THE ALL-PARTY PARLIAMENTARY GROUP
FAIR FUEL FOR UK
MOTORISTS AND HAULIERS

Cebr

Economic impacts of the 2030 – 2040 bans on the sale of fossil fuel vehicles

A Cebr report Funded by FairFuelUK, the Alliance of British Drivers, and the Motorcycle Action Group

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Authorship and acknowledgements

This proposal has been produced by Cebr, an independent economics and business research consultancy established in 1992.

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Contents

1. Key Points

- This is a study that uses official government methodology to compare the projected environmental benefits from the proposed bans on the sale of fossil fuel powered vehicles with the likely costs.

- The study shows that the environmental benefits from the proposed bans are dwarfed by the additional costs.

- The study assesses economic impacts over the period 2022 until 2050. 2022 prices are used as a common baseline and all costs and benefits are discounted to a 2022 base year (with selected values also presented on an annual/undiscounted basis).

- Using the government's values for reduced carbon emissions, the value of the environmental benefits add-up to £76 billion. In contrast, the assessed costs add up to £400 billion. These costs are FIVE times the benefits; even when using the government's own valuations of the environmental benefits.

- The study shows that the major costs from the proposed ban are likely to be additional costs of:

    I. New vehicle purchases of £188 billion (in extra costs).
    II. Increased time lost due to waiting whilst recharging EVs, valued at £47 billion.
    III. Infrastructure for electricity generation and additional charging points of £99 billion.

Even the overall environmental benefits are rather lower than might be assumed since approximately 50% of any reductions in emissions from usage are likely to be offset by increased emissions in vehicle production.

Furthermore, this analysis does not take account of the likely increased emissions and other social costs from the massive increase in mining likely to be required by EVs. These extra emissions will be transnational in nature, relating to the processing of raw materials and associated shipments across the globe.

Finally, there is likely to be a loss of tax revenue of £5.8 billion per annum (£2.7 billion when discounted to 2022 base year terms), on average, in the scenario of a ban in comparison to a no-ban scenario, as fuel duty and VAT dwindle away. The annual revenue loss is £198 million in 2030 (£150 million when discounted to 2022 base year terms), rising to about £16 billion in 2050 (£6 billion when discounted). We assess that replacing this revenue, for example, would require increasing the rate of VAT or the basic income by an increasing amount throughout the period of analysis, peaking at an increase of 0.8% for VAT or 1.1% for the basic rate of income tax in 2050.

From the perspective of the average household, these additional costs over the period 2022 to 2050 amount to a total of £14,700 per household in 2022 terms. Using undiscounted values, this is an impact of £27,400 per household, or just under £1,000 per household per year from 2022 until 2050.

The study also looks at how sensitive the results are to a range of different assumptions. For instance:

- Using a 'social cost' valuation of the benefits as proposed in the Stern Report rather than the government's current valuation approach reduces the assessed NPV by £26 billion.
- Assuming that investment could alternatively be made in generating widespread usage of low carbon fuels to replace existing fuels reduces the assessed NPV by £15 billion.

It is conventional in policy analysis that where a policy appears to have assessed costs well in excess of the benefits that the policy at the very least needs to be scrutinised extremely closely to see if, on balance, it still makes sense.

We strongly recommend that HMG commissions an independent analysis of the costs and benefits of the proposed policy and compare this to other viable options to see whether it should proceed with the proposed bans.

2. Introduction

This report examines the costs and benefits associated with the forthcoming bans on internal combustion engine vehicles. This decision represents a major regulatory change as well as implicitly dedicating the government to undertaking high levels of investment to facilitate those changes.

One of the main ways the government hopes to achieve Net Zero by 2050 is to decarbonise the transport sector. Transport is now the highest emitting sector of the UK economy, accounting for 22% of total greenhouse gas (GHG) emissions, 113 MtCO2e in 2019. This compares to 21% coming from energy supply, 18% from business, 16% from the residential sector and 11% from agriculture. [1]

In particular, cars comprise 13% of UK GHG emissions (and approximately 0.2% of global emissions), vans 4% and HGVs 4%. The level of GHG emissions deriving from the transport sector has remained fairly consistent over time, with improvements in fuel efficiency offset by increased travel. Meanwhile, other major emitters like energy production have decarbonised significantly.

A central part of the government's plans to decarbonise transport involves ending the sale of new:

- Petrol and diesel Internal Combustion Engine (ICE) cars, motorbikes, and vans from 2030;
- Hybrid Electric Vehicle (HEV) and Plug-in Hybrid Electric Vehicle (PHEV) cars motorbikes, and vans from 2035;
- And, subject to consultation, ICE, HEV, and PHEV heavy goods vehicles (HGVs) over 26 tonnes from 2040.

As a result, it is expected that the number of EVs, and especially pure EVs (or Battery Electric Vehicles, BEVs) – powered wholly by a battery which is charged from electricity – will in response rise substantially. For instance, the Climate Change Committee's (CCC)[2] Sixth Carbon Budget Balanced Pathway projects that the number of pure EVs on the road could grow to 14 – 18m by 2030 from only half a million in 2021. Furthermore, the CCC envisions a rapid uptake of EVs to 23.2 million by 2032 (55% of all vehicles).

FairFuel UK, the Alliance of British Drivers, and the Motorcycle Action Group would like to understand the economic impacts of the Government's plans. In particular, they would like to ascertain the costs to the economy.

The bans on ICE vehicles will affect the UK's 37m drivers. Whilst using the conventional valuations it is believed there will be benefits in the form of reduced GHG emissions and cleaner air, there will also be negative impacts. This report considers both by means of cost-benefit analysis.

1 BEIS - Link

2 Climate Change Committee (CCC) – Link

The Current Situation

The decarbonisation of vehicles has begun to pick up pace partly as both consumers and industry anticipate the forthcoming bans. For instance, there are already over half a million electric cars on UK roads. Moreover, many manufacturers have already started to re-orient their operations and transition away from the production of conventional petrol and diesel cars towards EV production.

The pace of this change has differed by sector. Whilst there has already been a significant application of zero emission technology in the fleet of small commercial vehicles, there has been much less change with respect to larger heavy goods vehicles. Nevertheless, there have been some applications in this area. An example of a HGV zero emission vehicle is that of Leyland Trucks, a PACCAR company and the UK's largest HGV manufacturer. DAF LF Electric vehicles are entering service with a range of public bodies, including the NHS and Local Authorities.[3]

There are also significant challenges with respect to the extent to which consumers are prepared to take up new vehicles. Ofgem research has found that consumers find these to be the key blockers of EV uptake:

1. Vehicle prices are too high or up-front costs;
2. Short battery life/short driving range;
3. Nowhere to charge a vehicle close to home.

The Department for Transport's transport technology tracker survey has shown that, when asked about the benefits of electric vehicles, 55% mention anticipated savings on road tax and 40% cite reduced running costs. This, however, does not account for the fuel duty incorporated into fuel prices, which increases the operating cost for petrol or diesel vehicles. A large percentage (81%) also talk about the environmental benefits of electric vehicles. However, the most significant concern limiting uptake was the availability of charge points, given by 73% of people surveyed. Respondents also mentioned the range of vehicles, the time taken to charge, and knowing how to charge.

Infrastructure Needs

There are significant costs associated with the need to provide sufficient infrastructure to meet the changing demands of so many more drivers of electric vehicles.

According to Zap-Map there were approximately 34,000 public charging devices in the UK as of August 2022 and more than 940,000 plug-in cars with approximately 530,000 BEVs and 410,000 PHEVs registered.[4] The CCC expect that in order to grow the UK's EV fleet to an estimated number of 23.2 million by 2032, 325,000 public charging points will be required. Currently, it is estimated that 80% of EV users charge their vehicles at home overnight, while 25% of households do not have off-street parking (e.g., multi-story flats) and need to charge on-street or elsewhere. This means that there is a need for charge points on homes but also in public areas, especially on motorways and major roads, and at destinations like supermarkets.

3 https://www.leylandtrucksltd.co.uk/en-gb/news-and-media/news-article-folder/2022/battery-electric-truck-trial-hits-the-road

4 Zap map – Link

It is possible that the market for charging points will provide the relevant supply. But given the importance of this to the government's ambitions, it is likely that it will want to play a pivotal role in supporting the private sector in providing the necessary infrastructure due to the high up-front costs and the significant associated financial risks. The government will need to play a central role, as there is a risk that the private sector will only provide charging infrastructure and services where there is sufficient profitability available, rather than for reasons associated with public need.

3. The Analytical Approach

The analytical approach of this report is to assess whether or not, from the Government's perspective, and taking into account their own methodological assumptions, this represents a decision that is 'good for society'. It is not merely an economic assessment, as it takes into account the Government's tools of valuing environmental and health impacts, in particular, values for CO_2e emissions. The analysis in this report allows the impacts on society to be assessed in a way consistent with other Government assessments. However, the report does not make any judgement as to the validity or robustness of the methodological frameworks and scientific assumptions implied by these appraisal tools and methods. This ensures that the findings of the report can be used to inform Government decision makers about its policy choices; whether to persist with the planned bans or to adjust them.

The key measures to summarise the impacts are ways of comparing present value monetised costs and benefits. The Present Value of Benefits (PVB) is the sum of all discounted benefits and dis-benefits and the Present Value of Costs (PVC) similarly measure the discounted costs over the appraisal period. It then gives the value of these impacts in the prices of a given base year (in this case, 2022).

The Benefit-Cost Ratio (BCR) is given by PVB / PVC and indicates how much benefit is obtained for each unit of cost, with a BCR greater than one indicating that the benefits outweigh the costs. The Net Present Value (NPV) is a measure of the total economic impacts of a proposal. It is simply the discounted present value of the sum of all benefits and costs.

Typically, if a project has a BCR below one (i.e., a negative NPV), it indicates that the costs exceed the benefits over the appraisal period, and hence that given proposal should not proceed unless there are important non quantifiable benefits that have not been taken into account[5]. In practice, it is desirable to have a BCR above the level of two (where benefits are twice that of costs) for a project or proposal to be sufficiently competitive when compared against a portfolio of potential options or alternative projects. Where costs exceed benefits, the Government will consider that project 'Poor' value for money and the BCR will be between zero and one. The methods and techniques used to derive both the BCR and NPV results are consistent with both HMT's Green Book and the Department for Transport's Analysis Guidance (TAG)[6].

<u>Benefit valuation</u>

Greenhouse gas emissions values ("carbon values") are used across government for valuing impacts on GHG emissions resulting from policy interventions. This is the approach used

5 See for example the seminal paper by Nobel Laureate Kenneth Arrow et al presented to the American Association for the Advancement of Science 'Is There a Role for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation?' Kenneth J. Arrow, Maureen L. Cropper, George C. Eads, Robert W. Hahn, Lester B. Lave, Roger G. No11, Paul R. Portney, Milton Russell, Richard Schmalensee, V. Kerry Smith, and Robert N. Stavins https://scholar.harvard.edu/files/stavins/files/is_there_a_role_for_benefitcost_analysis.pdf

6 DfT TAG guidance Link

here. This ensures that the report can be used as an effective means of understanding whether the decision is 'good' or not, on the basis of the government's own principles and analytical approach.

Carbon values represent a monetary value that society places on one tonne of carbon dioxide equivalent (£/tCO_2e). The government uses these values to estimate a monetary value of the greenhouse gas impact of a policy or proposal. The fundamental purpose of assigning a value to the GHG emissions impacts that arise from potential government policies is to allow for an objective and consistent method of determining whether such policies should be implemented. Carbon values are used in the framework of broader cost-benefit analysis to assess whether, taking into account all relevant costs and benefits (including assumed impacts on climate change and the environment), a particular policy may be expected to improve or reduce the overall welfare of society. As such, both Carbon and NO_x (air quality) values capture the government's view of the value of emissions impacts such as associated health impacts.

Valuing emissions impacts explicitly when making policy decisions therefore helps the government to:

- ensure the climate impacts of policies are fully accounted for
- ensure consistency in decision making across policies
- improve transparency and scrutiny of decision making

The previous approach used within government to value carbon in policy appraisal was the 'Shadow Price of Carbon' approach. This was based on estimates of the lifetime damage costs associated with greenhouse gas emissions drawn from the Stern Review[7]. The current approach, in contrast, is, based on estimates of the abatement costs that will need to be incurred to meet specific emissions reduction targets.

The current approach is focused on ensuring that valuations are consistent with the UK's domestic and international climate targets. In contrast, the previous approach measured social costs directly, rather than focusing on consistency with government targets. The valuations of the previous, more direct, approach tended to be a much lower. For example, in January 2002, a Government Economic Service working paper entitled 'Estimating the social cost of carbon emissions' suggested a value of £19/tCO2 within a range of £10 to £38/tCO2[8]. This cost was set to rise at a rate of £0.27/tCO2 per year to reflect the increasing marginal cost of emissions. Accounting for inflation, this means that the values under the current approach are many multiples higher; with this been driven by the need to ensure consistency with climate targets. This also implies that the current, much higher, valuations of environmental and health impacts are derived from the importance of the targets themselves rather being direct measures of health or environmental outcomes.

7 HM Treasury Link

8 UK Government Link

4. Methodology

The analysis covers the period from 2022 until 2050 and assesses cars, motorcycles, LGVs and HGVs separately as well as aggregated values covering all vehicle types.

4.1. Baseline and Alternative scenarios

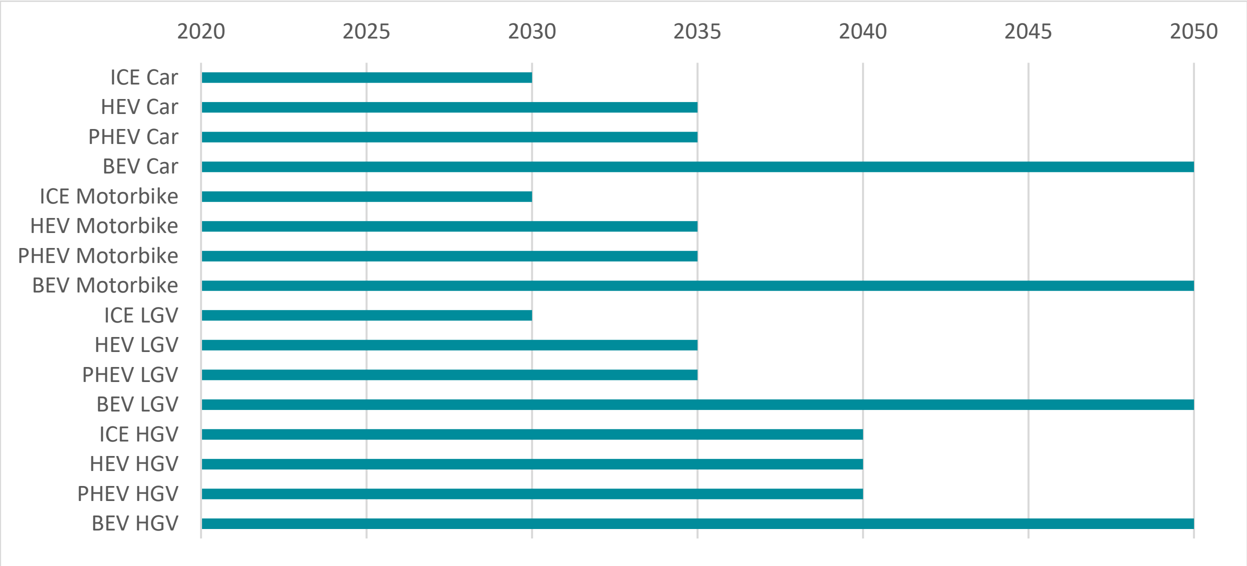
Our analysis tests two core scenarios, a baseline case of no ban and an alternative scenario where both of the proposed bans come into operation. The model is run from 2022 to 2050:

- In the **Baseline**, there is no ban on vehicles in any category. Therefore, the law is not changed, and households, businesses, and manufacturers operate with this expectation in mind.

- In the **Alternative**, planned bans[9] on the sale of new vehicles go ahead as follows:
    - In 2030, internal combustion engine (ICE) cars, motorbikes, and LGVs.
    - In 2035, hybrid electric (HEV) and plug-in hybrid electric (PHEV) cars, motorbikes, and LGVs.
    - In 2040, ICE, HEV, and PHEV heavy goods vehicles (HGVs).

Therefore, in the Alternative scenario only battery electric vehicles (BEVs) can be bought as new from 2040 onwards, as illustrated in Figure 1, which shows the differing time periods of availability of different types of vehicles.

Figure 1: Availability of new vehicles by type and propulsion, Alternative scenario



9 *Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030*, November 2020, Link. *UK confirms pledge for zero-emission HGVs by 2040 and unveils new chargepoint design*, November 2021, Link. As it stands there is uncertainty around the nature of proposed bans regarding motorbikes, and hybrid cars and vans. We have assumed that motorbikes will be treated the same as cars. The 2030 ban announcement says that *'Between 2030 and 2035, new cars and vans can be sold if they have the capability to drive a significant distance with zero emissions (for example, plug-in hybrids or full hybrids), and this will be defined through consultation.'* Therefore, stricter emissions standards for hybrids may apply in the 2030-2035 period under the ban – but we have not assumed this in our modelling.

4.2. The UK's vehicle fleet in 2022

The first step in our modelling is to develop a snapshot of the current state of the UK's vehicle fleet. This captures how many vehicles there are by type, propulsion, and age. To do this, we combine various datasets from the DfT's vehicle licensing statistics[10]:

- VEH0105: Licensed vehicles by body type (car, LGV, etc.) and fuel (diesel, petrol, other).
- VEH0124: Breakdown of licensed vehicles by age.
- VEH0133: Licensed ultra-low emission vehicles (ULEVs) by body type and fuel (battery electric, plug-in hybrid electric petrol/diesel, hybrid electric petrol/diesel).
- VEH0142: Licensed plug-in vehicles by body type and fuel type.
- VEH0171: ULEVs registered for the first time by body type and fuel type.

These were brought together to develop a robust view of the fleet not provided in a single data source.

4.3. Future development of the UK's vehicle fleet

By its midyear of 2035, the industry body – the Society of Motor Manufacturers and Traders (SMMT) estimates that 46% of cars on the roads could be zero emission under a central scenario; whilst the percentages for goods vehicles will be lower[11]. Ofgem estimate that there may be 14m EVs on UK roads by 2030 and the Climate Change Committee (CCC) estimate have an estimate of 14-18 million. The CCC estimate that there will be 23.2 million battery electric or plug-in hybrid cars by 2032 (55% of all vehicles)[12]. In contrast the Cebr estimate that the share of BEV and other non-ICE vehicles could be 35% by 2032 and 50% by 2035.

New purchases

Additions of new vehicles to the fleet are calculated by first taking new registrations in 2021, from DfT data discussed above, as a starting point. In the Baseline Scenario, these are then assumed to change in future years due to trend growth[13] and own-price elasticities[14].

In the Alternative, when vehicle classes are banned, additions to the fleet are set to zero and the previous year's demand is divided between remaining vehicle classes according to their demand that year. For instance, in 2030, demand for ICE cars is divided between HEV, PHEV,

10 *Vehicles statistics*, July 2022, Link.

11 Transport Decarbonisation plan https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1009448/decarbonising-transport-a-better-greener-britain.pdf

12 Climate Change Committee – Briefing Document – The UK's transition to electric vehicles - Link

13 *A trend growth rate, which is set to ensure that by 2050 in the Alternative scenario there are 49 million vehicles total, consistent with the CCC estimate.*

14 *Own-price elasticity. This is assumed to be -0.18 for all vehicles, i.e., a 1.00% increase in the price of a vehicle class would lead to a 0.18% decline in demand for it and vice-versa. This is based on a recent study by the United States Environmental Protection Agency (EPA) - The demand for new automobiles in Norway – a BIG model analysis, Institute of Transport Economics, Norwegian Centre for Transport Research, 2018, Link. In the Alternative, this elasticity is not applied after ICE bans have been introduced – it only makes sense to use this when drivers have the option of switching between ICE and BEV. For BEVs, an elasticity with respect to petrol and diesel prices of 0.6*

and BEV cars. In 2035, demand for HEV and PHEV cars goes to BEV cars. Demand is therefore kept consistent.

New vehicle prices

Prices for brand new vehicles used in the model were based on data from ONS and industry evidence. [15] [16] Prices were converted into 2022 values. For the core results, they are assumed to remain constant to 2050.

Scrappage

Scrappage is the mechanism through which vehicles (mainly older models) are removed from the fleet. There is no hard data on scrappage rates, however it seems reasonable to assume that they increase with vehicle age – older vehicles are more likely to develop mechanical faults that render them 'write-offs', i.e., the cost of repair exceeds their value. Moreover, as technology progresses and fuel efficiency improves, the greatest savings in running costs by changing vehicle will be available to those with older models.

For subsequent years, scrappage rates change according to developments in prices in the second-hand market.[17]

Fuel consumption

The DfT's Transport Appraisal Guidance (TAG) data book contains both historical and forecasted values for vehicle fuel consumption:

- Fuel consumption parameters, relating litres of liquid fuel or kilowatt hours of electricity consumed per kilometre to speed of travel. These are provided for petrol, diesel, and electric cars and LGVs, and for diesel ordinary goods vehicles (OGVs).
- Projected proportions of car and LGV kilometres travelled by petrol, diesel, and electricity. The relative petrol/diesel proportions are used to weight petrol/diesel consumption and emissions figures in calculations for ICE vehicles.

These provide a useful starting point for our analysis but needed to be supplemented with further figures from the BEIS *Conversion factors for company reporting*[18]. This dataset includes per-kilometre emissions from use of liquid fuels and electricity for various types of vehicle. These are used to estimate:

- HEV and PHEV liquid fuel consumption relative to ICE vehicles.
- PHEV electricity consumption relative to BEV vehicles.
- Motorcycle fuel consumption relative to cars.

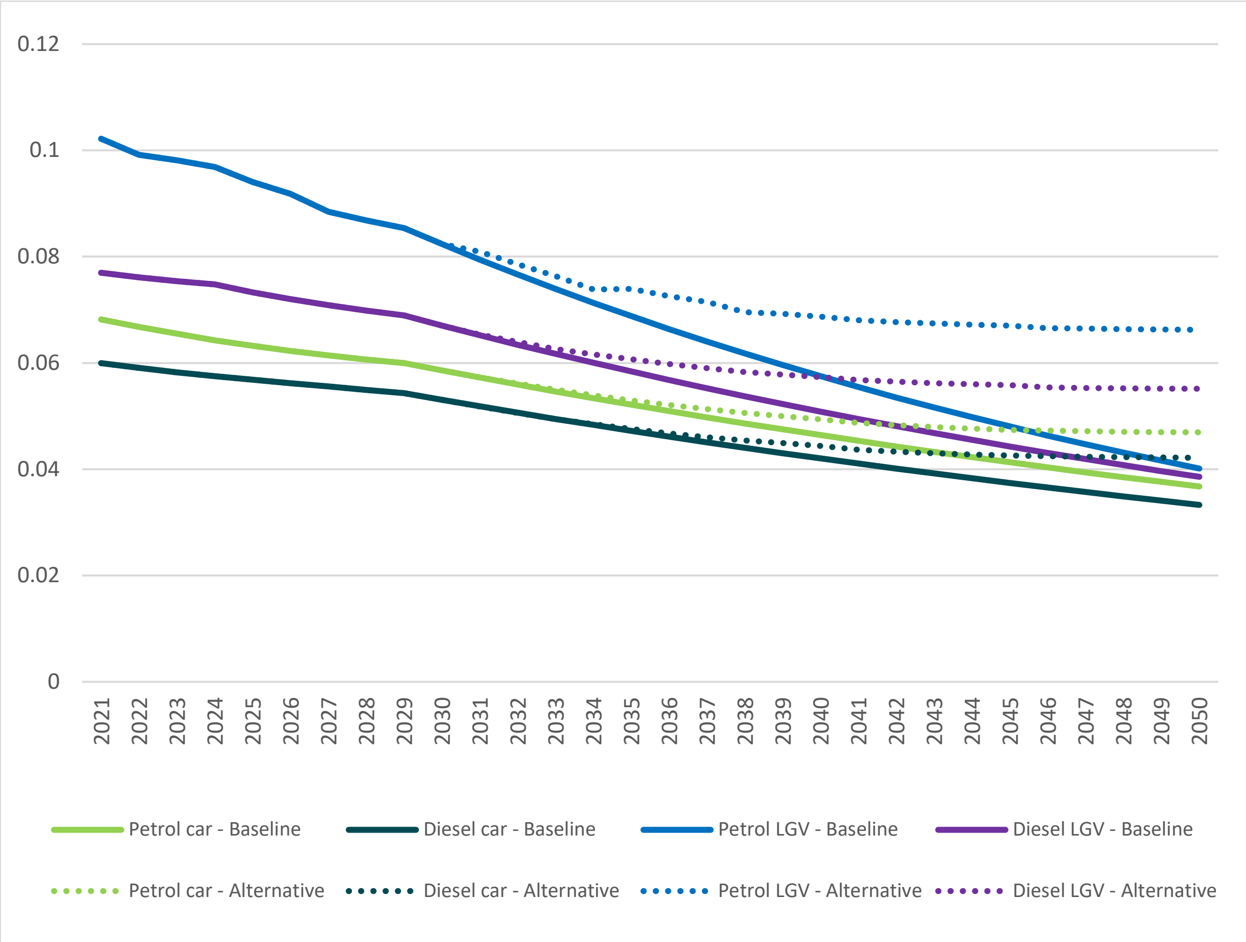
15 *Average car prices: 2021*, ONS, April 2022, Link.

16 *Where are the mid-priced electric bikes?*, BikeSocial, Link.

17 *The EPA study referred to previously estimates an elasticity of -0.21 with respect to used vehicle prices; intuitively, the higher the value of a used vehicle, the less likely that it is uneconomic to repair it.*

18 *Government conversion factors for company reporting of greenhouse gas emissions*, Gov.uk, Link.

Figure 2: Fuel consumption projections in Baseline and Alternative scenarios (litres/km)



In the Alternative scenario, fuel consumption projections from TAG are used throughout. In these projections, improvements in petrol/diesel consumption efficiency slow down after 2030. In the Baseline, we assume that efficiency continues to improve as it did prior to 2030, up until 2050. This captures the possibility that, in the absence of a ban on ICE vehicles, manufacturers would continue to make fuel efficiency improvements, rather than purely focussing on electric propulsion. Arguably, the TAG assumption is a rather strong one – ultimately the market for cars is a global one, and as long as there is significant demand for new ICE vehicles in other countries, manufacturers will have incentives to improve their efficiency.

The UK's proposed 2030 ban is unusual by international standards. For instance, in the United States, some state-level bans are in place for 2035 onwards, including in large states like California and New York. though a federal ban has not yet been announced[19]. The EU Parliament recently approved a ban to start five years after the UK's, for cars, starting in 2035[20] though the ban covers a wider range of vehicles than that in the UK. Various emerging markets

19 *These Are the States Banning New Sales of Gas and Diesel Vehicles*, YAA, Link.

20 *EU lawmakers back effective ban on new fossil-fuel cars from 2035*, Reuters, Link.

will form a larger part of overall demand in future, and in some cases, they are targeting much later dates – for instance 2050 in Indonesia, the world's fourth most populous country[21].

Figure 2 shows how fuel consumption for petrol and diesel cars and LGVs develops under each scenario[22].

4.4. Charging and refuelling times

Recharging and refuelling times

Typical charging times faced by users of plug-in vehicles (PHEV and BEV) depend on:

- The mix of chargers available by speed (slow, fast, rapid, and ultra-rapid) and how they are distributed by charging location – e.g., home, on-street, en-route.
- Where each type of vehicle is charged, and therefore the likely charging speed.

A Competition & Markets Authority (CMA) report[23] into the UK's electric vehicle charging network provides some useful data to support these estimates:

- Typical charging times by charger type: 3-8 hours for slow; 1-3 hours for fast, 20-40 minutes for rapid; 15-30 minutes for ultra-rapid. We take average times from each of these as the respective charging times.
- Number of public charge points by type in the UK in 2020 and forecast requirement in 2030. We assume that the number and mix of chargers evolves as set out in this forecast, which we extrapolate beyond 2030.
- Qualitative and quantitative information on where charging takes place and types of chargers by location; for example, that the 25% of drivers without off-street parking will rely on kerbside on-street charging, which tends to be slow or fast.

On the basis of this information, we project the mix of chargers and therefore average charging times by location type (home, workplace, destination, on-street, en-route), and mix of charging locations by vehicle (i.e., while most charging of cars, motorbikes, and LGVs will take place at home chargers, HGVs will be charged en-route).

We then adjust these charging times to account for the proportion or amount of time spent which is additional, i.e., the real time cost of charging to the user rather than simply the raw charging time. For non-public charging, most of this charging is assumed to take place overnight or during the working day, so it represents time spent putting the vehicle on and off charge.[24]

21 *Indonesia aims to sell only electric-powered cars, motorbikes by 2050*, Reuters, Link.

22 Diesel OGVs are not shown – their fuel consumption is much higher (0.185 litres/km in 2021) and not suitable for the same scale; however, the impact of these assumptions on their trajectory is similar.

23 *Building a comprehensive and competitive electric vehicle charging sector that works for all drivers*, Competition & Markets Authority, July 2021, Link.

24 The modelling does not account for the potential for rapid and ultra-rapid charging to cause damage to battery's when used frequently. This could cause a loss of value for EVs in the second-hand car market.

TAG figures do not include motorcycles, but we have made similar assumptions and also for HGVs regarding charging. HGV operators will want to charge at home base as often as possible on bulk electricity rates rather than pay third party profits[25].

Recharging and refuelling frequencies

In order to estimate total time spent recharging or refuelling per vehicle per year, estimates of recharging or refuelling frequency are made. These are based on:

- Maximum distance travelled on a typical tank or battery, using available sources on ICE and BEV ranges by vehicle type[26]. Multiplying these distances by current fuel consumption (litres/km or kWh/km) provides figures for tank or battery capacity.
- Future changes in fuel consumption – this means that as vehicles become more efficient, a tank or battery of the same size will allow them to travel further before recharging or refuelling.
- Annual kilometres travelled (discussed further under emissions) – this along with fuel consumption determines annual demand for litres of petrol/diesel or kWh of electricity, and therefore number of refills needed.

Values of time

Table 1: Values of time, 2022 (£/hour/vehicle)

	Assumed % of journey time, value of time per person			Occupancy	Value of time
	Business	Commuting	Other		
Car	11%	25%	65%	1.61	£16.83
	£25.33	£14.25	£6.50		
Motorbike	4%	51%	45%	1.00	£11.26
	£25.33	£14.25	£6.50		
LGV	90%	10%	0%	1.25	£21.95
	£17.93	£14.25	£6.50		
HGV	100%	0%	0%	1.00	£20.67
	£20.67	£14.25	£6.50		

We monetise the time spent recharging or refuelling by vehicle type, drawing on TAG values of time and National Travel Survey (NTS) data on journey purposes.

TAG values of time are forecast (growing in line with real GDP/capita) to 2089. These are available for working time by type of vehicle driver/passenger, commuting time, and other (i.e., leisure/personal business). For car and LGV, these are adjusted by assumed occupancies – 1.61 for car (based on TAG) and 1.25 for LGV.

25 *4.5 hours driving and 45 minutes charging. A viable solution for electric trucks?*, trans.info, January 2021, Link.

26 Ranges for: ICE car, BEV car, ICE motorbike, BEV motorbike, ICE LGV, BEV LGV, ICE HGV, BEV LGV.

The NTS[27] provides distance travelled by car and motorcycle in total and by purpose including business and commuting. We use 2019 values from the NTS – the most recent data, for 2020, is seriously affected by Covid-19. This gives us business/commuting/leisure breakdowns for car and motorcycle travel, and the corresponding values of time are weighted accordingly.

These calculations are summarised in Table 1.

4.5. Driving and production emissions

One of the core motivations of the Government's policy is to help reduce the pace of climate change. Under this policy, tackling climate change is primarily achieved through reducing the annual rate of carbon dioxide (CO_2) emissions. Like most economies, UK emissions generally come from the both the production and use of energy, including from the electricity sector itself. The extent to which the electricity sector contributes to overall emissions is heavily dependent upon the extent of fossil-fuelled-based electricity generation.

Annual kilometres per vehicle

The DfT provides annual statistics on road traffic by vehicle type[28]. Dividing total distances (using 2019 values to avoid impacts of the pandemic) by vehicle numbers gave estimated annual kilometres per vehicle. These are combined with per-kilometre emissions to calculate total driving emissions, and are used elsewhere in the analysis, for example in charging time calculations.

Carbon dioxide emissions per kilometre travelled

TAG provides figures for carbon dioxide equivalent (CO_2e) emissions per litre of petrol or diesel burnt and per kWh of electricity used. Petrol and diesel emissions per litre do not decline after 2020 (i.e., no change in their composition is assumed), whilst emissions associated with electricity consumption continue to decline until 2050, reflecting anticipated changes in the UK's energy generation mix.

These are combined with fuel consumption figures (litres or kWh per km) to estimate emissions per km by vehicle class to 2050. Whilst emissions per litre or kWh are assumed identical in each scenario, the differing fuel consumption assumptions do lead to lower emissions per kilometre for vehicles which use petrol or diesel in the Baseline than in the Alternative.

Air quality pollutant emissions per kilometre travelled

The National Atmospheric Emissions Inventory (NAEI) provides figures for emissions per kilometre of various air pollutants by vehicle type[29]. We focus on nitrous oxides (NO_x) and particulate matter (PM10 and PM2.5) in our analysis.

27 *National Travel Survey*, Gov.uk, September 2021. Link. Table NTS0409b Average distance travelled by purpose and main mode: England, from 2002.

28 *Road traffic statistics*, Department for Transport, Link.

29 *Emission factors for transport*, National Atmospheric Emissions Inventory, Link. Fleet Weighted Road Transport Emission Factor 2020.

Emissions are provided for both exhaust and non-exhaust sources. The former is only relevant for vehicles which use petrol and diesel – they are used as given for ICE vehicles and scaled according to fuel consumption for HEV and PHEV equivalents. The latter, which includes tyre wear, brake wear, and road abrasion, applies to all vehicles; therefore, EV emissions are lower than for ICE equivalents but not zero.

Vehicle production emissions

There are also CO_2e emissions associated with the production of new vehicles, which we apply to new vehicle purchases each year. Whilst electric vehicles have lower per-kilometre emissions, their production emissions are systematically higher.

Precise estimates on relative production emissions vary. We combine the findings of a research paper[30] which estimates emissions for ICE, HEV, PHEV, and BEV cars and a Volvo study which estimates BEV production emissions at 70% higher than ICE vehicles[31].

Monetising emissions

Total emissions in tonnes of CO_2e, NO_x, PM10, and PM2.5 have therefore been calculated by scenario, year, and source. These are valued according to TAG, which provides carbon values forecast to 2100 and damage cost values for pollutants[32]. Low, central, and high values are provided. Our core results use the central values.

30 *Lifecycle emissions from cars*, Low Carbon Vehicle Partnership.

31 https://auto.hindustantimes.com/auto/news/volvo-study-shows-making-evs-leads-to-70-more-emission-compared-to-ice-vehicles-41637402945989.html .

32 Pollutant values are assumed by TAG to remain constant in real terms, so future forecasts are not required or provided.

5. Results

5.1. Core results

Monetised Impacts

There are a range of impacts that can be converted into monetary terms. This allows a comparison of these costs by taking the ratio of or arithmetic difference between total costs and benefits. This provides a measurement of the benefit cost ratio and net present value respectively. All values are converted into present value terms through discounting and prices converted into 2022 terms.

The results in this section compare the estimates for the 'Alternative Case' where the bans come into effect with the 'Baseline Case' where they do not.

Monetised Benefits

There are a range of assessed benefits associated with the 2030 ban. These form the basis of the arguments for the Government implementing bans on ICE vehicles.

Reduced CO2 and air quality emissions during driving

The aim of the Government is to play its declared part in the limitation of limit global warming to well below 2°C and to pursue efforts to limiting to 1.5°C means. However, the UK car market accounts for a very small (0.2%) percentage of global emissions.

There are fewer CO_2e emissions deriving directly from 'tail-pipes' in the alternative scenario of the bans going ahead. Emissions impacts are monetised through application of DfT values per tonne of CO_2e, with this valuation implicitly economic benefits from CO_2e emission reductions. This occurs because of the increasing proportion of EVs in the fleet mix from 2030 onwards. Whilst second hand ICE vehicles continue to be part of the mix for several years, due to natural scrappage rates, after time their presence is expected to decline significantly.

Figure 3 below shows how the composition of the total vehicle fleet (cars, motorbikes, LGVs, and HGVs) by propulsion changes under each scenario. In the Baseline, ICE vehicles have gradually fallen to below 70% of the overall fleet by 2050. In the Alternative, however, a rapid decline in their share begins after the ban on most ICE vehicles in 2030, with the result that by 2050 they make up less than 10% of the fleet, and over 80% of vehicles are BEVs (with HEVs/PHEVs making up the remainder).

Figure 3: Fleet composition by scenario

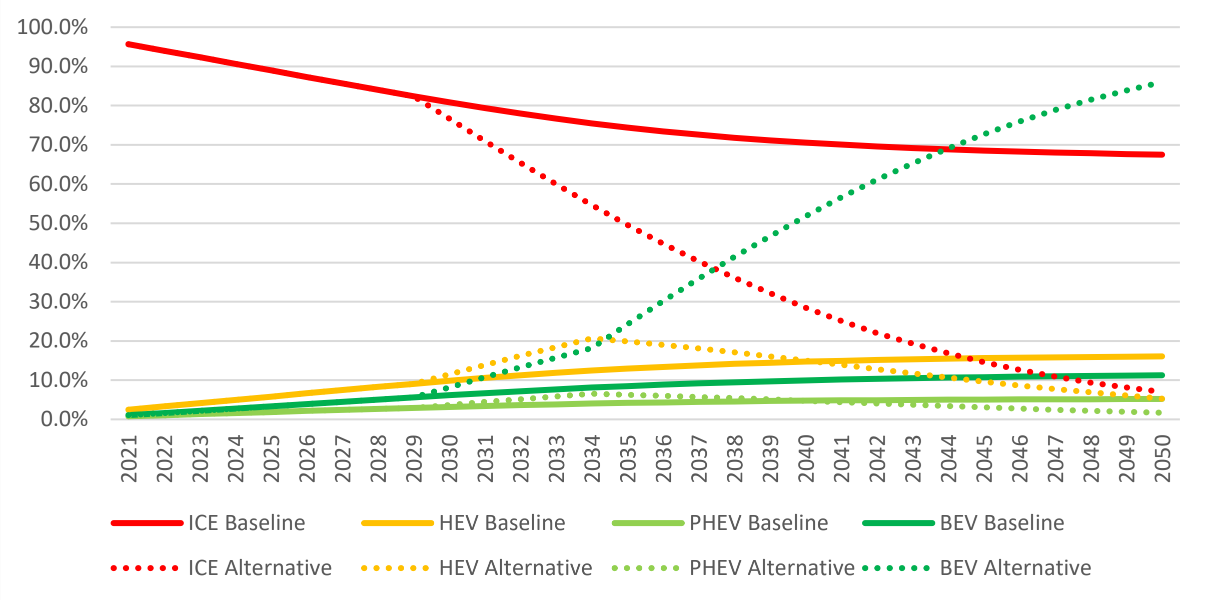
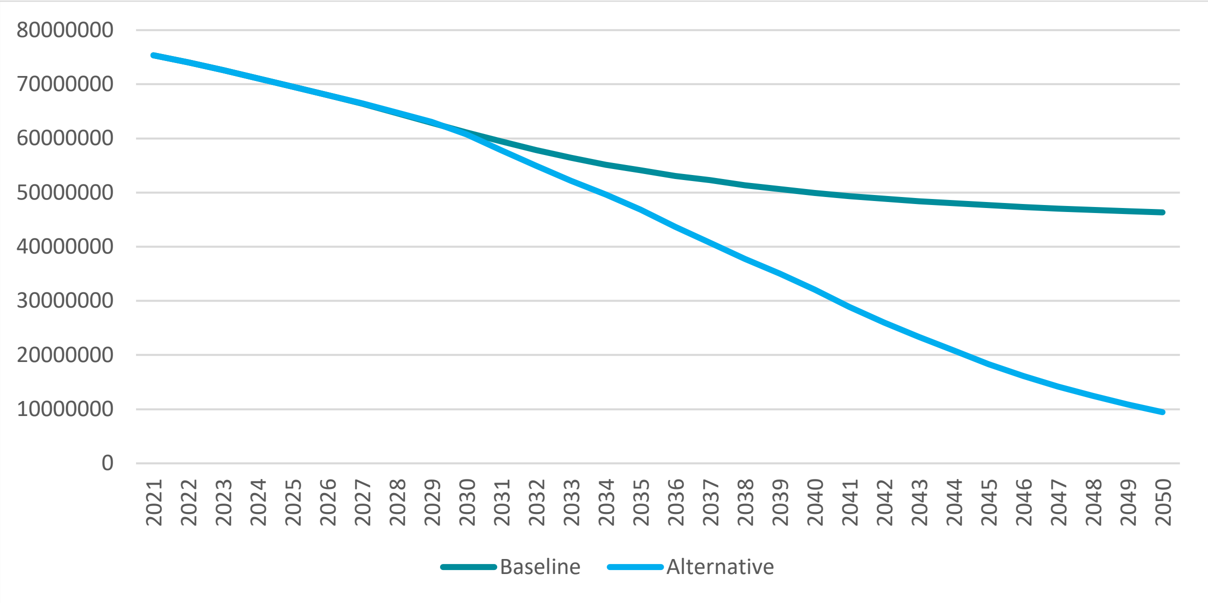


Figure 4 shows how vehicle traction emissions (i.e. those produced by kilometres driven, not by vehicle manufacture) develop under each scenario – under the Alternative scenario they are dramatically lower by 2050.

Figure 4: Total vehicle traction emissions per year (tonnes CO_2e)



The overall value of reduced CO_2e emissions has been calculated to be £64.7 billion, in present value terms (using TAG central values of emissions). The largest portion of this, at £37.7 billion, relates to cars, which make up the largest part of the fleet.

There will also be significant assessed benefits generated by reduced NO_x, PM10, and PM2.5 emissions. The monetised value of these benefits is significantly lower than the CO2e benefits, with a total beneficial impact of £11.2 billion.

Environmental impacts (£Bn)	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	64.7	37.7	0.7	19.8	6.5
Air quality emissions	11.2	4.5	0.1	5.7	0.9

Reduced cost of fuel

The difference in fuel costs is significantly driven by the difference in tax applied through Fuel Duty and VAT. The reduced cost to consumers due to a transition to electric vehicles has been calculated below. The total reduction in expenditure related to fuel/charging expenditure has been calculated to be £41.8 billion over the years 2022 to 2050. If, however, we look at resource cost only (excluding Fuel Duty and VAT), results indicate a £34.9 billion cost, since the tax element is merely a transfer and not a resource cost.

Household/business spending (£Bn)	Total	Car	Motorbike	LGV	HGV
Fuel	41.8	29.4	0.6	9.2	2.6
Fuel (resource cost only)	-34.9	-17.1	-0.3	-13.3	-4.3

Monetised Costs

Increased CO2e emissions during vehicle manufacture

It is widely recognised that the production of EV vehicles generate more CO2e emissions than during the process of manufacturing ICE vehicles. The impact in terms of the value of increased production emission is calculated to be £32.5 billion

Environmental impacts (£Bn)	Total	Car	Motorbike	LGV	HGV
CO2e, vehicle manufacture	32.5	21.5	1.1	8.9	1.1

Increased purchase costs of new vehicles

Despite the subsidy provided for the purchase of new EV vehicles, they are still currently generally more expensive than new ICE vehicles. The total additional costs over the period 2022-2050 are estimated to be £187.8 billion.

Household/business spending (£Bn)	Total	Car	Motorbike	LGV	HGV
New vehicles	187.8	98.0	7.2	67.2	15.4

Increased time spent refuelling/ recharging

A 2016 Department for Transport survey showed concern about recharging was the most significant factor preventing consumers buying an electric vehicle (45%), followed by the distance travelled by one charge (39%). The increased waiting times in a scenario of a faster transition to EVs due to the bans, could be the most visible significant impact. Indeed, if the bans come into effect and the charging system is inadequate, the consequences could be immensely disruptive and could easily mean higher not lower emissions as drivers depend more on an aging fleet of vehicles. This report makes assumptions that are similarly optimistic to those made by government departments and agencies about the likely costs and achievable charging times (i.e., the avoidance of major queuing). In this sense, the estimated costs could prove to be relatively conservative, and the estimated benefits could prove to be optimistic.

In a DfT and 'Britain Thinks' survey of charging habits, respondents were asked about how often they charge at home during the day and overnight. Overnight charging was more common than daytime charging and the most commonly report charging frequency was 1-2 times per week.[33] The survey also found that the public charging locations most used on a regular basis were at work/place of education or in a business or organisation's car park, with three in 10 respondents indicating that they charged at each of these locations at least once a week (30% at each location). [34] This shows that there are opportunities to save time by charging at times when other activities are being undertaken. However, this will not always be the case.

For instance, a quarter of respondents also reported charging at a service station/dedicated EV charging hub at least once a week. Furthermore, there are a significant proportion of drivers that do not and will not have access to off-street parking. The survey found that those persons were also significantly more likely than average to report charging at business or organisation's car park (51%) at least once a week.

A significant additional cost is the extra time taken to re-charge with compared to re-fuelling an ICE vehicle. Whilst this impact will decline over time, as charging times decrease, there are still significant costs in the interim. Moreover, there needs to be significant public and private investment to generate improvements in re-charging times.

The estimated scale of this impact is £46.5 billion in total.

Value of time impacts (£Bn)	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	46.5	25.6	0.4	12.9	7.5

The need to upgrade transport and energy infrastructure

Costly electricity network upgrades will be required to cater to the demand from a growing electric car and van fleet, and potentially heavy goods vehicles too. The costs and will vary between sites, depending on the location and available capacity. This is not only to accommodate additional demand, but to facilitate a sufficient 'Smart' grid, which is deemed necessary to facilitate the significantly increased demand for electricity, potentially at specific times i.e., rush hour.

Additional investment will be required whether bans are implemented or not, given the expected increase in EV use in both scenarios. However, it is assumed that the required investment in the case of bans being implemented is much more during the years 2022-20250

[33] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1078871/dft-ev-driver-survey-summary-report.pdf

[34] Electric Vehicle Charging Research - Link

than with no bans, due to the need to support many more EVs joining the fleet during that period.

The National Infrastructure Commission's analysis suggests that a 100% uptake of electric cars and vans could increase total annual electricity demand by 26% by 2050.[35] They have estimated the impact of that the rapid uptake of electric vehicles and hybrid heat pumps could increase total expenditure on distribution networks by up to £50 billion by 2035. This has been used as the basis of estimating the impact of the increase in EVs on the grid.

An in-house Cebr model has been used to supplement this estimate by calculating the impact of increased renewables use on the National Grid. This is required to achieve sufficiently clean energy to ensure EVs do not generate substantial emissions through drawing electricity from an unclean electricity grid. A key challenge is that both average capacity and peak capacity will need to increase to a level sufficient to handle extended periods of low wind and sun. A relatively low cost of achieving this has been assumed. The capital cost of new generation has been estimated to be £119 billion over the period 2022-2050.

The government will likely need to play a significant role in providing this investment for several reasons. Firstly, there are significant risks to undertaking investment in charging facilities, which is likely to exceed levels that the private sector is willing to bear. Secondly, this represents a key government regulatory policy change, and so there will remain pressure on the government to ensure that sufficient funds are secured to prevent it from failing. Finally, the benefits of the bans are largely 'externalities' that the private sector is unlikely take full responsibility for facilitating.

Charging infrastructure

To meet demand, a large number of new charge points will be required. The CCC forecast a potential 370,000 public charge points will be required by 2035. However, many experts would suggest that this amount and implied rate of roll out would be far too low to provide sufficient capacity. Over the same period, we estimate up to 19 million home charge points may also be required, to meet EV uptake projections. However, this may be a relatively conservative estimate.

An example of the type of investment required includes that of Pivot Power, a UK-based energy company, who is working with National Grid to build 45 new charging sites, each with up to 100 charge points, across the country, investing £1.6 billion.[36] The government has plans to invest a similar amount to develop charge points. This has been used as a basis of estimating the investment required to per charge point.

35 https://nic.org.uk/app/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible-1.pdf#page=53

36 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1065576/taking-charge-the-electric-vehicle-infrastructure-strategy.pdf

Having sufficient charging infrastructure is particularly important as currently many users believe that changepoints can be difficult to find, difficult to use and often may turn out to be unavailable for use or broken when a driver reaches them. This can be particularly disconcerting for disabled users. For instance, it is estimated that there could be around 10 million electric cars and vans that are regularly parked overnight on-street in the UK by 2050. There would be a likely requirement for them to have access to charge points to manage the impact on the UK's electricity system. It is likely that the increased demand will see electricity usage increase as a result. To minimise such an impact on the required electricity production infrastructure, much charging would have to occur overnight and on low charging tariffs to consumers. The corollary is a need for ubiquitous, low cost, overnight on-street charging. But creating this will involve considerable costs.

There is also a need to transform the network to make is sufficiently 'smart' and also bolster the network to achieve much higher rates of renewable energy. Without smart charging, CCC modelling suggests that peak demand in 2050 could be increased by 19-26GW (32 to 44% of current peak demand).[37]

The consensus within government is that flexibility provided by smart charging can reduce the investment needed in the new generation of storage and network infrastructure This will be essential to keep costs low. For instance, smart technology could allow the charging of vehicles at times of low demand such as overnight or on a windy day. When the grid signals low demand or high supply, it can be cheaper to draw power from the grid. Vehicle to grid charging technology could mean that stored energy from EV batteries is pumped back into the grid or buildings when needed.

We provide an estimate of all of these additional required investment costs generated by the ban. Over the 2022-2050 period an impact of £98.5 billion is estimated.

Infrastructure impacts (£Bn)	Total	Car	Motorbike	LGV	HGV
Investment Costs	-98.5	n/a	n/a	n/a	n/a

Tax Revenue losses

As time goes on, there will be a need to replace lost revenue from the £35bn of annual Fuel Duty and VAT currently generated, or to make commensurate public spending cuts.[38]

As the fleet mix transitions to be more predominantly made up of EV vehicles, these assessed losses in revenues from the ban will decline – over the 2022-2050 period an impact of £76.8 billion is estimated.

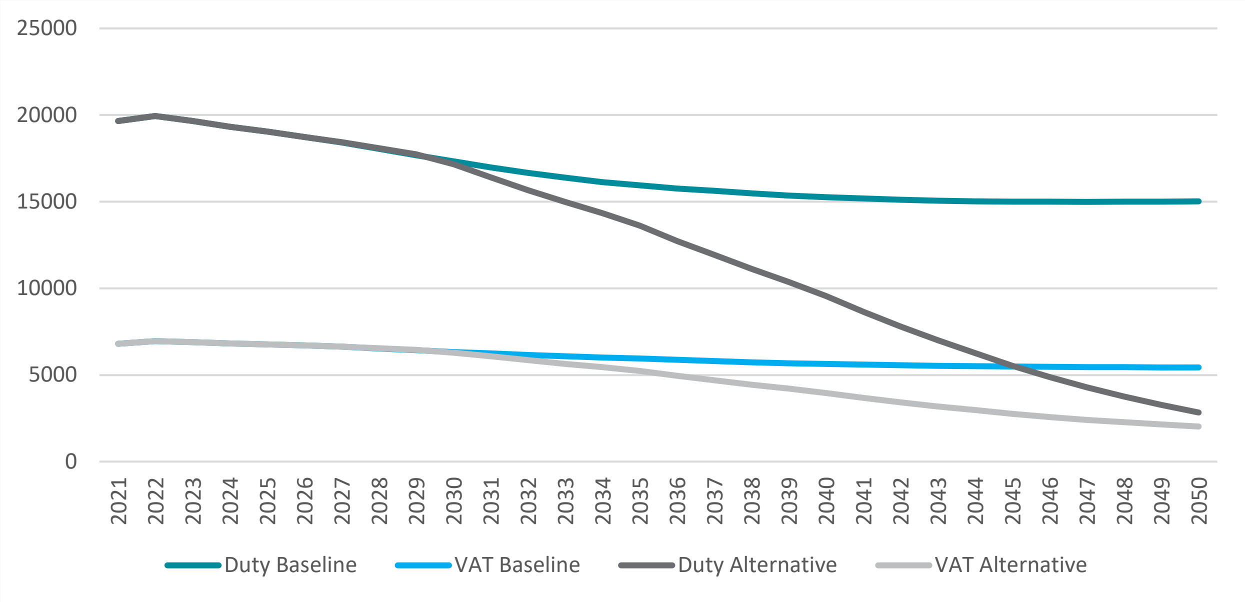
Tax revenue impacts (£Bn)	Total	Car	Motorbike	LGV	HGV
Fuel Duty	59.5	35.9	0.7	17.6	5.3
VAT on fuel	17.3	10.6	0.2	5.0	1.5

[37] FES2021 net zero compliant scenarios (Consumer Transformation, System Transformation and Leading the Way). https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021

38 FairFuel UK - Link

Figure 5 illustrates this decline in annual tax revenues by scenario.

Figure 5: Fuel Duty and VAT revenues (£ million) by scenario



Cebr has an in-house analysis tool used to estimate tax revenues associated with employment according to number and salary of employees. We use figures from this model to put in context the tax impacts of the 2030 ban. The median salary of a full-time worker in the UK is approximately £31,300[39]. £6,500 of this is paid in Income Tax and Employees' NICs, with Employers' NICs bringing the total to £9,700.

In present value terms, the estimated impact of the 2030 ban on Fuel Duty and VAT revenues between now and 2050 is £76.8 billion. This is equivalent to the Income Tax, Employees' NICs, and Employers' NICs revenue which would be raised from 414,000 UK full-time workers on median earnings over the same time period. If these impacts are evaluated starting in 2030 rather than 2022, impact is equivalent to the revenue from 669,000 of these taxpayers. These calculations assume that real median incomes and tax bands/rate do not change relative to each other, so tax revenues per worker remain the same.

[39] Employee earnings in the UK: 2021
https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2021

Summary Benefit Cost Ratio (BCR) figures

(£Bn)	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	64.7	37.7	0.7	19.8	6.5
Air quality emissions	11.2	4.5	0.1	5.7	0.9
CO2e, vehicle manufacture	-32.5	-21.5	-1.1	-8.9	-1.1
Time spent refuelling/recharging	-46.5	-25.6	-0.4	-12.9	-7.5
Fuel (resource cost only)	-34.9	-17.1	-0.3	-13.3	-4.3
New vehicles	-187.8	-98.0	-7.2	-67.2	-15.4
Infrastructure Investment Costs	-98.5	n/a	n/a	n/a	n/a

	Total	Car	Motorbike	LGV	HGV
Benefits	75.9	42.2	0.8	25.4	7.4
Costs	400.3	162.3	9.0	102.2	28.2

	Total	Car	Motorbike	LGV	HGV
BCR	0.19	0.26	0.09	0.25	0.26
NPV	-225.9	-120.1	-8.2	-76.8	-20.8

	Total	Car	Motorbike	LGV	HGV
BCR (excl. new vehicle costs)	0.36	0.66	0.43	0.73	0.58
NPV (excl. new vehicle costs)	-38.1	-22.1	-1.0	-9.6	-5.4

In standard appraisal, where the majority of impacts are measured in monetary values, the value for money category is primarily informed by one of two metrics: the Benefit Cost Ratio (BCR) and the Net Present Value (NPV). These metrics provide a primary indication of the extent to which a proposal is expected to represent value for money. Both metrics are used to express the relationship between the Present Value of Costs (PVC) and the Present Value of Benefits (PVB)

The BCRs capture the ratio of present value benefits and present value costs. A BCR of greater than one indicates that the benefits outweigh the costs, whereas a BCR below one indicates the opposite: the costs outweigh the benefits.

Unlike the BCR, the NPV does not measure the likely benefits relative to the likely costs. Instead, it measures the total impact on societies welfare of a proposal. It is simply the sum of all benefits net of costs.

The overall BCR of 0.19 above represents that total costs are just over five times those of total benefits. For motorbikes, for instance, this ratio is much lower, indicating that the costs of the bans on motorbikes are over 10 times the associated costs.

5.2. Household impacts

This section puts costs into context on a per-household basis.[40] These figures are summarised in Table 2. Summing all costs results in an estimated cost per household of £14,700; rising to £19,100 when considering only those households that own a car. Using undiscounted figures gives an impact of £27,400 per household – nearly £1,000 per year between now and 2050.

Table 2: Summary of impacts per household

		Discounted	Undiscounted
All households	**2022-2050**	£14,743	£27,435
	Per year	£527	£980
Car-owning households only	**2022-2050**	£19,147	£35,630
	Per year	£684	£1,272

The discounted per-household impacts (i.e., equivalent to the £14,700 above) for 2022-2030 and 2022-2040 are £2,000 and £7,700 respectively. For car-owning households only they are £2,5000 and £10,000. This reflects that total costs per household increase progressively throughout the period.

5.3. Van user impacts

Focusing on LGV users, we reach the figures shown in Table 3, which gives present value impacts per van owner (i.e., per van). Total estimated impact is a net cost of approximately £20,600 per vehicle owner.

Table 3: LGV impacts, 2022-2050 present value (£Bn)

New vehicle costs	Fuel costs	Time costs	Tax impacts
-14791.9	2034.3	-2833.7	-4958.2

40 Not all costs are borne directly by households – for instance, most of the costs relating to LGVs and HGVS (and a significant proportion of those relating to cars and motorbikes) will be most immediately faced by businesses, and significant infrastructure costs are incurred by government. Ultimately, however, all costs will be passed onto households, e.g., in the form of lower profits, lower wages, or higher taxation. Moreover, these calculations focus on the cost side of the equation only – i.e., CO_2e from vehicle manufacture, time spent refuelling/recharging, fuel (resource cost only), new vehicle costs, infrastructure investment costs.

5.4. Sensitivity tests

In this section we consider the impact of changing various assumptions in our model. In each case, summary results are presented alongside differences vs. the core results.

Alternative carbon prices

Our core results use central CO_2e values from TAG. Under these values, a tonne of CO_2e in 2022 is priced at £255.40. Other values can be used however – for instance the 'social cost of carbon' estimated by the US Government[41] in 2022 is £48.54. In either case, values grow over time to reflect larger impacts of climate change and higher GDP.

Using the US social costs of carbon results in significantly lower monetised environmental benefits from a ban – both driving emissions and production emissions changes are valued less; therefore, the net environmental impacts of the ban are reduced by roughly £36 billion.

Table 4: Headline results - Alternative carbon prices sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	12.9	7.5	0.1	3.9	1.3
Air quality emissions	11.2	4.5	0.1	5.7	0.9
CO2e, vehicle manufacture	-6.5	-4.3	-0.2	-1.8	-0.2

Value of time impacts	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	-46.5	-25.6	-0.4	-12.9	-7.5

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
Fuel Duty	-59.5	-35.9	-0.7	-17.6	-5.3
VAT on fuel	-17.3	-10.6	-0.2	-5.0	-1.5

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	41.8	29.4	0.6	9.2	2.6
Fuel (resource cost only)	-34.9	-17.1	-0.3	-13.3	-4.3
New vehicles	-187.8	-98.0	-7.2	-67.2	-15.4

Infrastructure impacts	Total	Car	Motorbike	LGV	HGV
Investment Costs	-98.5	n/a	n/a	n/a	n/a

41 Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf Table A-1

Table 5: Differences vs. core results - Alternative carbon prices sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	-51.8	-30.2	-0.6	-15.8	-5.2
CO2e, vehicle manufacture	26.0	17.2	0.9	7.1	0.8

TAG fuel consumption projections in both scenarios

In our core results, we assume a different trajectory for petrol and diesel consumption after 2030 in the two scenarios; in the Baseline, the rate of decline continues, reflecting manufacturers' investment in efficiency improvements if they do not expect a ban. In this sensitivity test, the higher TAG values for fuel consumption are used in the Baseline as well as the Alternative.

Table 6: Headline results - TAG fuel consumption projections in both scenarios sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	80.4	45.4	0.8	25.6	8.5
Air quality emissions	11.2	4.5	0.1	5.7	0.9
CO2e, vehicle manufacture	-32.5	-21.5	-1.1	-8.9	-1.1

Value of time impacts	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	-44.4	-24.4	-0.4	-12.2	-7.5

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
Fuel Duty	-73.2	-42.9	-0.8	-22.5	-7.0
VAT on fuel	-22.2	-13.1	-0.2	-6.7	-2.1

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	71.4	44.6	0.8	19.8	6.2
Fuel (resource cost only)	-24.0	-11.5	-0.2	-9.4	-2.9
New vehicles	-187.8	-98.0	-7.2	-67.2	-15.4

Infrastructure impacts	Total	Car	Motorbike	LGV	HGV
Investment Costs	-98.5	n/a	n/a	n/a	n/a

Table 7: Differences vs. core results - TAG fuel consumption projections in both scenarios sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	15.7	7.7	0.1	5.8	2.0

Value of time impacts	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	2.1	1.3	0.0	0.7	0.0

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
Fuel Duty	-13.7	-7.1	-0.1	-4.9	-1.7
VAT on fuel	-4.9	-2.5	0.0	-1.8	-0.6

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	29.6	15.2	0.2	10.5	3.6
Fuel (resource cost only)	10.9	5.6	0.1	3.9	1.3

Low carbon fuel (biofuel) adoption

An alternative and perhaps complementary approach to de-carbonising the vehicle fleet is to use low carbon liquid and gaseous fuels. The use of these fuels– predominantly biofuels deployed in road transport – currently deliver about a third of all domestic transport carbon savings under current carbon budgets.[42]As with materials for EV vehicle construction, the availability of sustainable raw materials for low carbon fuels is limited, with increasing demands from other sectors. The government's strategy has therefore been to prioritise the use of low carbon fuels for modes with limited alternatives to liquid and gaseous fuels, such as aviation. But low carbon fuels will continue to be an available as a potential resource to bring about emissions savings in the UK vehicle fleet.

Given the limited progress of electrifying long-haul HGVs, this is likely to be a priority area for the use of low carbon liquid or gaseous fuels. More generally, in the transport sector, the priority will be to use these fuels to the aviation and maritime sectors.

The government estimates that 5.4 MtCO2e were saved in 2019 by displacing fossil fuels with low carbon fuels, which is equivalent to taking 2.5 million cars off the road. Moreover, in 2019, low carbon fuels accounted for approximately 5% of total UK fuels by volume, of which 2/3 were made from waste materials, such as used cooking oil, fatbergs, food waste or roadside grass.[43] The evidence on the precise environmental impact of biofuels is mixed. Based on

[42] Transport Decarbonisation plan https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1009448/decarbonising-transport-a-better-greener-britain.pdf

[43] Transport Decarbonisation plan https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1009448/decarbonising-transport-a-better-greener-britain.pdf

evidence published by the European Commission,[44] we assume that greenhouse gas emissions of fuels with a 100% biofuel blend are 30% lower, and this target is progressively reached by 2050. This reduces by some £15 billion the environmental benefits of a ban, as emissions from petrol and diesel using vehicles are lower. For comparative purposes, it is assumed that this could be achieved with the same investment required to facilitate the infrastructure improvements to facilitate the increased EV vehicle usage induced by the bans.

Table 8: Headline results – Low carbon fuels sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	49.3	28.8	0.5	15.3	4.7
Air quality emissions	11.2	4.5	0.1	5.7	0.9
CO2e, vehicle manufacture	-32.5	-21.5	-1.1	-8.9	-1.1

Value of time impacts	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	-46.5	-25.6	-0.4	-12.9	-7.5

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
Fuel Duty	-59.5	-35.9	-0.7	-17.6	-5.3
VAT on fuel	-17.3	-10.6	-0.2	-5.0	-1.5

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	41.8	29.4	0.6	9.2	2.6
Fuel (resource cost only)	-34.9	-17.1	-0.3	-13.3	-4.3
New vehicles	-187.8	-98.0	-7.2	-67.2	-15.4

Infrastructure impacts	Total	Car	Motorbike	LGV	HGV
Investment Costs	-98.5	n/a	n/a	n/a	n/a

Table 9: Differences vs. core results – Low carbon fuels sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	-15.4	-8.9	-0.2	-4.5	-1.8

Energy price shocks

The Russia-Ukraine war coincided with a sharp increase in global energy and food prices. This has been an example of a significant global supply shock that has impacted global energy markets. Such shocks may significantly impact the results of the analysis. To understand potential impacts three shocks have been assumed so to ascertain the likely impacts.

[44] Biofuels – the way forward? https://ec.europa.eu/environment/integration/research/newsalert/pdf/1si_en.pdf

Three shocks are considered:

- A doubling of petrol, diesel, and electricity costs.
- A doubling of petrol and diesel costs.
- A doubling of electricity costs.

In all cases this shock is assumed to persist over the full horizon period.

Petrol, diesel, and electricity prices

Doubling in resource costs for fuels leads to a smaller impact on prices paid by consumers for petrol and diesel than for electricity, as liquid fuels are more highly taxed (and Fuel Duty does not change in response to prices). Therefore, the relative increase in operating costs for electric vehicles are larger, and overall, the savings to consumers from operating them rather than petrol or diesel vehicles are smaller.

Table 10: Headline results – Petrol, diesel, and electricity price shock sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	65.4	38.3	0.7	19.9	6.5
Air quality emissions	11.3	4.6	0.1	5.7	0.9
CO2e, vehicle manufacture	-32.6	-21.6	-1.1	-8.9	-1.1

Value of time impacts	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	-47.0	-26.0	-0.4	-13.0	-7.5

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
Fuel Duty	-60.2	-36.5	-0.7	-17.7	-5.3
VAT on fuel	-22.9	-14.3	-0.3	-6.5	-1.9

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	12.5	16.1	0.4	-2.6	-1.3
Fuel (resource cost only)	-70.6	-34.7	-0.6	-26.8	-8.5
New vehicles	-186.4	-96.7	-7.2	-67.1	-15.4

Infrastructure impacts	Total	Car	Motorbike	LGV	HGV
Investment Costs	-94.3	n/a	n/a	n/a	n/a

Table 11: Differences vs. core results – Petrol, diesel, and electricity price shock sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	0.7	0.6	0.0	0.2	0.0
Air quality emissions	0.1	0.1	0.0	0.0	0.0
CO2e, vehicle manufacture	-0.1	-0.1	0.0	0.0	0.0

Value of time impacts	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	-0.5	-0.4	0.0	-0.1	0.0

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
Fuel Duty	-0.7	-0.6	0.0	-0.2	0.0
VAT on fuel	-5.7	-3.7	-0.1	-1.5	-0.4

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	-29.3	-13.4	-0.2	-11.9	-3.8
Fuel (resource cost only)	-35.7	-17.6	-0.3	-13.5	-4.3
New vehicles	1.4	1.3	0.0	0.1	0.0

Infrastructure impacts	Total	Car	Motorbike	LGV	HGV
Investment Costs	4.2	n/a	n/a	n/a	n/a

Petrol and diesel prices

This significantly increases the savings to consumers from operating electric vehicles – their operating costs have not increased but petrol and diesel are drastically more expensive.

Table 12: Headline results – Petrol and diesel price shock sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	65.4	38.3	0.7	19.9	6.5
Air quality emissions	11.3	4.6	0.1	5.7	0.9
CO2e, vehicle manufacture	-32.6	-21.6	-1.1	-8.9	-1.1

Value of time impacts	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	-47.0	-26.0	-0.4	-13.0	-7.5

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
Fuel Duty	-60.2	-36.5	-0.7	-17.7	-5.3
VAT on fuel	-27.1	-16.6	-0.3	-7.8	-2.3

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	100.0	64.8	1.2	26.4	7.6
Fuel (resource cost only)	12.7	11.7	0.3	0.8	-0.1
New vehicles	-186.4	-96.7	-7.2	-67.1	-15.4

Infrastructure impacts	Total	Car	Motorbike	LGV	HGV
Investment Costs	-94.3	n/a	n/a	n/a	n/a

Table 13: Differences vs. core results – Petrol and diesel price shock sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	0.7	0.6	0.0	0.2	0.0
Air quality emissions	0.1	0.1	0.0	0.0	0.0
CO2e, vehicle manufacture	-0.1	-0.1	0.0	0.0	0.0

Value of time impacts	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	-0.5	-0.4	0.0	-0.1	0.0

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
Fuel Duty	-0.7	-0.6	0.0	-0.2	0.0
VAT on fuel	-9.8	-6.0	-0.1	-2.9	-0.8

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	58.2	35.4	0.7	17.1	5.0
Fuel (resource cost only)	47.6	28.8	0.5	14.1	4.2
New vehicles	1.4	1.3	0.0	0.1	0.0

Infrastructure impacts	Total	Car	Motorbike	LGV	HGV
Investment Costs	4.2	n/a	n/a	n/a	n/a

Electricity prices

This flips around the benefit in the ‘Fuel’ row of household/business spending – electric vehicles are now more expensive to operate than petrol or diesel, so the ban on ICE vehicles forces consumers to spend more operating their vehicles.

Table 14: Headline results – Electricity price shock sensitivity test (£Bn)

Environmental impacts	Total	Car	Motorbike	LGV	HGV
CO2e, driving emissions	64.7	37.7	0.7	19.8	6.5
Air quality emissions	11.2	4.5	0.1	5.7	0.9
CO2e, vehicle manufacture	-32.5	-21.5	-1.1	-8.9	-1.1

Value of time impacts	Total	Car	Motorbike	LGV	HGV
Time spent refuelling/recharging	-46.5	-25.6	-0.4	-12.9	-7.5

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
Fuel Duty	-59.5	-35.9	-0.7	-17.6	-5.3
VAT on fuel	-13.1	-8.3	-0.2	-3.6	-1.1

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	-44.6	-18.5	-0.3	-19.5	-6.3
Fuel (resource cost only)	-117.2	-62.7	-1.1	-40.6	-12.7
New vehicles	-187.8	-98.0	-7.2	-67.2	-15.4

Infrastructure impacts	Total	Car	Motorbike	LGV	HGV
Investment Costs	-98.5	n/a	n/a	n/a	n/a

Table 15: Differences vs. core results – Electricity price shock sensitivity test (£Bn)

Tax revenue impacts	Total	Car	Motorbike	LGV	HGV
VAT on fuel	4.1	2.3	0.0	1.4	0.4

Household/business spending	Total	Car	Motorbike	LGV	HGV
Fuel	-86.4	-48.0	-0.9	-28.7	-8.8
Fuel (resource cost only)	-82.3	-45.7	-0.8	-27.4	-8.4

Infrastructure impacts	Total	Car	Motorbike	LGV	HGV
Investment Costs	0.0	n/a	n/a	n/a	n/a

The table below shows a summary of the Net Present value results under each sensitivity test.

Table 16: Summary of Net Present Value Results (£Bn)

	Total	Car	Motorbike	LGV	HGV
Central	-225.9	-120.1	-8.2	-76.8	-20.8
Excl. new vehicle costs	-38.1	-22.1	-1.0	-9.6	-5.4
US carbon values	-251.6	-133.0	-7.9	-85.5	-25.1
Same fuel consumption in both scenarios	-197.2	-105.5	-8.0	-66.4	-17.3
Low carbon fuel (biofuel) adoption	-241.3	-129.0	-8.4	-81.3	-22.6
Petrol, diesel, and electricity prices double	-259.9	-136.2	-8.5	-90.1	-25.0
Petrol and diesel prices double	-176.6	-89.8	-7.7	-62.5	-16.6
Electricity prices double	-308.2	-165.8	-9.1	-104.1	-29.2

6. Non-monetised impacts

The proposed bans are driven by the desire to demonstrate and make an effective contribution to the tackling of widely held global and domestic environmental concerns. The use of DfT values for GHG and air quality emissions conveniently summarises the government's assumptions on the implied environmental and health impacts of the proposed bans. In contrast, there are a wide range of costs, over and above those assessed in monetary terms above, that are much more challenging to capture and summarise. These are now considered below. These would all serve to further adversely impact the benefit-cost ratio of the proposed bans.

However, it is important to distinguish between emissions deriving from the process of driving and direct production and those emerging from other areas. Whilst we account for production emissions, there is also other environmental degradation and human welfare losses as those who work in mines are often treated poorly and work in in oppressive conditions. They serve to further worsen the value for money of the proposed ban.

Impact of international demand for raw materials and the associated environmental damage.

The main raw metals used in the production of electric vehicles are lithium, nickel, and cobalt. Analysts believe there is a potential shortfall in the global mining capacity required to extract these minerals to manufacture sufficient batteries to meet projected EV demand.[45] Industry forecasters expect a very substantial growth in the mining of graphite, lithium, nickel, and cobalt. An additional 384 new mines may be needed by 2035 to supply all those new EVs assesses industry forecaster Benchmark Minerals[46]. In early March 2022, the price of nickel hit headlines as prices quoted on the London Metal Exchange (LME) surged to over $100,000 a ton on fears over constricted Russian supply and the wider consequences of the war in Ukraine. According to industry research company by Benchmarking Mineral Intelligence, since January 2020, lithium prices have increased by over 700%, nickel by 250% and cobalt by 100%. The rising cost of raw materials needed for batteries such as lithium and nickel has prompted cell suppliers to push up prices to car makers, which are then passing on costs to buyers.[47]

Sam Jaffe, who is a vice president of battery solutions at E Source, a research firm in Boulder, Colorado argued that "the tsunami of demand is coming…I don't think the battery industry is ready for it", predicting that EV battery costs could spike by 22% by 2026 as raw material shortages drag on.[48] In such a scenario, EV vehicles could remain significantly more expensive than equivalent ICE vehicles. Moreover, the increased demand for these materials

45 https://www.linklaters.com/en/insights/thought-leadership/electric-vehicle-batteries/powering-the-future/sourcing-raw-materials#:~:text=Lithium%2C%20nickel%20and%20cobalt%20are,used%20to%20make%20EV%20batteries.

46 Dig This: The Shift To EVs Requires A Massive Expansion Of Battery Metal Mining (forbes.com)

47 https://www.autocar.co.uk/car-news/business-tech%2C-development-and-manufacturing/how-global-raw-materials-costs-are-affecting

48 https://www.cnbc.com/2022/05/18/ev-battery-costs-set-to-spike-as-raw-material-shortages-drags-on.html

due to EVs could in the future push up the costs, making EVs and also other products more expensive, where these raw materials are essential input factors.

According to an UNCTAD report, the expected boom in mining for the raw materials used to make rechargeable batteries poses environmental and social risks that must be urgently addressed. “Most consumers are only aware of the ‘clean’ aspects of electric vehicles,” says Pamela Coke-Hamilton, UNCTAD’s director of international trade. “The dirty aspects of the production process are out of sight.” This is because while the majority of the consumers live in industrialized nations, the lion’s share of the raw materials is concentrated in a few developing countries.[49]

A prime example of the environmental risks from increasing demand for EVs is found in the salt flats in the Andean regions of Argentina, Bolivia, and Chile, where more than half of the world’s lithium resources lie. Lithium mining requires huge amounts of groundwater to pump out brines from drilled wells, and some estimates show that almost two million litres of water are needed to produce one ton of lithium. In Chile’s Salar de Atacama, lithium and other mining activities consumed 65% of the water, causing groundwater depletion, soil contamination and other forms of environmental degradation, forcing local communities to abandon ancestral settlements.

From a social dimension, the rising demand for such materials raises concerns over the working conditions for those involved in their extraction. The DRC, which was responsible for 71% of global cobalt production in 2019 and just over 50% of worldwide reserves lends itself as a useful example. Large-scale or industrial mining is responsible for over two thirds of cobalt production in the DRC, with the other third supplied by artisanal mines. While some of this artisanal mining is formal and registered, most is not and is often associated with unethical labour practices.[50]

Lithium Shortages

Boston Consulting Group (BCG) have recently estimated that the global supply of lithium is set to fall short of demand for the first time by 2030, with the gap set to expand rapidly to 24% in 2035.[51] The BCG report predicts that expanding mining projects and increased recycling will enable global lithium supply to continue exceeding demand until at least 2025, and possibly 2030. However, it states that the most likely case-scenario in 2030 is a 4% shortfall between supply and demand.

This relative rise in demand is expected to be driven directly by the growing use of lithium-ion batteries across the world. Lithium is the most critical raw material for the manufacture of EVs, but there are also other minerals that need to be mined to make and EV vehicles, including as nickel, manganese, and cobalt.

49 https://unctad.org/news/developing-countries-pay-environmental-cost-electric-car-batteries

50 https://www.iisd.org/articles/trade-electric-vehicle-raw-materials

51 https://www.edie.net/acute-lithium-shortages-forecast-by-2035-as-battery-supply-chains-expand/

This implies that the cost of EVs, once subsidies are removed, are unlikely to fall sufficiently to become equal to that of ICEs in the foreseeable future.

Range Anxiety

EVs cause range anxiety due to the limited amount of charge a battery stores, which limits how far it an EV car can travel before it requires recharging. It may take only 30 minutes to charge a battery up to 80%, but in many cases, it may take a lot longer than 30 minutes. In contrast, with an ICE car, refuelling can be done comparatively much more quickly. This can cause anxiety as persons may worry about the large time cost that may be incurred if they have to take a significant amount of time out of their day (or night) to charge a battery. This can be particularly challenging for those who require vehicles for their job and perhaps do not have home chargers.

A common view is that it will be essential to develop a 'Smart Grid' to allow electricity to be drawn from electric vehicles when charging to be able to balance the energy on the grid. This may both be essential for ensuring the management of electricity on the gird but, in turn, may be a source of anxiety for those who fear that this may reduce the charge of their cars at times when emergency use is required.

Job losses

Manufacture and maintenance of ICE and BEV vehicles require some of the same skillsets but many different skills also. This means that whilst jobs will be created, there will also be associated job losses as the vehicle production industry transitions in synchronisation with increased EV vehicle purchases. It is hard to predict the net impact and views differ amongst experts and industry insiders. For instance, according to the CEO of Aston Martin, the internal combustion ban is 'either disastrous or pointless'. Andy Palmer has hit out at the proposals that fail to take into account potential British job losses, for example at internal combustion engine plants like Ford's in Bridgend. Speaking to Autocar, he said:

> *"It's not thinking about the consequential effects to the 800,000 people in our industry. It's not taking into account the impact to things like petrol station garages and the [Ford employees] who have been making engines in Bridgend."*[52]

According to the SMMT, more than 22,000 jobs in the UK's car industry are at risk as firms pivot away from making engines and traditional car parts and towards batteries and other components for EVs:

> *"While some companies are already on the journey, many risk being left behind as the jobs and skills involved with internal combustion engine technology may not be transferable."*

52 https://www.carthrottle.com/post/aston-martin-is-furious-about-the-uks-disastrous-or-pointless-internal-combustion-ban/

Moreover, the Institute of the Motor Industry, 97% of active mechanics aren't suitably qualified to work on electric vehicles.[53] There is also evidence from the European continent who are implementing similar plans. European Commission announced its intention earlier this year to eliminate 100% of carbon emissions from new cars by 2035. The policy effectively bans the sale of fossil-fuel powered vehicles after that date. European auto suppliers have estimated that half a million jobs will be at risk under EU plans to effectively ban combustion-engine cars by 2035. Their view is that more than two-thirds of those of these 501,000 will be gone in the five years preceding the ban.

More recently, Toyota CEO Akio Toyoda, said that going all-EV could cost Japan 5.5 million jobs and eight million units of lost vehicle output by 2030.[54] There are also concerns form the Toyota CEO about how quickly consumers will embrace the new technologies. The CEO also said that a lack of sufficient infrastructure will hold back EV adoption rates, which is a factor in its decision not to go all in on electricity.

A government-sanctioned report in Germany has reached similar conclusions. It warned that approximately 400,000 jobs could be lost in Germany as a result of the transition away from ICE vehicle manufacturer. The job losses can occur as the types of people gaining jobs are not necessarily those who lose jobs. Furthermore, the German auto industry association VDA has estimated that a ban of combustion-engine vehicles in 2030 would threaten more than 600,000 German industrial jobs, of which 436,000 are at car companies and suppliers.

However, there are also likely to be jobs created from the take-up of EVs. For instance, a survey by PwC found that 226,000 jobs would be created in manufacturing of electric parts. The key to understanding the impact is the net job loss (or creation). The PwC survey estimates that this 226,000 job gain will limit the net number of job losses to approximately 275,000 over the next couple of decades.

A key aspect is that a portion of the extra jobs are merely a cost of the transition to a new type of vehicle. As a new generation of engineers are trained specifically to handle EVs, this will limit the net costs, as this will represent a substitution away ICE training.

Job losses in local the local automotive industry

ONS data indicates that there are approximately 3,553,000 people employed in the sector. Employment rates seem to be steadily increasing since 2012. Many of those employed in this sector will not be able to re-purpose their skills to meet a rapidly changing sector. History has shown that rapid structural changes in an economy can lead to pockets of significant long-term unemployment. This was a key characteristic of the staple industries that were predominantly in the north of the UK in the early 20th century but have since rapidly declined, leaving the present need to 'level up' the economy.

53 https://www.fixter.co.uk/blog/how-is-the-future-of-all-electric-vehicles-going-to-affect-the-local-mechanics-of-today/

54 https://insideevs.com/news/534262/all-ev-plans-threaten-japan/

7. Conclusion

This report has assessed the economic impacts of the government's stated plans of banning the sale of fossil fuel vehicles from 2030 onwards. The clear message deriving from the analysis is that this decision represents 'poor' value for money as associated costs are five times the estimated benefits. The analysis implies that even when the full benefits of the contribution of the ban to achieving the goal of Net Zero are priced in, the costs still far outweigh these benefits.

The central benefit-cost ratio estimate is 0.19, meaning that the costs of the forthcoming bans internal combustion engine vehicles are estimated to be just over five times higher than the benefits. The net present value is negative £226 billion; with this representing an estimated net cost per household of £14,700 (£27,400 in undiscounted figures).

The main source of estimated benefits stems from lower emissions at the tailpipe. However, the extent to which these emissions are clean is heavily dependent on cleanliness of the National Grid's energy supply. To make this source fully zero emission will may prove to be prohibitively expensive in the long run.

In present value terms, the estimated impact of the bans on Fuel Duty and VAT revenues between now and 2050 is £76.8 billion. This represents a huge hole in public finances which will need to be addressed. This is equivalent to the Income Tax, Employees' NICs, and Employers' NICs revenue raised on an additional 414,000 UK full-time workers on median earnings over the same time period.

This social cost-benefit analysis indicates that the key costs to society including significantly increased waiting times as charging electric vehicles will take a lot more time than refuelling ICE vehicles at petrol pumps. Moreover, it is likely that drivers will have to pay a lot more for new vehicles, especially given the expectation of shortages of key raw materials that are essential for building EVs. There will also be huge costs required to rapidly reorient the National Grid to generate sufficient renewable energy, in a smart way, to supply energy for EVs. The more rapidly these demands increase, the more costly it is likely to the economy. The government itself will face a significant fall in tax revenue and the average household will face significant personal costs, both in terms of direct monetary outgoings but also in much more lost time.

Even without a ban, there will be significant falls in carbon emissions as EVs are likely to gain significant traction over time without significant regulation, and petrol and diesel vehicles will become more fuel-efficient. As such, this report focuses on the marginal costs and benefits of the increased speed of the transition caused by the forthcoming regulatory change.

The analysis has been undertaken in a way that is consistent with the government's analytical methodological guidance. This indicates that this is a decision that should be reconsidered so not to yield impacts that are, in net, detrimental to the economy and society more generally.

The environmental benefits of the ban, in so far as it helps the government meet Net Zero, are fully captured in the estimated benefits. This has allowed this study to weigh up those assessed implied environmental and health benefits against other factors that determine the welfare of UK citizens.

Whilst there may remain strategic reasons for implementing the ban, such as demonstrating the UK's commitment to achieving Net Zero by 2050, this regulatory policy should be seen primarily as one that reduces the welfare of UK citizens.

The core recommendation of this report is that the government undertake their own rigorous analysis so that the full extent of net impacts can be more fully explored. The findings of this report strongly suggest that a similar government led analysis would come to a similar conclusion: that the benefits to UK households of implementing the fossil fuel vehicle sale bans are far outweighed by the costs.