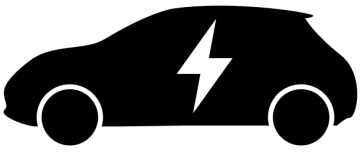
new zealand electric car guide



By Sigurd Magnusson, Wellington, NZ. 27 July 2019. Updated monthly. Download latest from www.electricheaven.nz

Questions, corrections, feedback to sigurdmagnusson@gmail.com or 021 42 12 08. Please share this document.[1]

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.[2] 80% of New Zealand electricity is generated by rain (hydro dams), geothermal, and wind[3], 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[4] 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.[5] Each year, an estimated 256 New Zealanders prematurely die from harmful diesel and other vehicle emissions[6] (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 electric cars now outselling fuel-driven vehicles. Norway thus expects to end fuel car sales in 2025.

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[7]), making electric cars steadily cheaper. On average New Zealand drivers travel 28km per day[8], and 95% of days within 125km[5]. 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[9], 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 in 2019[10]; Jaguar 2020, Mercedes 2022, Toyota/Lexus 2025[11]; Porsche & VW 2030[12].

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[1] This document is released under the Creative Commons Attributions license at creativecommons.org/licenses/by/3.0/nz/

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

[3] 2015 MBIE report mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/energy-in-new-zealand

[4] stats.govt.nz/browse_for_stats/industry_sectors/imports_and_exports/OverseasMerchandiseTrade_HOTPFeb16.aspx

[5] EECA Life Cycle Assessment of EVs eeca.govt.nz/assets/Resources-EECA/ev-lca-final-report-nov-2015.pdf

[6] NZTA links to 2012 Health and Air Pollution in New Zealand Study hapinz.org.nz/HAPINZ%20Update_Vol%201%20Summary%20Report.pdf

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

[8] 2010-2013 Distance per driver trends transport.govt.nz/assets/Uploads/Research/Documents/Drivers-2014-v911-Final-v3.pdf

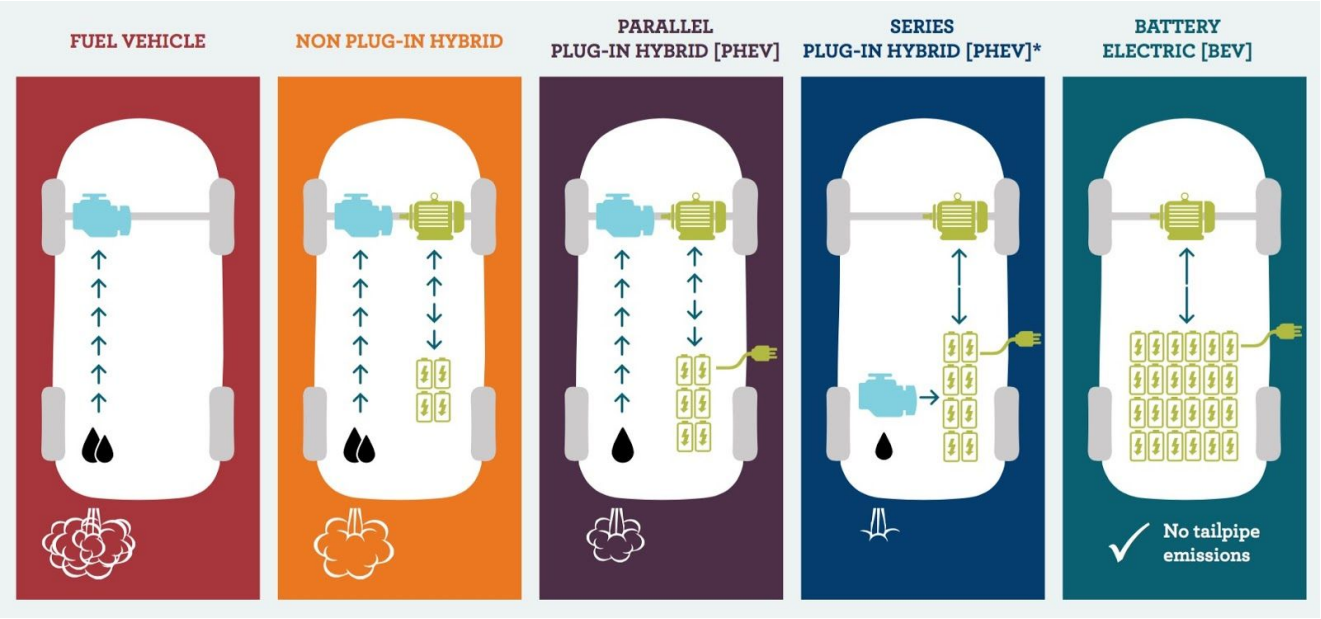
[9] stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-transport-comms/number-motor-vehicles.aspx

[10] media.volvocars.com/global/en-gb/media/pressreleases/189874/volvo-cars-announces-new-target-of-1-million-electrified-cars-sold-by-2025

[11] electrek.co/2017/12/18/toyota-electric-car-plans/ and electrek.co/2018/04/09/porsche-ceo-only-electric-vehicles-2030/

[12] 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.[13] A demonstration refueling project is to be trialed at Port of Auckland[14], and Hyundai have displayed a Nexo hydrogen SUV at a *Fielddays* expo in New Zealand.

[13] More information and sources about the hydrogen section: 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/
Essay by hydrogen race-car builder has published essay at ssj3gohan.tweakblogs.net/blog/11470/why-fuel-cell-cars-dont-work-part-1

[14] poal.co.nz/media/ports-of-auckland-to-build-auckland's-first-hydrogen-production-and-refuelling-facility

common electric cars in new zealand[15]

Car (and if battery electric or plug-in hybrid)	**Seats**	**Electric Range**	**Battery (kWh)**	**0-100, Power**	**Fast[16] Charge**	**Cost ($000) used - new**	**# in NZ** (last month)
Nissan Leaf (Fully electric) 	5	2011-17 models: 117 km Gen1 135 km Gen2 172 km Gen2 2017-19 models: 243 km 363 km (2019)	24 24 30 Note[17] 40 62 **SOON**	9-10 secs 80kW 110hp - 8 secs 110kW 147hp 160kW 215hp	Yes ★ ★ ★ ★ ★★	$10k - $59k used $59k new (40kWh) *(Most Nissan Leafs are used imports from Japan)*	7846 +282 (Over 50% of EVs in NZ)
Hyundai Ioniq (Full Electric OR Plug-in Hybrid EV) 	5	219 km *~300 km* (Or, if PHEV, then 47km electric range + hundreds of km petrol range)	28 *38* **SOON**	10 secs 88 kW (118 hp)	Yes ★★	$45 - 60k	632 (535 BEV) +58
BMW i3 (Full Electric OR Plug-In Hybrid EV) 	4	130 km Gen1 183 km Gen2 260 km Gen3 (Or, if PHEV, then extra +116 km petrol range)	22 33 42 **SOON**	7 secs 125kW (168hp)	Yes ★	$35 - $85k	581 (193 BEV) +13
Nissan e-NV200 (Fully Electric) 	2, 5, or 7	121 km Gen1 194 km Gen2	24 40	11 secs 80kW (110hp)	Yes ★	$20k+ $50k+ *(Imports only. High price due to low supply.)*	346 +8
Tesla Model S (Fully Electric) 	5 (plus 2 kids as option)	416 km or 595 km	75 or 100	4.2 or 2.7 secs 568 kW (762 hp)	Yes ★★★	$130k + optional upgrades *(Buy new from NZ section of www.tesla.com)*	335 +7
Hyundai Kona (Fully Electric) 	5	415 km (A smaller range battery option exists but is not available in NZ)	64	7.6s 150kW	Yes ★★	$74k	322 +51
Tesla Model X (Fully Electric) 	5, 6, or 7	383 km or 474 km	75 or 100	5.2 or 3.1 secs *(Ludicrous)* 568 kW (762 hp)	Yes ★★★	$140k+ optional upgrades *(Buy new from NZ section of www.tesla.com)*	315 +10
VW e-Golf (Fully Electric) 	5	Generation 1: 133 km Generation 2: 201 km	24 36	9.6 secs 85 or 100kW (115-134hp)	Yes ★	$40 - 62k	247 (239 BEV) +21
Renault Zoe (Fully Electric) 	5	140 km Gen1 280 km Gen2 350 km Gen3 (Manufacturer claim, not EPA)	22 41 52	13.5 secs 65 kW /88hp 100kW/134hp	No No Yes ★Gen3	$30k $40k TBC *(UK import)*	117 +2

[15] Costs from TradeMe & aa.co.nz/cars/buy-sell/new-cars/new-car-prices/. Electric Range is U.S. EPA from fueleconomy.gov, unless stated otherwise.
[16] Car fast charge ratings: ★ = under 50 kW max DC charge rate (slowest/poorest). ★★ between 50 and 100 kW. ★★★ = over 100 kW (fastest/best).
[17] Nissan Leaf 30kWh Battery Software Update: flipthefleet.org/2018/30-kwh-leafs-soh-loss/ + Breaks Update flipthefleet.org/2018/leaf-brakes-failures/

Mitsubishi i-Miev / Peugeot iOn (Fully elec.) 	4	100 km	16	13 secs 49 kW (66 hp)	Yes ★	$12k+ *(No longer sold new; import only. The Peugeot is higher spec.)*	108 +3
Kia Niro (Full Electric OR Plug-in Hybrid EV) 	5	289 km 455 km (Or, if PHEV, then 42km electric range + hundreds of km petrol range)	39 64	7.8s 150 kW	Yes ★★	$68k $74k	98 (44 BEVs) +15
Renault Kangoo (Fully Electric) 	2 or 5	Generation 1: ~100 km Generation 2: ~150 km (Manufacturer claim, not EPA)	22 33	44 kW (60 hp)	No	$75k	53 No change
Jaguar i-Pace (Fully Electric) 	5	376 km	90	290 kW 4.8 secs	Yes ★★	$144k	51 +43
LDV EV80 (Fully Electric) 	3	Estimated 150+ km	56	100 kW	Yes (slow charge optional) ★	~ $80k (or $75k with cab & chassis only)	35 +1
Kia Soul EV (Fully Electric) 	5	150 km 179 km 391 km *(2019)*	27 30 64	11 secs 81 kW (109 hp)	Yes ★	$35k+ *(Imported. Not sold new in NZ. Long range 2019 version price TBC)*	23 No change
Tesla Model 3 (Fully Electric) **AVAILABLE NOW** 	5	386 km 500+ km 500 km	55 75 75	5.6*s* 211kW 4.6*s* 307kW 3.4*s* 353kW	Yes ★★★	$75k *standard+* $95k *long range* $103k *performance*	**None** *Available August 2019.*
Audi e-Tron Quattro (Fully Electric) **COMING** 	5	328 km	95	5.7 secs 300 kW (402 hp)	Yes ★★★	$149k	**4** *Order now for 2019 delivery.*

Medium-range Plug In Hybrids *(**30-100km EPA electric range**)*:	**Low-range** Plug In Hybrids *(**under 30km EPA electric range**)*:	
Holden Volt PHEV (56km) **Hyundai Ioniq PHEV** (47km) **Kia Niro PHEV** (42km) **Mitsubishi Outlander PHEV** (35km) **Toyota Prius Prime** (40km)	**Audi**: A3, Q7 **BMW**: 225xe, 330e, 740e, X5, i8 **Landrover:** Range Rover / Sport **Mini**: Countryman **Mercedes Benz**: C350e, GLE500e, S500e	**Porsche**: Cayenne & Panamera e-hybrid **Toyota**: Plug-In Prius **Volvo**: XC60, XC90, S90

11,146 full electric + 3581 plug-in hybrid + 140 heavy electric vehicles **= 14,867 total**

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

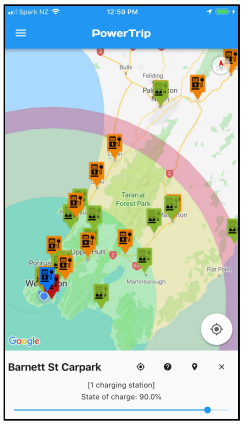
New electric models coming between 2017 - 2020 to New Zealand: 30 full electric + 25 plug-in hybrid models

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

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” (fueleconomy.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 Power Trip app available from thepowertrip.co.nz 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, as battery prices drop, at which point it will be cheaper for car manufacturers to build electric cars than fuel cars.[18]

Travelling by electricity is cheaper than petrol: EECA calculates it is equivalent to 30 cents a litre, about 7 times cheaper than petrol.[19] 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/
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).

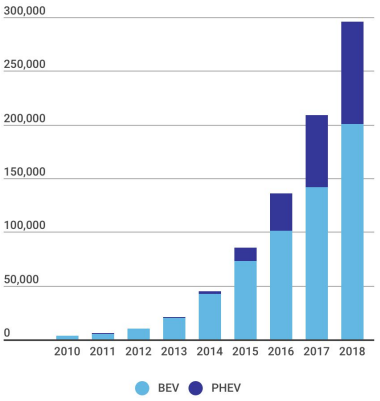
Assuming you commute 40km a day, you would probably need about 8 units of electricity (kWh) to recharge. At a low overnight rate of 11c per kWh this is $0.88 a day. Overnight charging is good for the national electricity grid because it is at its lowest demand, meaning the power is likely generated with 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, Sweden, Netherlands and India, 2032 in Scotland, and 2040 in France and Britain[20]. 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[21]. China is working towards 5 million charging locations by 2020[22].

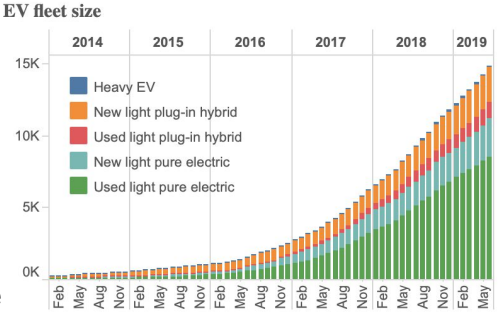
[18] Malcolm McCulloch (Oxford University, UK), radionz.co.nz/news/national/307388/electric-cars-close-to-price-parity,-conference-told
[19] energywise.govt.nz/on-the-road/electric-vehicles/
[20] theguardian.com/politics/2017/jul/25/britain-to-ban-sale-of-all-diesel-and-petrol-cars-and-vans-from-2040
[21] electrek.co/2017/02/08/vw-electric-vehicle-charging-infrastructure-dieselgate-settlement/
[22] chinadaily.com.cn/business/motoring/2015-10/13/content_22170160.htm

EVs in Norway[23] (above) and NZ (below):



Norway has the most incentives globally, and has a similar population, land size, and vehicle count as NZ, but higher proportion of clean 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 don't pay the 25% sales tax, enjoy halved fringe benefit tax, and free use of bus lanes, toll roads, urban street parking, and charging stations. Monthly electric car sales now outnumber fuel car sales; the country has over 300,000 electric vehicles (the highest per capita globally), and 10,000 charging points.

NZ POLICIES AND GROWTH



For New Zealand to reach the goal of being net zero carbon by 2050, 100% of cars entering NZ from 2030 would need to be electric (otherwise large numbers of fuel cars will need to be scrapped in the year 2050, because 20% of our cars are over 20 years old). This will require electric vehicle sales to jump astronomically; in 2019 less than 3% of cars entering NZ are electric. Electric vehicle numbers are rising steadily, but so far only account for 15,000 out of our 3.8 million light vehicles. 3.8 million electric vehicles would demand 17% more electricity, which can be met with renewable power stations that have consent to be built.[24]

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, almost 2% of all vehicles, or 12% of car sales being electric), a $1M/year (for 5 years) nationwide education 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 car purchases and charging stations. The annual 'rego' fee for electric cars is ~$75/ year[25]. See electricvehicles.govt.nz.

The current approach to reducing the cost of electric vehicles is set to change in 2021, assuming no change in government. Since 2009, electric vehicle owners have not paid road user charges (RUCs), saving an owner $620 per 10,000km compared to a small diesel car. From 2021 this is proposed to be replaced by a *Clean Car Rule* and a *Clear Car Discount* as detailed at transport.govt.nz/clean-cars/. The *Rule* requires car importers to progressively sell cars with lower CO_2 emissions, at levels that trail Japanese rules by 10 years. The *Discount* will award buyers $8000 off new electric and $2600 off used electric imports. Hybrids and very efficient fuel cars will get small discounts. High emitting vehicles will face up to a $3000 purchase penalty. These policies follow logic outlined in a 2015 report by Barry Barton at University of Waikato[26] and a detailed follow up by the Productivity Commission in 2018[27]. These reports explained NZ was one of the last countries to introduce such policies and how they are successful overseas. Heavy electric vehicles over 3 tons (e.g. buses and trucks) will instead continue to retain the RUC exemption through to 2025. Rising petrol prices and fuel taxes (up to 9-12c/litre within 3 years across New Zealand, plus 10c/litre in Auckland since 2018[28]) will increase the savings available to electric car drivers. Japan and UK are a cheap source for used electric imports as their governments also subsidise their purchase, and we don't charge high import fees.

Electric vehicle adoption is supported by an industry (DriveElectric.org.nz) and owner association (BetterNZ.org). Some large NZ firms have said they will make a third of their cars electric by 2019[29]. Councils have few electric cars however EECA has released a local government guide for councils[30]. Auckland's mayor has pledged the streets for a part of the city will be 'fossil fuel free' by 2030[31]

[23] European policies: icct.org/sites/default/files/publications/ICCT_EVpolicies-Europe-201605.pdf Norway graph & facts: elbil.no/english/
[24] Meridian Energy calculation: http://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=11851629
[25] $18 ACC levy + $52 NZTA licensing + admin fee: nzta.govt.nz/vehicles/licensing-rego/vehicle-fees/licensing-fees/
[26] Barry Barton Paper: waikato.ac.nz/__data/assets/pdf_file/0007/278080/Electric-Vehicle-Policy-New-Zealand-in-a-Comparative-Context.pdf
[27] Low Emissions Economy report: https://www.productivity.govt.nz/inquiry-content/3254?stage=3
[28] National increase: transport.govt.nz/assets/Uploads/Multi-Modal/Documents/Draft-GPS-2018.pdf & Auckland region: parliament.nz/52PLLaw25421/
[29] airnewzealand.co.nz/press-release-2016-landmark-commitment-will-boost-new-zealand-ev-numbers
[30] eeca.govt.nz/assets/Resources-EECA/research-publications-resources/electric-vehicles-local-government-guide.pdf
[31] 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.
A detailed Norwegian study showed almost all cars are charged daily or weekly at home, and that most cars use a public fast charger once a month or less[32] which is likely consistent with New Zealand.

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.[33]

Normal 3 pin socket (S3112) 8-10 amps, single phase AC 230V 1.8 - 2.3 kW **10km+ per hour recharging** **100km takes 10 hours**[34] 	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.leadingthecharge.org.nz/where_to_buy_charging_equipment) *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).*
Blue Commando (IEC 60309) 16 amps, single phase AC 230V 3.7 kW **18km+ per hour recharging** **100km takes 5 hours** 	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. Unless a car is parked for many hours, this is rather slow for daytime recharging, but it is a very low cost solution. *Note: Read WorkSafe guidelines for restrictions about installing this socket outside of a domestic environment.*

[32] wpstatic.idium.no/elbil.no/2016/08/EVS30-Charging-infrastrucure-experiences-in-Norway-paper.pdf
[33] worksafe.govt.nz/managing-health-and-safety/consumers/safe-living-with-electricity/safely-charging-your-electric-vehicle-at-home/
[34] 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.

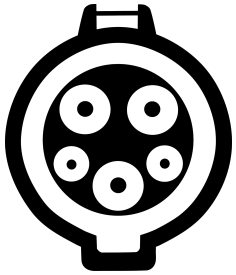
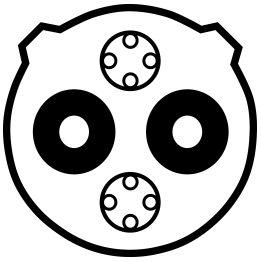
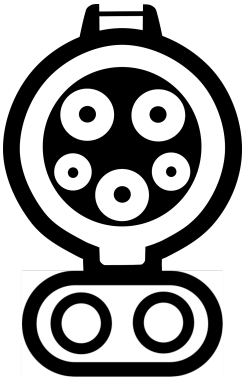
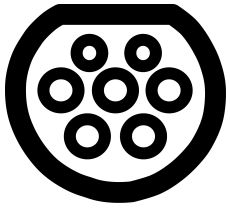
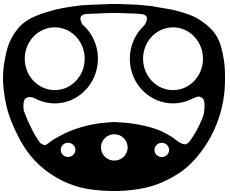
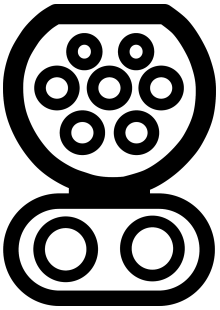
Dedicated "slow" (AC) charging station 15-40 amps single phase AC 230V 3-9kW **18-45km per hour recharging** **100km takes 2-5 hours** **Or** 32 amps, three phase AC 415V 22kW **110km per hour recharging** **100km takes just under an hour** 	For around $800 or more, you can buy a dedicated wall-mounted charging station[35]. 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[36]. 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: 25 kW** *(Common in NZ)* Adding 100km takes up to **1 hour** **Fast: 50 kW** *(Common in NZ)* Adding 100km takes **25 minutes** **Faster: 120 kW** *(Rare in NZ[37])* 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**[38] 	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. 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 carparks. They are overkill in locations where people intend to park for hours; a slower charger would be more appropriate there. 25 minutes typically adds 100km. However this depends on how quickly the car can fast charge and whether the charger is delivering the full power that the car can manage. (*See Fast Charge star ratings pages 3-4*). E.g. an older Nissan Leaf charges much slower than what a typical fast charger offers (50kW), whereas Tesla and many new electric cars can charge much quicker than what a 50kW fast charger offers. Cars usually can only be fast-charged to between 85-95% full, and the charging slows down *significantly* as the car completes charging.

Your car will normally come with a portable cable for a 3 pin socket, and might come with a cable to plug into a "Type 2" wall socket. 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.

[35] Pictured EVSE: Type 2 socketed wall-mounted device with an untethered cable (as per NZTA guidance)
[36] The Zappi electric car charger measures unused solar energy to smartly control the car charge rate myenergi.uk/product/zappi/
[37] Tesla's SuperChargers in NZ run at 120-135kW and go above 200kWh in the future. 100kW+ Delta DC chargers are sold in NZ by yhipower.co.nz.
[38] 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[39]:

Slow (AC)	**Fast** (DC)	**Combo** (slow AC and fast DC)
Type 1 ("J1772") (Japan / US)  Audi A3 e-tron, Q7 (historically) BMW - bought in NZ (historically) Holden Volt Kia Soul Nissan Leaf and eNV200 Mitsubishi iMiev and Outlander Toyota Prius Plugin (not Prime)	CHAdeMO (Japan / US)  BMW i3 imported from Japan Kia Soul Nissan Leaf and eNV200 Mitsubishi iMiev and some Outlander Tesla Model S/X *(with adapter from Tesla)*	Type 1 CCS (Japan / US)  BMW i3 bought in NZ (historically) *NOT supported by NZ charging stations*
Type 2 ("Mennekes") (Europe)  Audi (from 2017) BMW (from mid 2017) Hyundai Ioniq, Kona Jaguar i-Pace Kia Niro (and Kia Soul 2019+) Renault Zoe, Kangoo Tesla *(slow AC. Fast DC at SuperCharger)* Toyota Prius Prime VW eGolf	Tesla Supercharger (Japan/US)  *This socket isn't found on Tesla cars in NZ. Here, Tesla Model S/X use CHAdeMO (with special cable supplied by Tesla) and modified Type 2 (not CCS) for both AC and DC). Model 3 is expected to use Type2 CCS* *NOT supported by NZ charging stations*	Type 2 CCS (Europe)  BMW (mid 2017 onwards) Jaguar i-Pace Kia Soul (from 2019), Niro BEV Hyundai Ioniq, Kona Tesla Model 3 VW eGolf

NZTA issued guidelines in 2016 (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[40], an early stage demonstration by Vector in Auckland is currently underway[41].
- 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[42].
- Wireless charging (also known as induction) is available overseas (e.g. pluglesspower.com).

[39] Vector diagrams for the sockets available commons.wikimedia.org/wiki/EV_Charger_Gallery
[40] Nichibon launched a low cost Japanese V2H product in 2012 nichicon.co.jp/english/product_news/new124.html
[41] Vehicle to Grid demo: vector.co.nz/news/vector-set-to-unleash-power-of-evs-via-two-way-cha
[42] Detailed USA-based BMW/PGE case study: pgecurrents.com/wp-content/uploads/2017/06/PGE-BMW-iChargeForward-Final-Report.pdf

Where can I charge?

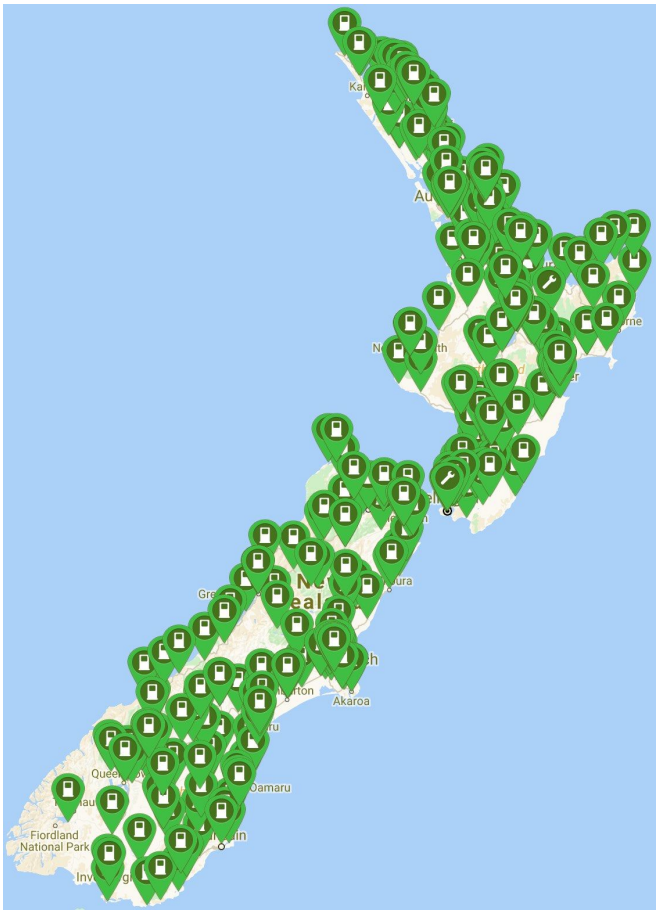
Home is where the majority of charging takes place. Some New Zealand employers are providing workplace charging to staff. (This is popular in the USA where workplace charging is available to over 1 million workers; a charging station makes employees six times more likely to own an electric car[43]).

A national network with over 100 public fast chargers and growing is being installed by 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.

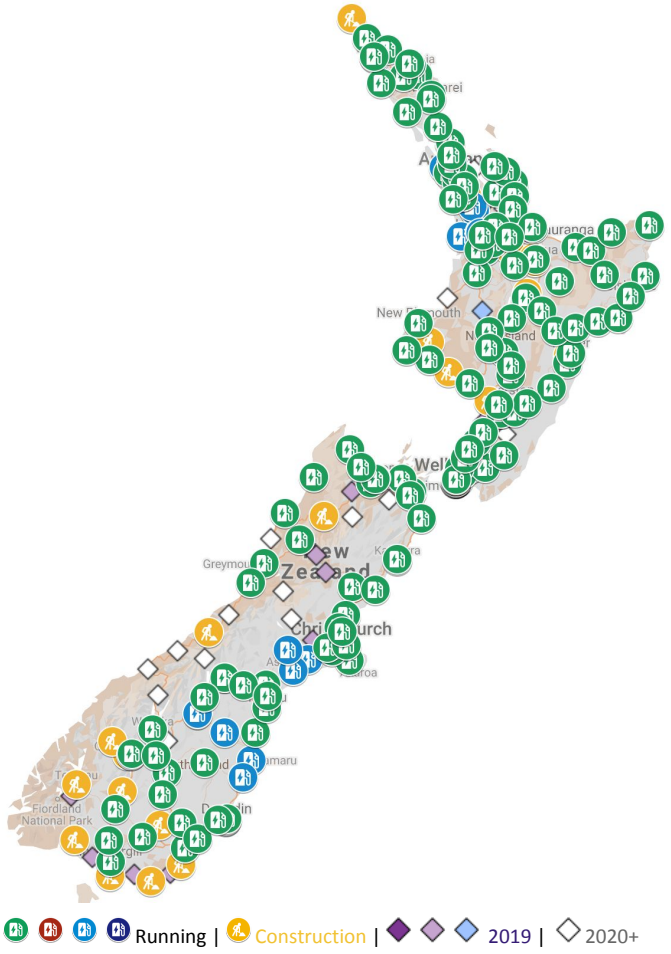
Use plugshare.com (pictured left) for a map of where to charge. NZTA collates and publicly shares official charging locations through a programme named EVRoam, visible on NZTA and the AA website.

Slow Charging (for destinations)



All of the above slow chargers are operating today.

Fast Charging Network (for road trips)

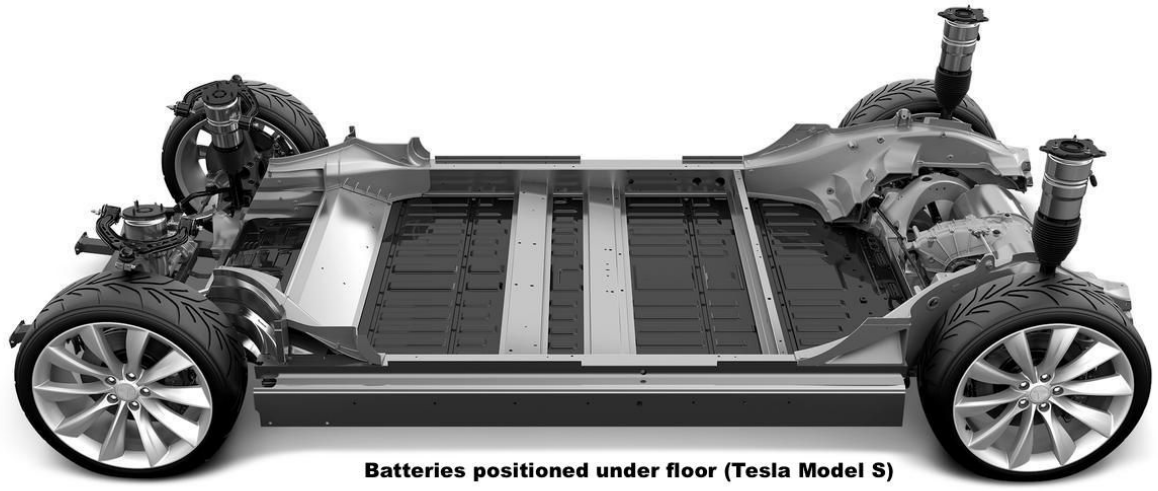


Offering car charging to staff, customers, or the public? You should certainly list it on PlugShare (it's free). Describe whether charging is free to the public, free to customers, or paid, or restricted to employees, the hours of operation (hopefully 24/7!), connector types and electrical power, and upload photos to promote your listing. Add signage to the physical space (e.g. "Electric car charging only") and use NZTA's official symbol, 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.

[43] A wealth of statistics and information on workplace charging is found at energy.gov/eere/vehicles/workplace-charging

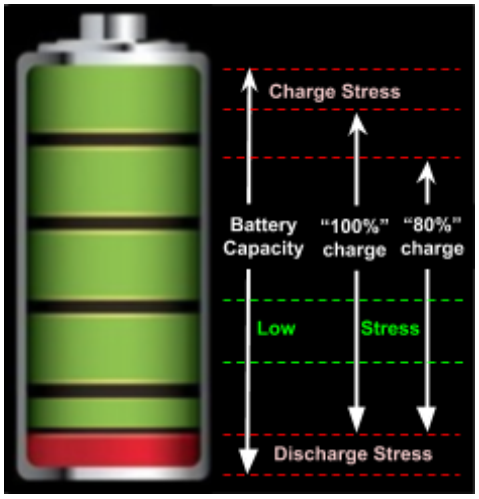
Batteries: size, life, replacement

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[44]. 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[45].

Nissan expect 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 (~20°C)[46]. A survey of Tesla owners show longer battery lifespans: averaging 90% health after driving 300,000km, likely owing to different battery chemistry, active battery cooling, and fewer charge cycles given it has a much larger capacity battery[47]. You can assess battery capacity on the dashboard or smartphone app when you test drive a car[48]. While minor loss of capacity is typical in a used vehicle (e.g. 10-15%), 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, something that cannot be said for petrol after it has been used. Used batteries could be used 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, Renault). 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 (reconditioned $750-$5000), including swapping for larger battery sizes (>$15k).

[44] Wealth of battery information at batteryuniversity.com; Dalhousie Uni lecture by Jeff Dahn youtube.com/watch?v=9qi03OawZEk
[45] US government study on slow vs fast charging: avt.inl.gov/pdf/energystorage/FastChargeEffects.pdf
[46] electricvehiclewiki.com/Battery_Capacity_Loss#Nissan.27s_Responses_and_Actions
[47] steinbuch.wordpress.com/2015/01/24/tesla-model-s-battery-degradation-data/ (Updated 2018)
[48] 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 gives people 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, europcar.co.nz/electric-vehicles, mevo.co.nz, snaprentals.co.nz, yoogoshare.co.nz

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 and at evsales.nz. 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 (Kiwi made); zeromotorcycles.com, Harley Davidson Livewire (2019)
- Formula **racing** cars compete in "Formula E" (fiaFormulaE.com); An electric supercar is the fastest around the gruelling Nurburgring circuit (www.nio.io/ep9).
- Over 400 one-seat "Paxster" ully electric delivery buggies are used by NZ Post.[49]
- **4WD Utes:** Coming soon e.g. greatwall.co.nz, rivian.com, bollingermotors.com, and Tesla
- **Trucks** are made by zevnz.com and Waste Management locally. Electric truck importers include etrucks.co.nz and 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)
- Fully electric **buses** are mass produced, particularly in China which has 350,000 on their roads. Wellington[50] and Auckland[51] have electric buses, and plan to go all-electric in the years to come.
- Fully electric **motorhomes** are now available for hire (e.g. www.britzev.com)
- The world's first electric **ferry** launched in 2015 in Norway (carries 300 people, 120 cars)[52].
- 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[53].

Further Information and Events

EVTalk, a NZ electric vehicle news website, email newsletter, and monthly print magazine. evtalk.co.nz
NZ EV Podcast, produced weekly, podcasts.nz/nz-ev-podcast/
EVolocity, nationwide annual high school competition to build and race electric vehicles. evolocity.co.nz
EVWorld, public / industry conferences. www.evworld.nz (August 2019)
International Drive Electric Week. Multiple test drive events. driveelectricweek.org (September)
Flip The Fleet. Enter driving statistics and be a part of a national EV research project. 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 (Next: 2020)

Facebook "EV Owner" groups

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

[49] nzpost.co.nz/about-us/media-centre/media-release/eco-vehicles-confirmed-as-way-of-future-for-new-zealand-post
[50] evtalk.co.nz/electrics-launch-greater-wellington-bus-fleet/
[51] c40.org/press_releases/mayors-of-12-pioneering-cities-commit-to-create-green-and-healthy-streets
[52] cleantechnica.com/2015/06/13/worlds-first-electric-battery-powered-ferry/
[53] atwonline.com/airframes/norway-s-avinor-eyes-all-electric-domestic-flights-2040