

How Many Electric Motors Are in Your Car?



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The U.K., Norway, the Netherlands, Denmark and France have already proposed plans to outlaw internal combustion engines (ICE), with China also studying when to ban ICE vehicles. So the writing is on the wall that powerful electric motors, also known as traction motors, will play a significant and increasing role as the engine propelling the vehicle. But electric motors are already dominant in many other automotive applications. Let's take a motor census of the typical automobile.

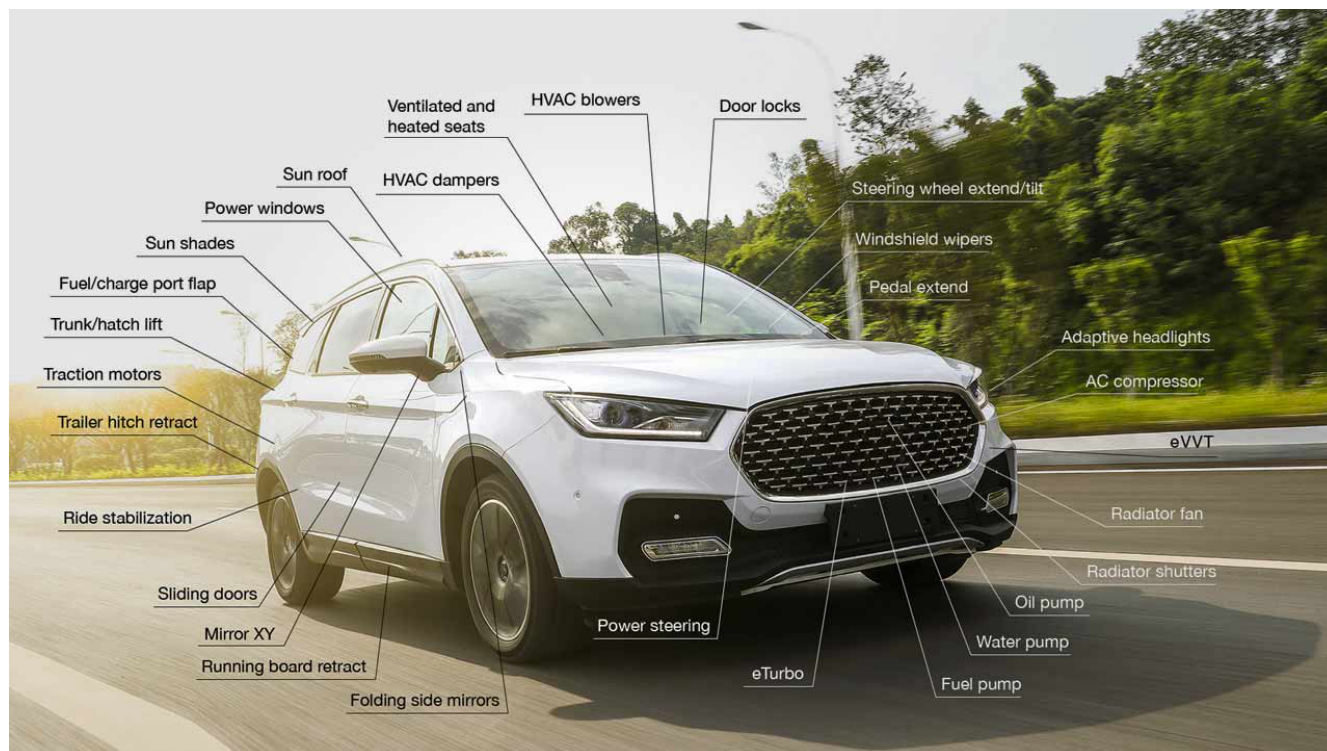


Figure 1. Electric motor applications in an automobile

Existing – and increasing – motor populations

Electric starter motors have been part of automobiles since your great-grandparents decided there had to be a better way than a hand-crank to start the car. Starter motors are still typically the most powerful electric motors other than traction motors. With the advent of start-stop technology and mild hybrid vehicles, the starter motor is morphing into the starter-generator, and taking on more functions. In some designs, an enhanced starter motor can be used to “creep” forward in stop-and-go traffic, blurring the lines between a starter motor and an electric traction motor.

Windshield wipers are perhaps the most prevalent example of electric motors in existing automobiles. Every car has at least one wiper motor for the front wipers. The popularity of SUVs and hatchbacks with less-streamlined back windows has meant the presence of rear wipers and corresponding motors on a large fraction of cars as well. Another motor pumps washer fluid to the windshields, and in some cars to the headlights, which may have their own small wipers.

Just about every car has blower fans that circulate air from the heating and cooling system; many vehicles have two or more fans in the cabin. High-end vehicles have fans built into the seats for cushion ventilation and heat distribution.

Power seats are fertile ground if you're looking for electric motors. In economy cars, motors provide convenient front and back adjustment and back cushion tilt. In premium cars, electric motors control options like height adjustment, bottom cushion tilt, lumbar support, headrest adjustment and cushion firmness. Other seat functions that use electric motors include power-seat folding and power stowage of back seats.

Windows used to crank up by hand, but now power windows are common; future generations won't understand the traditional circular hand motion to ask someone to lower their windows.

Each window is another potential location for an electric motor, including variants such as sunroofs and rear-vent windows in minivans. The drives for these windows can be as simple as a relay, but safety requirements such as detecting an obstacle or pinched object lead to more intelligent drive options, with motion monitoring and limits on drive force.

Locks are another convenience option where manual operation has given way to an electric motor drive. The advantages of electrical control include convenience features such as remote operation, enhanced security and intelligent functions, such as automatic unlock after a collision. Unlike power windows, power door locks must retain the option of manual operation, so this impacts the design of the electric door lock motor and mechanism.

Indicators on the instrument panel, or cluster may evolve to light-emitting diodes (LEDs) or other types of displays, but for now, each dial and gauge uses a small electric motor. Other electric motors in the convenience category include common features like side mirror fold and position adjustment, as well as more exotic applications like convertible roofs, extendable running boards, and glass partitions between the driver and passengers.

Under the hood, electric motors are becoming more common in several places. In most cases, electric motors are replacing belt-driven mechanical components. Examples include radiator fans, fuel pumps, water pumps and compressors. Moving these functions from a belt drive to an electric drive has several advantages. One is that driving electric motors with modern electronics can be much more power-efficient than using belts and pulleys, leading to benefits like higher fuel efficiency, reduced weight and lower emissions. Another advantage is that using electric motors rather than belts allows freedom in mechanical design, as the mounting position of pumps and fans need not be constrained by having to run a serpentine belt to each pulley.

Technology trends

Most electric motors in today's cars run from the standard 12-V automotive system, with a belt-driven alternator to generate voltage and a lead-acid battery for storage. This arrangement has worked fine for decades, but the latest vehicles need more and more current for comfort, entertainment, navigation, driver assistance and safety features.

A dual-voltage 12-V and 48-V system could move some of the higher-current loads off the 12V battery. The advantages of using a 48-V supply are a 4x reduction in current for the same power, and an accompanying reduction in weight in terms of cables and motor windings. Examples of high-current loads that may migrate to a 48-V supply include the starter motor, turbocharger, fuel pump, water pump and cooling fans. Implementing a 48-V electrical system for these components could result in fuel-consumption savings of around 10%.

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Brushed DC motors are the traditional solution for driving most electric convenience features in an automotive body. Since the brushes provide the commutation, these motors are simple to drive and are relatively inexpensive. In some applications, brushless DC (BLDC) motors can provide significant benefits in terms of power density, thus reducing weight and providing better fuel economy and lower emissions. Manufacturers are using BLDC motors in windshield wipers, cabin heating, ventilation and air-conditioning (HVAC) blowers and pumps. In these applications, the motor tends to run for long periods, as opposed to momentary operation such as in power windows or power seats, where the simplicity and cost-effectiveness of brushed motors still hold an advantage.

So how many electric motors are in your car?

You would be hard-pressed to find a late-model car with less than a dozen electric motors, while typical modern cars on American roads might easily have 40 electric motors or more. The increasing popularity of electric vehicles will spur many innovations in automotive electric motors. However, electric motors are already prevalent throughout ICE-propelled vehicles, with more applications in each successive model year bringing more convenience, better intelligence and safer operation while reducing environmental impact. Still – there is always room for more.

Read more to find out ["How analog integration simplifies automotive body motor controller designs."](#)

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