Name: _____ Date: _____

# How Do Electric Bikes Work?

Reading level 11 (7th grade) · 1384 words

Halfway up the hill on her way to work, Imani noticed what people notice first about an electric bicycle. Her legs were turning the pedals as they always did. But the bicycle seemed to be helping. So how do electric bikes work? An electric bicycle is an ordinary bicycle with a few added parts: a battery, a motor, a controller and a sensor. While she pedals, the battery sends power to the motor. The motor adds its push to hers.

The sensor is how the bicycle knows that Imani is pedaling. On a pedal-assist bicycle, it detects how fast she pedals, how hard she pushes, or both. The controller sits between the battery and the motor. It uses that signal to decide how much power to send. Yamaha unveiled its first pedal-assist system in July 1993. It was built to ride like an ordinary bicycle, with help in line with the rider's pedaling force. Stop pedaling, and the help stops too.

The motor is where electricity turns into motion. Many e-bikes use a hub motor, built into the middle of a wheel, usually the back one. The wheel itself is the motor. Imani's was in the back wheel. Others use a mid-drive motor, mounted low between the pedals. It pushes on the chain, so it borrows help from the bicycle's own gears. Mid-drives are usually rated at about 250 to 500 watts. Hub motors are an old idea. An inventor patented a bicycle with one in 1895.

The battery is the heavy part, and the clever one. It is a pack of lithium-ion cells wired together, the same kind of cell that powers phones and laptops. Charging pushes lithium ions from one electrode, the cathode, over to the other, the anode. The cell stores the energy as chemical energy. Riding runs it backward. The ions flow back, and electric current flows out to the motor. The 2019 Nobel Prize in Chemistry honored the people who developed this battery.

One cell is small, so a pack joins many of them, some in a row to raise the voltage and some side by side to raise the current. A pack's capacity is counted in watt-hours, and one watt-hour is one watt used for one hour. Imani's battery was a pack like that, clipped to her frame. How far one charge goes is another matter. A 2021 guide from Bosch, which makes motor systems for electric bicycles, says one charge might take a rider 14 miles one day and up to 90 another. It depends on the rider, the terrain, the wind, the temperature and the weight.

In most states, an e-bike's class is a short label for what its motor may do. Under a model law from the bicycle group PeopleForBikes, a Class 1 motor helps only while the rider pedals. It stops helping at 20 miles an hour. A Class 2 motor may move the bicycle with a throttle alone, and it also cannot assist at 20. A Class 3 motor helps only while the rider pedals, up to 28 miles an hour. Imani's bicycle was a Class 1, so its motor stopped helping at 20.

A class is not a law, though, and laws are not the same everywhere. PeopleForBikes itself says that electric bicycle laws are different in every state. Under its model law, Class 3 riders must be 16 and wear a helmet, and a local authority may keep Class 3 off some paths. In January 2026, New Jersey passed a law that, the group says, counts only Class 1 as a low-speed electric bicycle. And since October 24, 2025, every e-bike and e-scooter in New York City has been limited to 15 miles an hour.

A class also says where the help ends, not how fast a bicycle can roll. On Imani's flat stretches, her motor faded out at the top of its range, and after that only her legs, or a downhill, added speed. Europe draws its line differently. A pedal-assist bicycle there is treated as a bicycle if its motor cuts out before 25 kilometers an hour, which is 16 miles an hour. Faster ones, called speed pedelecs, are likely to be classed as mopeds in Europe. They need a license plate and a licensed rider.

On the way home, at the bottom of the hill, a van pulled out, and Imani squeezed both brakes. Her reaction took time, and the bicycle kept moving the whole while. A stop has two parts. The first is reaction distance, which is the speed times the time it takes to notice and respond. The second is braking distance. It depends mainly on the starting speed and on the grip between tire and road. It grows with the square of the speed. Twice the speed means four times the braking distance.

An electric bicycle changes that math in two ways. It lets riders go faster than on a plain bicycle, and speed counts most in the braking formula. It is also heavier, because of the battery, motor and sensors. If tire grip sets the limit, weight cancels out: a heavier bicycle presses harder on the road, so its tires grip harder too. What the extra weight changes is the energy the brakes must get rid of. Braking in a panic can also pitch a rider over the handlebar. Using both brakes gave stronger stops, yet most riders studied favored one.

At the crossing, a scooter rider rolled past Imani. A scooter uses the same ideas in a different body. A stand-up scooter has a flat deck between two inline wheels, a hand throttle, and an electric hub motor in a wheel. Its wheels are often 8 to 11 inches across, and the rider stands upright. Italian engineers tested braking with three riders, one scooter and one bicycle, and found no significant difference. They still questioned whether the law should treat the two as the same.

One safety fact stands out: helmets. A review of five studies of bicycle crashes found that helmets cut the risk of head, brain and severe brain injury by 63 to 88 percent. Imani wore hers. In Austin, CDC investigators studied e-scooter injuries and found that hardly any of the injured riders had worn a helmet. Half said a pothole or crack may have played a part. For e-bikes, the Consumer Product Safety Commission's April 2026 report counted 310 deaths from 2017 through 2024. Most involved a motor vehicle, and losing control came next.

A battery brings a different kind of risk. The liquid inside a lithium-ion cell can burn. If a cell

overheats, it can enter thermal runaway, a reaction that feeds itself and makes more heat. It can throw out hot gas and flame, and the fire can spread to the next cell. A battery management system watches each cell's voltage, current and temperature. It can cut the pack off. It cannot stop a flaw built into a cell. Heat also comes from the motor working harder, as on a hill. Batteries are sometimes recalled when they can overheat. In July 2025, one maker recalled about 24,000.

Safety standards test for this. UL 2849 covers the motor system, the battery and the charger together. Its tests include dropping a steel ball on the battery case and overcharging the pack. In June 2026, the Consumer Product Safety Commission proposed a federal rule that would require these standards. It had counted 227 battery incidents in e-bikes, scooters and similar devices from 2019 through 2023. Its staff saw that certified products were less of a fire risk. Its advice is plain: use the charger that came with the bicycle, and never charge it while you sleep. Imani does.

So what counts as a bicycle? That is still being decided, one law at a time. Federal law defines a low-speed electric bicycle as one with pedals and a motor under 750 watts. The National Park Service lets each park decide where e-bikes may go. Some people who wrote to the Park Service worried about crowded trails. The Service answered that research is still being gathered. So far it suggests some classes affect trails like bicycles do. And cities such as New York are setting speed limits of their own. For now, each state, city and park draws that line for itself.

## Questions

**1. What does the controller do?**

A. It uses the sensor's signal to decide how much power the motor gets
B. It stores the energy
C. It turns the wheel by hand

**2. Why does the book say a fast bike needs so much more room to stop?**

A. Fast bikes have smaller tires
B. Braking distance grows with the square of the speed
C. The rider cannot see at speed

**3. In this book, what does "class" mean for an e-bike?**

A. The size of the frame
B. The year it was made
C. A label for what its motor may do

**4. What is a hub motor?**

A. A motor built into the middle of a wheel
B. A motor low between the pedals

C. A motor on the handlebar

**5. Why does a class not settle what is allowed where you live?**

A. Every bike has the same class

B. Laws differ from state to state and city to city

C. Classes were repealed

**6. What does CPSC advise about charging?**

A. Charge overnight so it is ready

B. Any charger that fits will do

C. Use the charger that came with the bike and stay while it charges

## Words to know

controller: power manager

hub: wheel's middle

watt: power unit

pedelec: pedal-assist bicycle

thermal: about heat

# Answer key: How Do Electric Bikes Work?

1. A. It uses the sensor's signal to decide how much power the motor gets
2. B. Braking distance grows with the square of the speed
3. C. A label for what its motor may do
4. A. A motor built into the middle of a wheel
5. B. Laws differ from state to state and city to city
6. C. Use the charger that came with the bike and stay while it charges