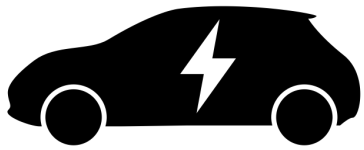
new zealand electric car guide



By Sigurd Magnusson, Wellington, NZ. 11 February 2016. 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 17% 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]; this is close to the number who die in crashes and would be reduced 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, having reached the point where about a third of all new car sales are fully or partially electric.

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 drive electric but keep a backup fuel car. The dashboard displays how far you can drive with remaining battery.

Since 2016, prices and options for electric cars in NZ have improved. The majority of fully electric cars here are short-range Nissan Leaf hatchbacks. Full sized, long-range, high performance cars by Tesla Motors are also popular here and overseas. The upcoming Tesla Model 3 will provide the first medium range and cost electric vehicle in New Zealand, though its popularity will create long delivery times (400,000 were pre-ordered globally within three weeks of launch).

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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 2016 mfe.govt.nz/publications/climate-change/new-zealand-greenhouse-gas-inventory-1990-2014

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

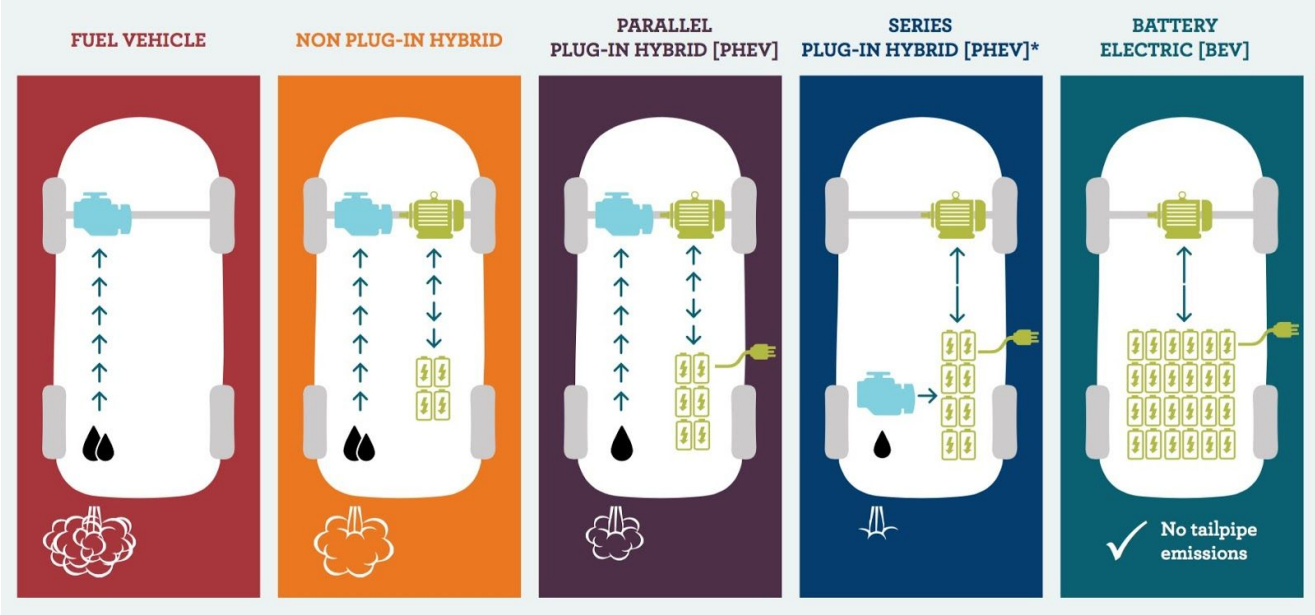
[6] NZTA links to 2012 Health and Air Pollution in New Zealand Study hapinz.org.nz/HAPINZ%20Update_Vol%201%20Summary%20Report.pdf

[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-y911-Final-v3.pdf

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

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 petrol, avoiding the need to frequently recharge. These vehicles also have regenerative braking, which captures energy that would be wasted as braking heat. They cost somewhere in the middle between affordable (short range) and expensive (long range) fully electric cars. The drawback of plug-in hybrids is a complicated engine requiring maintenance, petrol refueling costs, air pollution, and engine noise.

Depending on the model, the petrol engine will either help the electric motor turn the wheels ("parallel PHEV") or only recharge the battery ("series PHEV") but some can do both. A few can drive a reasonable distance electrically; most have very small batteries that don't drive far. As battery prices drop, plug-in hybrids will be replaced by full battery electrics.

What we used to call Hybrids no longer count

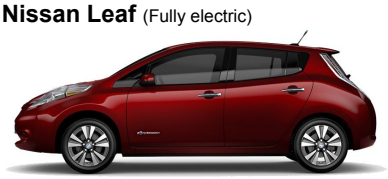
Cars such as the *non-plug-in* Toyota Prius Hybrid found in this country over the past decade are different–they can not be plugged into an electric socket to recharge. They can only fill up on petrol, and use the petrol engine and regenerative braking to recharge a small battery that gives a short (1-2 km) electric range. A plug-in vehicle has many more benefits.

What about Hydrogen?

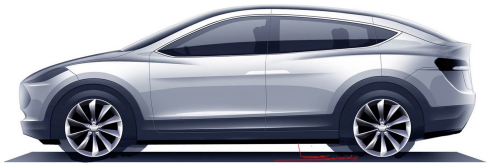
There is an ongoing debate about whether the long-term future of cars would use hydrogen fuel cells or stored electricity (i.e. batteries). While hydrogen vehicles can drive long distances, the challenge is that hydrogen is made by splitting it out of natural gas (which releases greenhouse gases) or 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 are simpler than hydrogen, 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.[10]

[10] 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

common electric cars in new zealand[11]

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**
Nissan Leaf (Fully electric) 	5	Generation 1 117 km Generation 2 135 km 172 km	 24 24 30	9 secs 80kW (110hp)	Yes	$15k - $45k *(NZ-new cars sold out. Used imports from Japan & UK abundant)*	1075
Mitsubishi Outlander (Plug-in Hybrid) 	5	40km electric + 700km petrol	12	11 secs 120 kW (180hp) + 2L engine.	Only if imported. Will be added to NZ sales in 2017.	$39 - 60k	536
BMW i3 (Full Electric OR Plug-In Hybrid) 	4	130km *or* 183 km (+116 km petrol range if range extended plugin hybrid)	22 *or* 33	7 secs 125kW (168hp)	Yes *(but optional extra)*	$50 - $85k	170 (34 are BEV)
Tesla Motors Model S (Fully Electric) 	5 (plus 2 kids)	337 km or 506 km	60 or 100	2.7 secs 568 kW (762 hp)	Yes	$122k + optional upgrades *(Buy from NZ section of www.tesla.com)*	53
Mitsubishi i-Miev / **Peugeot iOn** (Fully electric) 	4	100 km	16	13 secs 49 kW (66 hp)	Yes	$12k+ *(No longer sold new; import only. The Peugeot is higher spec.)*	48
Nissan e-NV200 (Fully Electric) 	2, 5, or 7	121 km	24	11 secs 80kW (110hp)	Yes	$35k+ *(Imports only)*	36
Renault Kangoo (Fully Electric) 	2 or 5	80 - 120km *Winter vs Summer claimed by Renault.*	22	44 kW (60 hp)	No	$75k	35
VW e-Golf (Fully Electric) 	5	133 km *(~ 200km coming 2017)*	24 (36 kWh coming 2017)	10 secs 85kW (115 hp)	Yes	$60-70k *(UK Import now or buy new in NZ 2017)*	9

[11] Costs from TradeMe and aa.co.nz/cars/buy-sell/new-cars/new-car-prices/.
Range is U.S. EPA, sourced from fueleconomy.gov (except where supplied by dealers to cover gaps).

Renault Zoe (Fully Electric) 	5	Generation 1 115-170km Generation 2 230-340km	22 41	13.5 secs 65 kW (88hp)	No *60 min to 80% AC recharge available*	$27 - 75k *(41kWh avail as UK import at present)*	8
Hyundai Ioniq (Full Electric OR Plug-In Hybrid) 	5	219 km (Or, if PHEV, then 30km electric range + hundreds of km petrol range)	28	10 secs 88 kW (118 hp)	Yes	$60k	7
Kia Soul EV (Fully Electric) 	5	150 km	31	11 secs 81 kW (109 hp)	Yes	$35k+ *(Imported. Not sold new in NZ)*	4
Tesla Motors Model X (Fully Electric) 	7	465 km	100	3.1 secs 568 kW (762 hp)	Yes	$136k+ optional upgrades *(Buy from NZ section of www.tesla.com)*	3?
Tesla Motors Model 3 (Fully Electric) **COMING** 	5	346 km	*TBC*	4 secs *(high spec)* 6 secs *(base model)*	Yes	USD 35k+ *Since March 2016 NZers can pay USD1000 deposit online*	**None** *First NZ shipments 2018*

*The following **plugin hybrids** are available for purchase in NZ and offer less than 30km average electric range:*		
Audi A3 Sportback e-tron (Hatch)	$75k	58
BMW 225xe (Hatch/SUV)	$68k	19
BMW 330e (Sedan)	$90k	4
BMW 740e (Sedan)	$199k	3
BMW X5 xDrive40e (SUV)	$149k	7
BMW i8 (Sports)	$276k	18
Mercedes Benz C 350 e (Sedan or Wagon)	$96k or $99k	8
Mercedes Benz E 350 e (Sedan)	$143k	-
Mercedes Benz GLE 500 e (SUV)	$150k	3
Mercedes Benz S 500 e (Sedan)	$255k	-
Porsche Cayenne S e-hybrid (SUV)	$175k	17
Toyota Plug-In Prius (Hatch)	$40k (used)	17
Volvo XC90 T8 (SUV)	$134k	26
Total *(including small numbers of other makes and models, and home-conversions):*	**1750 electric + 880 plug-in hybrid = 2630**	

The Motor Industry Association surveyed manufacturers and found 16 new full electric models and 28 new plug-in hybrid models are expected to come to New Zealand between 2016 and 2020[12].

[12] Full survey breakdown: mia.org.nz/Portals/0/MIA%20Public%20Documents/Environment/EV%20and%20PHEV%20model%20availability.pdf

Driving range

The Electric Range of a car can be overstated in marketing material. A US government agency measures the range of all electric vehicles for sale using a standardised test and publishes this information at fueleconomy.gov. This is known as "EPA range" and assumes a mix of road speeds (highway and suburban) to reflect a typical journey.

A number of situations will result in a car using up its battery before reaching the EPA range. For example (and particularly if combined) frequent strong acceleration, climbing significant hills, constant high speeds, use of air conditioning or heaters, towing a trailer, and battery age. Conversely, travelling slowly or staying on flat terrain can enable you to exceed EPA ratings.

The European electric car range test (NEDC) is less useful as it gives overly generous figures about electric range and (in the case of PHEVs) fuel and CO_2 savings.

Expensive upfront; cheaper overall

The main cost of an electric car is its upfront purchase. Electric cars are currently more expensive to buy new than fuel vehicles, largely due to battery prices and low production volume. Within a decade, it will be cheaper for car manufacturers to build electric cars than fuel cars.[13]

Travelling by electricity is cheaper than petrol: EECA calculates it is equivalent to 30 cents a litre, about 7 times cheaper than petrol.[14] An electric car owner can save 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, which at a low overnight rate of 11 cents per kWh would be $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 charging time' to just before 7am, so your battery isn't full for long, and so it randomises the start time, which makes managing overall electricity demand easier for the power companies.

Global leaders

Electric cars are supported in various ways by most countries. Regulations in America, Europe and China force car companies to sell cleaner cars every year. By 2025 these will mandate 22% of cars sold in many US states must be electric[15]. Over 200 European cities have low emission zones where fuel vehicles are prevented entry or pay fees (e.g. Paris, London). These help governments to achieve international climate change commitments by encouraging car owners to shift to electric cars, reducing carbon dioxide and cancer-causing diesel emissions. A typical petrol car emits more than its weight in CO_2 a year (2 tonnes). Norway and Holland have goals that all vehicle sales will be electric from 2025, with Germany, U.K., California, New York and others agreeing to follow suit in later years as part of an international alliance (zevalliance.org). Global leadership in generating electric car adoption comes from Tesla Motors and its visionary leader Elon Musk.[16]

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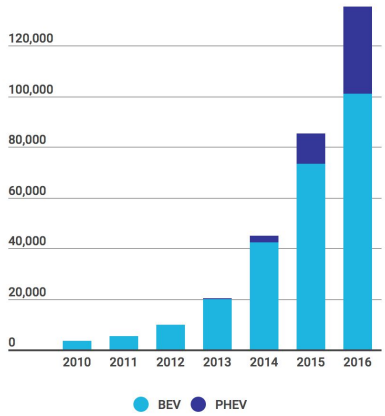
[13] Malcolm McCulloch (Oxford University, UK), radionz.co.nz/news/national/307388/electric-cars-close-to-price-parity,-conference-told

[14] energywise.govt.nz/on-the-road/electric-vehicles/

[15] Look up CARB (US) and CAFE (US), and EU CO_2 regulations, e.g. arb.ca.gov/msprog/zevprog/zevregs/1962.2_clean.pdf

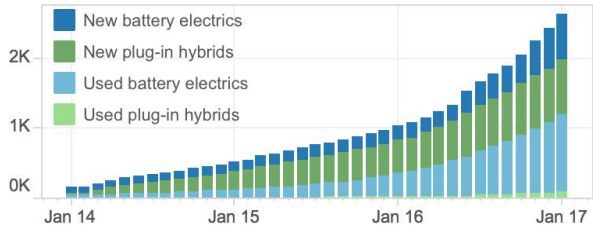
[16] waitbutwhy.com/2015/06/how-tesla-will-change-your-life.html provides a comprehensive look at Elon Musk, Tesla, and SpaceX.

Norwegian electric car adoption[17]



Norway has the greatest incentives globally, and has a similar population, land size, and vehicle count as NZ, but higher proportion of renewable electricity. Norway charges a purchase 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, and have halved fringe benefit tax, free use of bus lanes, toll roads, urban street parking, and charging stations. This led to 135,000 vehicles (100,000 fully electric) and 7000 charging points in 5 years. This is much better than its neighbours, e.g. Denmark sales plummeted in 2016 after introducing a tax on electric vehicles.

New Zealand Policies and Growth



New Zealand electric car numbers are low but are doubling each year. (See graph). When all our three million vehicles are electric this will demand just 10% more electricity, which can be fortunately met with renewable power stations that have consent to be built.[18]

The government supports electric cars with a publicly stated target (a doubling of electric vehicles every year to 64,000 by 2021, about 2% of all vehicles, and about one in eight cars entering NZ being electric), a $1M/year (for 5 years) nationwide education and promotion campaign led by EECA, offering money to fund projects that aid electric car adoption (fund pool is $6M/year; next applications Feb/March 2017), allowing electric vehicles to drive in certain bus and high-occupancy vehicle lanes, and efforts across government agencies and business to support: bulk purchase, public charging infrastructure, and decision-making. A review of tax depreciation and fringe benefit tax for electric vehicles is underway. This was announced in May 2016. From July 2017 the motor vehicle registration fee for electric (and plug in hybrid) cars will reduce to about $75 per year, which will be less than fuel vehicles.[19] See www.electricvehicles.govt.nz.

The government does not charge road user charges (RUCs) on electric vehicles. This rule began in 2009, and will be continue until light vehicles reach 2% of the fleet. These save an electric car owner $620 versus a small diesel car if driving 10,000km a year. From 2016 the RUC exemption covers electric vehicles over 3 tons (buses and trucks) and will continue until 2025 or until 2% of heavy vehicles are electric.

A 2015 report on electric car policy was published by Barry Barton at University of Waikato[20]. It compared electric vehicle growth in different countries, and determined New Zealand would benefit from a cost-neutral "feebate" scheme, used today in France. 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 New Zealand is one of the only countries to have no fuel efficiency standards, which place costs or restrictions on buying high emission cars. Other parties also have policies.[21]

Electric vehicle adoption is supported by an electric vehicle-specific industry association (DriveElectric.org.nz) and owner association (BetterNZ.org.nz).

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[17] European policies: icct.org/sites/default/files/publications/ICCT_EVpolicies-Europe-201605.pdf Norway graph & facts: elbil.no/english/

[18] transport.govt.nz/assets/Uploads/Our-Work/Documents/Electric-Vehicles-Package-of-Measures-to-Encourage-Uptake.pdf

[19] $18 ACC levy + $52 NZTA licensing + admin fee: nzta.govt.nz/vehicles/licensing-rego/vehicle-fees/licensing-fees/

[20] Barry Barton Paper: waikato.ac.nz/__data/assets/pdf_file/0007/278080/Electric-Vehicle-Policy-New-Zealand-in-a-Comparative-Context.pdf

[21] E.g. Green Party: greens.org.nz/policy/smarter-economy/business-tax-breaks-clean-transport-options and United Future radiolive.co.nz/tabid/615/articleID/127842/Default.aspx

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, which gives you an idea of how quick to recharge

Depending on driving style and car, you can usually expect to travel around 5 to 6km 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.[22]

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.[23]

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**[24] 	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), but is too slow to be very useful for daytime recharging. This socket is probably what you already have inside your garage at home. If your car doesn't come with a connector for this socket, you can purchase a portable 8 amp unit at JuicePoint.co.nz. *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 an 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. One supplier of Blue Commando based equipment is www.BlueCars.nz. 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.*

[22] See 0h50m on EVTV show youtube.com/watch?v=7NlmTiaR1Zg and various other research papers at avt.inl.gov

[23] energysafety.govt.nz/legislation-policy/electricity-acts-regulations-codes/regulatory-guidance-notes/electric-vehicle-charging-safety-guidelines

[24] km/hour charging on this and next page is a rough guide on the basis of 5 km per kWh; you'll go a little further in flat/urban driving.

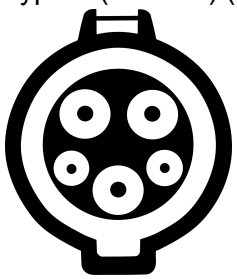
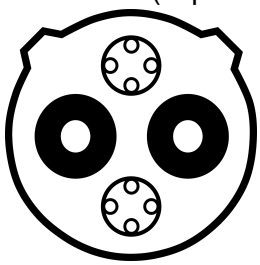
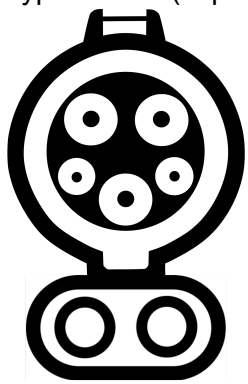
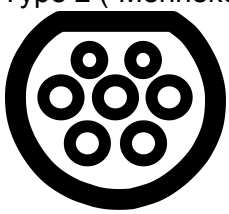
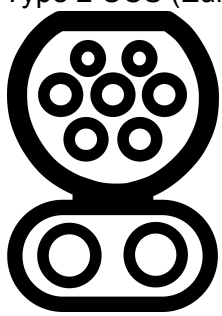
Dedicated "slow" charging station 15-40 amps, single phase AC 230V 3-9kW **18-45km per hour recharging** **100km takes 2-5 hours** **Or** 32 amps, three phase AC 415V 22kW **110km per hour recharging** **100km takes just under an hour** 	For around $800 or more, you can buy a dedicated wall-mounted charging station. They are safer and more robust compared to regular wall sockets, and charge your car faster. WorkSafe guidelines indicate standards you should look for in a product. Some take payment, can connect to a smartphone[25], or return electricity from your car back to your home or the power grid. 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 dedicated 22 kW charger will work, it will charge only as fast as the car supports. On the other hand, a Renault Zoe and some Tesla Motors cars can charge up to 22 kW, and drivers could feel impatient using a lower-rated unit. These units (especially 3-phase 22kW) provide fast enough speeds to suit users parked at day-time destinations (e.g. workplaces, malls), without the 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: 12-25 kW** Adding 100km takes **1-2 hours.** **Fast: 50 kW** *(Common in NZ)* Adding 100km takes **25 minutes** **Faster: 120 kW** *(Coming[26])* Adding 100km takes **10 minutes** **Ultra Fast: 400 kW** *(No car yet supports charging this quickly[27])* Adding 100km takes **3 minutes**[28] 	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 (under $10,000 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.

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 sell you a cable for a Japanese shaped wall socket or 100V electricity; this is unsafe and not permitted.

[25] Pictured EVSE: Type 2 socketed wall-mounted device with an untethered cable (as per NZTA guidance)
[26] Tesla's coming SuperChargers run at 120kW and will increase in the future. 120kW Delta DC chargers are sold in NZ by yhipower.co.nz.
[27] In 2017, 400kW chargers are being installed in USA (chargepoint.com/products/commercial/express-plus) and 350kW chargers across Europe.
[28] Assuming your battery is large enough and you travel 5km per kWh; you could go further with urban/flat driving.

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[29]:

Slow (AC)	**Fast** (DC)	**Combo** (slow AC and fast DC)
Type 1 ("J1772") (Japan / US)  Nissan Leaf and eNV200 Mitsubishi iMiev and Outlander Holden Volt Audi A3 e-tron BMW i3, BMW plug-in hybrids (for now) Kia Soul	CHAdeMO (Japan / US)  Nissan Leaf and eNV200 Mitsubishi iMiev and some Outlander BMW i3 imported from Japan Kia Soul	Type 1 CCS (Japan / US)  BMW i3 bought in NZ (for now)
Type 2 ("Mennekes") (Europe)  Hyundai Ioniq Renault Zoe, Kangoo VW eGolf BMW (from 2017) Tesla *(see note right on Supercharger)*	Tesla Supercharger (Japan/US)  *Unlikely to be found on a Tesla in NZ. Tesla bought in Australia and Europe can fast charge using Type 2 (without CCS) due to a special use of the connector.*	Type 2 CCS (Europe)  Hyundai Ioniq BMW from 2017 VW eGolf (Will become common in NZ over time)

NZTA issued guidelines[30] in September 2016 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), supplemented with an AC Type 2 socket.

Overseas, wireless charging (also known as induction) is available.

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

Calculating recharging times

Charging speed is rated in kW and battery capacity in kWh. For example, a 7kW charger takes 10 hours to recharge a 70kWh battery. In practice, the times vary slightly because a little energy is lost to heat, and the last 10% or so of a battery is charged slowly to preserve battery health. This trail-off is noticeable when using fast charging stations.

[29] Vector diagrams for the sockets available commons.wikimedia.org/wiki/EV_Charger_Gallery

[30] See "charging point connectors' under www.nzta.govt.nz/ev

Where can I charge?

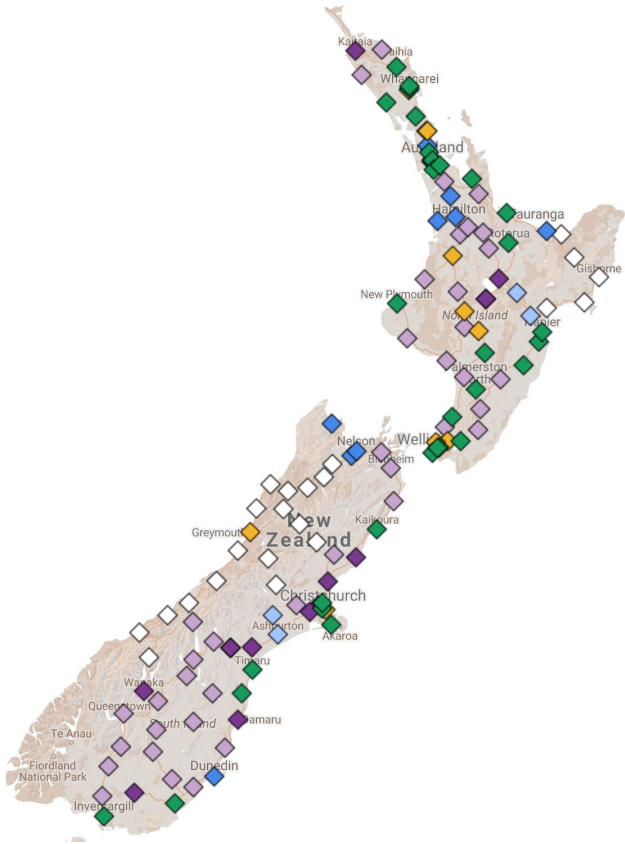
Besides home, which is where the majority of charging takes place, some employers are providing slow charging sockets in staff car parks. There are also public charging locations:

- A national network of about 100 fast chargers are being installed by charge.net.nz in cities and every ~80km along major state highways. The first stations were installed in 2015 and the network will be largely complete by the end of 2017, assisted by BMW. *(Map below right)*
- Tesla is installing SuperChargers for road trips and slower chargers at relevant destinations
- Fast chargers separately provided by some electricity companies, particularly Vector.
- Phoneboxes are being upgraded to provide slow charging (see spark.co.nz/plug)
- A nationwide coverage of hotels, motels and campervan grounds where you can plug in at powered car parks for slow charging. These often require a Blue Commando plug.
- A growing number of destinations (tourist sites, malls, supermarkets, etc) have slow chargers.

Slow Charging (for destinations)

All of the above are operating today

Fast Charging Network



Open Under Construction Q1 2017 2017 Future Other Network

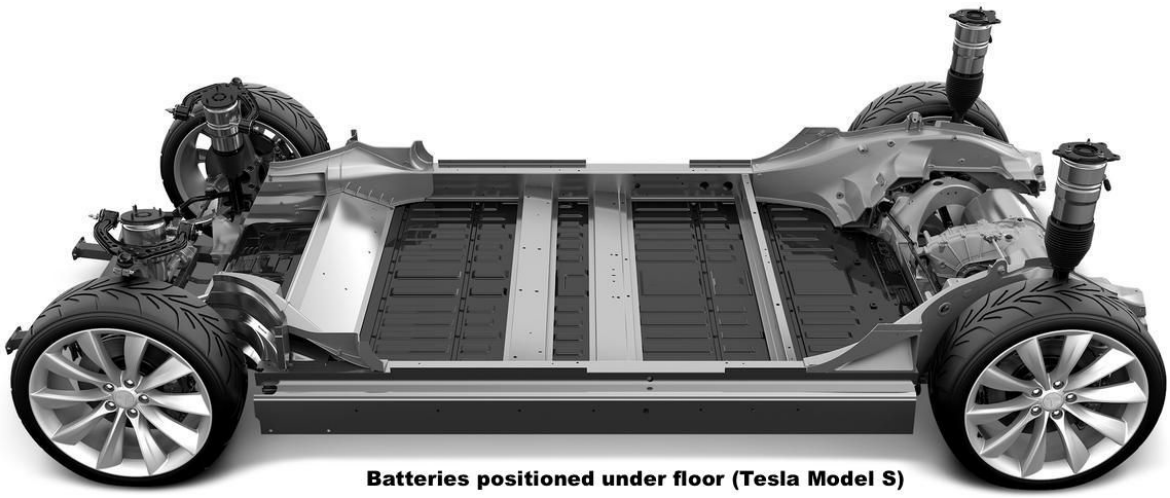
Visit www.plugshare.com (pictured left) or use the PlugShare smartphone app for a map of charging locations, complete with costs and other details.

If you offer car charging to staff, customers, or the public, you should certainly list it on PlugShare (it's free). Include a description on 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 EV charging symbol, to increase public awareness of electric cars, and to avoid petrol cars blocking the park.

See NZTA public charging infrastructure guidance at www.nzta.govt.nz/ev and download their EV symbol from nzta.govt.nz/resources/traffic-control-devices-manual/sign-specifications/view/1074

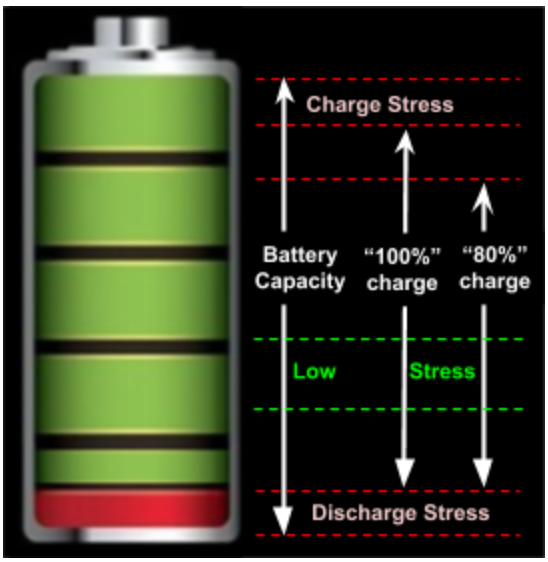
Batteries: size, life, replacement

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 and the high-end Tesla Motors cars have 100 kWh. This affects range and cost.



The life of a battery is reduced when at extreme high or low levels of charge[31]. 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. Excessive (more than daily, for years) fast-charging will slightly reduce battery life[32].

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)[33]. 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[34]. 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.

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. (A BMW i3 bought with a 22kWh battery can be officially upgraded to 33kWh for example).
- You may need to replace only individual dead cells, at a lower price than a full replacement.
- A new Nissan Leaf battery costs little under $10,000 (2015); prices are quickly falling.

[31] Wealth of battery information at batteryuniversity.com; Dalhousie Uni lecture by Jeff Dahn youtube.com/watch?v=9qi03QawZEk

[32] US government study on slow vs fast charging: avt.inl.gov/pdf/energystorage/FastChargeEffects.pdf

[33] www.electricvehiclewiki.com/Battery_Capacity_Loss#Nissan.27s_Responses_and_Actions

[34] 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 is what commonly gives buyers the confidence to proceed with the purchase. You can test drive an electric car by asking a dealer, asking existing owners if they're prepared to let you drive theirs, or rent from bluecars.nz and mevo.co.nz.

Where to Buy and Get Service?

Used and new car dealers throughout New Zealand sell electric vehicles. You will find many listings by selecting "Fuel Type: Electric" in the *Advanced Car Search* at trademe.co.nz/motors.
Tesla sells direct from their website. Cars bought in the Japan or the U.K. are eligible for electric car incentives and these can reduce the price of imports by thousands of dollars.

If buying a used car from Japan, the dashboard consoles are usually not in English, but some dealers replace these with English systems but this can reduce dashboard features. Official local support and service is found for the models above (except Tesla, which is coming soon).

What about other types of vehicles?

- **Bicycles**: commonly sold in local bicycle shops, with 40-100km "pedal assisted" range.
- **Motorbikes**: ubcobikes.com (kiwi made, off-road); zeromotorcycles.com (import, for road).
- Formula **racing** cars now compete in "Formula E", a global tournament (fiaFormulaE.com).
- "**Tuk tuks**" are used for tourism[35] and one-seat delivery buggies are used by NZ Post.[36]
- **Trucks** are locally made by zevnz.com; hybrid utes and SUVs by US-based viamotors.com, and wrightspeed.com and Tesla are building heavy trucks[37].
- Fully electric **buses** are mass produced by BYD.com; London is buying hundreds[38].
  New Zealand may gain hundreds of plug-in hybrid buses by Wrightspeed from late 2016[39].
- The world's first electric **ferry** launched in 2015 in Norway (carries 300 people, 120 cars)[40].
- Prototype electric **airplanes** exist. In 2016 the *Solar Impulse 2* flew around the entire globe.

Community Groups and Events

EVolocity, the largest annual national electric vehicle event, including test drives, demonstrations, workshops, competitions between petrol and electric race cars, and a high-school competition in which teams design and build their own electric vehicles. (Last: Nov 2016). evolocity.co.nz

Leading the Charge, an annual roadtrip of Tesla and other electric cars from the north to the south of New Zealand, stopping in towns for display and rides. leadingthecharge.org.nz (April each year)

International Drive Electric Week, September 10-18: locations host parades, displays, and events to help people to see, ride, or drive electric vehicles. See driveelectricweek.org

Facebook "EV Owner" groups

- NZ EV Owners: facebook.com/groups/NZEVOwners/ *(lots of discussion)*
- Whangarei: facebook.com/WhangareiElectricVehicleMeetup/ and facebook.com/revupnz/
- Auckland: facebook.com/groups/291373964545996/
- Wellington: facebook.com/groups/WellyEV/
- Christchurch: facebook.com/groups/ChristchurchEVGroup/
- Dunedin: facebook.com/Dunedin-EV-Owners-919185271451575/

[35] stuff.co.nz/travel/destinations/nz/77235562/tuktuks-taking-to-the-streets-of-wellington
[36] nzpost.co.nz/about-us/media-centre/media-release/eco-vehicles-confirmed-as-way-of-future-for-new-zealand-post
[37] www.sfgate.com/business/article/Tesla-co-founder-Ian-Wright-snags-FedEx-for-new-5792082.php
[38] tfl.gov.uk/info-for/media/press-releases/2015/july/more-than-50-all-electric-buses-to-enter-service-in-london
[39] nzbus.co.nz/news-from-nzbus/media-release-nz-bus-investing-in-electric-powered-vehicles
[40] cleantechnica.com/2015/06/13/worlds-first-electric-battery-powered-ferry/