sup>38</sup> Nichicon launched a low cost Japanese V2H product in 2012 [nichicon.co.jp/english/product\\_news/new124.html](http://nichicon.co.jp/english/product_news/new124.html)

<sup>39</sup> Vehicle to Grid demo: [vector.co.nz/news/vector-set-to-unleash-power-of-evs-via-two-way-cha](http://vector.co.nz/news/vector-set-to-unleash-power-of-evs-via-two-way-cha)

<sup>40</sup> Detailed USA-based BMW/PGE case study: [pgecurrents.com/wp-content/uploads/2017/06/PGE-BMW-iChargeForward-Final-Report.pdf](https://pgecurrents.com/wp-content/uploads/2017/06/PGE-BMW-iChargeForward-Final-Report.pdf)

## where can i charge?

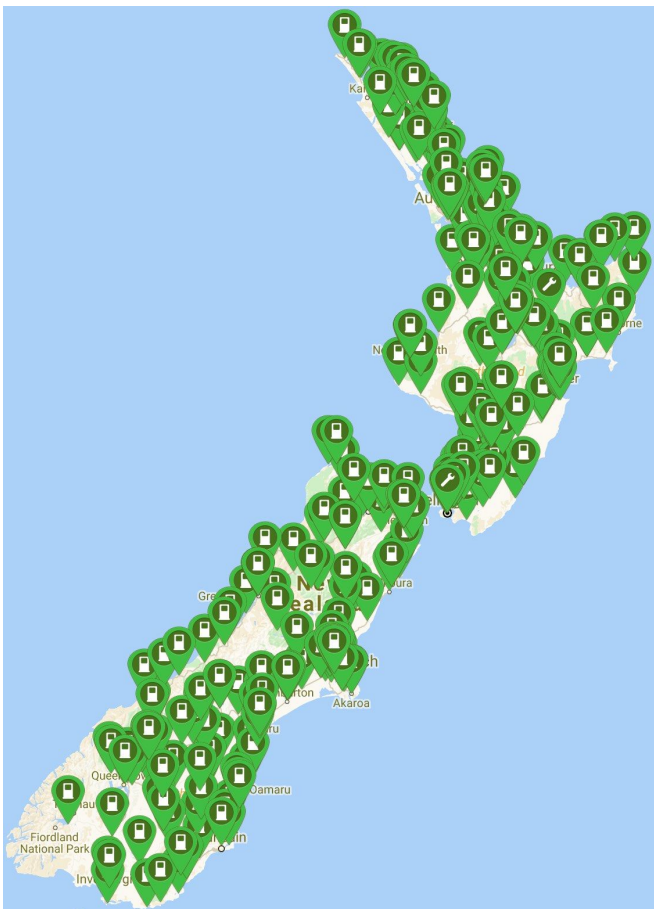
Home is where the majority of charging takes place. Some New Zealand employers are providing workplace charging to staff. (This is popular in the USA where workplace charging is available to over 1 million workers; a charging station makes employees six times more likely to own an electric car<sup>41</sup>).

A national network with over 100 public fast chargers and growing is being installed by [charge.net.nz](https://charge.net.nz) in cities and every 50-100 km along major state highways (*Map below right*). The first stations were installed in 2015, assisted by BMW, Foodstuffs, EECA, Councils, and lines companies. An access fob, phone app, and website offered by Charge Net NZ allows drivers to pay for charging across both their network and many (but not all) stations installed by others.

- Tesla is also installing SuperChargers for road trips, and slower chargers at destinations.
- Some electricity companies are also installing charging stations (e.g. Vector in Auckland).
- Hotels, motels and campgrounds offer charging. Many require a Blue Commando plug.
- A number of tourism destinations and retailers are adding slow chargers for customers.
- Wellington City Council is trialing street pole chargers for residents who only have on-street parks.

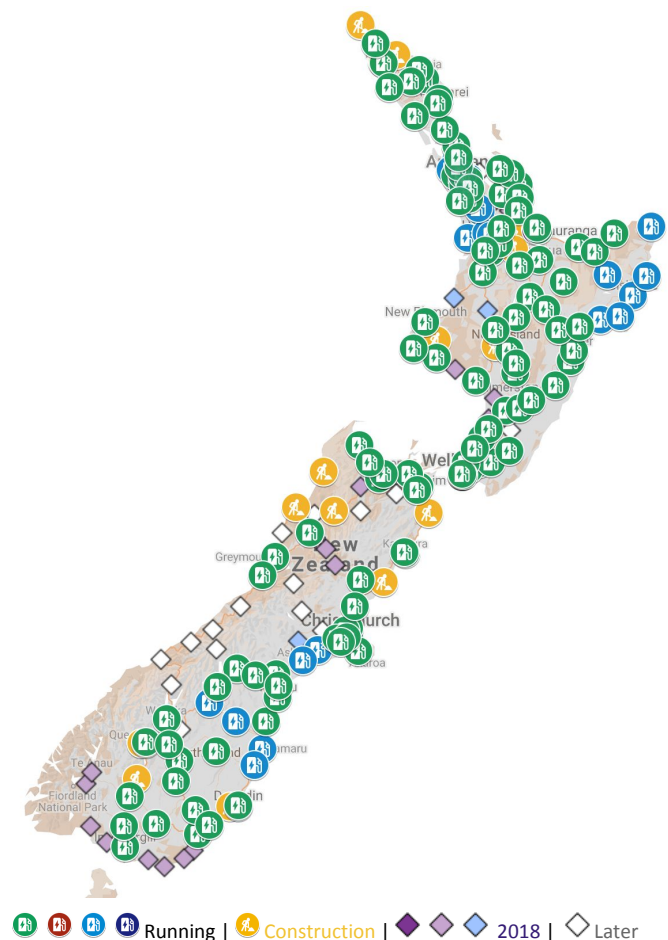
Use [plugshare.com](https://plugshare.com) (pictured left) for a map of where to charge. NZTA collates and publicly shares official charging locations through a programme named EVRoam, visible on NZTA and the AA website.

**Slow Charging** (for destinations)



All of the above slow chargers are operating today.

**Fast Charging Network** (for road trips)



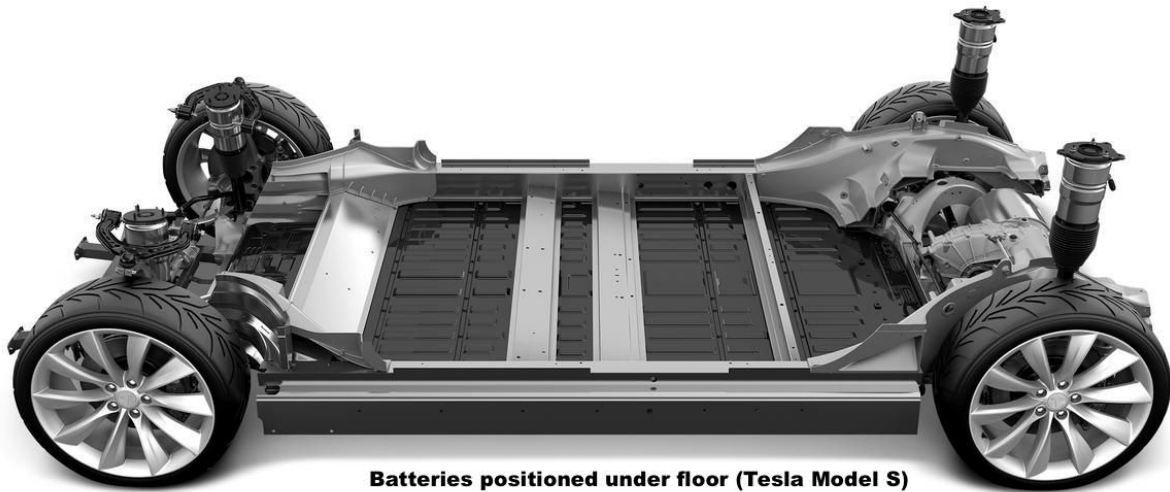
**Offering car charging to staff, customers, or the public?** You should certainly list it on PlugShare (it's free). Describe whether charging is free to the public, free to customers, or paid, or restricted to employees, the hours of operation (hopefully 24/7!), connector types and electrical power, and upload photos to promote your listing. Add signage to the physical space (e.g. "Electric car charging only") and use NZTA's official [symbol](https://nzta.govt.nz/ev/), to increase public awareness of electric cars, and to avoid petrol cars blocking the park. NZTA has guidance on installing public charging infrastructure and information on EVRoam at [nzta.govt.nz/ev/](https://nzta.govt.nz/ev/).



<sup>41</sup> A wealth of statistics and information on workplace charging is found at [energy.gov/eere/vehicles/workplace-charging](https://energy.gov/eere/vehicles/workplace-charging)

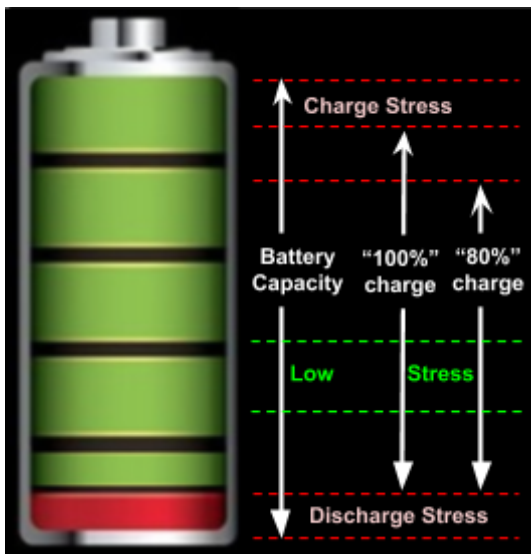
## BATTERIES: SIZE, LIFE, REPLACEMENT

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



**Batteries positioned under floor (Tesla Model S)**

Battery size is measured in kilowatt-hours, or kWh. Lower priced electric cars have ~24 kWh batteries; high-end Tesla cars have up to 100 kWh; buses and trucks much more still. This affects range and cost.



The life of a battery is reduced when at extreme high or low levels of charge<sup>42</sup>. To avoid cars reaching either end, not all of the battery capacity is made available.

You can lengthen the life of your battery by fully charging it only on occasion (hence the “80% charge” option on most cars) and by avoiding the car being left too long at a high or low level of charge (e.g. finishing your charge at 7am is ideal, but if it gets totally flat, recharge a bit straight away). The battery will last longer if it is generally around a third to half charged. Hot temperatures (particularly over 30°C) reduce battery life; some cars actively cool the battery to extend their lifetime. Excessive (more than daily, for years) fast-charging will reduce battery life slightly<sup>43</sup>.

Nissan state expected battery capacity to reduce to 80% after 5 years and 70% at 10 years, assuming 20,000km of annual driving in a Los Angeles climate (10-30°C, average ~20°C)<sup>44</sup>. Car manufacturers use different battery chemistries which may offer different lifespans. You can assess battery capacity on the dashboard or smartphone app when you test drive a car<sup>45</sup>. While minor loss of capacity is typical in a used vehicle (e.g. 10%), you might be saving half or a third of the cost of a new car, and the range will be still be higher than a typical daily drive. Car batteries have warranties, but conditions vary. Only some dealers provide warranties with used imports, although the [Consumer Guarantees Act](#) standard of “fit for purpose” applies to all sales to private individuals.

Eventually the battery will need replacement. It can then be recycled or, reused, for example by homeowners who want to store electricity from solar panels or overnight off-peak power.

- You may be able to buy a battery with more capacity than the car initially came with. (e.g. BMW i3 is upgradable from 22 to 33kWh; Renault Zoe from 22 to 41kWh).
- You may need to replace only individual dead cells, at a lower price than a full replacement.
- [BlueCars.nz](#) can test, fix weak, or replace Nissan Leaf car batteries, including swapping for larger battery sizes (Testing \$35+; work jobs \$750 - \$5000 for used batteries; \$15k+ for upsizing).

<sup>42</sup> Wealth of battery information at [batteryuniversity.com](#); Dalhousie Uni lecture by Jeff Dahn [youtube.com/watch?v=9qj03OawZEk](#)

<sup>43</sup> US government study on slow vs fast charging: [avt.inl.gov/pdf/energystorage/FastChargeEffects.pdf](#)

<sup>44</sup> [electricvehiclewiki.com/Battery\\_Capacity\\_Loss#Nissan.27s\\_Responses\\_and\\_Actions](#); one model has concerns [flipthefleet.org/2018/30-kwh-leafs-soh-loss](#)

<sup>45</sup> Nissan Leaf shows health on dashboard; LeafSpy is an iOS / Android app showing more detail. Similar tools exist for other cars.

## GO FOR A TEST DRIVE!

The experience of test-driving an electric car usually gives people the confidence to buy. You can test drive an electric car by asking a dealer, asking existing owners if they're prepared to let you drive theirs, or rent from: [bluecars.nz](http://bluecars.nz), [europcar.co.nz/electric-vehicles](http://europcar.co.nz/electric-vehicles), [mevo.co.nz](http://mevo.co.nz), [snaprentals.co.nz](http://snaprentals.co.nz), [goyoogo.com](http://goyoogo.com).

## WHERE TO BUY AND GET SERVICE?

Used and new car dealers throughout NZ sell and service electric cars. You will find hundreds of listings by choosing "Electric Cars" at [trademe.co.nz/motors](http://trademe.co.nz/motors). Used cars from Japan usually have console displays stuck in Japanese; this isn't an issue with UK imports or cars sold new in NZ. The driver's dashboard can be configured to display English by dealers. To change the central entertainment headunit to English dealers can sell a new (English) Nissan or third party system.

## WHAT ABOUT OTHER TYPES OF VEHICLES?

- **Bicycles:** commonly sold in local bicycle shops, with 40-100km "pedal assisted" range.
- **Motorbikes:** [ubcobikes.com](http://ubcobikes.com) (Kiwi made, off-road); [zeromotorcycles.com](http://zeromotorcycles.com) (import, for road).
- Formula **racing** cars compete in "Formula E" ([fiaFormulaE.com](http://fiaFormulaE.com)); An electric supercar is the fastest around the gruelling [Nurburgring circuit](http://www.nio.io/ep9) ([www.nio.io/ep9](http://www.nio.io/ep9)).
- Over 400 one-seat "Paxster" fully electric delivery buggies are used by NZ Post.<sup>46</sup>
- **Taxis:** Green Cabs in Wellington have EVs.
- **Trucks** are made by [zevnz.com](http://zevnz.com) and Waste Management locally. Electric truck importers include [etrucks.co.nz](http://etrucks.co.nz) and [sea-electric.com](http://sea-electric.com). Tesla is releasing a truck in 2019 that can carry 36 tons a distance of 800km and still recharge to 80% in 30 minutes ([tesla.com/semi](http://tesla.com/semi))
- Fully electric **buses** are mass produced, particularly in China which has 350,000 on their roads. Wellington<sup>47</sup> and Auckland<sup>48</sup> have electric buses, and plan to go all-electric in the years to come.
- The world's first electric **ferry** launched in 2015 in Norway (carries 300 people, 120 cars)<sup>49</sup>.
- Electric **airplanes** are in commercial development. The *Solar Impulse 2* flew the globe in 2016; Norway aims to have all domestic air travel go electric before 2040<sup>50</sup>.

## FURTHER INFORMATION AND EVENTS

**EVTalk**, a NZ electric vehicle news website, email newsletter, and monthly print magazine. [evtalk.co.nz](http://evtalk.co.nz)

**NZ EV Podcast**, produced weekly, [podcasts.nz/nz-ev-podcast/](http://podcasts.nz/nz-ev-podcast/)

**EVolocity**, nationwide annual high school competition to build and race electric vehicles. [evolocity.co.nz](http://evolocity.co.nz)

**EVWorld**, public / industry conferences. [www.evworld.nz](http://www.evworld.nz) (Aklid Aug 2018. Chch Nov 2018)

**International Drive Electric Week**. Multiple test drive events. [driveelectricweek.org](http://driveelectricweek.org) (September)

**Flip The Fleet**. Enter driving statistics and be a part of a national EV research project. [flipthefleet.org](http://flipthefleet.org)

**Leading the Charge**, an annual 2500km electric car roadtrip the length of New Zealand, stopping in multiple towns for public display and rides. [leadingthecharge.org.nz](http://leadingthecharge.org.nz) (Next: 2019)

### Facebook "EV Owner" groups

- NZ EV Owners: [facebook.com/groups/NZEVOwners/](https://www.facebook.com/groups/NZEVOwners/) (*lots of discussion*)
- Northland: [facebook.com/groups/1472323112818001/](https://www.facebook.com/groups/1472323112818001/) and [facebook.com/revupnz/](https://www.facebook.com/revupnz/)
- Auckland: [facebook.com/groups/291373964545996/](https://www.facebook.com/groups/291373964545996/)
- Waikato: [facebook.com/groups/WaikatoEV/](https://www.facebook.com/groups/WaikatoEV/)
- Nelson: [facebook.com/groups/365895557107117/](https://www.facebook.com/groups/365895557107117/)
- Wellington: [facebook.com/groups/WellyEV/](https://www.facebook.com/groups/WellyEV/)
- Christchurch: [facebook.com/groups/ChristchurchEVGroup/](https://www.facebook.com/groups/ChristchurchEVGroup/)
- Dunedin: <https://www.facebook.com/groups/403816650002889/>

<sup>46</sup> [nzpost.co.nz/about-us/media-centre/media-release/eco-vehicles-confirmed-as-way-of-future-for-new-zealand-post](http://nzpost.co.nz/about-us/media-centre/media-release/eco-vehicles-confirmed-as-way-of-future-for-new-zealand-post)

<sup>47</sup> [evtalk.co.nz/electrics-launch-greater-wellington-bus-fleet/](http://evtalk.co.nz/electrics-launch-greater-wellington-bus-fleet/)

<sup>48</sup> [c40.org/press\\_releases/mayors-of-12-pioneering-cities-commit-to-create-green-and-healthy-streets](http://c40.org/press_releases/mayors-of-12-pioneering-cities-commit-to-create-green-and-healthy-streets)

<sup>49</sup> [cleantechnica.com/2015/06/13/worlds-first-electric-battery-powered-ferry/](http://cleantechnica.com/2015/06/13/worlds-first-electric-battery-powered-ferry/)

<sup>50</sup> [atwonline.com/airframes/norway-s-avinor-eyes-all-electric-domestic-flights-2040](http://atwonline.com/airframes/norway-s-avinor-eyes-all-electric-domestic-flights-2040)