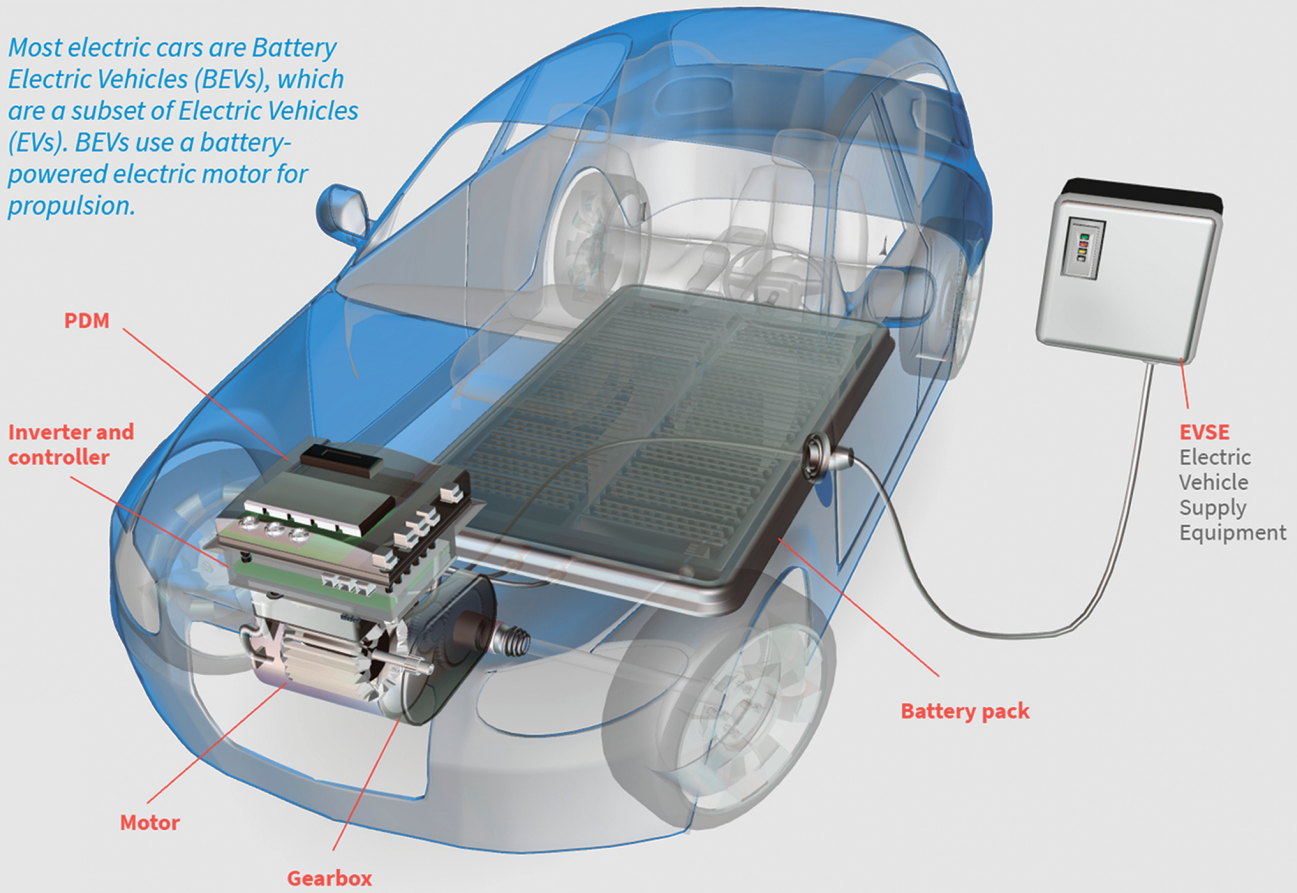


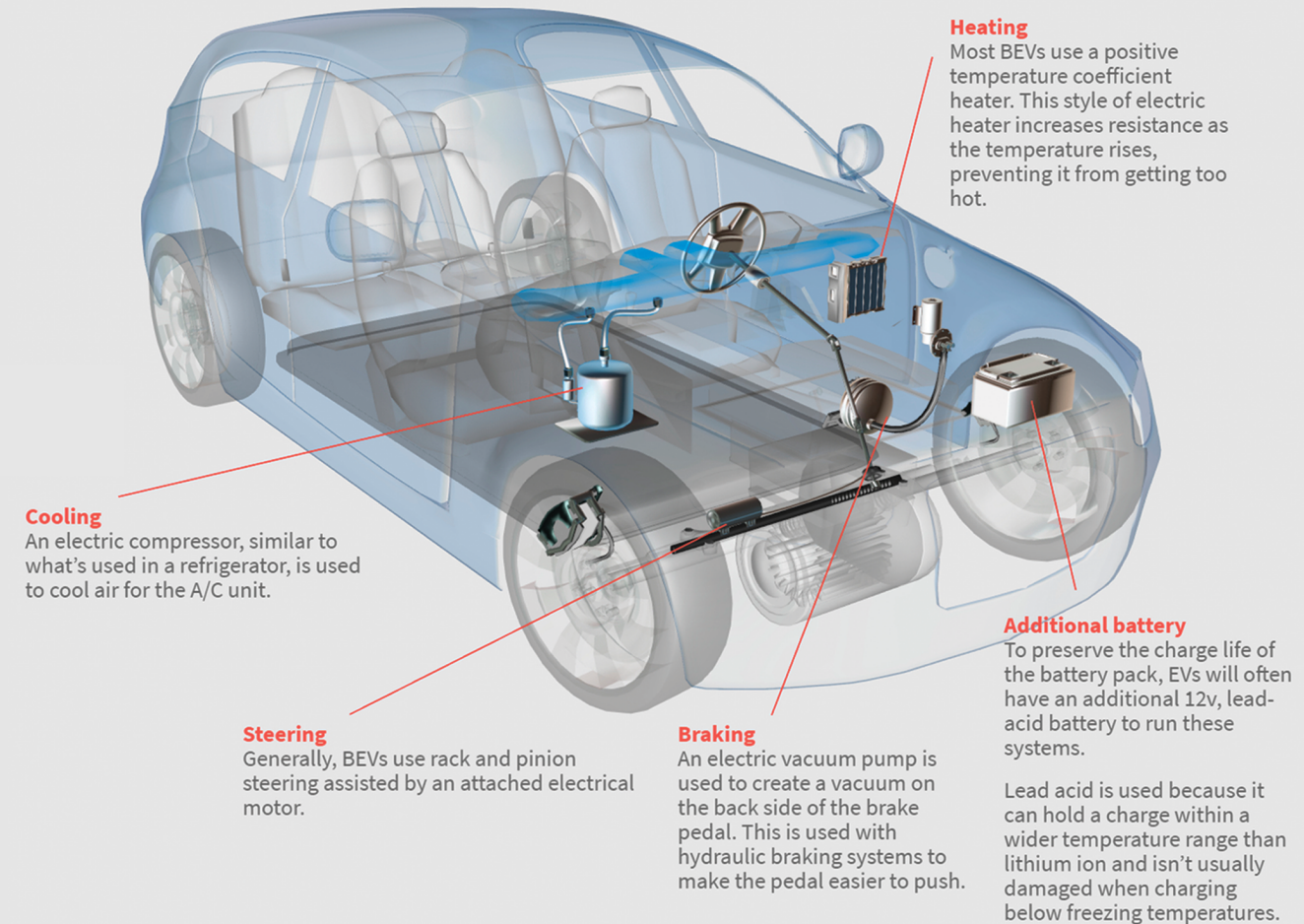
How Electric Cars Work

Most electric cars are Battery Electric Vehicles (BEVs), which are a subset of Electric Vehicles (EVs). BEVs use a battery-powered electric motor for propulsion.

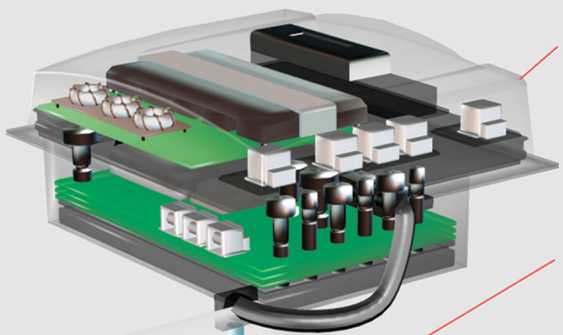


Additional systems

The heating, cooling, steering, and braking systems are completely electric.



Drive system



PDM

The Power Delivery Module is an onboard charger for the battery pack, and converts AC (alternating current) power from the EVSE to DC (direct current) to charge the battery pack.

Inverter & Controller

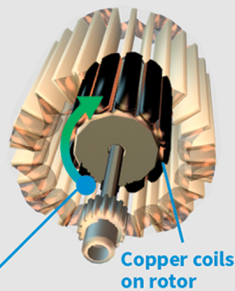
The inverter modifies power coming from the batteries to be compatible with the motor.

The controller uses a PWM (Pulse Width Modulation) systems that pulses on and off very quickly; the more the current is "on," the more power is delivered to the motor and the faster it will spin.

Electric motor

BEVs generally use a variation of an AC motor. Due to possible heat issues, the electric motors are artificially limited to max out from $\approx 10\text{-}20\text{k}$ RPMs (revolutions per minute).

PERFORMANCE: AC induction

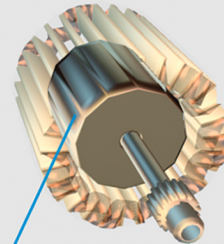


Copper coils on rotor

Slip: rotor in the motor is slightly behind the magnetic field created by the stator

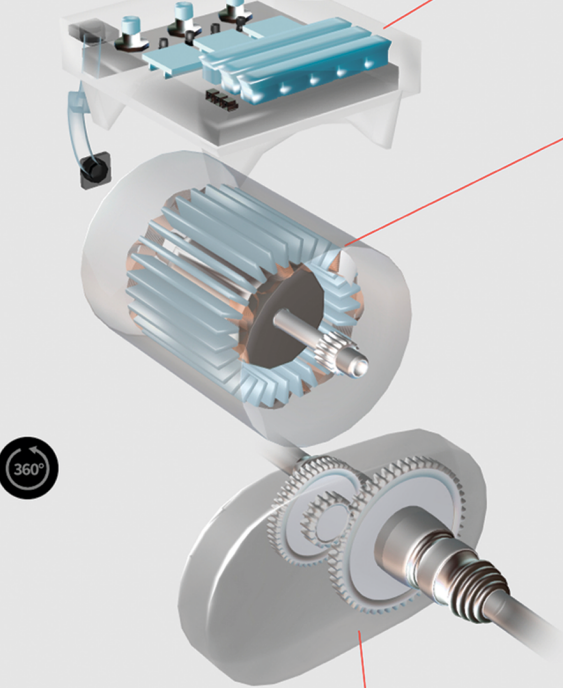
AC induction motors use coils on the rotor, which produces "slip," (the rotor in the motor is slightly behind the magnetic field created by the stator). Because of this, they can produce max torque (twisting force) through high RPMs (revolutions per minute).

ECONOMY: AC synchronous



Permanent magnets on rotor

AC synchronous motors use permanent magnets on the rotor, which keeps the motor in sync and reduces slip. They can be more efficient at lower RPMs, and produce max torque at 0 RPMs, which can make them well suited for "commuter" vehicles.



SINGLE SPEED GEARBOX



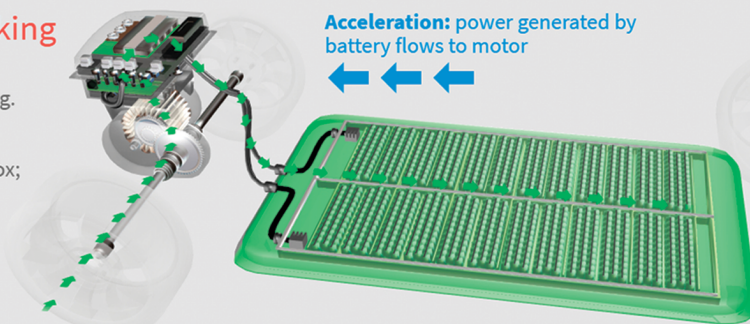
Gearbox

Because of the electric motor's torque and high RPM abilities, most BEVs use a single speed, 9.7:1 ratio gearbox (the motor spins 9.7x for every 1 tire revolution), so the vehicles never "shift gears" but can still have top speeds between 70-160 mph.

Regenerative Braking

Some BEVs are designed to collect energy when coasting. When the "gas pedal" is released, the wheel/axle assembly pushes the gearbox; this turns the motor which generates electricity for the battery.

Aside from charging the battery, resistance in the motor can also significantly slow the vehicle.



Coasting / braking: power generated by motor flows back into battery



Battery



Li-ion

The majority of BEVs use Lithium ion (Li-ion) batteries for the battery pack. Lithium ion can store more energy while being smaller and lighter than lead-acid batteries (the type of battery in a regular car), and are more readily available than NiMH (Nickle-Metal Hydride) batteries.

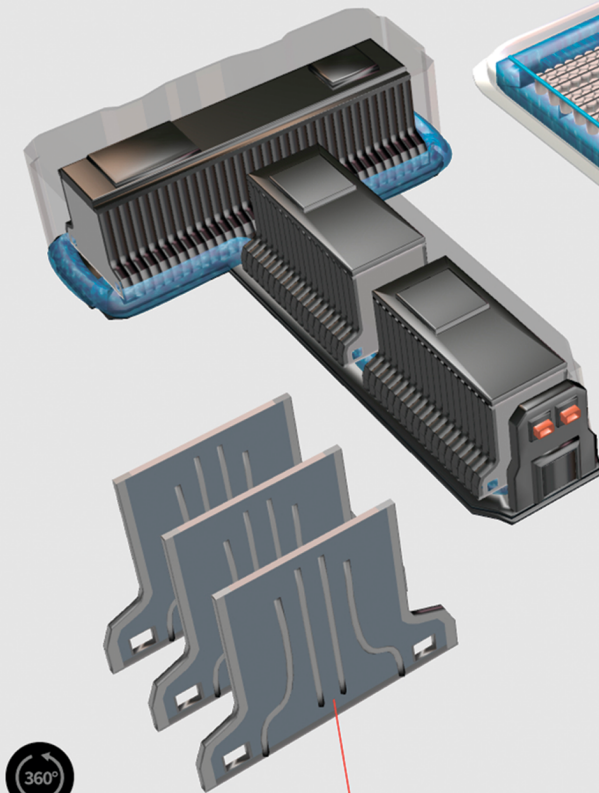
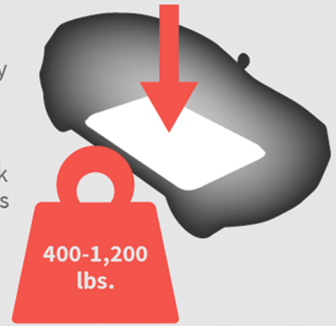
Cold temperature performance

One drawback to Li-ion batteries is that at temperatures below freezing, they can be damaged if charged too quickly. Because of this, the batteries may charge slowly until they have "self-warmed" enough to charge at a higher rate.



Weight & placement

At 400-1,200 lbs. (\approx 180-550 kilos), the location of the battery pack can greatly affect the vehicle's center of gravity (the average location of an object's weight). For most BEVs, the pack is under the cabin, which creates a low center of gravity and can improve handling.



Common battery designs

Pouches

A common battery pack design uses DC prismatic cells or "pouches" where each pouch is about as thick as a piece of cardboard. The pouches are usually stacked within modules, and the modules within the pack.

Cylinders

Other styles of battery use a cylindrical design for each battery, which looks similar to a regular AA. The cylinders are usually placed side-by-side within modules, and modules within the pack. This design allows for small gaps between individual batteries and may improve cooling.

Charging

Though regular home outlets can be used for charging, EVSE stations safely supply higher voltages, which allows the onboard charger to recharge the battery pack more quickly.



Cooling

Though battery packs can be air-cooled, water cooling is usually able to keep the batteries at a more consistent temperature. Batteries getting too hot can cause them to drain much more quickly, significantly decreasing the driving range of the car.