TMC
FUEL GUIDE
2019

INTRODUCTION

Anti-diesel sentiment in the UK almost halved diesels' share of the new car market from over 50% to 30% between 2017 and 2018

The movement away from a predominantly diesel fleet is due to a number of factors; a worldwide drive to reduce greenhouse gas emissions and air pollution, the limited supply of refined diesel and governments reversing previously supportive attitudes to diesel cars. As a result, diesel has fallen out of favour and fleets are looking at other options.

Petrol has started to make a comeback – very often in the form of hybrid and plug-in hybrid cars. LPG could find a larger niche for itself for LCVs operating into and out of city centre air-quality charging zones.

The number of plug-in vehicles continues to expand steadily (though probably not spectacularly until the 2030s) as public charging infrastructure gradually improves and consistent tax policies emerge. Hydrogen fuel cell vehicles are a proven technology, though it is unclear whether a hydrogen transport infrastructure could economically be scaled up to the same extent as electric to ultimately replace combustion engines.

Over the past twenty years, we have seen the government favour various fuel types. LPG benefited from conversion grants from 1996-2005; then the take up of diesel was encouraged with (favourable) tax policies c. 2003 - c. 2015 and more recently, plug-in petrol hybrids received grants from 2011-2018.

Going into the 2020s, it appears that electric vehicles will be the main – perhaps only – beneficiary of significant government incentives. At the same time, business fleets will have to rely on conventional liquid fuels for some years.

This guide offers a concise fuel-by-fuel overview covering price, real world cost-per-mile, environmental impact and fuel availability, to help businesses better understand the pros and cons of each fuel type.

A NOTE ABOUT THE COMPARISONS

There are many ways of comparing different fuels. This guide uses four:

ENERGY DENSITY - the amount of energy stored per unit of fuel. This guide uses kWh per kg as this makes it easier to compare.

CONVERSION EFFICIENCY - the average proportion of energy in the vehicle's tank or battery that reaches the wheels to propel the vehicle.

WELL-TO-WHEEL CO2 - the carbon dioxide equivalent in grams per kilometre of the total emissions from every stage of the fuel's journey from extraction to the road. This makes it easier to compare liquid fuels such as diesel, with sources such as electricity or hydrogen, where CO2 and other emissions occur at the point of generation, not at the tailpipe. The data comes from the European Commission projections for 2020-model vehicles and emissions standards and excludes 'embodied CO2' from vehicle manufacture.

40 RANGE - another way of looking at comparative range delivered by fuels of differing energy density. It shows the representative range achievable on 40 litres of diesel or petrol; a fully-charged 40kWh EV battery (e.g. in the 2018 Nissan Leaf), or the equivalent amount of LPG or hydrogen.

DIESEL

Diesel vehicle exhaust contains more air quality pollutants, e.g. particulates and oxides of nitrogen, than petrol, though current exhaust control systems make diesel far cleaner than a few years ago. Primary refining of conventional crude oil produces less diesel than petrol, so secondary processing is required to balance demand, which gives diesel a slightly higher production cost.

EFFICIENCY

Weight for weight, diesel fuel contains more energy than any other fuel except liquid hydrogen: more than 13 kWh per kg. Notably, its energy density is 53 times greater than lithium-ion batteries. However, only around 25% of the energy stored in a diesel vehicle's fuel tank reaches the wheels, compared with 80-90% of the energy in an EV battery.

- Energy density: 13.3 kWh per kg
- Conversion efficiency: 25%
- Total well-to-wheel CO2: 110g per km
- "40" range: 415 miles

DIESEL USE

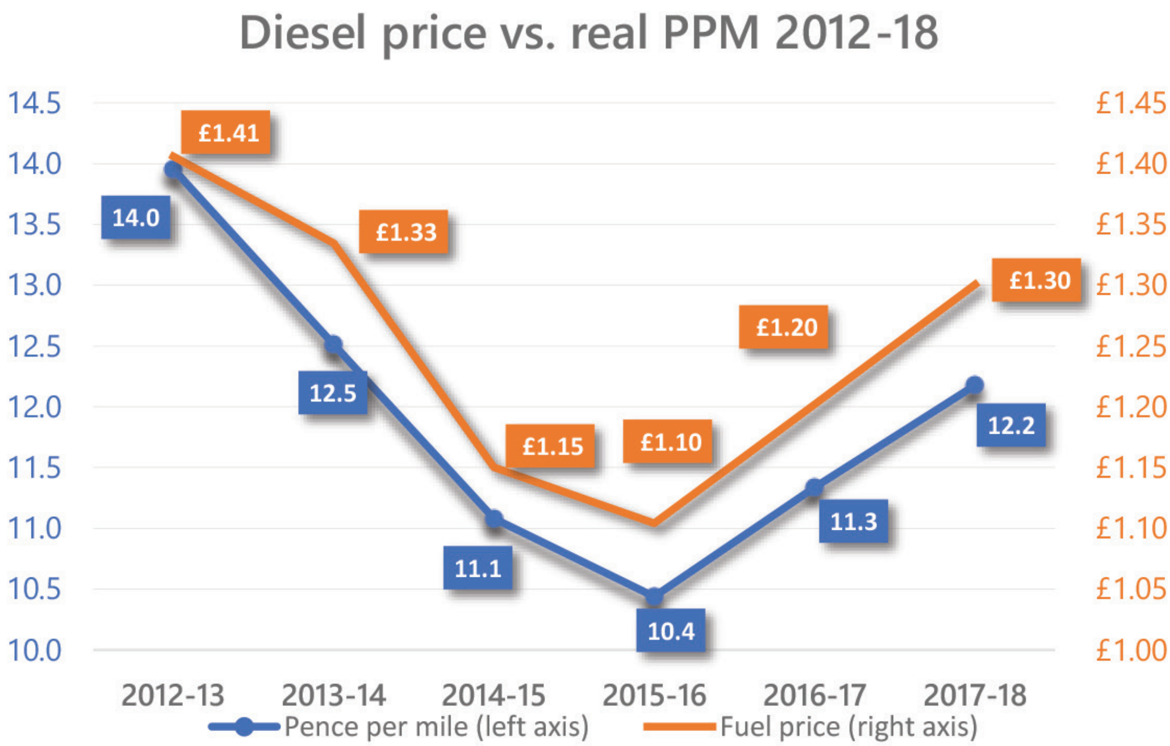
The UK Petroleum Industries Association, predicts that 2017 or 2018 will prove the high point for diesel fuel volume in Britain, followed by a slow but steady decline. Diesel accounted for 63% of the major road fuels (diesel, petrol, LPG) consumed in the UK in 2017. That represented an increase in consumption of 1% to a record 24.9 million tonnes despite sharply falling sales of new diesel cars. Increasing activity by commercial vehicles, especially LCVs, is the main reason why the declining diesel car market is not yet reflected in diesel fuel volumes.

DIESEL PRICE

Aside from the UK and Switzerland, all countries in Europe levy lower duty on diesel than petrol. As a result, diesel is cheaper at the pump outside the UK although the pre-tax cost of diesel everywhere is around 4% higher than petrol.

TMC DATA TRENDS

Analysis of a total of 10,300 diesel and petrol cars on TMC's audited mileage capture database from 2012 to 2018, shows the average diesel cost 1.6 pence-per-mile (11.8 per cent) less to fuel than the average petrol car. Furthermore, diesels' real-world fuel economy improved by 6 per cent over this period. This improvement in fuel efficiency slightly helped to reduce the impact of higher pump prices after 2015 (although for company car drivers any fuel cost benefit was countered by the significant increase in diesel company car tax after 2014).



Sources: TMC Mileage Capture database and Department for Business, Energy and Industrial Strategy (BEIS)

PROS AND CONS OF DIESEL

For: Cost. Network. Practicality

- Diesel's biggest advantage relative to other mainstream road fuels is its higher mpg, resulting in a lower cost-per-mile and lower greenhouse gas emissions, leading, in turn, to lower liability for CO2-based taxation.
- Along with petrol, diesel is the most widely-available road fuel everywhere on the planet. The UK has one filling station for every 1,400 registered diesel cars vs. one for every 2,500 petrol cars.
- Diesel fuel's light weight, simple storage requirements and handling safety (it is normally only flammable under high compression) make it the ideal energy source for most existing transport infrastructure.

Against: Pollution. Political hostility/taxation. Supply constraints

- While it is important to note that measurements of pollutants associated with diesel, including CO2, NOx and particulates, have fallen in most countries in recent years, and that diesel transport is responsible for a relatively small portion of total pollution, diesel combustion creates more pollutants than petrol. While clean-diesel systems such as AdBlue have closed the gap with petrol regarding NOx, manufacturers are now moving on to preventing remaining pollutants such as ammonia, formaldehyde and other volatile compounds escaping into the environment.
- The diesel emissions scandal that began in 2015 added political hostility to the environmental headwinds already facing diesel. Since the scandal began, governments have increased taxes on diesel users, e.g. higher excise duty and company car tax (CCT) surcharges in the UK. A growing number of UK and European cities have announced toxicity charge schemes or even diesel bans to bring roadside NOx levels below EU targets (which the UK says it will apply after Brexit). Anti-diesel sentiment in the UK almost halved diesels' share of the new car market from over 50% to 30% between 2017 and 2018. Diesel company cars that comply with the Real Driving Emissions (RDE2) standard will return to CCT parity with petrol – but will that come too late to affect drivers' perception?

SUMMARY

Diesel is unbeatable as a fuel for medium and heavy payload, extra-urban and long-distance road transportation. Therefore, vans and HGVs will continue to use diesel for the foreseeable future. Nevertheless, all OECD countries want to cut overall diesel fuel consumption in the next two decades. Many view reducing diesel car sales, specifically, as the best way to do this, since practical alternative fuels and powertrains are already available.

PETROL

A barrel of oil (156 litres) yields roughly twice as much petrol as diesel: around 75 litres of petrol per barrel. Petrol is less energy-dense than diesel, and petrol engines are less efficient, so petrol's cost-per-mile and emissions-per-mile are higher. Government policies around the world have begun to re-emphasise petrol as a passenger car fuel, partly in order to redress a growing imbalance in supply and demand for diesel, and partly because petrol vehicles pose fewer risks to urban air quality (see the pros and cons section below).

EFFICIENCY

Petrol comes third to liquid hydrogen and diesel in terms of energy density. At 12.9 kWh per kg, it is only slightly less energy-dense than diesel and holds 51 times more energy per kg than a fully-charged lithium-ion battery. Petrol engines are lighter than diesel but, because they don't convert as much of the energy in the fuel to heat, they are less efficient. Only 15% of the fuel energy reaches the wheels, compared to 25% for diesel. This difference is evident in mpg and cost-per-mile data, where petrol cars lag diesels by 15%-20%

- Energy density: 12.8 kWh per kg
- Conversion efficiency: 15%
- Total well-to-wheel CO2: 130g per km
- "40" range: 335 miles

PETROL USE

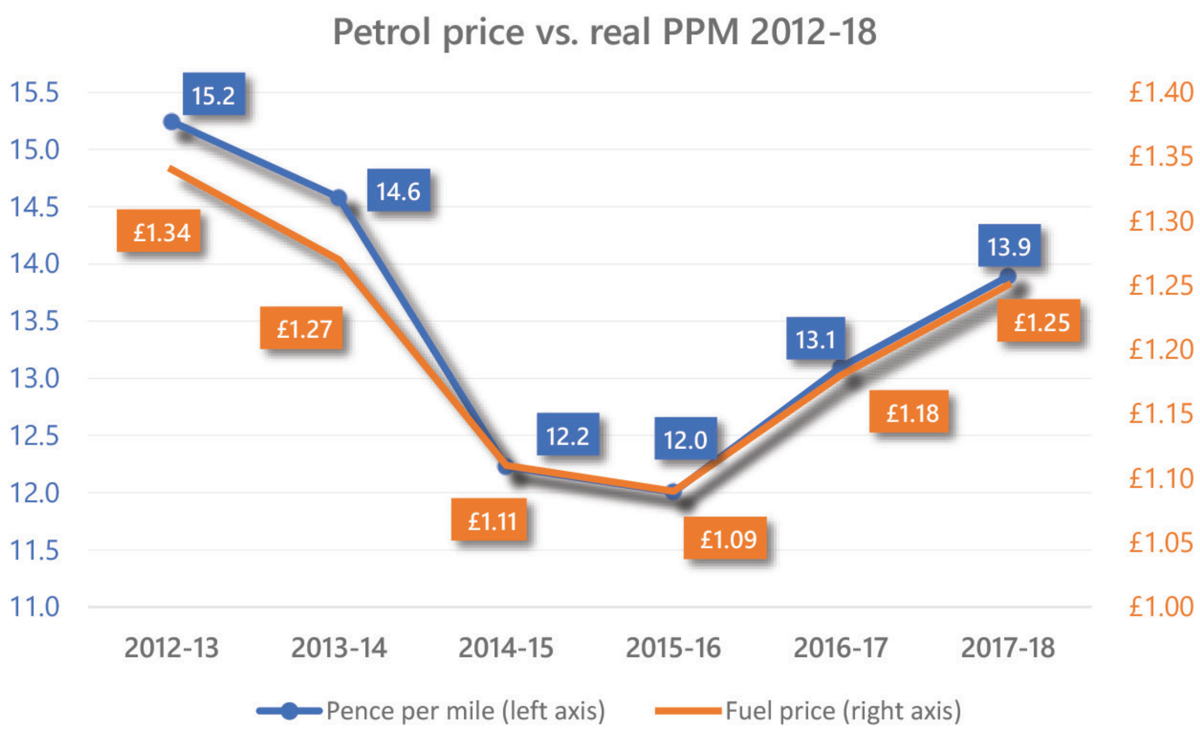
Petrol accounted for 29% of road fuel consumed in the UK in 2017. Annual petrol consumption across the EU in 2016 was 78.5 million tonnes (vs. 226 million tonnes of diesel), representing 21% of EU road fuel consumption. UK petrol consumption fell by 1% in 2017, to its lowest-ever level of 11.7 million tonnes; almost half the volume sold in 1998. Petrol cars account for between 8% and 9% of total UK greenhouse gas emissions, which is approximately the same as emissions from UK agriculture.

PETROL PRICE

Between 2003 and 2018, the pump price of petrol in the UK averaged 4.3p per litre less than diesel. The chief reasons for the historic differential are petrol's lower production cost and declining consumption due to improving MPGs, and to car drivers switching initially from petrol to diesel and now increasingly to plug-ins. Given that the majority of global diesel demand is commercial and is not influenced by competition from alternative fuels, it is likely that petrol will remain relatively cheaper than diesel. The price differential may widen in future as diesel demand intensifies relative to supply growth (see the diesel section).

TMC DATA TRENDS

Perhaps because manufacturers have focused their attention on improving diesel fuel economy, and on developing new hybrid and electric powertrains, the average real-world MPG of conventional petrol cars on TMC's databases increased by only 2.4 per cent since 2012 (compared with 6 per cent for diesels). Without the buffer provided by increasing efficiency, petrol fuel costs track movements in pump prices more closely than diesel costs.



Sources: TMC Mileage Capture database and Department for Business, Energy and Industrial Strategy (BEIS)

PROS AND CONS OF PETROL

For: Availability. Air quality

- Petrol does not face the same issues with declining global feedstock availability and refinery capacity as diesel. Much of the light, tight oil exploited by fracking in the US is suitable for making petrol. Petrol is therefore not expected to be subject to the same upward pressure on prices, over and above fluctuations in underlying oil prices, as diesel.
- Petrol combustion is less harmful to urban air quality – notably emitting far fewer particulates and oxides of nitrogen – making petrol vehicles less susceptible to future urban air quality charges and restrictions. Almost all hybrid and plug-in hybrid vehicles on the market and in the pipeline feature petrol engines.

Against: Cost. Greenhouse gas emissions

- While it seems likely that the ongoing backlash against diesel cars will persuade more fleet and private drivers to choose petrol-engined cars, the shift will have an adverse impact on fuel costs. TMC's real-world fuel data on 20,000 vehicles from 2018 shows that non-hybrid petrol vehicles cost an average of 2.7 pence per mile more to fuel than diesel.
- Although petrol engines' fuel economy will continue to improve gradually, the key to significantly better petrol mpg is mild or plug-in hybridisation. But as TMC's data also shows, it is essential for businesses to ensure that drivers use petrol hybrids correctly (e.g. routinely charging the battery), otherwise their fuel economy can fall to as little as 25% of the advertised figure and significantly worse than the equivalent conventional petrol model.
- As discussed above, petrol vehicles have higher CO2 emissions than diesels of similar size and power. Therefore, they may incur higher carbon tax penalties (e.g. via company car tax and capital allowances in the UK), which drives up their whole life cost compared to diesel.

SUMMARY

Putting drivers into conventional petrol cars will mean higher fuel and tax-related costs. However, these may be increasingly offset by higher residual values compared to diesel and avoidance of the toxicity charges targeted primarily at diesel. Petrol hybrids offer an obvious way forward, although they call for radically different approaches to selection and driver management from either conventional diesel or petrol vehicles.

ELECTRICITY

Battery electric (BEV) and hydrogen fuel cell (HFCV) vehicles are widely seen as the key to tackling air pollution and climate change by decarbonising transportation. As of January 2019, eleven countries including the UK, France, Norway, India, Germany and China had already passed legislation to ban the sale of new combustion engine vehicles at different dates between 2020 and 2050. Aside from Norway, however, these bans will apply solely to passenger cars. Norway, which has already electrified 40% of its car parc, says all new heavy-duty vans, 75% of long-distance buses and 50% of HGVs must be zero-emission from 2030. Omitting commercial vehicles from future bans recognises that no current low- or no-carbon alternative drivetrain is capable of replacing diesel for long-distance extra-urban transportation (although plug-in LCVs are of course successfully taking over from diesels in lower mileage roles). Nevertheless, JP Morgan estimates that BEVs will account for one in five new vehicle sales globally by 2030, with ICEs accounting for 41% and hybrids the remainder.

EFFICIENCY

Electric vehicle batteries are 50 times less energy-dense than diesel, weight for weight. A battery holding the same energy as 50 litres of diesel would weigh as much as an entire diesel Ford Focus. However, electric vehicles use on-board energy far more efficiently than internal combustion engine (ICE) vehicles. Over 80% of the energy from charging the battery reaches the wheels, compared with 15%-25% of petrol and diesel energy. EV designers must therefore balance energy storage against battery weight. This gives real-world ranges of 120-300 miles for EV cars and 80-110 miles for EV LCVs available in 2018.

- Energy density: 0.25 kWh per kg
- Conversion efficiency: 80% of mains input
- Well-to-wheel CO2 equivalent: 70g per km1
- “40” range: 170 miles[2]

ELECTRICITY USE

Although cumulative worldwide EV sales rose quickly, from one million in late 2016 to over 4 million by the end of 2018, fully-electric vehicles represent only a quarter of 1% of all light duty vehicles in circulation.

ELECTRICITY COST

Based on an average domestic electricity payment of 15.2p per kWh in the UK[3] electricity for a 40kWh EV with a 170-mile range costs 3.6p per mile. That is in line with HMRC's advisory electric rate (AER) of 4p per mile. UK domestic electricity bills went up by 8% in real terms between 1996 and 2016, whereas the real price of petrol at UK pumps increased by 20% over that time. Most scenarios for electricity prices in the UK and Europe predict they will increase as e-mobility expands. European generators will need to increase their output by 25% if the regions' current ICE car parc goes 100% electric.

PROS AND CONS OF EVS

For: Cost. Environment. Government policy

- Under the right circumstances, EVs make very efficient fleet cars or vans, with mileage costs 60%-75% lower than ICEs, and very low CCT and employer's NI liability. EV service and maintenance costs are lower than ICEs, although list prices are usually substantially higher, even when the plug-in grant is included. Nevertheless, studies are finding that EV whole life costs are already competitive with ICEs. A comparison by Lex Autolease for the Energy Saving Trust calculated that WLCs (whole life costs) for EVs from BMW, Hyundai and VW could be between £6 and £120 per month lower than on equivalent ICE models from the same manufacturers. EVs are currently exempt from existing and planned congestion and air quality charging zones, a feature that may tip fleets' powertrain choice to electric for vehicles operating mainly in these areas, including LCVs.
- Battery-electric vehicles' green selling-point is that they are zero emission at the point of use in terms of greenhouse gases and – more importantly for urban-use – compounds harmful to air quality. Of course, EVs are only as clean as the electricity they use. Nearly 30% of electricity in the UK and Europe came from renewable sources in 2017. The remainder came chiefly from natural gas, with some nuclear power and coal in the mix. EU data estimates that EVs' 'well to wheel' carbon footprint will be around 70g/km in the mid-2020s. Renewables' share of European electricity generation is expected to reach 50% by mid-century.

- The government will pay subsidies for you to go electric. Total UK government funding for subsidies for EV purchases, charging infrastructure, R&D and information campaigns in the next few years is almost £1 billion. And to further de-risk EV adoption, current UK legislation should ensure that the entire new-car market will be electric by 2040: even plug-in hybrid new-car sales will end by then.

Against: Range. Payload. Impracticality. Early adopter risk

- Mainstream EV car models' real-world range is currently around 200 miles per charge, although the Tesla Model 3 can achieve over 300 in ideal conditions. Electric LCVs can typically cover 80-100 miles per charge. The range of electric cars and vans is improving.
- Batteries are heavier than an equivalent engine, which eats into plug-in vans' payload capacity. The UK government allows standard car licence holders to drive electric vehicles up to 4.25 tonnes gross weight (compared with 3.5 tonnes for ICEs), to compensate for batteries.
- While it's expected that most EVs will be charged overnight at home, millions of potential users don't have off-street parking or a regular kerbside space at which to charge a vehicle, if kerbside charging becomes more widely available. Consideration needs be given about overnight charging for LCVs.
- Fleets taking up EVs still face a significant degree of early-adopter risk. Vehicle technology, the public charging infrastructure market, and the used EV market are still maturing. Battery supply is another issue. Supply growth is expected to be led by China, Korea and the US, whose own rapidly-growing domestic markets for EVs and grid storage already soak up the majority of current supply. The UK government is investing in R&D rather than battery production capacity.

SUMMARY

Europe, China and elsewhere seem to have the political will to create fully-electric passenger car markets over the next 20 years. The next stage of the transition (in the 2020s) seems likely to be dominated by plug-in hybrid car choices. As fleet operators are already discovering, even PHEVs require very different approaches to car allocation, cost calculation and fuel/expenses management than ICEs. Full-scale e-mobility will change expectations and practices around car ownership and travel even more profoundly. As-yet unpredictable advances in battery technology will strongly influence the pace and direction of the EV market's development, as will the level of investment in roadside charging infrastructure.

HYBRID AND PLUG-IN HYBRID

While fleets operating EVs and petrol/diesel vehicles can expect real-world fuel costs to fall within relatively narrow ranges, hybrids, especially plug-ins, are a lot more sensitive to driver behaviour, terrain and driving conditions. Give the same model of PHEV to two drivers and the average fuel consumption they get might differ by 300 mpg!

EFFICIENCY

It is not possible to give representative fuel economy or well-to-wheel efficiency figures for hybrids and PHEVs, because of the huge variation of engine size and battery capacity combinations on the market. Mild hybrids recycle energy from braking to assist with acceleration and improve automatic stop/start response but not power the vehicle by itself. They offer small improvements in MPG and CO2. Full hybrids feature stronger batteries and electric motors capable of propelling the car for short durations. Plug-in hybrids may offer over 30 miles of electric-only driving as well as a powerful petrol drivetrain. However, the extra weight of the large battery and the power-management systems. Means they consume petrol heavily unless they are charged whenever possible.

HYBRID USE

The first plug-in hybrid models appeared on European roads in 2010. PHEV sales caught up with pure EVs in 2016. PHEV sales in the EU and Scandinavia in 2017 were 144,000 units out of a total market for new cars and light vans of 15.6 million. In the UK, petrol PHEVs were the fastest-growing alternative fuel segment during the first 11 months of 2018. PHEV registrations in the UK rose 26.7% to 40,473 units, compared to 13,940 pure EVs (up 10.9% year-on-year). However, JP Morgan Research forecasts that PHEVs will eventually occupy a small market niche between BEVs and standard hybrids. It estimates PHEVs will account for two per cent of global new vehicle sales by 2030, with standard hybrids taking 39 per cent, BEVs 18 per cent and ICEs the remaining 41 per cent.

HYBRID FUEL COST

The scale of the problem of unmanaged PHEV fuel costs was exposed by a BBC news story in November 2018, in which real-world fuel consumption data supplied by TMC confirmed that many fleet PHEVs burn more fuel than diesels, while some drivers never charge their cars at all. The data on 1,500 PHEVs showed they averaged an actual mpg of 39.3 against an average manufacture-advertised mpg of 129.7. However, the data also showed that when fit for purpose and used correctly – i.e. regularly charged – PHEVs can achieve impressive MPG results. 2% of the sample were achieving an average MPG of over 100. TMC's data showed that although drivers benefited from tax savings arising from PHEVs' low advertised CO2 emissions, their employers missed out on the fuel cost savings that should offset plug-in hybrids' significantly higher purchase prices. Overall, the 2,432 PHEVs and non-plug-in hybrids on TMC's fuel and mileage database averaged 49.06 mpg on the road, which is about the same as the average for diesel cars. However, within that sample, 2% are achieving upwards of 100 MPG, showing the potential of hybrids.

PROS AND CONS OF HYBRIDS

For: Fuel cost. Flexibility

Full and plug-in hybrid technology has the potential, where deployed correctly, to make petrol fuel economy competitive with diesel for short and medium-distance fleet roles. TMC data captured from over 20,000 vehicles shows that petrol cars' average real-world fuel costs are almost 21% higher than diesel. PHEVs performed slightly worse than pure petrol cars overall, though this seems to be mainly due to unfamiliarity/misuse by drivers. Several PHEVs in the sample showed it is possible to achieve 100 mpg-plus fuel economy by making full use of the battery.

So long as drivers don't use them simply to cheat the tax system, PHEVs offer a bridge between current ICE and future EV operations. PHEVs can cost-effectively perform medium-distance roles that are currently beyond the reach of EVs with today's limited public charging infrastructure.

Against: Price. Unsuitable for high mileage roles

- Hybrids and especially PHEVs cost more to manufacture and maintain than straight ICEs. In October 2018, the UK government withdrew plug-in car grants from vehicles incapable of 70 or more miles on electric power alone. This added up to £2,500 to the cost of ineligible PHEVs.
- The UK's company car tax rules from 2020 will be based on how many zero-emission miles hybrids can cover. This will steer drivers towards asking for the big-battery models that perform worst when used incorrectly – e.g. in high mileage roles. On the other hand, as long as fleets monitor and manage mileages and fuel volume, and take steps to correct misuse, big-battery PHEVs could offer significant tax and fuel savings over ICEs (assuming the data does not support a BEV as the optimum choice).

SUMMARY

Properly-managed hybrids and PHEVs are, and will remain, crucial to operating a cost-effective car fleet as the transition to full zero-emission transport accelerates. Fortunately, effective management tools are readily available, to allow companies to capture mpg data and address the behaviours of drivers who don't regularly charge up. Businesses need to ensure they have a strategy when adopting PHEVs, to make sure they are fit for purpose and that the necessary infrastructure is there for charging them both at work and at drivers' homes.

LIQUID PETROLEUM AND NATURAL GAS

Liquefied petroleum gas (LPG), often referred to as propane or auto gas, is stored in a pressurised tank and released to a slightly-modified petrol engine as gas at atmospheric pressure. Although it is less energy-dense than petrol or diesel, its clean-burning qualities and relatively low cost make it the world's third most common transportation fuel. Naturally-occurring natural gas liquids and compressed natural gas (CNG) produce a very similar vehicle fuel. Europe is virtually self-sufficient in LPG feedstock, thus the global refining balance issues starting to affect diesel will not have an impact on LPG supply.

EFFICIENCY

LPG delivers less energy when burned than petrol and diesel, although this drawback is partly compensated for by the LPG's reduced exhaust emissions. Nevertheless, it takes more LPG by volume than petrol to drive the same distance. Most LPG vehicles are bi-fuel so they require both an LPG tank (around 60kg in weight), and a normal petrol tank, which affects MPG and payload.

- Energy density: 13.3 kWh per kg
- Conversion efficiency: 16%
- Total well-to-wheel CO2: 120g per litre
- "40" range: 290 miles[4]

LPG USE

Around 150,000 UK cars and LCVs (0.5% of the total UK vehicle park) use LPG. LPG penetration in the EU is higher at an average of 3%, with Italy at 5% and several eastern European countries higher still. LPG refuelling pumps are available at more than 1,500 sites around the UK. Many of them are located at petrol stations, although a significant number are on the premises of other businesses.

LPG COST

UK fuel duty on LPG in 2018 was 31.6p per kg, compared with 57.95p per litre for petrol and diesel. UK LPG typically retails at 66-69p per kg. Comparing LPG consumption with petrol is complicated by the fact that most LPG vehicles are dual-fuel and automatically switch to petrol in some situations, such as starting and under hard acceleration. Motoring magazine tests of a converted Ford Focus in 2015 reported its LPG cost as 9 pence-per-mile vs. 15 pence when running on petrol. As with all LPG cars and most LCVs, the cost of conversion must be set against the fuel cost-saving. The fuel saving from the Ford Focus demonstrator above would pay for its LPG conversion over about 30,000 miles.

PROS AND CONS OF LPG

For: Fuel cost. Environment. Infrastructure

- LPG fuel cost per mile is significantly lower than diesel and petrol over the vehicle's lifetime, even allowing for the conversion cost. LPG emits 26% less greenhouse gas, well-to-wheel, than petrol, and fewer air quality pollutants such as NOx and particulates.
- The UK has an established LPG refuelling network, although it is less than a quarter the size of the petrol and EV charging point networks (an average of 144 miles between LPG outlets, vs. 26 miles for petrol and 32 miles between EV points).

Against: Vehicle availability and conversion cost. Payload compromise. No BIK advantage

- No LPG-powered cars are available directly from manufacturers in Europe. Factory LCV options are limited – mainly because the majority of OEM LCVs are diesels, which cannot be economically converted to LPG. Conversion typically costs £1,500-£2,000 per van or car . Conversion may invalidate all or part of the vehicle manufacturer's warranty, though most accredited installers have agreements with car brands to ensure the warranty for all current parts of the car remains valid, even after installing their LPG system.
- LCVs incur a payload penalty from the LPG tank, which is heavier than the same volume of petrol and takes up extra space in dual fuel conversions.

- A driver of an LPG company car does not benefit from a tax saving due to its lower CO_2 emissions. BIK is applied to the advertised emissions of the OEM petrol model. However, the conversion cost is not added to the P11D figure.

SUMMARY

LPG lost its momentum in the UK when government conversion grants ceased in 2005. But things could be about to change for some commercial users. LPG offers LCV fleets a potential alternative to diesel, which could be cost-competitive over its lifetime and which avoids urban toxicity charges aimed at diesel emissions. Car fleets, which can more easily turn to hybrid and BEV powertrains, are less likely to want to consider LPG except in cases where the data shows that the fuel cost saving would make up for the lack of a BIK or NIC advantage over petrol.

HYDROGEN

Like electricity, hydrogen is not strictly a fuel but an energy carrier. It is the most abundant element in the universe but does not occur naturally as hydrogen gas. It must be separated from other compounds – usually natural gas or water. Hydrogen acts as a store of some of the energy used to separate it. When the hydrogen is chemically recombined with oxygen in a fuel cell, each hydrogen atom splits into a proton and an electron. The electrons create a current that can be tapped to power an electric motor before they recombine with the protons and oxygen as water. Water is the only exhaust emission at the vehicle: the emissions from hydrogen fuel cell vehicles (FCVs) occur when and where the hydrogen is generated.

EFFICIENCY

Compressed hydrogen contains three times the energy of diesel by weight, but only a fraction of the energy by volume. Even when compressed to 10,000 pounds per square inch and stored in a pressurised tank, it holds about one sixth of the energy as the same volume of diesel.

- Energy density: 37.2 kWh per kg. 1.5 kWh per litre
- Conversion efficiency of fuel cell: 60%
- Well-to-wheel CO2 equivalent: 70g/km to 130g/km depending on hydrogen production method[5]
- “40” range: 91 miles[6]

HYDROGEN USE

To date, seven hydrogen car models have gone into limited production, of which three are still being produced by Honda, Hyundai and Toyota. Total sales amount to a few thousand vehicles. Most manufacturers that began hydrogen ventures when the US offered substantial funding for hydrogen initiatives between 2003 and 2009, appear to have switched their attention to EVs. As of January 2019, there were 10 public hydrogen filling stations in the UK (plus a few at universities and research centres), 40 each in the US and western Europe and 91 in Japan.

HYDROGEN FUEL COST

Compressed hydrogen is dispensed by the Kilogram. The UK price in 2018 was £9.99 per kilo. Autocar magazine reported in 2017 that their £65,0000 Toyota Mirai long-term test hydrogen car cost £47 to refuel for a range of 270 miles. That is the equivalent of 17.4p per mile, compared with the TMC average of 12p per mile for all diesels, and 3.5p-4p per mile for electrics.

PROS AND CONS OF HYDROGEN

For: Range. Refuelling time

- Current hydrogen models offer significantly greater range than typical EVs, although the range is less than 300 miles (due to the space taken up by the large hydrogen tanks). Refuelling is much faster than an EV. It takes around five minutes per 300 hydrogen miles, vs. 0.5 hours to 5.5 hours to charge an EV battery for 100 miles of range.

Against: Physics. Infrastructure. CO2

- Whether the starting point for hydrogen is steam-treated natural gas or electrolysis of water, the extra steps required to get electricity to the motor of an FCV, mean the car ends up with less on-board energy than if you'd put LPG directly into an ICE or plugged an EV into a charger.

- Hydrogen fuelling infrastructure is extremely limited at present, with half the UK network of 10 public filling stations located within the M25. Hydrogen is expensive to store and transport because it leaks incredibly easily and a proportion of each tank 'boils off' every day unless the container is kept constantly cooled. Estimates of what it would cost to equip the US road network with hydrogen refuelling points range as high as half a trillion dollars, compared to less than 10 billion dollars to install sufficient public EV charging infrastructure for the US's needs up to 2025.

- Nearly 95% of commercial hydrogen is produced from natural gas – i.e. fossil fuel – in a chemical process involving steam. The CO2 emissions from generating heat for the steam, plus those from the energy required to compress and distribute the hydrogen by road, are roughly the same as the well-to-wheel footprint of an EV (including vehicle and battery manufacturing). Hydrogen produced via electrolysis costs significantly more than hydrogen from natural gas.

SUMMARY

It is possible that hydrogen cars will prove too inefficient on a well-to-wheel basis, and require too much investment in completely new refuelling infrastructure, to scale up as a mass mobility solution. Their fuelling time and range advantage over EVs does offer hydrogen a niche in sectors, e.g. buses, blue light and military, where range and instant availability are the overriding criteria. Government policy is also starting to consider hydrogen as a potential solution for long-distance freight, since batteries will take up too much payload to be practical for HGVs. A transition from diesel to hydrogen in freight would open up a hydrogen market, although it would likely take place after the scheduled transition of cars and LCVs to electricity.

BIOFUELS

Biofuels are the largest renewable component of transport energy – providing over 5% of Europe's transport needs. Some agencies predict they will meet over a quarter of transport needs by mid-century. However, as biofuels currently barely register on the list of standalone fleet fuel options, we won't cover them in the same detail as other fuels:

Bioethanol, equivalent to petrol, is mainly produced from cellulose crops such as maize and wheat for blending with petrol under the EU Renewable Transport Fuels Obligation. Limited quantities are sold as E85 vehicle fuel – a blend of 65%-85% bioethanol with petrol – for use in modified petrol engines (E85 damages some standard rubber and metal components). The main market for E85 in Europe is Sweden with 1,700 filling stations. Germany and France have 600 each. The UK has 21 outlets. No production-line E85 vehicles are available in the UK, although Ford, Mercedes and Volvo sell a small number of OEM models in Europe, mainly in Sweden.

Biodiesel is produced from energy crops such as oil seed rape and palm oil, or from waste cooking oils and fats. Unmodified diesel engines can use low percentage blends of biodiesel including the 5% mixture ('B5') dispensed at UK diesel pumps. Modified vehicles can run on mixes up to 100% biodiesel. There are no public fuel pumps supplying high-percentage biodiesel blends in the UK, but customers can order bulk deliveries to their own bunkers.

Wood, seaweed and other forms of biomass are also burned to generate renewable heat/electricity or fermented to produce biogas. The goal is to reduce greenhouse gas emissions from the overall energy mix.

FLEET FUELS OUTLOOK

Diesel cars decline. Lean petrol and hybrids gain. Plug-ins consolidate. Gases may expand

The emissions scandal, concerns over urban air quality, and nervousness about the future security of diesel supply, have caused the U-turn on diesel-car-friendly tax policies in the UK and some other European markets.

This change of heart marks the start of a period of heightened uncertainty for fleets. Petrol is not yet competitive against diesel for many fleet car purposes. PHEV users are on a steep learning curve. Fully-fledged e-mobility is still perhaps 5-10 years away. Although there is potential for hydrogen, with only 12 fuelling stations in the UK at present, it isn't an option for the masses. This means there is no single 'safe' fleetwide fuel choice such as the one fulfilled by diesel so far this century.

Fleet fuel mixes have already started to diversify: EVs will expand where range isn't a major issue and users can take advantage of government subsidies and low mileage costs, especially relevant in urban areas. Petrol, hybrids and, perhaps once again, LPG will take over a spectrum of car and light commercial applications currently covered by diesel. Diesel will remain the choice for trucks, the majority of vans and high-business-mileage cars.

One outcome of rapidly raising CCT over the last four years might be that more employees choose to opt out of a company car altogether, rather than restrict their choice to the low-CO2 options available. Of course, drivers who move into grey fleet and non-taxable schemes like Employee Car Ownership still require full, accurate mileage-reporting, duty of care and expenses reimbursement processes. These will call for even more oversight and control than today, given a future of multi-fuel and drivetrains, with consequently wide variations in fuel prices, real-world fuel consumption rates and tax treatments.

The early 2020s will require fleets to review their strategies for vehicle selection and allocation, based on the most appropriate fuel type and usage model. A key factor in reaching decisions will be the degree of visibility over fuel, mileage and Business Mobility data.

HOW TMC CAN HELP

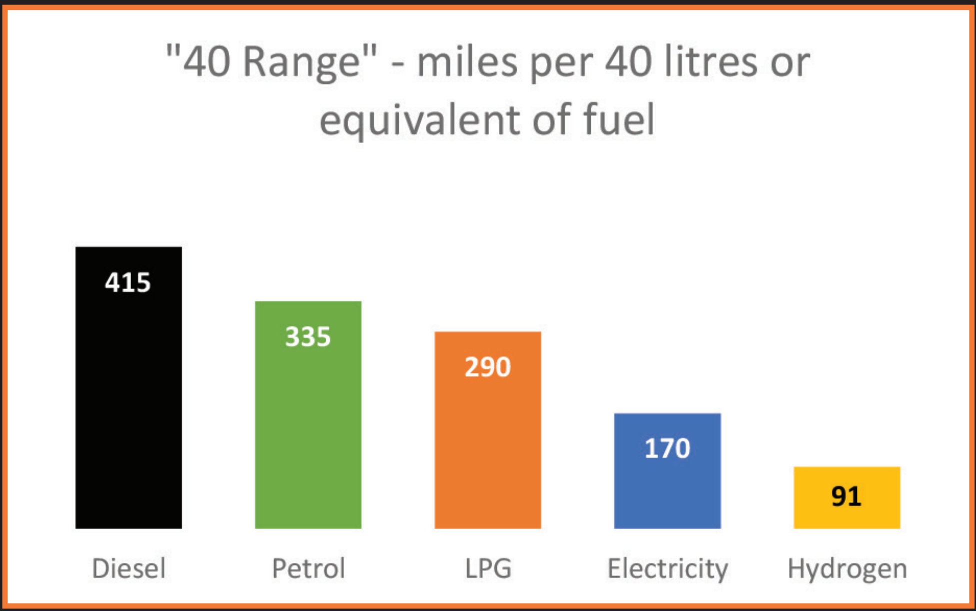
TMC can analyse each driver and vehicle's journey profile in terms of location and mileage and suggest the most suitable fuel and asset option. We can help with EV and PHEV adoption and your ongoing strategies – ensuring you have a policy in place to monitor the driver/vehicles' ongoing performance- for example, are PHEVs achieving expected MPGs – are drivers charging them?

We can take data from your telematics provider(s), fuel card and mileage to get a full picture of how and where vehicles are driven. We can also help with fuel cards/reimbursement of business mileage and identify drivers who aren't achieving expected efficiencies. We can speak to these drivers to find out the reasons behind their poor performance.

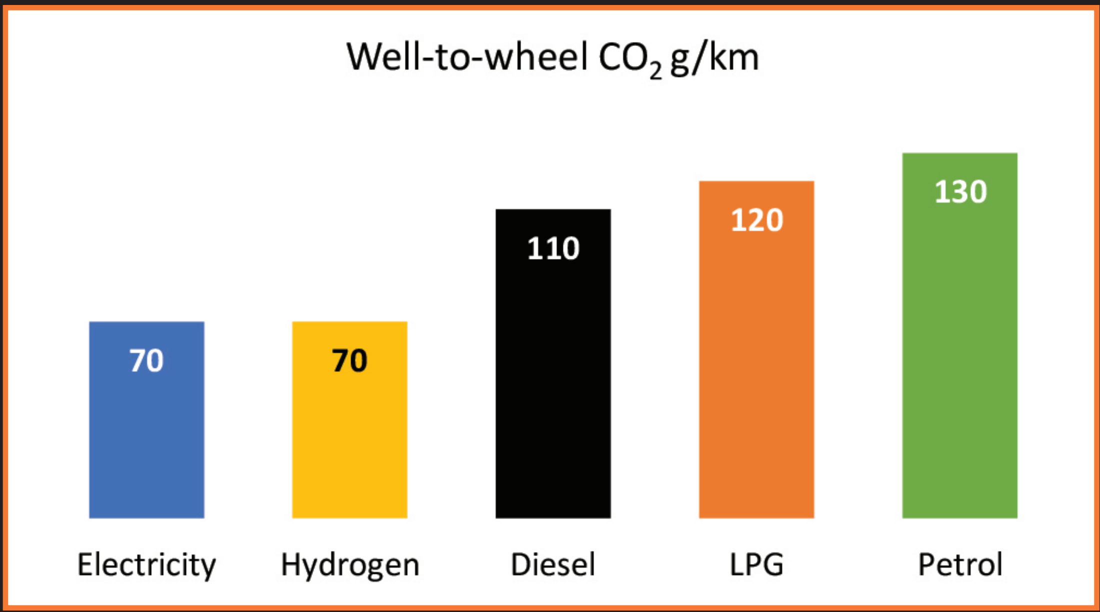
For more information on how TMC can help you optimise your fleet, please don't hesitate to contact us.

You can call us on **+44(0)1270 525 218**, email us at **reply@tmc.co.uk** or visit our website - **www.tmc.co.uk** – for more information.

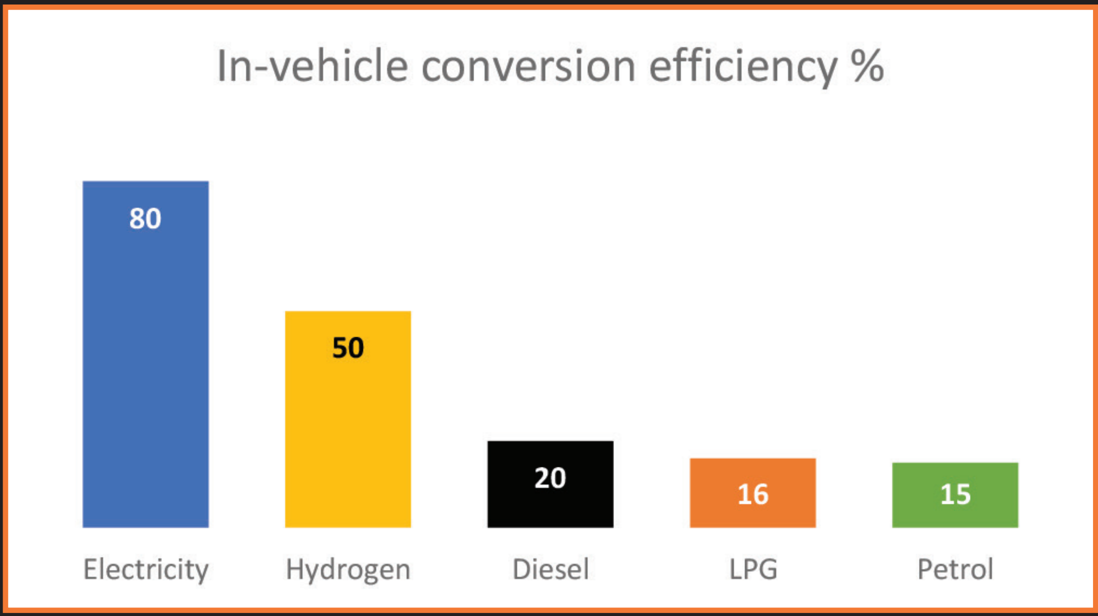
CHARTS + CAPTIONS



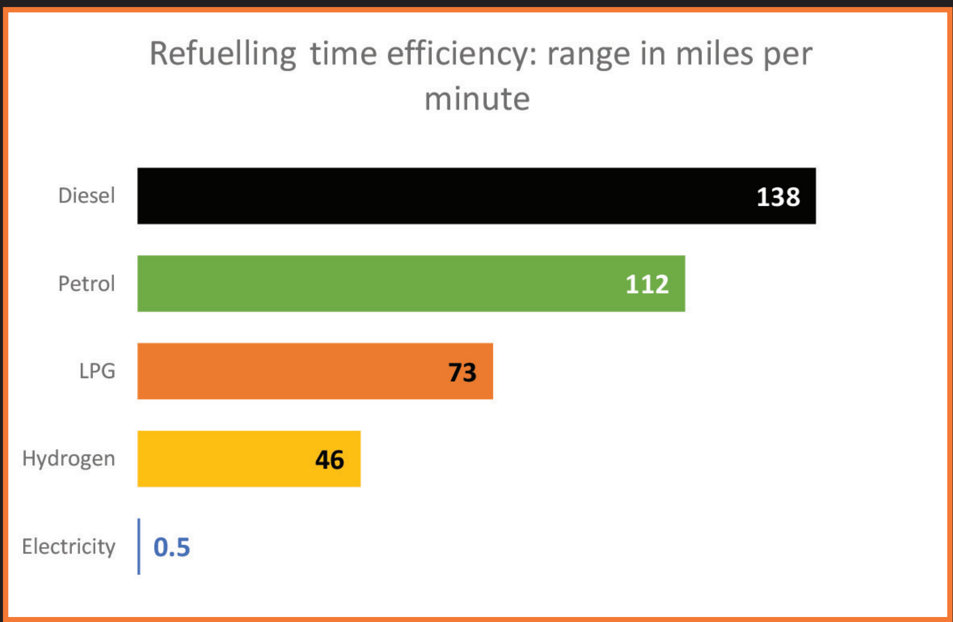
A convenient comparison between road fuels is how far you can travel on 40 litres of liquid fuel, or the equivalent in LPG or hydrogen, or on a fully-charged 40kWh battery. Fossil fuels win on range. The obvious solution for EVs is bigger batteries, which are becoming steadily more cost-effective as manufacturing capacity rises and unit cost per kWh of storage drops.



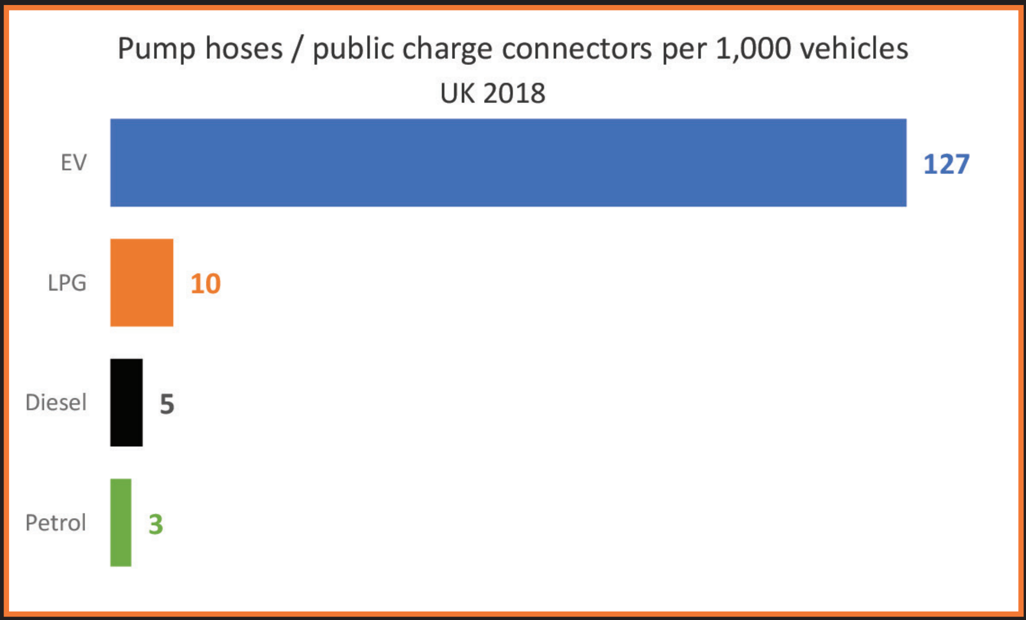
Well-to-wheel CO2 calculations include emissions from extraction, refining, generation and distribution, as well as from the vehicle powertrain. Figures shown are European Commission estimates for 2020-standard vehicles and EU energy generation mix, including renewable electricity and biofuels. Hydrogen is assumed to come from natural gas (the CO2 figure for hydrogen electrolysis using grid electricity would be 130g/km). On this basis, EVs are around half as polluting as petrol vehicles.



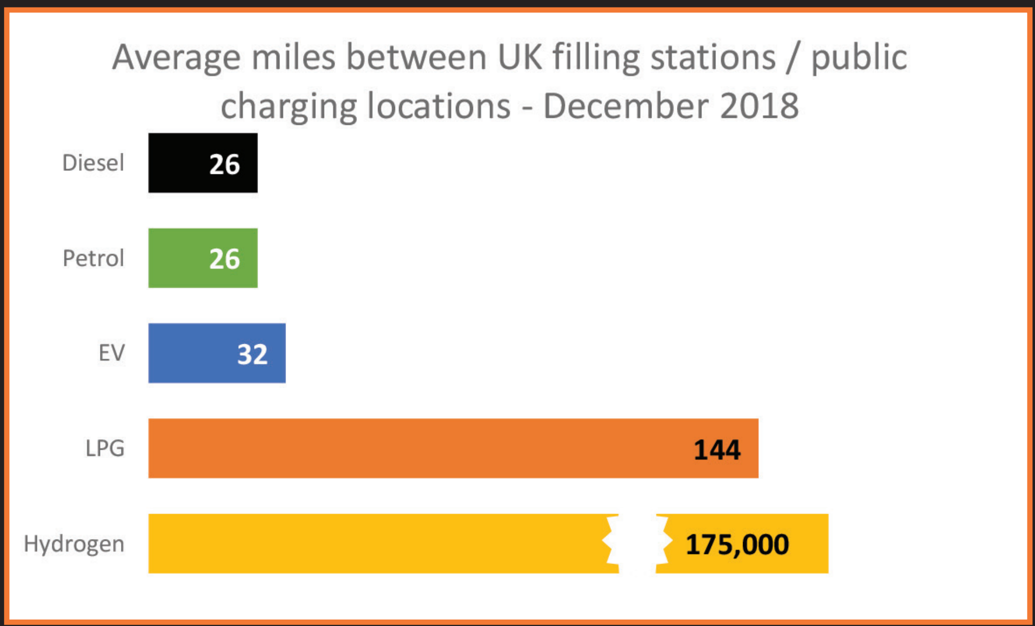
EVs are dramatically more efficient at converting energy stored on board into power at the wheels. ICEs lose 80%-85% of energy in the fuel tank as heat and friction in the drivetrain. Fuel cells appear relatively efficient in this comparison but only because it does not show the considerable energy lost while converting natural gas to hydrogen, before transferring it to the vehicle.



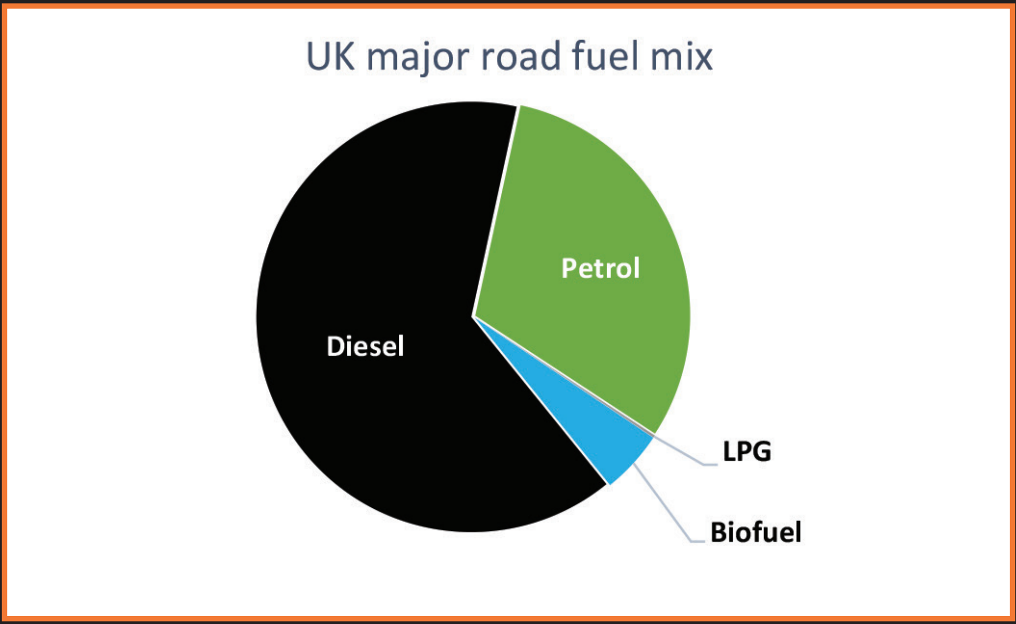
Another way to compare fuels is how far they will take you for each minute spent at the fuel pump or charging point. This chart shows the miles per minute of filling time using this guide's "40" range figures for each fuel. Electricity assumes fully charging a 40kWh battery from a 22kW fast-charge point (six hours). An 80% charge from a 50kW charger (taking 40 minutes) gives 3.4 miles range per minute of charging time.



According to zap-map.com, the UK had over 19,000 public EV charge point connectors at the end of 2018: an average of 127 for every 1,000 registered EVs and PHEVs. Petrol users are served by just three pumps per 1,000 cars (assuming an average of 7.5 pumps at each of the UK's 8,400 petrol stations).



Averaged across the entire UK road network of 215,000 miles (all classes of road), the distance between EV charging locations was only eight miles more than that between petrol filling stations at the end of 2018. Most LPG sites are on or close to A-roads and motorways, where there is an LPG station every 21 road miles on average, although like EV charge points this means that large stretches of the rural road network are completely unserved.



Diesel dominates UK surface transport fuel consumption, even though petrol vehicles outnumber diesels by three to two. The main reason is higher mileage per diesel vehicle, with HGVs, medium and light commercial vehicles, buses and business car travel all contributing to the greater level of demand. Virtually all the biofuels consumed were blended with pump fuel. 64,000 tonnes of LPG were used in transport in 2017, compared with 25 million tonnes of diesel.

1. EU estimate based on projected 2020 EV designs and EU electricity generation mix
2. Typical range from fully-charged 40kWh battery. Example used is 2018 new-model Nissan Leaf
3. House of Commons Library energy price briefing paper February 2018. Includes standing charge and VAT
4. Typical range provided by LPG equivalent of 40 litres of fuel (20.4kg)
5. EU calculation based on projected 2020 FCV designs and EU electricity generation mix
6. Range from 40 litres of compressed hydrogen. Example used is Toyota Mirai with a real-world range of 280 miles from 122 litres of hydrogen