A NZ Guide to Electric Bikes

By Rob McEwen and Alex Kendon

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"I love my electric bike because it is liberating - fresh air and exercise without the hills or headwinds." Daphne Bell, Hamilton.

What is an ebike?

An **electric bicycle**, also known as an **e-bike**, is a bicycle with an integrated electric motor which can be used for propulsion. There are a great variety of e-bikes available worldwide, from e-bikes that only have a small motor to assist the rider's pedal-power (known as pedelecs) to somewhat more powerful e-bikes which tend closer to moped-style functionality. All, however, retain the ability to be pedalled by the rider and are therefore not electric motorcycles. E-bikes use rechargeable batteries and the lighter varieties can travel up to 25 to 32 km/h, depending on the laws of the country in which they are sold, while the more high-powered varieties can often do in excess of 45 km/h (28 mph).

Visit

https://www.nzta.govt.nz/vehicles/vehicle-types/low-powered-vehicles/ for info on low powered vehicles that do not require registration or a driver's license.

What's the Point?

- Ride faster versus a conventional bike
- Enjoy riding up hills and into head winds
- No need to sweat
- Easy on the joints
  - Ebikes put less pressure on knees, hips and other joints
- Keep up with younger or fitter riders
- Avoid using the car
  - Save money
  - Save CO2 emissions
- Have more fun

Benefits for Commuters

- Won't break a sweat on the way to work
- Parking is a breeze
- No more waiting in traffic
- Monthly costs of between $4 - $8

"Oh the joy of riding my ebike. I can put as much or as little effort into it as I want." **Lucy Casey, Auckland.**

MY ELECTRIC LOVE. YOUR ELECTRIC LOVE.

Lifestyle Benefits

- Ride further afield without worrying about having enough energy to ride back
- Run errands quickly and easily, replacing the car and its emissions & costs
- Flatten out hills
- Spend quality time with your partner, children or grand children

Ebikes come in many different styles. This fat tyre ebike is perfect for fun at the beach and on trails.

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Health Benefits

- Become more active and work on your fitness goals
- Burn calories, getting the level of exercise you choose
- Spend more time outside in the fresh air
- Reduced commuting stress ➔ a calmer start to your day

"When I bought an ebike in 2012, I weighed 457 pounds. Riding an ebike was my first form of exercise. I could barely walk 150 steps at a time. With my ebike I began a journey to a new shape and a new life, losing more than 270 pounds in the process." **Rhonda Martin.**

Benefits for Mountain Bikers

- Tackle challenging ascents you wouldn't normally attempt
- Avoid needing a car to drop you off at the top of a hill
- Ride to the trail instead of driving
- Significantly increase your range

"I love my eBike because it makes me want to get out and ride. A 30km ride becomes not only possible, but fun as well as good for me." **John Curtis, Taupo**

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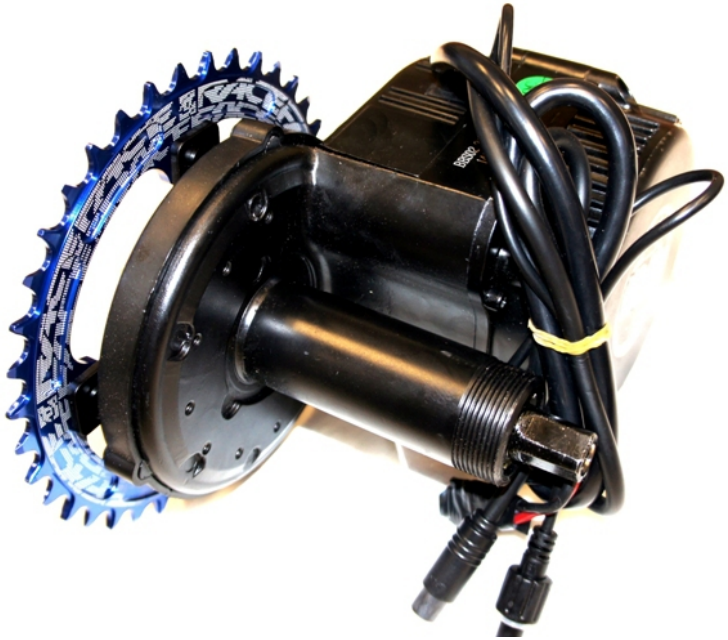
Motors

There are three main types of electric bike motor: A front wheel motor, a rear wheel motor and a mid-drive motor. The following pros and cons of each are derived from an article in Electric Bike Report, February 2015 and have been edited by the authors of this guide.



A Bafang 8fun mid drive motor

Front Wheel Motors

Pros

- Creates an all-wheel drive bike because the motor drives the front wheel and you can power the rear wheel with your pedal power. This can be advantageous for riding in snow or in sand. Some fat e-bikes are coming with front hub motors to create this all-wheel drive system. Any type of bike drivetrain (gears) can be used: traditional gears with cogs, chain and derailleurs or internal geared hubs (IGH) with a chain or belt drive.

- Front hub motor systems are easy to install or remove from the bike because there are no gear systems to deal with (chain, derailleur, etc.) when compared to a rear hub motor. This is handy for fixing a flat tire or adding/removing electric assist from a conventional bike.

- Front hub motors can provide for a more balanced bike weight distribution if the battery is mounted in the middle or back part of the bike. This helps when lifting the bike onto a car rack or carrying the bike up stairs.

Cons

- Since there is much less weight over the front wheel there is a tendency for the wheel to spin when accelerating on roads that have a layer of loose material or when climbing a steep hill. This is more noticeable on the powerful front hub motors.

- Front hub motors generally have a throttle and/or a cadence sensor pedal assist. It is rare to find a torque sensor based pedal assist system for a front hub motor.

- Front hub motors generally need a sturdy fork, especially for the higher powered motors. This is very important if you are installing a front hub motor kit on a conventional bike. Check with the kit company for their recommendations on what is required for the front fork. If the bike has suspension forks, the unsprung weight of the motor will reduce the efficiency of the suspension.

- The higher torque hub motors (generally the more powerful) need larger spokes and sturdy rims.

Rear Hub Motors

Pros

- There is significantly less tendency for the rear wheel to spin on loose road conditions because the majority of the rider's weight is over the rear wheel.
- There is a wide range of power options (250 watts to 750 watts and beyond) because the bike's frame provides a good structural platform to handle high torque from the motor.
- Rear hub motors can provide assist with a throttle and/or cadence or torque sensor pedal assist.
- Some direct drive rear hub motors provide regenerative braking.

Cons

- Rear hub motors are a little more cumbersome to install or remove because the gears (chain, derailleur, etc.) need to be worked around.
- They have a tendency to "bog down" on long steep climbs.
- Bikes that have a rear hub motor with a rear rack battery are back heavy and that can affect the handling of the bike. Some riders may not notice this if they are riding in a more cautious manner vs. a performance riding style. Back heavy e-bikes can be hard to handle while lifting onto a car rack or carrying the bike up stairs. Removing the battery can help with this.
- If the bike has rear suspension the unsprung weight of the motor will reduce the efficiency of the suspension.
- The higher torque hub motors (generally the more powerful) need larger spokes and sturdy rims.

Mid Drive Motors

Pros

- Able to climb long steep hills because they can leverage the lower gears of the bike and keep their rpm's in an efficient range without getting bogged down – great if you ride in areas that have long climbs.
- Leverage the higher gears of the drivetrain to cruise along at high speeds on the flat or inclined roads.
- Provides a low and centred weight distribution.
- Removing the front or rear wheel is easy because there are no motor wires or hardware to remove.
- Can use a throttle and/or cadence or torque sensor pedal assist. Some mid drives are pretty sophisticated with sensors that measure the pedal power, wheel speed & crank speed to provide assist that blends with the riders power to create a very intuitive ride feel.
- Mid-drives are generally quieter and more efficient than comparable hub motors as they only have to cover the rev-range of the rider's cadence.

Cons

- Since the power is being transferred through the drivetrain of the bike there can be more wear applied to the drivetrain components (chain, cogs, derailleur, etc.)
- To keep the mid drive motor operating efficiently you need to be shifting the gears properly for climbing hills or cruising along the flats.
- Some mid drive systems can sense when you are going to shift the gears and they will reduce the power for a smoother shift. There are some systems that don't have these sensors and that can lead to abrupt shifts when the motor is applying full power, which increases wear on the drivetrain.
- A majority of mid drives have a single chain ring which limits the gear range to a rear cog set or to the gear range of an internally geared hub. For most riding conditions this is okay because the motor makes up for the gear range that is missing and the gear range of a rear cog set or IGH is pretty wide these days.

Batteries

Today's batteries are Lithium Ion, a chemistry that has proven highly reliable in laptops and cell phones for many years. Lithium batteries have become the gold standard for electric bicycles. Their light weight and long cycle life have made them a great fit for any small electric vehicles where weight and efficiency often take a premium over cost. When it comes to choosing the right electric bicycle battery, you need to consider the following criteria:

- **Voltage**
- **Capacity**
- **Type**

Voltage. Most modern systems in the range of 200 – 400W use a 36 volt battery and 500 – 1500W systems use a 48 volt battery. Some older/cheaper systems run 24 volt, but these are becoming less common. The main thing to check is that you select the correct voltage for your system.

Capacity. There are two main factors to consider when choosing battery capacity: range, and maximum discharge rate. As a rule of thumb, a 300W mid-motor will deliver about 8km of range/100wh of capacity at maximum assist on a flat road. Higher capacity batteries will always deliver more range. The maximum discharge rate determines what power of motor the battery can support. This generally increases with battery capacity. Check with your battery supplier to ensure it is compatible with your motor.

Battery Types: Lithium Ion

Most new electric bikes are equipped with lithium-ion batteries. Of the battery types commonly used on eBikes they offer the best energy/unit weight and energy/unit volume. There are actually a number of different chemistries that are referred to as lithium-ion, including $LiMn_2O_4$, $LiCoO_2$ and $LiNiMnCoO_2$ but there is a huge amount of research happening in this area and new chemistries are entering production. Lithium-ion cells produced by reputable manufacturers such as Samsung, LG, Sanyo and Panasonic offer good reliability, safety and charge/discharge rates (Charge times can be as low as 2.5 hours without significantly affecting battery longevity).

The cells used in the battery are just one component in the complete battery though. A quality battery will also include a battery management system (BMS) that shuts the battery down under fault conditions like short circuit, over-temperature, over-charge, over-discharge etc... The BMS should also keep the cells "balanced", which extends the service life of the battery. The quality of construction is also important. Since lithium-ion batteries are relatively complex there are a lot of interconnects and joints that can fail if they are poorly made of if the cells are not well supported within the battery casing. This is generally only an issue on rock-bottom priced batteries though and well manufactured batteries have proven very rugged.

In addition to their high energy density lithium-ion batteries have a very "flat" discharge characteristic, which means the output voltage doesn't fall much as the battery discharges. For e-Bikes this means you won't feel the power from the motor reducing as the battery empties out. This can also help keep the motor operating at optimal efficiency so your effective range is slightly higher than with other battery types. Effective range is also increased by the weight savings that lithium-ion batteries offer.

Battery Types: Lithium Ion (cont'd)

Cycle life and shelf life varies quite a lot with chemistry and manufacturer. Most common types now offer a minimum of 600 cycles at 80% depth of discharge (which is where the BMS normally disconnects the battery) before the battery capacity drops below 80% of its original capacity. The number of charge cycles is much higher at a lower depth of discharge and for some types it can stretch to thousands of cycles at 20% depth of discharge. If the batteries are properly looked after they should last 3 to 5 years. One thing that's clear is that really cheap lithium-ion batteries need replacing a lot sooner than ones using decent quality cells.

About the only thing that really tends to "kill" lithium-ion batteries that have a good BMS is letting them go totally flat. The BMS will disconnect the battery before it can be run dead flat but, like all batteries, they will gradually self-discharge when left unattended for long periods. Most types will only need topping up every 2 or 3 months. Lithium Manganese cells have a higher self-discharge rate and should be topped up every month.

The cost to purchase and replace lithium-ion batteries is still higher than lead-acid, NiMh or NiCd. Prices have been gradually reducing but at the time that this article was written the lithium cell price had been relatively constant due to limited supply of raw materials (lithium). The global lithium-ion cell price is expected to drop when the Tesla/Panasonic "Gigafactory" comes online.

Lithium-ion batteries are not currently recycled in New Zealand, but many recycling centres will accept them. They are generally shipped off-shore to be recycled. Due to the high-value materials the cells contain recycling is financially practical so cells that are dropped off to be recycled most likely will be. For the purposes of disposal in landfill current lithium-ion chemistries are considered benign, although some do contain nickel, which can be toxic to plants.

Battery Types: Lithium Ion Phosphate

Although less common than "lithium-ion" batteries in the e-Bike market LiFePO4 batteries are quite common in China's domestic electric car market. It is, in fact, another lithium-ion chemistry but in the e-Bike community it is not often referred to as such. You'll often see LiFePO4 batteries called LFP (for lithium-ferrophosphate), lithium-ion or incorrectly as LiPO. They are constructed in the same way as other lithium-ion batteries and should also have a BMS.

LiFePO4 cells have a lower energy density than other lithium-ion cells. In general about 70% of the capacity for a given volume and weight. This is, in part, due to the lower cell voltage of 3.3V, compared to a cell voltage of 3.6 or 3.7V for most other lithium-ion chemistries.

Despite their lower energy density LiFePO4 batteries remain popular due to their high shelf life and cycle life. They will generally offer at least 1000 cycles at 80% depth of discharge and under heavier loads than other lithium-ion chemistries. Since the cycle life and maximum discharge rate varies widely from manufacturer to manufacturer and even between models of cell it's hard to compare the maximum discharge rates, but rates of 5C and even 10C are not unusual for LiFePO4. This is about double the maximum discharge rate of most other lithium-ion types. The self-discharge rate of LiFePO4 is also very low. It's still recommended to charge them every couple of months but good quality LiFePO4 batteries can retain up to 70% of their charge after being left to sit for a year at 20 degrees Celsius (note that self-discharge rates increase at higher temperatures).

Battery Types: Lithium Polymer

Non-rigid "pouch" cells are often referred to as Lithium Polymer cells (also LiPO, Li-Polly and others), where the casing is a flexible polymer and the cell format is "prismatic" rather than cylindrical. There is such a thing as a solid polymer electrolyte cell, which does not contain any liquid at all, but these have never entered large scale production. Most lithium polymer cells use a micro-porous sheet containing a gel electrolyte, while cylindrical cells referred to as "lithium-ion" use a plain gel electrolyte. While many in the industry regard lithium polymer batteries as a totally different animal to lithium-ion, they are from a technical standpoint still a type of lithium-ion battery. Like other lithium-ion batteries lithium-polymer types should have a BMS fitted.

Energy density is typically 10-30% better than cylindrical cells and the space inside the battery casing can be better utilised when using pouch cells, which are usually rectangular and relatively flat.

Pouch cells are not as mechanically rugged as cylindrical cells, which are always manufactured in a metal cylinder. The often lack internal protection devices, such as a PTC, that are pretty standard in cylindrical cells, so rely completely on the BMS for protection. Shelf life, cycle life and maximum discharge currents are similar to cylindrical cells of the same chemistry.

The manufacturing process for lithium polymer pouch cells is more expensive than cylindrical cells, so uptake on e-Bikes has not been widespread.

Range and Speed

Range is approximately 8km/100wh for a 300W mid-motor and slightly less for a 300W hub motor. Top speed on electric only is about 25 km/hr for a hub motor and 32 km/hr for a mid-motor in high gear. Range and top speed are dependent on riding conditions and rider weight.

***"I love my electric bike because it is so versatile ~ I can go on the road or along the river paths. No excuses for not getting out-and-about and taking the scenic route or long way home, knowing I have assistance when needed."* – Jane Lawrence, Hamilton**

Conversions

Many people love the bike they already have but just haven't ridden it much lately due to the effort involved. Converting an existing bike to electric is generally straightforward and can be tackled by anyone with basic DIY skills. The process generally takes about 4 hours, It is more environmentally friendly (makes use of an existing bike rather than requiring the manufacture of a new bike) and will save you money.

What does an ebike conversion involve?

To convert any standard bicycle into an ebike, four parts need to be installed: the battery, controller, motor and throttle. Most ebike parts come packaged together with those four crucial parts and everything is designed to attach easily to the bicycle. The battery and controller simple bolt onto the frame or bicycle rack using the supplied hardware. The motor is installed by removing your existing crank case. Finally, the throttle just slides over the end of your handlebar.

A mid drive conversion kit

Helpful Hints for DIY Converters

1. Consider taking your bike into a bike shop and having them remove your cranks and your front derailleur.
2. If you're installing a mid-drive motor (most common now), then this video will walk you through the steps involved - https://www.youtube.com/watch?v=jf6BMf28ats
3. Make sure your rolling chassis is sturdy enough and is worthy of you investing $1600 or so to convert it to electric. (Be aware that production electric bikes come in a wide variety of prices, starting at under $2000, so get some advice and weigh up your options before proceeding.

See if your bike is suitable for conversion.
http://meloyelo.nz/convert-your-bike/

Maintenance

When you're doing e bike maintenance, it's important to remember that there are both mechanical and electrical elements that need your attention. Electric bikes have all the mechanical parts of a regular bike but with the addition of an electrical motor that also requires maintenance. Here are a few do-it-yourself electric bike maintenance tips:

Regular cleaning
Cleaning the bike often will help to keep dirt, dust, and debris from getting into the engine and messing with the motor. It also helps to keep all the mechanical parts moving properly without grinding against each other or blocking the chain. Like all bikes, ebikes should be washed regularly and cleaned after trail riding.

When you clean your e-bike, do not use a pressurized hose or stream of water. This might compromise the integrity of the seals around electrical equipment and wear them down, eventually leading to exposed and wet electrical systems that will then malfunction. Instead, use a low-pressure water stream or a wet rag and dry the bike off once you're doing washing it.

Lubrication
In order to keep all the mechanics in working order, you can apply lubrication on the major moving parts such as the chain. You should use a special cleaning solution to clean off the chain before applying a bike lubricant to it. This should ideally be done at least once a week if you use the bike often, though with more advanced lubes, you don't need to apply this often as long as the drivetrain is kept clean.

Maintenance

Check the bolts
Do a quick once-over and check for any loose screws, bolts, nuts, or anything else on the bike. If there is too much play in the bolts, tighten them up a little bit and see if you can identify the cause of the looseness. Don't tighten the bolts too far. We recommend using a torque wrench or having your bike mechanic do a safety check once in a while.

Tyre pressure
The sidewalls of your bike tyres should tell you how much pressure is ideal for proper use of the bike. You can check to see what the current pressure is in the tires by using a simple pressure gauge. If it's too low, or if the tires can visibly sink when you push your finger into them, you should get out your bike pump and inflate them properly to the pressure indicated on the tires. Operating tyres on low pressure increases the draw on the battery and can lead to pinch-flats.

Brake pads
Take a good look at the brake pads on your bike every few weeks to see how they are holding up. It's essential that you have effective brakes or else you could end up in a serious accident. Brake pads can easily and cheaply be replaced whenever necessary.

Battery care
The most important component on the bike is the battery. Read the manufacturer's instructions on how to properly charge it before you attempt to charge. Charging it improperly will probably end up damaging the battery and wearing it out quicker. Battery replacements can be pricey, so take care of the battery you have and help it last as long as possible.

Frequently Asked Questions

How fast can they go? Most electric bikes designed for the NZ market will provide you with assist up to 30 km/hr or more. Bikes designed for the European market provide assist up to 25 km/hr. This includes most European makes.

Why can't they go faster? The intent of an electric bicycle is to be very similar to a conventional bicycle and that includes the speed that it can travel. If eBikes provided higher power assisted speeds then they would be regulated like a scooter/motorcycle which requires registration, licence, insurance, etc. In addition, this would limit where eBikes can be ridden. Bicycles and electric bicycles are great vehicles because they do not require registration, licences, insurance, and there are so many places they can be ridden.

How far can they go? Most electric bikes have a range of 30 – 50kms and that depends on the riding conditions (hills, headwinds, etc.), how much pedal power you are providing, and how much weight you are moving (yourself + cargo). You can get eBikes with more range (up to 100kms) but they are generally more expensive and weigh more because of the larger battery pack. Quick tip: charging your battery at work will help to increase your daily range.

Frequently Asked Questions

How long does it take to charge the battery? Most electric bike batteries will fully charge from empty in 3 to 6 hours depending on the battery size.

How much does it cost to charge the battery? In general it will cost $0.20 to $0.50 to charge an electric bike battery pack. This will depend on what your local electricity supplier charges.

Can I charge the battery by pedaling? Some electric bikes have this feature but this requires a substantial amount of your pedal power, so be ready for one heck of a workout! Some of these same eBikes have regenerative braking that will charge the battery as you are braking, similar to the way electric cars do. This feature is not that common however, as it increases cost and provides only a small improvement in range.

How much do they cost? Electric bikes range in price from $1800 to $10,000+ but the average price range for quality electric bikes is $2200 - $4000.

Can you get any exercise on an electric bike? Absolutely! You decide how much exercise you want to get by adjusting the power assist level on the bike. One strategy is to commute to work with higher assist so you arrive with minimal to no sweat and then use a lower assist when riding home to get more of a work out and unwind from a long day. You can also push yourself to the limit knowing the electric power is there to help you get home.

How much do they weigh? Generally electric bikes range from 20 to 27 kgs. Of course there are the exceptions on both sides of that range.

About MeloYelo

MeloYelo is the social enterprise arm of EVolocity, a registered charity which runs an electric vehicle design & build competition in NZ high schools. It's about turning NZ youth onto engineering, sustainability and clean transportation technologies.

MeloYelo is building a network of regional electric bike experts, who are trained in retrofitting existing bikes with electric motor kits and who can answer your electric bike questions. Many of these experts also offer new ebikes for sale, and will gladly allow you to test ride an ebike.

Funds raised through the sale of ebikes and retrofit kits support our EVolocity programme in schools.

Buy through MeloYelo and help turn NZ youth onto engineering, sustainability and clean transportation technologies.

Buy these electric motor kits through MeloYelo

300 Watt Mid Drive Motor Kit: $999
http://meloyelo.nz/product/techbikes-300w-mid-motor-kit/

300 Watt Torque Controlled Mid Drive Motor Kit: $999
http://meloyelo.nz/product/techbikes-300w-torque-controlled-mid-motor-kit/

Buy these battery packs through MeloYelo

36V 13AH RACK BATTERY (R007-36-13)

$899.00-$949.00

36V 15AH RACK BATTERY (S015-36-15)

$999.00

36V 11AH BOTTLE BATTERY (S003-36-11)

$649.00

36V 8AH BOTTLE BATTERY (S003-36-8)

$575.00

36V 13AH FRAME MOUNTED BATTERY (R001-36-13)

$899.00

36 VOLT 10.4 AMPHOUR RACK BATTERY (S015-36-10.4)

$649.00

http://meloyelo.nz/product-category/motor-kits-batteries/

Coming Soon

An exciting range of affordable, factory-new ebikes.

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Got a Question?

You'll find this pop up box at the bottom right hand corner of our web pages. Simply click, ask your question and submit.

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