

The environmental impact of electric cars

Just how green are low-emission vehicles? Graeme Paton and Anna Lombardi track their production, from mineral mines to the road and beyond



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For more than a century, vehicles have been powered by fossil fuels. Latest

figures show that there are 31.7 million cars on UK roads, of which about 31.5 million are still propelled completely, or in part, by petrol or diesel.

The future, however, [will be electric](#). By the end of this decade, the UK will ban the sale of pure fossil fuel-powered cars and vans, followed five years later by hybrids which run using a combination of a combustion engine and battery.

From a very low base, the UK is starting to accelerate towards a greener future. Industry figures show that electric cars made up almost 11 per cent of those sold in the UK last month, with numbers more than doubling year-on-year. The move is seen as critical in the drive to cut greenhouse gas emissions to net zero by the middle of the century. Transport is the country's biggest single source of carbon dioxide, eclipsing even the energy sector, and cars and vans contribute the vast majority of these emissions.

Electric cars will, undoubtedly, clean up our cities. However, lingering concerns remain over the emissions generated by the manufacturing process and the production of energy to charge vehicle batteries. So just how green are electric cars?

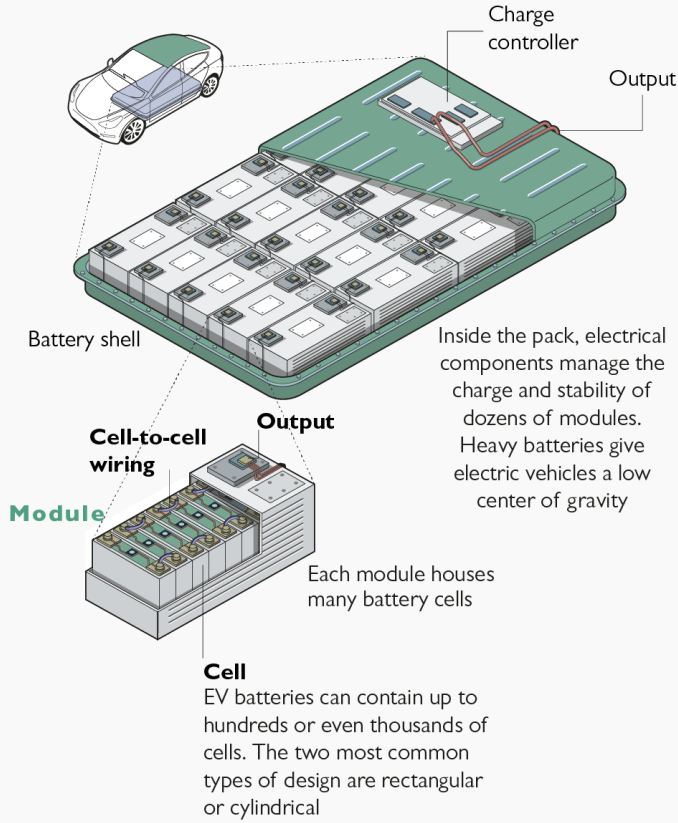
Batteries

Electric cars are powered using large lithium-ion batteries, which are made up of base metals such as copper and aluminium as well as lithium, nickel, cobalt and graphite. These are mined using, at times, highly polluting processes. One report estimated that 75 million tonnes of acid waste water — used to separate the various elements — can be produced for every tonne of rare minerals mined.

Currently, the vast majority of batteries used in British electric cars are sourced from East Asia, primarily through Chinese, Korean and Japanese companies.

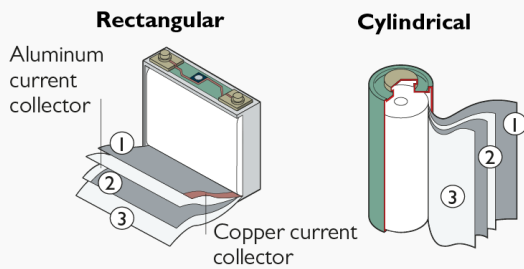
Electric car batteries

What's inside an electric vehicle battery pack?



Cell components

Each cell contains all essential components of a battery. They release and store electricity, as lithium atoms move between electrodes



1. Cathode

It contains the most valuable recyclable materials

2. Anode

Made of graphite, carbon or silicon-based components

3. Electrolyte and separator

Australia (51%), **Chile** (22%), and **China** (12%) are the three largest producers of lithium.

71% of its global end-use market is represented by batteries

A European Environment Agency report said that 35-50 per cent of total electric vehicle manufacturing emissions arise from the electricity consumption for battery production.

No batteries are currently produced in the UK although this will change in the coming years. Earlier this month, Nissan confirmed that a new battery plant would be built in Sunderland, powering 100,000 vehicles a year. Another is being built by Britishvolt in Blyth, Northumberland, with enough batteries for 300,000 electric cars produced by 2027. The government is reportedly in discussions with at least six companies interested in setting up [further gigafactories](#).

Manufacturing

Emissions from electric vehicle production are generally believed to be higher than those for conventional combustion engine vehicles. A study led by Tsinghua University, Beijing, four years ago estimated that carbon dioxide (CO₂) emissions were up to 60 per cent higher than for a fossil fuel car, with the battery production process largely responsible.

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Last year, the Swedish electric car company Polestar admitted that the manufacturing process for its existing Polestar 2 car had a carbon footprint of 26 tonnes of CO₂. Motorists would have to travel 48,500 miles before its carbon footprint dropped below that of the combustion engine-powered Volvo XC40. This fell to 31,000 miles when all of the Polestar's recharging power came from renewable sources.

Polestar has now pledged to build the world's first "climate neutral" car by 2030 using a combination of recycled materials and production processes powered completely by renewable energy. It insisted that the target did not include any attempt to offset emissions by planting trees.



On the road

Once on the road, electric cars are far cleaner than combustion engine alternatives, with zero tailpipe emissions.

Transport & Environment, a campaign group, has estimated that electric cars emit 64 per cent less CO₂ than combustion engine equivalents after accounting for electricity generation.

But electric cars are not 100 per cent emission free. They will still produce airborne particulate matter, which is generated by the wearing down of brakes, suspension, tyres and road surfaces. The extra weight of electric cars means that they could emit more particulate pollution, particularly in certain circumstances such as high-speed motorways.

However, a study by Birmingham University in January suggested that regenerative braking — when the electric motor slows the car — dramatically cuts electric vehicle pollution in urban areas.

Electric car range

Research last year by the RAC found that the distance that an electric car could travel was one of the biggest barriers to adopting the technology, with most drivers requiring a range of 375 miles before they buy one.

The Tesla Model S is the only car on the market that currently hits the target although others are close, including the Tesla Model 3 “long range” with 350 miles and the new VW ID.3 with almost 340 miles. Many other models, such as the Nissan Leaf, Jaguar i-Pace and Kia e-Niro officially achieve between 200 and 300 miles on a full charge.

Most modern electric vehicles take anything between 30 minutes and 12 hours to charge, depending on the size of the battery and the speed of the charging station. Some Teslas, for example, can be charged from 20 per cent to 80 per cent in just 20 minutes.

StoreDot, an Israeli technology company, is now producing an “extreme fast charging” battery that can gain 100 miles of range in just five minutes. The company said that it was hoping to mass produce the batteries in 2024.

The present lithium-ion batteries use graphite, a form of carbon, to store the charge. Instead, the StoreDot batteries use metalloid nanoparticles such as silicon, which the company says can charge more quickly without short-circuiting the battery. It said that switching to silicon was also cheaper because of the mass supply of the element, bringing down overall production costs.

Inside a garage converting classic cars into electric motors

Powering electric cars

The UK’s burgeoning electric car fleet is only as clean as the power generated to charge the batteries. Most charging is done at home, where about 120,000 domestic chargers have already been installed. That is projected to triple by the middle of the decade. Additionally, there are 23,000 public chargers, of which around a fifth are the most powerful “rapid” chargers.

Energy production is not yet 100 per cent green but it is certainly on course. Last year, the UK went the equivalent of 208 days without coal-generated power. By October 2024 coal will disappear from UK energy supply, a year earlier than had been planned.

The share of power created using renewable sources is also on the rise. Earlier this year, the UK broke a new wind power record, with just over a third of the country’s energy coming from wind. Its share has doubled since 2015. By 2050, solar power is set to have the largest share of electricity generation in the UK.

However, some charging companies already guarantee to supply power from renewable sources. Gridserve is developing solar power stations specifically to supply its own network of charging hubs being opened across the UK.

Disposal of batteries

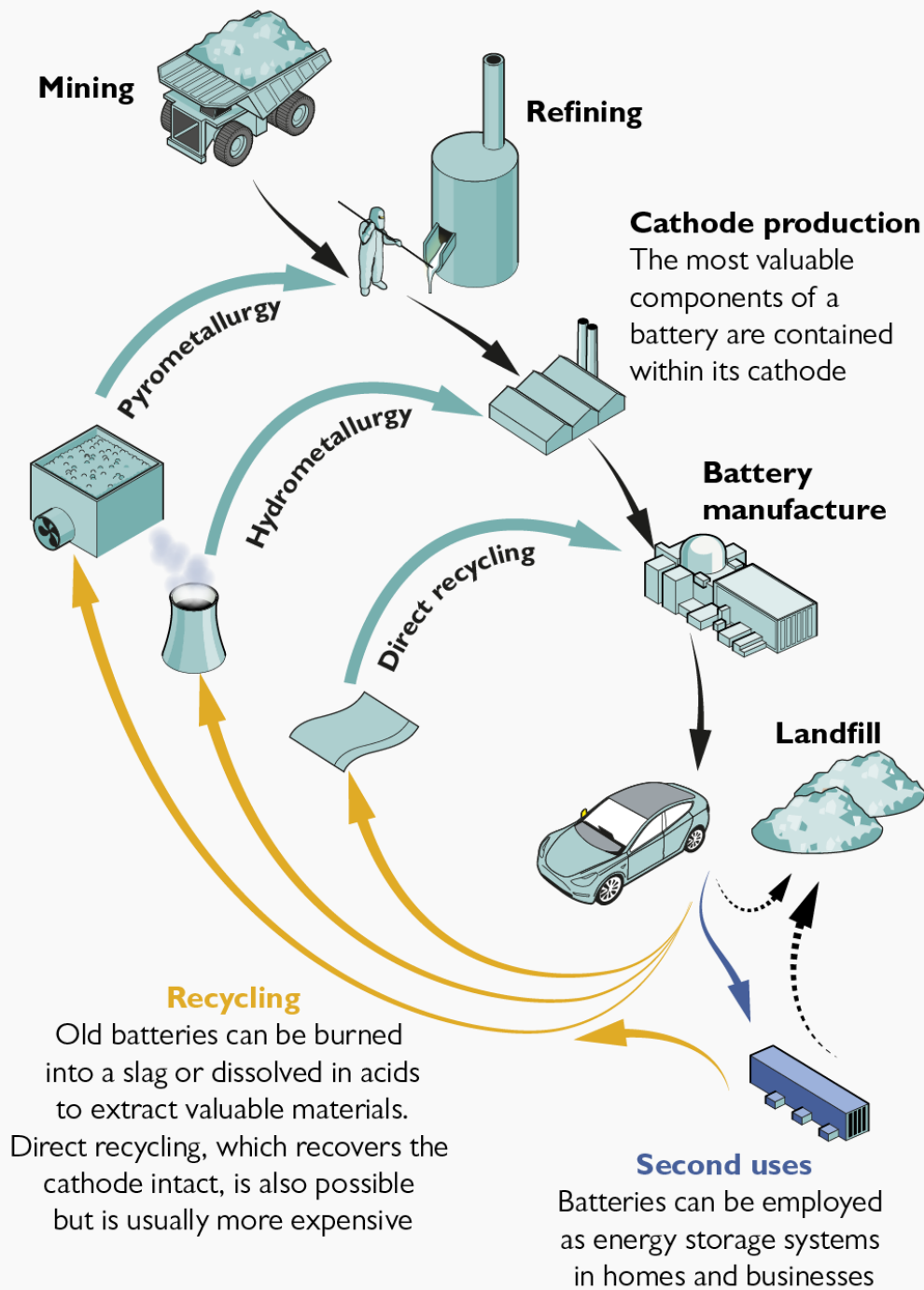
The batteries used in electric cars are made up of hundreds of individual lithium-ion cells. They contain hazardous material that can be released into [the environment](#) if dumped on a landfill site. It is possible to recycle batteries but the process is in its infancy. It is not cheap or easy, particularly when confronted with an older electric car.

The chemistry and construction of older batteries can vary significantly, making efficient recycling difficult. The cells are wired together into battery packs and housed in a protective metal casing that can make it physically challenging to separate them and even liable to cause an explosion.

Additionally, much of the raw minerals inside a battery — the lithium, cobalt and nickel — are reduced to a black mass during recycling. This needs to be processed to recover the material in a useable form.

Recycling options

Electric car batteries will have a lifespan of about 20 years, but they don't have to end up in a landfill afterwards



It has often been seen as more convenient to build a new battery rather than recycle an old one. The tide, however, is turning, as more car batteries reach the end of their working life over the coming decade.

Anwar Sattar, lead engineer at Warwick Manufacturing Group at the town's university, said recently that more than 90 per cent of the battery cell could be technically recovered but it was a "commercial activity and companies will only recycle those parts that give them a positive financial return".

Now car companies are looking to build recycling into the production process as they scale up electric vehicle manufacturing. Volkswagen recently opened its first recycling plant in Salzgitter, Germany, with plans to recycle up to 3,600 battery systems a year during a pilot phase. Nissan, Renault and Volvo are also committed to similar operations.



The alternatives to battery-powered cars

Hydrogen fuel cell technology is an established zero-emission technology used to power buses, trains and HGVs. Under the system, hydrogen gas is carried by the vehicle and used by a fuel cell to create a chemical reaction which generates electricity to power a motor. Water is the only waste product.

Some believe it can be better than battery power as a long-term replacement for fossil fuel. Refuelling with hydrogen can take a few minutes. It could also be a better environmental solution.

For now, hydrogen remains a niche technology for cars, with the Hyundai Nexo and Toyota Mirai the only models on sale in the UK. Department for Transport figures show there were 191,600 battery powered electric cars on the roads at the

end of 2020 but only about 200 hydrogen fuel cell cars. This could be about to change, particularly for heavier vehicles that need very large battery packs. Last month it was announced that the Land Rover Defender is being remodelled as a zero-emission hydrogen vehicle. Honda is also developing the technology.

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