

# Electric bicycle

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An **electric bicycle**, also known as an **e-bike** or **booster 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 (i.e., *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 (16 to 20 mph), 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). In some markets, such as Germany, they are gaining in popularity and taking some market share away from conventional bicycles,<sup>[1]</sup> while in others, such as China, they are replacing fossil fuel-powered mopeds and small motorcycles.<sup>[2][3]</sup>

Depending on local laws, many e-bikes (e.g., *pedelecs*) are legally classified as bicycles rather than mopeds or motorcycles, so they are not subject to the more stringent laws regarding their certification and operation, unlike the more powerful two-wheelers which are often classed as electric motorcycles. E-bikes can also be defined separately and treated as a specific vehicle type in many areas of legal jurisdiction.

E-bikes are the electric motor-powered versions of motorized bicycles, which have been around since the late 19th century.

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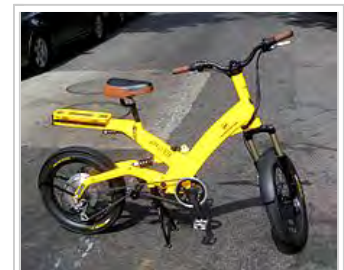
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Pedego Trail Tracker electric bike



A mountain bike styled e-bike: a *Cyclotricity Stealth*



A moped-style e-bike: an *A2B Bicycles Ultramotor metro/octave* \$3599



E-bike charging station, Germany

## History

In the 1890s, electric bicycles were documented within various U.S. patents. For example, on 31 December 1895, Ogden Bolton Jr. was granted U.S. Patent 552,271 (<https://www.google.com/patents/US552271>) for a battery-powered bicycle with “6-pole brush-and-commutator direct current (DC) hub motor mounted in the rear wheel.” There were no gears and the motor could draw up to 100 amperes (A) from a 10-volt battery.<sup>[4]</sup>

Two years later, in 1897, Hosea W. Libbey of Boston invented an electric bicycle (U.S. Patent 596,272 (<https://www.google.com/patents/US596272>)) that was propelled by a “double electric motor”. The motor was designed within the hub of the crankset axle.<sup>[5]</sup> This model was later re-invented and imitated in the late 1990s by Giant Lafree e-bikes.

By 1898 a rear-wheel drive electric bicycle, which used a driving belt along the outside edge of the wheel, was patented by Mathew J. Steffens. Also, the 1899 U.S. Patent 627,066 (<https://www.google.com/patents/US627066>) by John Schnepf depicted a rear-wheel friction “roller-wheel” style drive electric bicycle.<sup>[6]</sup> Schnepf's invention was later re-examined and expanded in 1969 by G.A. Wood Jr. with his U.S. Patent 3,431,994 (<https://www.google.com/patents/US3431994>). Wood's device used 4 fractional horsepower motors; connected through a series of gears.<sup>[7]</sup>

Torque sensors and power controls were developed in the late 1990s. For example, Takada Yutky of Japan filed a patent in 1997 for such a device. In 1992 Vector Services Limited offered and sold an e-bike dubbed Zike.<sup>[8]</sup> The bicycle included NiCd batteries that were built into a frame member and included an 850 g permanent-magnet motor. Despite the Zike, in 1992 hardly any commercial e-bikes were available.

Production grew from 1993 to 2004 by an estimated 35%. By contrast, according to Gardner, in 1995 regular bicycle production decreased from its peak 107 million units.

Some of the less expensive e-bikes used bulky lead acid batteries, whereas newer models generally used NiMH, NiCd, and/or Li-ion batteries, which offered lighter, denser capacity batteries. Performance varies; however, in general there is an increase in range and speed with the latter battery types.

By 2001 the terms e-bike, power bike, "pedelec", pedal-assisted, and power-assisted bicycle were commonly used to refer to e-bikes. The terms "electric motorbike" or "e-motorbike" refer to more powerful models that attain up to 80 km/h (50 mph).

In a parallel hybrid motorized bicycle, such as the aforementioned 1897 invention by Hosea W. Libbey, human and motor inputs are mechanically coupled either in the bottom bracket, the rear wheel, or the front wheel, whereas in a (mechanical) series hybrid cycle, the human and motor inputs are coupled through differential gearing. In an (electronic) series hybrid cycle, human power is converted into electricity and is fed directly into the motor and mostly additional electricity is supplied from a battery.

By 2007 e-bikes were thought to make up 10 to 20 percent of all two-wheeled vehicles on the streets of many major Chinese cities.<sup>[9]</sup> A typical unit requires 8 hours to charge the battery, which provides the range of 25 to 30 miles (40 to 48 km),<sup>[9]</sup> at the speed of around 20 km/h.<sup>[10]</sup>

## Classes

E-bikes are classed according to the power that their electric motor can deliver and the control system, i.e., when and how the power from the motor is applied. Also the classification of e-bikes is complicated as much of the definition is due to legal reasons of what constitutes a bicycle and what constitutes a moped or motorcycle. As such, the classification of these e-bikes varies greatly across countries and local jurisdictions.

Despite these legal complications, the classification of e-bikes is mainly decided by whether the e-bike's motor assists the rider using a *pedal-assist* system or by a *power-on-demand* one. Definitions of these are as follows:

- With **pedal-assist** the electric motor is regulated by pedalling. The pedal-assist augments the efforts of the rider when they are pedalling. These e-bikes – called *pedelecs* – have a sensor to detect the pedalling speed, the pedalling force, or both. Brake activation is sensed to disable the motor as well.
- With **power-on-demand** the motor is activated by a throttle, usually handlebar-mounted just like on most motorcycles or scooters.

Therefore, very broadly, e-bikes can be classed as:

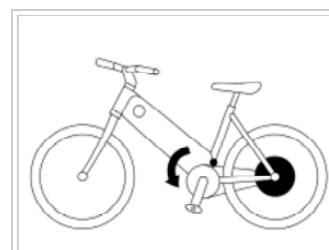
- *E-bikes with pedal-assist only*: either *pedelecs* (legally classed as bicycles) or *S-Pedelecs* (often legally classed as mopeds)
  - *Pedelecs*: have pedal-assist only, motor assists only up to a decent but not excessive speed (usually 25 km/h), motor power up to 250 watts, often legally classed as bicycles



A bike equipped with an after market electric hub motor conversion kit, with the battery pack placed on the rear carrier rack



BLDC Bicycle Hub Motor



Schematic of a Pedelec

- *S-Pedelegs*: have pedal-assist only, motor power can be greater than 250 watts, can attain a higher speed (e.g., 45 km/h) before motor stops assisting, legally classed as a moped or motorcycle (**not** a bicycle)
- *E-bikes with power-on-demand and pedal-assist*
- *E-bikes with power-on-demand only*: often have more powerful motors than pedelecs but not always, the more powerful of these are legally classed as mopeds or motorcycles

### E-bikes with pedal-assist only

E-bikes with pedal-assist only are usually called *pedelecs* but can be broadly classified into pedelecs proper and the more powerful S-Pedelegs.

#### Pedelecs

The term "pedelec" (from **pedal electric cycle**) refers to an e-bike where the *pedal-assist* electric drive system is limited to a decent but not excessive top speed, and where its motor is relatively low-powered. Pedelecs are legally classed as bicycles rather than low-powered motorcycles or mopeds.

The most influential definition which distinguishes which e-bikes are pedelecs and which are not, comes from the EU. From the EU directive (EN15194 standard) for motor vehicles, a bicycle is considered a pedelec if:

1. the *pedal-assist*, i.e. the motorised assistance that only engages when the rider is pedalling, cuts out once 25 km/h is reached, and
2. when the motor produces *maximum continuous rated power* of not more than 250 watts (n.b. the motor can produce more power for short periods, such as when the rider is struggling to get up a steep hill).

An e-bike conforming to these conditions is considered to be a pedelec in the EU and is legally classed as a bicycle. The EN15194 standard is valid across the whole of the EU and has also been adopted by some non-EU European nations and also some jurisdictions outside of Europe (such as the state of Victoria in Australia).<sup>[11]</sup>

Pedelecs are much like conventional bicycles in use and function — the electric motor only provides assistance, most notably when the rider would otherwise struggle against a headwind or be going uphill. Pedelecs are therefore especially useful for people living in hilly areas where riding a bike would prove too strenuous for many to consider taking up cycling as a daily means of transport. They are also useful when it would be helpful for the riders who more generally need some assistance, e.g. for elderly people.

#### S-Pedelecs

More powerful pedelecs which are not legally classed as bicycles are dubbed **S-Pedelecs** (short for *Schnell-Pedelecs*, i.e. Speedy-Pedelecs) in Germany. These have a motor more powerful than 250 watts and less limited, or unlimited, pedal-assist, i.e. the motor does not stop assisting the rider once 25 km/h has been reached. S-Pedelec class e-bikes are therefore usually classified as mopeds or motorcycles rather than as bicycles and therefore may (depending on the jurisdiction) need to be registered and insured, the rider may need some sort of driver's license (either car or motorcycle) and motorcycle helmets may have to be worn.<sup>[12]</sup>

### E-bikes with power-on-demand and pedal-assist

Some e-bikes combine both pedal-assist sensors as well as a throttle. An example of these is the *eZee Torq*<sup>[13]</sup> and Adventure 24+ by BMEBIKES.<sup>[14]</sup>

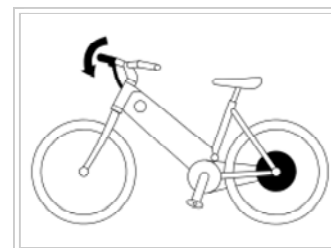
### E-bikes with power-on-demand only

Some e-bikes have an electric motor that operates on a **power-on-demand** basis only. In this case, the electric motor is engaged and operated manually using a throttle, which is usually on the handgrip just like the ones on a motorbike or scooter. These sorts of e-bikes often, but not always, have more powerful motors than pedelecs do.

With *power-on-demand* only e-bikes the rider can:

1. ride by pedal power alone, i.e. fully human-powered.
2. ride by electric motor alone by operating the throttle manually.
3. ride using both together at the same time.

Please note that some power-on-demand only e-bikes can hardly be confused with, let alone categorised as, bicycles. For example, the *Noped* is a term used by the Ministry of Transportation of Ontario for e-bikes which do not have pedals or in which the pedals have been removed from their motorised bicycle. These are better categorised as electric mopeds or electric motorcycles.



Schematic of an E-Bike



Different types of e-bikes

## Legal status

Country/jurisdiction	Type of e-bike	Speed limit, km/h	mph	Watt limit	Weight limit, kg	Age requirement	Demands license plates	Allowed on bike paths	References & footnotes
 Australia	pedelec	25	15.5	250	None	None	No	Yes	ACT <sup>[15]</sup> NSW <sup>[16]</sup> NT <sup>[17]</sup> QLD <sup>[18]</sup> SA <sup>[19]</sup> Tas <sup>[20]</sup> Vic <sup>[21]</sup> WA <sup>[22]</sup>
 Australia	hand-throttle	None	None	200	None	None	No	Yes	ACT <sup>[15]</sup> NSW <sup>[16]</sup> NT <sup>[17]</sup> QLD <sup>[18]</sup> SA <sup>[19]</sup> Tas <sup>[20]</sup> Vic <sup>[21]</sup> WA <sup>[22]</sup>
 Canada	hand-throttle	32	20	500	None	Various	No	Varies from municipal by-laws	
 China	Unknown	30	18.5	None	20	None	No	Yes	(***)
 European Union Also including:  Norway Not including:  UK	pedelec	25 +10%	17.1	250	None	None	No	Yes	<sup>[23]</sup>
 Hong Kong	none allowed	–	–	–	–	–	–	–	<sup>[24]</sup> (**)
 Israel	pedelec	25	15.5	250	30	14	No	Yes	
 Mexico	both	same as motorcycles	same as motorcycles	-	-	15+ <sup>[25]</sup>	Yes	No	<sup>[26]</sup>
 New Zealand	pedelec	None	None	300	None	None	No	Yes	
 Norway	speed pedelec	45	28	500	None	None	Yes	No	<sup>[27]</sup> (*)
 Taiwan	"Sloe Vehicle"	25	16	200	40	None	No	Yes	
 United Kingdom	pedelec	24.9	15.5	250	40	14	No	Yes	<sup>[28]</sup>
 United Kingdom	hand-throttle tandem or tricycle	27.5	17.3	250	60	14	No	Yes	
 United States	hand-throttle	32	20	750	None	None	No	Varies	(***)

(\*) Allowed on bike paths when electric systems are turned off (\*\*) E-bikes are illegal in this region (\*\*\*) Some regions have special regulations, see corresponding entry under Electric bicycle laws.

## Market penetration

E-bike usage worldwide has experienced rapid growth since 1998. It is estimated that there were roughly 120 million e-bikes in China in early 2010, and sales are expanding rapidly in India, the United States of America, Germany, the Netherlands,<sup>[2]</sup> and Switzerland.<sup>[29]</sup> A total of 700,000 e-bikes were sold in Europe in 2010, up from 200,000 in 2007 and 500,000 units in 2009.<sup>[30]</sup>

Today, China is the world's leading producer of e-bikes. According to the data of the China Bicycle Association, a government-chartered industry group, in 2004 China's manufacturers sold 7.5 million e-bikes nationwide, which was almost twice the year 2003 sales;<sup>[10]</sup> domestic sales reached 10 million in 2005, and 16 to 18 million in 2006.<sup>[9]</sup>

### Market predictions

PikeResearch, a for-profit market research firm, released a report in 2010 which included market analysis and forecasts for electric two-wheel vehicles. They concluded that, "*The worldwide electric two-wheel vehicle market is expected to grow at a compound annual rate of 9% through 2016*" and that "*a lack of a well-defined retail channel hampers faster adoption in North America and Europe.*"<sup>[31]</sup> PikeResearch also forecasted that worldwide sales of e-bikes, e-motorcycles, and e-scooters will reach more than 466 million between 2010 and 2016, and China will continue to dominate the world market, with more than 95% of sales during this period. E-bikes sales are expected to have the largest share with 56% of the market.<sup>[32]</sup>

However, the Los Angeles Times reported that e-bike sales in the U.S. have slowed in 2010 compared to 2009. This could be due to a slowing economy."<sup>[33]</sup>

## Technical

### Motors and drivetrains

The two most common types of hub motors used in electric bicycles are brushed and brushless. There are many possible types of electric motorized bicycles with several technologies available, varying in cost and complexity; direct-drive and geared motor units are both used. An electric power-assist system may be added to almost any pedal cycle using chain drive, belt drive, hub motors or friction drive. BLDC hub motors are a common modern design with the motor built into the wheel hub itself and the stator fixed solidly to the axle and the magnets attached to and rotating with the wheel. The bicycle wheel hub is the motor. The power levels of motors used are influenced by available legal categories and are often, but not always limited to under 750 watts.

Another type of electric assist motor, often referred to as the mid-drive system, is increasing in popularity. With this system, the electric motor is not built into the wheel but is usually mounted near (often under) the bottom bracket shell. In more typical configurations, a cog or wheel on the motor drives a belt or chain that engages with a pulley or sprocket fixed to one of the arms of the bicycle's crankset. Thus the propulsion is provided at the pedals rather than at the wheel, being eventually applied to the wheel via the bicycle's standard drive train.

### Batteries

E-bikes use rechargeable batteries, electric motors and some form of control. Battery systems in use include sealed lead-acid (SLA), nickel-cadmium (NiCad), nickel-metal hydride (NiMH) or lithium-ion polymer (Li-ion). Batteries vary according to the voltage, total charge capacity (amp hours), weight, the number of charging cycles before performance degrades, and ability to handle over-voltage charging conditions. The energy costs of operating e-bikes are small, but there can be considerable battery replacement costs. The lifespan of a battery pack varies depends on the type of usage. Shallow discharge/recharge cycles will help extend the overall battery life.

Range is a key consideration with milan tirkey e-bikes, and is affected by factors such as motor efficiency, battery capacity, efficiency of the driving electronics, aerodynamics, hills and weight of the bike and rider.<sup>[34][35]</sup> Some manufacturers, such as the Canadian BionX or American E+ (manufactured by Electric Motion Systems), have the option of using regenerative braking, the motor acts as a generator to slow the bike down prior to the brake pads engaging.<sup>[36]</sup> This is useful for extending the range and the life of brake pads and wheel rims. There are also experiments using fuel cells. e.g. the PHB. Some experiments have also been undertaken with super capacitors to supplement or replace batteries for cars and some SUVs. E-bikes developed in Switzerland in the late 1980s for the Tour de Sol solar vehicle race came with solar charging stations but these were later fixed on roofs and connected so as to feed into the electric mains.<sup>[37]</sup> The bicycles were then charged from the mains, as is common today.

### Controllers

There are two distinct types of controllers designed to match either a brushed motor or brushless motor. Brushless motors are becoming more common as the cost of controllers continues to decrease. (See the page on DC motors which covers the differences between these two types.)



E-bikes and electric scooters in a specialized shop in Beijing in 2008. (¥2750 is around USD400)



E-bikes are very common in China, with an estimated fleet of 120 million in early 2010.<sup>[2]</sup>



An e-bike in Shanghai



Hybrid bicycle speedometer with integrated battery level measurement.

*Controllers for brushless motors:* E-bikes require high initial torque and therefore models that use brushless motors typically have Hall sensor commutation for speed and angle measurement. An electronic controller provides assistance as a function of the sensor inputs, the vehicle speed and the required force. The controllers generally allow input by means of potentiometer or Hall Effect twist grip (or thumb-operated lever throttle), closed-loop speed control for precise speed regulation, protection logic for over-voltage, over-current and thermal protection. Bikes with a pedal assist function typically have a disc on the crank shaft featuring a ring of magnets coupled with a Hall sensor giving rise to a series of pulses, the frequency of which is proportional to pedaling speed. The controller uses pulse width modulation to regulate the power to the motor. Sometimes support is provided for regenerative braking but infrequent braking and the low mass of bicycles limits recovered energy. An implementation is described in an application note (<http://www.zilog.com/docs/z8encoremc/appnotes/AN0260.pdf>) for a 200 W, 24 V Brushless DC (BLDC) motor.<sup>[38]</sup>

*Controllers for brushed motors:* Brushed motors are also used in e-bikes but are becoming less common due to their intrinsic lower efficiency. Controllers for brushed motors however are much simpler and cheaper due to the fact they don't require hall sensor feedback and are typically designed to be open-loop controllers. Some controllers can handle multiple voltages.

## Design variations

Not all e-bikes take the form of conventional push-bikes with an incorporated motor, such as the Cytronex bicycles which use a small battery disguised as a water bottle.<sup>[39][40]</sup> Some are designed to take the appearance of low capacity motorcycles, but smaller in size and consisting of an electric motor rather than a petrol engine. For example, the *Sakura* e-bike incorporates a 200 W motor found on standard e-bikes, but also includes plastic cladding, front and rear lights, and a speedometer. It is styled as a modern mopéd, and is often mistaken for one.

Converting a non-electric bicycle to its electric equivalent can be complicated but numerous 'replace a wheel' solutions are now available on the market.<sup>[41]</sup>

Rear wheel solutions include: FlyKly and Superpedestrian.

Front wheel solutions include: EVELO Omni Wheel (<http://omni.evelo.com>) and GeoOrbital

An Electric Pusher Trailer is an e-bike design which incorporates a motor and battery into a trailer that pushes any bicycle. One such trailer is the two-wheeled Ridekick.<sup>[42]</sup>

Other, rarer designs include that of a 'chopper' styled e-bike, which are designed as more of a 'fun' or 'novelty' e-bike than as a purposeful mobility aid or mode of transport.

Electric cargo bikes allow the rider to carry large, heavy items which would be difficult to transport without electric power supplementing the human power input.<sup>[43]</sup>

Various designs (including those mentioned above) are designed to fit inside most area laws, and the ones that contain pedals can be used on roads in the United Kingdom, among other countries.

Folding e-bikes (<http://www.usaelectricbikecompany.com/Foldingebike.html>) are also available.<sup>[44]</sup>

Electric self-balancing unicycles do not conform to e-bike legislation in most countries and therefore cannot be used on the road,<sup>[45]</sup> but can be utilized in the sidewalk. They are the cheapest electric cycles and used by the last mile commuters, for urban use and to be combined with public transport, including buses.

## Tricycles

Electric trikes have also been produced that conform to the e-bike legislation. These have the benefit of additional low speed stability and are often favored by people with disabilities. Cargo carrying tricycles are also gaining acceptance, with a small but growing number of couriers using them for package deliveries in city centres.<sup>[46][47]</sup> Latest designs of these trikes resemble a cross-between a pedal cycle and a small van.<sup>[48][49]</sup>

## Health benefits

E-bikes can be a useful part of cardiac rehabilitation programmes, since health professionals will often recommend a stationary bike be used in the early stages of these. Exercise-based cardiac rehabilitation programmes can reduce deaths in people with coronary heart disease by around 27%;<sup>[50]</sup> and a patient may feel safer progressing from stationary bikes to e-bikes.<sup>[51]</sup> They require less cardiac exertion for those who have experienced heart problems.<sup>[52]</sup>



Diagram illustrating a standard bicycle converted to an e-bike using a retail conversion kit



A folding e-bike

E-bikes can also provide a source of exercise for individuals who have trouble exercising for an extended time (due to injury or excessive weight, for example) as the bike can allow the rider to take short breaks from pedaling and also provide confidence to the rider that they'll be able to complete the selected path without becoming too fatigued.<sup>[53]</sup>

Some individuals have even lost considerable amounts of weight by using an electric bike.<sup>[54]</sup> By making the biking terrain less of an issue, people who wouldn't otherwise consider biking can use the electric assistance when needed and otherwise pedal as they are able.<sup>[55]</sup>

## Environmental effects

E-bikes are zero-emissions vehicles, as they emit no combustion by-products. However, the environmental effects of electricity generation and power distribution and of manufacturing and disposing of (limited life) high storage density batteries must be taken into account. Even with these issues considered, e-bikes are claimed to have a significantly lower environmental impact than conventional automobiles, and are generally seen as environmentally desirable in an urban environment.<sup>[56]</sup>

The environmental effects involved in recharging the batteries can of course be minimised. The small size of the battery pack on an e-bike, relative to the larger pack used in an electric car, makes them very good candidates for charging via solar power or other renewable energy resources. Sanyo capitalized on this benefit when it set up "solar parking lots," in which e-bike riders can charge their vehicles while parked under photovoltaic panels.<sup>[57]</sup>

The environmental credentials of e-bikes, and electric / human powered hybrids generally, have led some municipal authorities to use them, such as Little Rock, Arkansas with their *Wavecrest* electric power-assisted bicycles or Cloverdale, California police with *Zap* e-bikes. China's e-bike manufacturers, such as Xinri, are now partnering with universities in a bid to improve their technology in line with international environmental standards, backed by the Chinese government who is keen to improve the export potential of the Chinese manufactured e-bikes.<sup>[58]</sup>

Both land management regulators and mountain bike trail access advocates have argued for bans of electric bicycles on outdoor trails that are accessible to mountain bikes, citing potential safety hazards as well as the potential for electric bikes to damage trails. A study conducted by the International Mountain Bicycling Association, however, found that the physical impacts of low-powered pedal-assist electric mountain bikes may be similar to traditional mountain bikes.<sup>[59]</sup>

A recent study on the environment impact of e-bikes vs other forms of transportation<sup>[60]</sup> found that e-bikes are:

- 18 times more energy efficient than an SUV
- 13 times more energy efficient than a sedan
- 6 times more energy efficient than rail transit
- and, of about equal impact to the environment as a conventional bicycle.

One major concern is disposal of used lead batteries, which can cause environmental contamination if not recycled.<sup>[2]</sup>

There are strict shipping regulations for lithium-ion batteries, due to the safety reason.<sup>[61]</sup> In this regard, lithium iron phosphate batteries are safer than lithium cobalt oxide batteries.<sup>[62]</sup>

## Road traffic safety

China's experience, as the leading e-bike world market, has raised concerns about road traffic safety and several cities have considered banning them from bicycle lanes.<sup>[2]</sup> As the number of e-bikes increased and more powerful motors are used, capable of reaching up to 30 miles per hour (48 km/h), the number of traffic accidents have risen significantly in China. E-bike riders are more likely than a car driver to be killed or injured in a collision, and because e-bikers use conventional bicycle lanes they mix with slower-moving bicycles and pedestrians, increasing the risk of traffic collisions.<sup>[2]</sup>

## Experience by country

### China

China has experienced an explosive growth of sales of non-assisted e-bikes including scooter type, with annual sales jumping from 56,000 units in 1998 to over 21 million in 2008,<sup>[63]</sup> and reaching an estimated fleet of 120 million e-bikes in early 2010.<sup>[2][64]</sup> This boom was triggered by Chinese local governments' efforts to restrict motorcycles in city centers to avoid traffic disruption and accidents. By late 2009 motorcycles are banned or restricted in over ninety major Chinese cities.<sup>[63]</sup> Users began replacing traditional bicycles and motorcycles and, in e-bike became an



A modern electric cargo trike in use in London, with a payload of up to 250kg

alternative to commuting by car.<sup>[2]</sup> Nevertheless, road safety concerns continue as around 2,500 e-bike related deaths were registered in 2007.<sup>[64]</sup> By late 2009 ten cities had also banned or imposed restrictions on e-bikes on the same grounds as motorcycles. Among these cities were Guangzhou, Shenzhen, Changsha, Foshan, Changzhou, and Dongguang.<sup>[63][64]</sup>

China is the world's leading manufacturer of e-bikes, with 22.2 million units produced in 2009. Production is concentrated in five regions, Tianjin, Zhejiang, Jiangsu, Shandong, and Shanghai.<sup>[65]</sup> China exported 370,000 e-bikes in 2009.<sup>[66]</sup>

## Germany

Sales of e-bikes in Germany increased almost threefold between 2007 and 2012, from 70,000 to 388,000 units per year.<sup>[30]</sup>

## India

The first pedal-assisted bicycles appeared in India in 1993. In 2008, the sales of e-bike sales exceeded moped sales. In recent years, 2-passenger and even 3-passenger (two adults and a child) e-bikes were introduced in India.<sup>[67]</sup>

## Netherlands

The Netherlands has a fleet of 18 million bicycles.<sup>[68]</sup> E-bikes have reached a market share of 10% by 2009, as e-bikes sales quadrupled from 40,000 units to 153,000 between 2006 and 2009,<sup>[69]</sup> and the electric-powered models represented 25% of the total bicycle sales revenue in that year.<sup>[68]</sup> By early 2010 one in every eight bicycles sold in the country is electric-powered despite the fact that on average an e-bike is three times more expensive than a regular bicycle.<sup>[64][69]</sup>

A 2008 market survey showed that the average distance traveled in the Netherlands by commuters on a standard bicycle is 6.3 kilometres (3.9 mi) while with an e-bike this distance increases to 9.8 kilometres (6.1 mi).<sup>[70]</sup> This survey also showed that e-bike ownership is particularly popular among people aged 65 and over, but limited among commuters. The e-bike is used in particular for recreational bicycle trips, shopping and errands.<sup>[70]</sup>

## United States

In 2009 the U.S. had an estimated fleet of 200,000 e-bikes.<sup>[66]</sup> In 2012 they were increasingly favored in New York as food delivery vehicles.<sup>[71]</sup>

In 2012, two e-bike advocates completed the first 4,000-mile (6,400 km) transcontinental e-bike tour from New York to San Francisco to advocate for e-bikes in major cities across the U.S.<sup>[72]</sup>

Many e-bikes in the United States are standard bicycles converted using a kit. In general, the kits include the motor (the majority of which are hub motors built into the front or rear wheel), a speed controller, throttle (usually twist-grip or thumb throttle), necessary wiring and connectors, and a battery. Several U.S. companies offer conversion kits which also offer advanced lithium battery packs. Major manufacturers also offer complete e-bikes. Trek offers a line of e-bikes using the Bionx system in which the rider programs the controller to determine how much effort the motor will give in response to rider effort, from 25% up to 200% of the rider's power. This system ensures a minimum level of rider participation and is also used to comply with many European laws mandating partial human effort before the motor engages.

## See also

- List of electric bicycle brands and manufacturers
- Electric bicycle laws
- Electric motorcycles and scooters
- Electric vehicle conversion
- Eurobike
- Outline of cycling
- Low-speed vehicle
- Motorized bicycle
- Motorbike
- Renewable electricity
- Timeline of transportation technology



An e-bike in China. Here the rider isn't using the pedals.



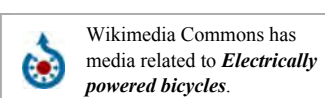
Pedelecs from the Call a Bike bicycle hire scheme in Berlin.



A police pedelec in Tokyo.



Delivery e-bike with license plate in Manhattan, New York City.



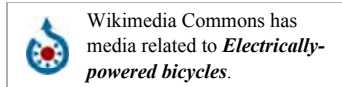


## References

- "Electric Bikes Now Constitute 10 Percent of German Market". *EVworld.com*. Archived from the original on 10 September 2013. Retrieved 3 April 2013.
- J. David Goodman (2010-01-31). "An Electric Boost for Bicyclists". *New York Times*. Retrieved 2010-05-31.
- Kathy Chu (2010-02-12). "Electric bikes face long road in U.S.". USA Today. Retrieved 2010-05-31.
- "Patent US552271 - Electrical bicycle".
- "Patent US596272 - Electric bicycle".
- "Patent US627066 - schnepf".
- "Patent US3431994 - Electric drive for bicycles".
- "Electric Bikes - Zike Bike Spares & Sales". Zikebike.com. Archived from the original on 2009-04-24. Retrieved 2009-08-31.
- "Cheap and green, electric bikes are the rage in China" (<http://postcarboncities.net/cheap-and-green-electric-bikes-are-are-are-china>), by Tim Johnson. Originally published 23 May 2007 by McClatchy Newspapers.
- "China's Cyclists Take Charge", By Peter Fairley. (<http://spectrum.ieee.org/jun05/1213>) IEEE Spectrum, June 2005
- "Power assisted bicycles". *VicRoads website*. VicRoads. Archived from the original on 28 March 2013. Retrieved 25 August 2013.
- "Was Sie über den Versicherungsschutz von pedelecs wissen sollten" (in German). Gesamtverband der Deutschen Versicherungswirtschaft (German Insurance Association). Retrieved 21 March 2013.
- "eZee electric bicycles: Torq". Archived from the original on 11 April 2013. Retrieved 29 March 2013.
- "www.bmebikes.com". Retrieved 22 October 2013.
- "Australian Capital Territory Government Road Transport (General) Amendment Act 2013" (PDF). Retrieved 26 November 2016.
- "New South Wales Government Roads and Maritime Services Vehicle standards information: Mopeds and power-assisted pedal cycles" (PDF). 8 December 2014. Retrieved 26 November 2016.
- "Northern Territory Government Department of Transport: V56 - Motorised Foot Scooters and Power-assisted Cycles" (PDF). 20 November 2015. Retrieved 26 November 2016.
- "Queensland Government: Bicycle road rules and safety". Retrieved 26 November 2016.
- "Government of South Australia: Riding a power-assisted bicycle". Retrieved 26 November 2016.
- "Tasmanian Government Information Sheet: Power-assisted Pedal Cycles". November 2016. Retrieved 26 November 2016.
- "Vicroads: Power assisted bicycles". Retrieved 26 November 2016.
- "Government of Western Australia: Bicycle rules, standards and safety". Retrieved 26 November 2016.
- European standard NF EN 15194 for Electrically power assisted cycles ([http://www.vae-enov.com/fiches\\_2010/norme\\_en\\_15194.pdf](http://www.vae-enov.com/fiches_2010/norme_en_15194.pdf)) section 4.2.6.1 Requirements: The maximum [assisted] speed [is] 25 km/h (...) During a production conformity check, the maximum speed may differ by ± 10% from the above-mentioned determined value.
- Transport Department, Hong Kong SAR Government ([http://www.td.gov.hk/filemanager/en/content\\_1178/motorcycle.pdf](http://www.td.gov.hk/filemanager/en/content_1178/motorcycle.pdf))
- "Permiso de conducir para menores de edad" (in Spanish). Archived from the original on 2015-12-22.
- "Reglamento de tránsito de la Ciudad de México" (PDF) (in Spanish).
- Article on speed pedelec in Norway (<http://www.tu.no/samferdsel/2014/08/20/denne-elsykkelen-kan-kjore-45-kmt-lovlig-i-norge>) (in Norwegian)
- "Electric bikes: the rules".
- M. Platter (2011-03-17). "Die Schweizer fahren immer mehr E-Bike". *NZZ*. Retrieved 2011-06-08.
- "Europe's E-Bike Imports Indicate Market Size". Bike Europe. 2013-08-05. Retrieved 2013-10-25.
- PikeResearch (2010-06-10). "Electric Bicycles, Motorcycles, and Scooters to Gain Increasing Acceptance Worldwide". PikeResearch. Archived from the original on 2010-06-15. Retrieved 2010-06-12.
- PikeResearch (2010-02-16). "466 Million Electric Two-Wheel Vehicles to Hit the Road by 2016". PikeResearch. Archived from the original on 2010-07-26. Retrieved 2010-06-12.
- LosAngelesTimes (2010-10-18). "Sales of electric bicycles lose momentum". LosAngelesTimes. Retrieved 2010-11-30.
- "Electric bike trip simulator". Retrieved 2013-05-25.
- "Electric Bicycle Range" (<http://www.electric-bicycle-guide.com/electric-bicycle-range.html>); Electric Bicycle Guide (retrieved 2014-03-09)
- "BionX FAQ Page". Archived from the original on 2010-03-22. Retrieved 2010-03-19.
- Technisches "Reglement der Tour de Sol 1989/1990", published by Tour de Sol, Bern, Switzerland
- Zilog, Inc (2008). "Electric Bike BLDC Hub Motor Control" (PDF). Zilog, Inc. Archived from the original (PDF) on 2011-07-18. Retrieved 2010-11-06.
- Henshaw, Peter (2008-09-05). "Cytrox Trek FX: A bike with boost". *The Telegraph*.
- Peace, Richard (2008-08-26). "Electric bikes start to come of age". Future Publishing.
- "Tron-inspired electric bike wheel chucks the hub". *www.gizmag.com*. Retrieved 2016-06-02.
- Chelsey, Walker (2011-06-19). "Ridekick – Takin' It to the Streets in Fort Collins". Ridekick International.
- "Electric Cargo Bike Guide". *Electric Bike Report*. 2010-09-01. Retrieved 2010-10-06.
- Sutton, Mark (January 6, 2012). "EBCO introduces Solex electric bikes to the UK". *Bike Biz*. Retrieved 10 January 2012.
- Electric Unicycle ([http://news.cnet.com/electric-gyroscopic-unicycle-is-like-a-segway-junior/8301-17938\\_105-20064007-1.html](http://news.cnet.com/electric-gyroscopic-unicycle-is-like-a-segway-junior/8301-17938_105-20064007-1.html)) by Amanda Kooser, May 18, 2011, cnet.com
- "Bubble Post".
- "Gnewt Cargo".
- "Cargo Trike".
- "Electric Delivery Trikes - will they catch on in Britain?". *ITV Central News*. 2013-11-20.
- "Exercise - Rehabilitation - NHS Choices". Nhs.uk. 2010-01-25. Retrieved 2010-10-06.
- "How To Use An Electric Bike For Effective Cardio Rehabilitation". *E-articles.info*. 2006-09-29. Retrieved 2010-10-06.
- "Rehabilitation and Fitness". *Theelectricbikeco.com*. Retrieved 2010-10-06.
- "Why You Need an Electric Bike". *MensFitness.com*. Retrieved 2015-12-15.
- "Woman's Dramatic 280-pound Weight Loss". 2014-12-03. Retrieved 2015-12-15.
- "Pedego Electric Bike Makes Exercise Look and Feel Easy". 2015-04-11. Retrieved 2015-12-15.
- Fishman, Elliot; Cherry, Christopher (30 Jul 2015). "E-bikes in the Mainstream: Reviewing a Decade of Research". *Transport Reviews*. Taylor & Francis Online. **36** (1): 72–91. doi:10.1080/01441647.2015.1069907.
- Eaton, Kit (March 16, 2010). "Sanyo's Solar Bike Sheds--Green Power, Healthy and Clever". *Fast Company*. Retrieved 2010-03-19.
- "Electric Bicycles; the Green Innovation gaining traction in world export markets". *Articlesbase.com*. Retrieved 2010-10-06.
- Newland, Cameron (September 24, 2015). "IMBA Preliminary Study Results Suggest That Electric Bikes Aren't Especially Damaging To Mountain Bike Trails". *Overvolted Electric Bike News and Reviews*. Retrieved 2015-09-25.
- Shreya, Dave (February 2010). "Life Cycle Assessment of Transportation Options for Commuters" (PDF). *Massachusetts Institute of Technology*. Archived from the original (PDF) on 2011-07-15.
- "Information on Batteries in Transport".
- Mitch Jacoby. "Assessing The Safety Of Lithium-Ion Batteries".
- Chi-Jen Yang (2010). "Launching strategy for electric vehicles: Lessons from China and Taiwan" (PDF). *Technological Forecasting and Social Change* (77): 831–834.
- "China's electric-bicycle boom - Pedals of fire". *The Economist*. 2010-05-13. Retrieved 2010-05-31.
- "China Remains World's Leading Electric Bicycle Manufacturer". *EV World*. 2005-05-28. Archived from the original on 2010-06-14. Retrieved 2010-06-01.
- "China switches to e-bikes". *Asia Times*. 2010-05-07. Retrieved 2010-06-01.
- "Electric bicycle market is enjoying the smooth growth.". *Energy Korea*. 23 April 2012. Retrieved 3 April 2013.
- "Netherlands bicycle capital of the world". *Dutch Daily News*. 2010-01-26. Retrieved 2010-05-31.

69. "In Holland One out of Eight Bikes Is Electric". Bike Europe. 2010-04-18. Retrieved 26 November 2016.
70. Ingrid Hendriksen et. al (2008). "Electric bicycles - market research and investigation". Fiets Beraad. Retrieved 2010-05-31.
71. Food deliverymen on wheels (http://www.nytimes.com/2012/03/04/nyregion/for-food-delivery-workers-speed-tips-and-fear-on-wheels.html?\_r=2&hp) By J. DAVID GOODMAN, New York Times, March 2, 2012
72. "TriplePundit.com". 2012-04-17. Retrieved 2012-04-17.

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