Gwasanaeth Ynni
Energy Service

Llywodraeth Cymru
Welsh Government

Technical advice note

Common concerns about battery electric vehicles

Over the past decade, the development of Battery Electric Vehicles (BEVs) and their charging infrastructure has been significant. In 2023 alone, the UK saw sales of over 300 thousand new BEVs, representing more than 16% of the new car market share. This note aims to address some of the common concerns associated with BEVs, including their environmental impact, capabilities, and charging requirements.

Do BEVs produce more emissions that petrol/diesel vehicles?

BEVs emit no tailpipe emissions. The amount of emissions they are responsible for depends on the electricity source used for charging. The 2023 UK greenhouse gas (GHG) conversion factors (for the year 2022) give the following data:

- UK grid carbon intensity of 207 gCO_2e/kWh,
- average medium BEV car at 48 gCO_2e/km,
- average medium petrol car at 178 gCO_2e/km,
- average medium diesel car at 167 gCO_2e/km.

Since 2015, the UK grid's carbon intensity has decreased for approximately 400 gCO_2e/kWh to 162 gCO_2e/kWh in 2023, with a target to drop below 100 gCO_2e/kWh by 2030. Consequently, as the grid becomes cleaner, BEVs will become even more environmentally friendly without any modifications required to the vehicles themselves.

In addition to producing zero tailpipe emissions, BEVs do not emit harmful air pollutants like nitrogen oxides (NOx) and particulate matter (PM), which are known to impact health, especially in urban settings. It's important to note, however, that BEVs still produce particulate emissions from brake and tyre wear, similar to internal combustion engine (ICE) vehicles. Given that BEVs tend to be heavier than their petrol or diesel counterparts, their particulate emissions from tyres may be slightly higher. However, these are significantly less concerning than the emissions from petrol or diesel vehicles, especially with the increasing popularity of larger ICE SUVs, which also contribute to higher vehicle weights.

While it's true that BEVs have a higher embedded carbon footprint during manufacturing compared to ICE vehicles, the lower emissions during their operational phase mean that this initial carbon cost is offset within approximately 10-15 thousand miles of driving, depending on factors like vehicle and battery size, and the carbon intensity of the electricity used for charging. Even when comparing a new BEV to an existing petrol or diesel vehicle (thus disregarding the ICE vehicle's manufacturing emissions), the carbon payback occurs within about 20-30 thousand miles.

Can BEVs do long journeys?

The typical real-world range for new BEVs cars is about 230 miles on a single charge. More expensive models can reach above 350 miles, while even the more affordable options offer ranges close to 200 miles. A 200-mile range is sufficient for long trips, such as from Cardiff to Holyhead, equating to roughly four hours of driving at 50 mph. Considering the AA's recommendation for a short break every two hours, drivers can easily incorporate one or two quick recharging stops. With a 50 kW rapid charger, you can add approximately 70-100 miles of range in just 30 minutes.

Are there enough public charge points?

As of December 2023, there are over 53,900 publicly-available charge points in the UK, across over 31,000 locations. This has grown 45% in 2023, and the UK target is to reach 300,000 charge points by 2030. There are areas of the UK that are less well served, namely more rural areas, where charge points are used less frequently. However, as with any car journey, it is worthwhile to plan your route to include charging stops, and there is availability all over the UK.

Issues such as charge points being out of service or busy are relatively rare, but they tend to receive disproportionate media attention. New public charge point regulations introduced by the UK Government in November 2023 aim to improve the reliability, ease of use, and accessibility of public charging, with operators required to ensure a 99% uptime for their networks.

Is home charging worth the investment?

Installing a home charging station typically costs around £1,000, but it enables access to lower electricity rates, potentially as low as £0.075/kWh. This is significantly cheaper than public charging rates, which range from £0.55-£0.81/kWh. For a BEV with an efficiency of 0.27 kWh/mile, charging costs can be as low as £0.02/mile at home, compared to £0.15/mile at public chargers. Given these figures, a home charger could pay for itself after approximately 7,700 miles of driving. Additionally, with nearly 70% of journeys being under 5 miles, having a home charger not only reduces dependence on public charging for shorter trips but also supports better battery health by enabling slower charging speeds.

Is BEV ownership limited to people with driveways?

Owning a BEV is not exclusively for those with driveways. While having a personal charge point at home does offer cheaper and more convenient charging, the UK's expansive public charging network provides ample alternatives. Local councils have been actively installing charge points in areas without off-street parking, supported by initiatives like the On-Street Residential Chargepoint scheme and the Local Electric Vehicle Infrastructure scheme, backed by UK Government funding. Additionally, many employers are introducing workplace charging stations, with the help of the Workplace Charging Scheme.

Although lacking a personal charge point may initially seem to increase charging costs, using slower charging options can mitigate these expenses. For instance, charging a BEV with a 0.27 kWh/mile efficiency at public charge points costing between £0.55-£0.81 per kWh, using a 7 kW charger, equates to approximately £0.15 per mile. Opting for a rapid 50 kW charger increases the cost to about £0.22 per mile. By comparison, driving a petrol car at £1.45 per litre with a fuel efficiency of 45 miles per gallon costs around £0.15 per mile, while diesel vehicles at £1.50 per litre and 50 mpg efficiency come to roughly £0.14 per mile.

Can the electricity grid support an increase in vehicle charging?

The efficiency of the UK's electrical systems has significantly improved, leading to a 16% reduction in peak electricity demand compared to its highest level in 2002. According to estimates by the National Grid, a complete transition to battery electric vehicles (BEVs) would only increase electrical demand by 10%. This indicates that the current grid has sufficient capacity to accommodate the rising adoption of electric vehicles. Moreover, BEVs have the potential to contribute positively to the grid's stability by serving as energy storage units that can release electricity back into the grid when needed.

While the overall capacity of the grid supports increased BEV charging, there are localised challenges with grid constraints, especially regarding the setup of large-scale fleet or public charging stations. However, targeted upgrades are underway to address these issues, ensuring that the infrastructure keeps pace with the growing number of electric vehicles.

Are batteries sustainable?

The sustainability of batteries, especially for electric vehicles (EVs), phones, and computers, does raise valid concerns, primarily due to the mining practices for essential materials. Managing these concerns is crucial. However, it's important to note that the largest mining operations globally are for fossil fuels. If the adoption of battery electric vehicles (BEVs) were to reach 100%, the demand for battery materials would still not match the current levels of fossil fuel extraction.

Advancements in technology have significantly reduced the amount of material required for batteries compared to a decade ago, and this trend towards efficiency is continuing. Modern vehicle batteries not only last much longer than early estimates suggested but they can also be repurposed for stationary storage once they've reached the end of their lifecycle in a vehicle. Remarkably, at the end of their second life, up to 98% of battery materials can be reused or recycled. This not only prevents waste but also contributes to reducing the need for new material extraction.

Electrification offers a pathway to decrease the overall need for mining, especially for specialised materials, thereby helping to lower emissions. The focus on improving battery technology and recycling processes underscores the potential for a more sustainable approach to powering our vehicles and devices.

Are BEVs more likely to catch fire?

Concerns about the fire safety of battery electric vehicles (BEVs) are taken seriously, and the UK's emergency services are continuously updating their response protocols to address such incidents effectively. However, it's crucial to look at the data to understand the actual risks. In Norway, a country where 21% of vehicles are BEVs, emergency services responded to six times more fires in petrol and diesel vehicles than in BEVs from 2018 to 2022.

Similarly, a UK investigation into bus fires between 2020 and 2022 found no instances of fires caused by electric bus batteries. Analysis by Tusker, a company specialising in salary sacrifice schemes for electric vehicles, showed that none of the over 30,000 BEVs in their fleet have caught fire. Further supporting this, a study by the Swedish Civil Contingencies Agency found that BEVs are 20 times less likely to catch fire compared to internal combustion engine (ICE) vehicles.

Despite this, media reports can sometimes give the impression that BEV fires are more common than they are. This perception is partly because vehicle fires, particularly those involving BEVs, tend to receive extensive media coverage, regardless of the cause. It's worth noting that 65% of vehicle fires are attributed to arson, highlighting that the issue is not specific to the battery technology of BEVs.

Will hydrogen solve everything?

By the end of 2022, the global count of hydrogen fuel cell electric vehicles (FCEVs) stood at approximately 72,000, a stark contrast to the 26 million battery electric vehicles (BEVs) registered. In the UK, the market offers two FCEV models: the Toyota Mirai and Hyundai Nexo, with the Vauxhall Vivaro FCEV potentially joining in 2024. Currently, the UK hosts eight hydrogen refuelling stations, with plans to open five more, including stations dedicated to buses. Despite their innovation, FCEVs have encountered maintenance challenges, leading some early adopters, including UK public bodies, to shift their focus towards BEVs.

A lifecycle analysis reveals that FCEVs require about 3-6 times more energy than BEVs due to lower efficiency and the energy-intensive hydrogen production process. The primary methods of producing hydrogen today include steam methane reforming and coal gasification, which are significant sources of CO_2 emissions. Although hydrogen can be produced using renewable energy via water electrolysis and potentially in a more environmentally friendly manner through carbon capture technologies, these cleaner methods currently account for a minimal portion of global hydrogen production. Directly using electricity in batteries remains more efficient.

Hydrogen does have potential applications within a decarbonised energy system, particularly in sectors where BEVs might not be feasible. However, for the majority of road vehicle applications, BEVs offer a more cost-effective and efficient solution. Hydrogen's best use is in specific areas where its characteristics provide the most benefit.

Will synthetic fuels solve everything?

Synthetic fuels, or e-fuels, are created by synthesizing carbon dioxide (CO_2) and hydrogen (H_2). The production of hydrogen, a key component, requires significant energy and can produce considerable emissions, depending on the method used. Moreover, synthesizing these fuels is an energy-intensive process, consuming about five times more energy than electricity to power a vehicle. Research by Transport & Environment highlights that using synthetic fuels is approximately 15% costlier than conventional fuels and about 40% more expensive than battery electric vehicles (BEVs), when considering total ownership costs.

Given that BEVs present a viable low-carbon alternative for transportation, the necessity for synthetic fuels is called into question, particularly due to their higher costs, greater energy demands, and larger emission footprint. While there are specific sectors where electrification might not be feasible, and synthetic fuels could play a role, their application should be prioritized accordingly. Like hydrogen, synthetic fuels are not a one-size-fits-all solution for decarbonisation. The focus should be on deploying the most effective solutions where they fit best, ensuring efficient and sustainable use of resources.

Are BEVs too expensive?

When considering the purchase or lease of a new Battery Electric Vehicle (BEV), it's clear that the upfront cost is generally higher than that of a comparable diesel or petrol vehicle. For instance, a new electric Vauxhall Corsa might be about 30% more expensive to buy or 20% more to lease than its petrol counterpart. The pre-owned market offers more variability, yet it's increasingly possible to find second-hand BEVs priced similarly to their Internal Combustion Engine (ICE) equivalents.

The true financial advantage of BEVs emerges in their operation. With lower costs for energy, maintenance, and taxes, the total cost of ownership (TCO) or whole life cost (WLC) of a BEV often undercuts that of petrol or diesel vehicles over time. To illustrate, if a BEV initially costs £8,000 more than a petrol car but saves £1,200 annually in running costs, over an eight-year period, it will end up being £1,600 cheaper than the petrol vehicle.

Addressing the affordability barrier for lower-income individuals is critical. Initiatives like France's 'social leasing scheme', which allows access to electric vehicles for a low monthly fee, demonstrate effective strategies to make BEVs more accessible, ensuring that more people can benefit from the lower operational costs of electric driving.

Are BEVs too heavy?

Battery electric vehicles (BEVs) typically weigh more than their petrol or diesel equivalents, a discrepancy primarily attributed to the batteries they carry. Nonetheless, advancements in battery technology are progressively improving energy density, potentially reducing the overall weight of BEVs in the future.

The trend towards larger and heavier vehicles isn't confined to electric cars; it's a broader automotive trend affecting SUVs and other vehicle types across all powertrains. This shift towards bigger vehicles contributes to reduced efficiency, higher energy consumption, and increased emissions. The table below, sourced from Parkers, illustrates the approximate weights of various car models, highlighting the weight differences between electric and internal combustion engine (ICE) vehicles:

Make and model	Fuel type	Car type	Weight (approx.)
Vauxhall Corsa	Petrol	Hatchback	980 kg
Fiat 500	Petrol hybrid	Hatchback	980 kg
Fiat 500-e	Electric (24 kWh)	Hatchback	1,200 kg
Peugeot 308	Petrol	Estate	1,300 kg
Fiat 500-e	Electric (42 kWh)	Hatchback	1,400 kg
Vauxhall Corsa-e	Electric (50 kWh)	Hatchback	1,400 kg
BMW 4 Series	Petrol	Saloon	1,500 kg
Peugeot e-308	Electric (54 kWh)	Estate	1,700 kg
Tesla Model 3	Electric (53 kWh)	Saloon	1,700 kg
BMW i4	Electric (70 kWh)	Saloon	1,900 kg
Tesla Model Y	Electric (60 kWh)	SUV	1,900 kg
Land Rover Discovery	Diesel	SUV	2,300 kg
Range Rover	Petrol	SUV	2,400 kg

Summary

Transitioning to battery electric vehicles represents a significant technological shift, necessitating adjustments mainly in how we refuel our cars – now charging instead of filling up at a petrol station. Yet, the experience behind the wheel remains largely unchanged, offering a familiar driving feel with numerous added benefits.

It is important to ask questions about this new technology, and seek independent advice – always question where the information came from and what is its purpose.

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