018/19

Title: Ending the sale of new non zero emission buses in the UK	**Impact Assessment (IA)**
IA No: DfT00432	**Date:** 09/09/21
RPC Reference No: N/A	**Stage: Consultation**
Lead department or agency: Department for Transport	**Source of intervention:Domestic**
	Type of measure: Secondary Legislation
	Contact for enquiries: buses@dft.gov.uk

Summary: Intervention and Options

RPC Opinion: Awaiting Scrutiny

Cost of Options (best estimate in 2019 prices)			
Total Net Present Social Value	**Business Net Present Value**	**Net cost to business per year**	**Business Impact Target Status**
£1.3bn to £1.7bn	£1.0bn to £1.3bn	-£59.3m to -£44.3m	Qualifying Provision

The UK has committed to reduce all greenhouse gas (GHG) emissions to net-zero by 2050. Transport became the largest GHG emitting sector in 2016, responsible for up 28% of domestic GHG emissions. Buses represent 3% of domestic transport GHG emissions, and, based on current firm and funded policies, emissions are projected to fall by 25% from 2018 levels by 2050. It is widely acknowledged that transport is one of the more challenging sectors to decarbonise, and as such delivering net zero emissions will require significant action across all segments of the sector, hence the need for further government intervention.

The aim of this policy is to support efforts to reduce GHG emissions from transport, specifically in the bus sector, to net-zero by 2050 at the absolute latest. To meet both overall and interim carbon budgets, there is a need to increase the pace of roll out of zero emission buses. Setting an appropriate but ambitious end of sales date will provide certainty to operators and manufacturers and focus R&D activities on achieving zero emissions, thereby reducing the need for subsidy support by making zero emission buses cheaper and reducing operator running costs.

A broad range of options are considered, Option 0 is our baseline, “do nothing” scenario – assuming no regulation. Option 1 considers the end of sale of all new non-zero tailpipe emission buses (i.e. those propelled either fully, or in part, by an internal combustion engine (ICE)) by 2025, each subsequent option considers end date one year later up to 2035, i.e. Option 2 proposes an end of sales along identical lines to option 1, albeit with a 2026 date. Options 3 – 11 replicate this in yearly increments up to 2035, however options 9-11 are purely for information, and are not presented as options for this policy throughout this paper. The rationale for intervention section details why non-regulatory approaches have not been considered.

Will the policy be reviewed? Yeswill not. **If applicable, set review date:** Month/Year

Does implementation go beyond minimum EU requirements?	Yes			
Is this measure likely to impact on international trade and investment?	Yes			
Are any of these organisations in scope?	**Micro**Yes	**Small**Yes	**Medium** Yes	**Large**Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)	**Traded:** 0.4 to 0.8	**Non-traded:** -12.4 to -16.3		

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits, and impact of the leading options.

Signed by the responsible Minister: ______________________ Date: ______________

Summary: Analysis & Evidence — Policy Options 1 to 8

Description: Options to end the sale of non zero emission buses between 2025 and 2032, options 9 - 11 presented in this impact assessment are purely for information, and do not represent options for this policy.

FULL ECONOMIC ASSESSMENT

Price Base	PV Base	Time Period	Net Benefit (Present Value (PV)) (£bn)		
			Low vehicle cost: £1.35 to £1.77	**High vehicle cost:** £1.40 to £1.83	**Best Estimate:** £1.40 to £1.81
2019	**2020**	**2021 to 2066**			

COSTS (£bn)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost**
Low vehicle cost	-	-	£0.13bn to 0.17bn	**£2.8bn to £4.0bn**
High vehicle cost	-		£0.18bn to 0.24bn	**£3.7bn to £5.9bn**
Best Estimate	-		£0.16bn to 0.21bn	**£3.4bn to 5.0bn**

Description and scale of key monetised costs by 'main affected groups'

Best estimate total costs (undiscounted) includes cost to bus operators comprising of vehicle capital cost with mid-life costs (£1.29bn - £2.23bn), new infrastructure to recharge and refuel (£0.54bn - £0.87bn), maintenance of new infrastructure (£0.46bn - £0.74bn). There will also be costs to government comprising of change in fuel duty revenues and indirect tax revenues (£3.12bn - £4.90bn) and increase in BSOG expenditure (£0.04bn – £0.08bn)

Other key non-monetised costs by 'main affected groups'

Non-monetised costs to bus operators include: costs as a result of leasing/credit mechanisms due to higher upfront capital costs; potential need to purchase more vehicle, in the short term, to account for current vehicle range constraints; need for additional depot space to accommodate infrastructure and vehicles.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit**
Low vehicle cost	-		£0.22bn to £0.28bn	**£4.1bn to £5.7bn**
High vehicle cost	-		£0.27bn to £0.36bn	**£5.1bn to £7.8bn**
Best Estimate	-		£0.25bn to £0.32bn	**£4.8bn to £6.8bn**

Description and scale of key monetised benefits by 'main affected groups'

Best estimate total benefits (undiscounted) includes benefits to operators comprising of lower operating costs (£3.61bn - £5.69bn) and lower vehicle maintenance cost (£1.14bn - £1.84bn). Social benefits include reduced carbon emissions (£3.84bn - £5.79bn), improvement to air quality from reduced particulate matter (£0.01bn – £0.02bn) and Nitrogen Oxides (£0.04bn - £0.07bn)

Other key non-monetised benefits by 'main affected groups'

Passengers may benefit in improved journey quality from smoother and quieter buses. non-monetised societal benefits include reduction in noise pollution created by non zero emission buses, the reduction in upstream carbon emissions associated with diesel production, such as refining and distribution to depots.

Key assumptions/sensitivities/risks — **Discount rate** 3.5%

Analysis assumes static fleet size and a constant annual turnover of buses. Do-nothing ZEB take up based on survey evidence on likelihood given costs by powertrain (e.g. electric or internal combustion). There is uncertainty in the extent zero emission bus vehicle costs will fall overtime, sensitivity analysis uses forecasted change in key component prices. Analysis assumes all zero emission and non zero emission buses are electric and diesel respectively, other powertrains are available and could change the impacts.

BUSINESS ASSESSMENT (Option 1 to 8)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m:**
Costs: £70.6m to £107.7m	**Benefits: £117.5m to £170.4m**	**Net: -£62.7m to -£46.9m**	-£296.3m to £221.6m

1.0 Policy Rationale

1. In considering whether the sale of new, non zero emission buses should end in the UK, it is important to recognise the wider policy context that impacts on decision making. This section of the document sets out the key developments and considerations which need to be taken into account.

2. It is not yet possible for all these considerations to be explored in developing the quantitative analysis within this IA, but they are provided here to give a full overview of the policy and how it sits within the wider context. We intend to use the consultation published alongside this IA to obtain further data to inform such quantitative analysis for the final IA, and the IA for any subsequent regulation.

Policy background

3. Climate change is the most pressing policy challenge of our time. We need to limit global temperature increases to well below 2°C. To contribute to this the UK has committed to net zero its contribution to climate change by 2050. The Climate Change Act 2008, as amended, imposes a duty on the government to ensure that the net UK carbon account for 2050 is at least 100% lower than the 1990 baseline (i.e. net zero emissions).

4. Transport is the largest contributor to UK domestic GHG emissions, contributing 28% of UK domestic emissions in 2018. Prior to the pandemic, transport emissions were rising, with 2018 emissions only 3% lower than in 1990[1]. The UK transport network supports people and goods to travel around the country. All transport modes must decarbonise to meet our economy wide net zero commitment.

5. Additionally, the government has a long-term strategy to improve air quality across the country and to bring areas where air pollution has breached the legal limits back into compliance.

[1] Department for Transport, *"Decarbonising transport, setting the challenge"*, 2020

6. The National Bus Strategy[2], published in March 2021, sets out the Government's vision for the future of buses in England, outside of London. The Government's ambition is to see buses play a greater role in enabling access to employment, skills, and training.

- 44% of bus trips are for work or education, compared with 27% of solo car journeys.
- Buses can help drive better employment outcomes for disabled people, and in cities outside London, 77% of jobseekers do not have regular access to a car, van, or motorbike.
- Having found employment, affordable bus travel helps ensure that work pays and can be sustained for everyone

7. The National Bus Strategy also stated that zero emission bus services, which meet the needs of passengers and communities, and attract passengers from other forms of transport, are at the heart of Government's plans.

8. The strategy presented five principles, to underpin our roadmap to a zero-emission fleet:

- Government will consider all technologies fairly, assessing their cost, contribution to decarbonisation and utility.
- Government will provide the financial support and incentives needed for the market to scale up quickly.
- Government will take a place-based approach to investment wherever appropriate.
- Both operators and Local Transport Authorities (LTA) must play their part.
- Government will ensure our plans for buses lead to overall carbon reductions.

9. These principles outline that government is adopting a technologically neutral, but not outcome neutral approach. We want and expect to see a fully zero emission bus fleet in the future.

10. In tandem with the publication of the National Bus Strategy, the Department launched an initial, light touch consultation on ending the sale of new diesel buses. This consultation sought preliminary views on when the sale of new diesel buses should end and proposals on what would be needed to support the transition.

11. On 14 July 2021, the Government also launched the Transport Decarbonisation Plan (TDP), which sets out the clear steps we will take to clean up, and decarbonise every part of our transport network – identifying the technologies we need and how we will support their development and deployment for the benefit of both users and operators.

12. In November 2020, as part of the Prime Minister's 10 point plan for a green industrial revolution, government announced a date for the end of sale of internal combustion (ICE) engine cars and vans, and has also launched a consultation on ending the sale of ICE HGVs alongside the TDP, in addition to a green paper on frameworks for future UK vehicle CO_2 regulation.

13. There is a clear direction of travel toward decarbonising transport in the UK, and globally.

[2] Department for Transport, "*National Bus Strategy", 2021*

Problem under consideration

14. There are around 38,200 buses in Great Britain: only 2% are zero emission buses (ZEBs)[3] so faster, deeper, and unprecedented action is needed to decarbonise at scale.

15. In addition to the Prime Minister's commitment for 4,000 ZEBs, which will represent approximately 12.5%[4] of the English bus fleet, we want to drive full decarbonisation of the entire fleet. The National Bus Strategy called for a green bus revolution and set out a roadmap to a zero-emission fleet, with the proposed end of sales a key driver in achieving this.

16. To encourage the decarbonisation of the remaining buses in the fleet we need to ensure that all buses transition to zero emission technologies at scale. As a result, it will be important to set the right incentives for the bus industry if we are to achieve our future emissions reductions commitments under the Net Zero 2050 target. The recently published Transport Decarbonisation Plan and Net Zero Strategy sets out the strategic overview.

17. The Climate Change Act 2008 requires the UK Government to set legally-binding 'carbon budgets' which act as stepping stones towards the 2050 target. A carbon budget is a cap on the amount of greenhouse gases emitted in the UK over a five-year period.

18. While we are on track to hit our targets under the third carbon budget (2018-2022), the trajectory of emissions reductions indicate additional policies will be required to meet the reductions required by the fourth (2023-2027) fifth (2028-2032) and sixth (2033-37) carbon budgets[5].

19. In addition, as part of the Prime Minister's 10 point plan for a green industrial revolution, government committed to a 68% reduction in emissions, from a 1990 baseline, by 2030. It is therefore important we look to utilise all opportunities to decarbonise transport where possible.

---

[3] Department for Transport, *"Vehicles operated by local bus operators",* 2021

[4] Department for Transport, *"BUS0602"*, 2020. The statistics released in October 2020 accounted for 32,339 buses in England. 4,000 buses represent 12.37% of the total.

[5] Climate Change Committee, "*Advice on reducing the UK's emissions",* 2021

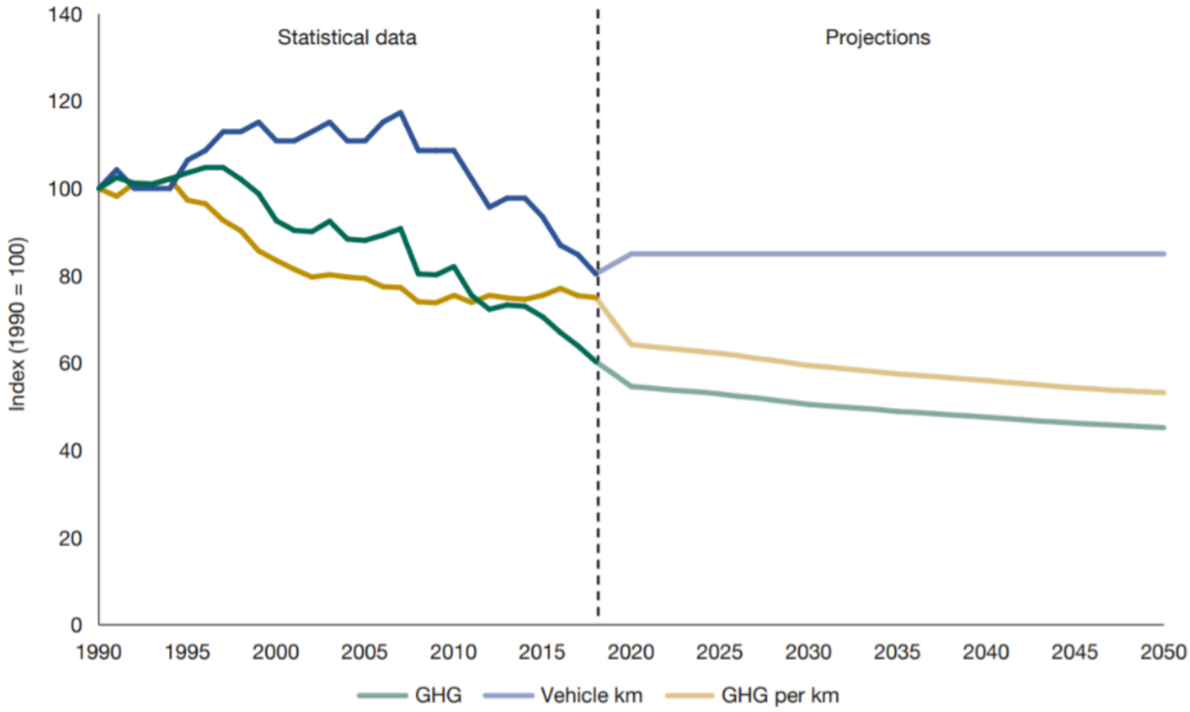

Figure 1 Bus sector projections[6]

20. The graph above (Figure 1 Bus sector projections)[7] illustrates the projections for sector GHG emissions in the absence of any further policies or regulation.

21. A key factor will be ensuring these ambitions do not make bus services more expensive to operate overall, otherwise fares could rise or services could be reduced – potentially leading to greater overall carbon emissions as more journeys are made by car.

Rationale for intervention

22. There is a need for government intervention to address market failure resulting from the use of internal combustion engine buses. Market failures occur when the market has not and cannot, in itself, be expected to deliver an efficient outcome[8]. The associated cost to society of contributing to climate change and degrading air quality are not taken in account when these vehicles are operated, and purchasing decisions on vehicles are made.

23. Achieving net-zero involves overcoming a series of market failures. Perhaps the most significant of these is the negative externality driving climate change: those who emit greenhouse gases generally do not face the full costs of their actions, leading to increasing concentrations of greenhouse gases in the atmosphere, above the level that would be seen if those emitting greenhouse gases faced the full costs[9].

---

[6] Department for Transport, *"Decarbonising transport, setting the challenge"*, 2020

[7] Historic emissions are final UK GHG statistics. Historic vehicle km are from road traffic statistics. Bus emission projections are made using the National Transport Model, with inputs from the Bus fleet model. Modelling assumes increased uptake of Ultra Low Emission Buses and further bus efficiency improvements. Bus service level projections are based on 2015 usage levels. The average km growth rates of the bus km figures from 2006 to 2015 are used to estimate future km travelled. Bus km are flatlined from 2020, and coach km from 2017. Projections do not include the estimated impact of the £5 billion Local Transport funding package, announced in February 2020.

[8] HM Treasury, *"Green Book"*, 2020

[9] HM Government, *"The Economics of Climate Change: The Stern Review"*, 2006

24. The most important market failure to address is the negative externality associated with the emission of greenhouse gases, but there are many others holding back the transition to net zero, including inertia, a lack of information, and bounded rationality. The market failures interact in complex ways within, and across sectors.

25. The Stern Review[10], in addition to a wide array of other literature[11,12,13], makes the case that the externalities relating to climate change are fundamentally different from other externalities. Climate change is:
    - global in both impact and causes;
    - the impacts are long-term and persistent, and;
    - uncertainties and risks of impacts are high

26. There is also a serious risk of major, irreversible change to the planet, with non-marginal economic effects.

27. Per the above, the externalities are so large that there is no meaningful approach to internalise the costs, as illustrated by government's decision to end the sale of new, non-zero emission cars and vans by 2035.

28. The development of technology will be important for meeting the net zero target, keeping costs down and maximising the potential economic benefits. Much of the finance required can come from the private sector, but the risks and uncertainties associated with novel technologies can hold this back. A clear policy framework setting out the government's approach can help address these uncertainties.

29. Buses and coaches represented 3% of domestic transport GHG emissions, in 2018, emitting 3.2 $MtCO_2e$. The main source of emissions from this sector are the fuels used for propulsion.

30. While there have been significant innovations and improvements in engine efficiency, and resultant reductions in GHG and air quality emissions, the fundamental principles under which non zero emission buses operate are incompatible with UK Government and international targets to reduce GHG emissions to zero.

31. The need to limit global warming to well below 2°C and to pursue efforts to limiting to 1.5°C means the UK Government is committed to moving as far, and as fast, as possible.

32. Consulting on, and setting an ambitious date for the end of sale will provide assurance and a clear direction of travel, not only for the bus sector but also for related industries which are critical for the transition, such as the infrastructure and energy sectors. The majority of respondents from the March 2021 consultation supported this view.

---

[10] ibid

[11] International Labour Organization, *Working on a warmer planet, the impact of heat stress on labour productivity and decent work,* 2019

[12] Smith, Schellnhuber & Mirza, *"Vulnerability to Climate Change and Reasons for Concern: A Synthesis",* 2001

[13] German Advisory Council on Global Change, *"World in Transition: Climate Change as a Security Risk",* 2007

33. This will allow manufacturers to adjust product planning and assembly lines by a set date, in turn improving efficiencies and reducing costs, as well as building confidence and certainty for the market.

34. Policy and regulation have a role in correcting this market failure. In placing restrictions on either those who produce the vehicles, or the emissions themselves, they can offset the negative effects of these externalities, and ensure that they are accounted for.

35. Government is best placed to intervene, and set a clear and ambitious date for the end of sales of new non zero emission buses, to help drive innovation and provide the impetus for operators to procure only zero emission buses. This would act to curb the amount of GHGs, and other air pollutants emitted, and reduce the negative impacts on wider society.

36. Moreover, DfT analysis of 33 major bus schemes found an average benefit/cost ratio of 4.2; in other words, they delivered benefits worth more than four times their cost. Buses generate a significant proportion of benefits which accrue to other road users and to society at large.

37. Non-regulatory options, such as industry-led self-regulation, were considered during policy formulation stages, but were not taken forward based on experience of the initial voluntary approach adopted for reducing CO_2 emissions from cars and vans which failed to deliver reductions. The proposed approach here mirrors that for the UK Government's end of sale of new internal combustion engine cars and vans.

38. In the light vehicle segment, policies which focus on driving down emissions have been in place for decades. For example, UK Government has set Vehicle Excise Duty (VED) by CO_2 emissions bands since 2000, with the EU introducing tailpipe CO_2 emissions targets for cars and vans in 2009.

39. By contrast, the bus market is not subject to fleetwide tailpipe CO_2 targets, with manufacturers only required to report on emissions. Tax policy for buses also diverges from that for cars and vans, with both registration and annual tax based on passenger capacity, rather than on an emissions basis.

40. Thus far, buses, and other heavier vehicles, have benefited from policies designed to decarbonise fuels, such as the Renewable Transport Fuel Objective (RTFO), and several rounds of funding to encourage uptake of low, ultra-low and zero emission buses. However, these polices are not designed to meet the totality of the challenge of reducing the UK's carbon emissions from buses.

International examples demonstrating intervention

41. As part of their "Mission Zero" strategy, the Dutch Government has set a date of 2025 for all new purchased buses to be zero emission at the tailpipe, backed by an administrative agreement between central and municipal governments.

42. The Norwegian Government, in their National Transport Strategy, has set an ambition for all new urban buses sold from 2025 to be net-zero, i.e. fully zero emission at the tailpipe, or using biofuels.

43. Cape Verde has set a date of 2035 for the end of sale of non-zero emission buses.

44. Many other nations, globally, are investigating appropriate end of sales/phase out dates as part of nationally determined contributions (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC).

Policy objective

45. The UK is a climate leader: the first major economy to set legally binding carbon budgets, amounts by which greenhouse gas emissions must come down, and by when. We were the first major economy to legislate to end its contribution to climate change. By law the UK's emissions must now be net zero by 2050.

46. As set out, transport is the largest contributor to UK domestic greenhouse gas emissions. We must deliver a step change in the breadth and scale of our ambition on transport emissions to reach net zero.

47. The measures we use to decarbonise transport will also deliver the vast wider benefits available during this change, improving air quality, noise, health, reducing congestion and delivering high-quality jobs and growth for everyone right across the UK.

48. For the UK to meet its future carbon budgets, additional emissions savings policies are required. In terms of road transport, shifting to zero tailpipe emission vehicles is a clear and well understood option for reducing GHG emissions.

49. The priority for the department is to ensure the following outcomes:
    - to meet the wider government Net Zero commitments, contribute to improved air quality and meet legal requirements.
    - to support the green transformation of the bus sector and to build back better post COVID-19, while protecting and improving bus services; and
    - ensure value for money.

50. Buses have a crucial role to play in transport achieving net zero and driving the green transformation.

51. Progressing this policy is also expected to foster the market conditions required to support the transition of UK automotive manufacturing to zero emissions. Failure to do this in the short term could lead to dependence on imports for zero emission buses, with the loss of important investment.

52. This is also a huge industrial opportunity, a once in a generation chance to increase economic growth and future prosperity, to invest in new jobs across our country.

53. Decarbonisation will deliver fundamentally better transport, for everyone, every day. It will make it more efficient, as well as cleaner, and provide huge wider benefits including increased reliability and better connectivity.

54. Buses are at the centre of the public transport network, making 4.07 billion journeys in England in 2019/20[14] , more than twice as many as the railways[15]. This specific policy sits within the broader strategic framework of, and contributes toward the objectives of, the National Bus Strategy.

55. Buses can improve productivity more widely, for instance by reducing congestion which affects all road users and costs urban economies at least £11bn a year[16]. Buses can also be key to levelling-up; users are disproportionately from less advantaged social groups and places[17]. Improved services will strengthen communities, sustain town centres, and connect disabled and isolated people.

56. Buses support our economy and connect our communities to the workplace, and to vital public services such as healthcare and education. They are England's most used form of public transport[18] and for millions of people, the bus is a fundamental part of each and every day.

57. However, the picture of bus usage across the country is mixed. Prior to the pandemic, bus patronage was increasing in London, with other areas often seeing a decline in passenger numbers[19]. The benefits of a reliable and innovative bus service are clear: less congestion, greater productivity and communities that are connected rather than apart.

58. For these reasons, it is vital that the bus fleet continues play a role in a decarbonised future to ensure the economy meets Net Zero carbon emissions and buses play a role in improving air quality.

59. Namely, the strategy seeks to make buses more frequent, more reliable, easier to understand and use, better co-ordinated and cheaper, with reduced congestion, carbon, and pollution, helping the disadvantaged and getting motorists out of their cars.

60. This policy, alongside the Zero Emission Bus Regional Areas scheme and All Electric Bus Town/City, serves as one of the first steps to further our commitments in the Government's ten-point plan for a green industrial revolution

Options considered

61. Given the need to ensure compliance with legally binding carbon budget targets, and the overall impetus to achieve net-zero emissions, non-regulatory options were not considered appropriate to be brought forward to this stage.

---

[14] Department for Transport, *"Local bus passenger journeys",* 2020
[15] Department for Transport, *"National Bus Strategy",* 2021
[16] Ibid
[17] Department for Transport, *"Local bus passenger journeys"*, 2020
[18] Department for Transport, *"Transport statistics, Great Britain 2019",* 2019
[19] Department for Transport, *"Local bus passenger journeys"*, 2020

62. In the course of policy development, officials considered the following non-regulatory models, but their efficacy meant such approaches were not applicable:

- **Industry-led "self-regulation" (ISR)** - ISR can be an advantageous complement to government policies, but it also poses a number of challenges. At the same time, ISR can potentially provide important benefits to both industry and consumers; their success in doing so depends on a number of factors, including:
  - the strength of the commitments made by participants;
  - the industry coverage of the ISR;
  - the extent to which participants adhere to the commitments; and
  - the consequences of not adhering to the commitments.

- **Co-regulation** - Also known as enforced self-regulation, this is an intermediate step between state-imposed and self-regulation. It involves some degree of explicit government involvement, beyond a stated government objective. For example, an industry may work with government to develop a code of practice. Enforcement would be by the industry or a professional organisation and accredited by government. Examples of such regulation are recognised codes, approved codes and standards and accreditation where government has been actively involved in the process. The advantages and disadvantages are similar to those of self-regulatory approaches.

63. In late 2006, the European Commission announced its intention to regulate the level of CO_2 from cars and vans sold in the EU, with the changes entering into force by 2008. This represented a significant shift from the previous model, implemented in 1998, which operated as a volunatary agreement. This illustrates the failure of non-regulatory approaches to reducing vehicle emissions.

64. From 1994 onwards, New Zealand’s electricity market went through a period of industry reform, and the market at one point was self-regulated, but ultimately returned to a government-regulated model due to concerns around the ability of the prior model to meet targets.

65. Based on the above experiences, these models were not considered sufficient to achieve the policy objective. Thus, the following options are presented for consideration:

Option 0 – Do Nothing – This option is present to establish a baseline, as to what would happen if there were no intervention.

Option 1 – End of sale of all new, non zero tailpipe emission buses by 2025 – This option would see the sale of all new buses, propelled totally, or in part, (including hybrids) by an internal combustion engine, irrespective of fuel type, end by 2025.

Option 2 – End of sale of all new, non zero tailpipe emission buses by 2026 – As for option 1, this would see the end of sale of new non zero emission buses, however with a date of 2026

Option 3 – End of sale of all new, non zero tailpipe emission buses by 2027 – As for option 1, however with a date of 2027

Option 4 – End of sale of all new, non zero tailpipe emission buses by 2028 – As for option 1, however with a date of 2028

Option 5 – End of sale of all new, non zero tailpipe emission buses by 2029 – As for option 1, however with a date of 2029

Option 6 – End of sale of all new, non zero tailpipe emission buses by 2030 – As for option 1, however with a date of 2030

Option 7 – End of sale of all new, non zero tailpipe emission buses by 2031 – As for option 1, however with a date of 2031

Option 8 – End of sale of all new, non zero tailpipe emission buses by 2032 – As for option 1, however with a date of 2032

Option 9 – End of sale of all new, non zero tailpipe emission buses by 2033 – As for option 1, however with a date of 2033

Option 10 – End of sale of all new, non zero tailpipe emission buses by 2034 – As for option 1, however with a date of 2034

Option 11 – End of sale of all new, non zero tailpipe emission buses by 2035 – As for option 1, however with a date of 2035

Please note: Options 9 – 11 are purely for information, and are not presented as options for this policy.

2.0 Costs and Benefits

66. Government intervention to end the sale of non-zero emission buses will result in costs and/or benefits to the environment, society, businesses (such as bus operators), and government finances. An overview of the key impacts by sector is outlined in Figure 2 Overview of key impacts on sectors

Stakeholders	Impacts
Impact on Operators	• Additional **capital cost** of buses and infrastructure • Change in **maintenance costs** • Change in **operating costs** • Change in **BSOG revenues**
Impact on Government	• Reduction in **tax revenues** • Change in **BSOG expenditure**
Environmental and Societal impacts	• Reduction in costs from **Greenhouse gas, Nitrogen oxide and Particulate Matter emissions** that would otherwise be omitted by non-zero emission buses. • Reduction in Greenhouse gas, Nitrogen oxide and Particulate Matter emissions resulting from any mode shift

	from car to bus, due to the introduction of zero emission buses. (non-monetised impact) • Reduction in **noise pollution** (non-monetised impact)
Impact on Transport users	• **Reduction in fares** due to lower bus operating costs • **Improved journey quality** from smoother and quieter buses (non-monetised impact)
Impact on Bus Manufacturers	• Changes in the powertrain of buses being manufactured (no additional cost to business – captured in the 'additional capital cost of buses')
Impact on the National Grid	• Additional grid connections and upgrades to substations. (additional cost incurred by operators)

Figure 2 Overview of key impacts on sectors

67. The most significant impacts are expected to the benefits from the reduced Greenhouse Gases (GHG) emissions and change in the costs incurred by bus operators.

68. In the short run the intervention would place additional costs on bus operators, given higher purchase cost of zero emission buses. In the long run, total cost of ownership is expected to be lower which could lead to reduced bus fares for transport users. There will also be a change in government expenditure, wider societal impact, such as improved air quality and wider impacts of bus users through improved journey quality.

69. Other sectors would be affected, for instance bus manufacturers would only be able to supply zero emission buses after an intervention to end the sale of non-zero emission buses, and increased electricity demand to depots would increase the upgrades needed to the electricity grid. The intervention is not expected to place any additional cost burdens on these businesses. The resulting change in costs are included in the cost to bus operators.

70. The scale of the impact of intervention will be dependent on the number of buses purchased per year, the breakdown of powertrains purchased in the do-nothing scenario, the year the end of sale of non zero emission buses would be introduced and the change in unit costs overtime such as the rate of fall of zero emission bus purchase costs. These factors are explored in the sections below, as part of a summary of the methodologies used to calculate the cost and benefits generated by policy options. All assumptions used will be tested during the consultation and updated (where applicable) in the final impact assessment.

71. Analysis to determine the impact of the policy options considers the change in buses purchased between the respective end date and 2050. The costs and benefits resulting from the change in purchases continues up to 2066, given the assumed 17 year operational life of a bus. Given each option starts at a different year the number of years the policy will have an impact will differ.

Number of new buses purchases per year

72. The Department's annual bus statistics indicated that, as of 31 of March 2020, England's bus fleet was made up of around 32,00 buses[20], with around 23,200 buses in England excluding London and 9,300 buses in London. Whilst in recent years there has been a downward trend in the bus fleet size, it is uncertain how this will change in the future, particularly given the recent publication of the National Bus Strategy. For the analysis presented it has been assumed the size of the bus fleet will remain static.

73. Each year some of the existing bus fleet will reach the end of operational life and will need to be replaced. Stakeholder advice indicates buses are expected to have an operational life of between 15 and 20 years. Given the spread of the age of buses in the current bus fleet in England, the variation in the number of new buses purchased per year is expected to be low. Consequently, it has been assumed on average buses will have an operational life of 17 years and the number of new buses stays constant at 1,911 buses, resulting in the full turnover of the bus fleet after 17 years, equivalent to a turnover rate of 5.9% per year (100% divided by 17).

Providing evidence, if possible, what do you understand the operating lifespan of the following types of vehicle to be:

a. **Euro VI diesel buses**
b. **Battery electric buses**
c. **Hydrogen fuel cell buses**

74. The English bus fleet is made up of a combination of single and double deck buses. Across all powertrains, due to their inherently different characteristics, single and double deck buses have differing associated costs and emissions. Given there is uncertainty in composition of future purchases, an assumption has been used in all scenarios that the split between single and double deck will be 50/50.

75. Whilst it is possible the intervention to end the sale of non-zero emission buses could influence the timing and number of purchases, for instance operators deciding to stretch the operational life of existing diesel buses, it is unclear to what extent and this would occur. The number buses purchased per year is assumed to be the same in the do-nothing and do-something scenarios. We are testing this assumption at consultation, and welcome views as to the potential for "front loading" of non zero emission bus purchases, prior to any phase out.

Do you believe that ending the sale of new, non-zero emission buses might cause operators to stretch the operational life of existing non-zero emission buses? If yes, please out line the extent to which you think this might occur.

76. Whilst new zero emission buses are expected to be made up of a mixture of electric buses and hydrogen buses, there is limited evidence on the impacts and take up of

---

[20] Department for Transport, *"Vehicles operated by local bus operators"*, 2020

hydrogen buses, as a result this analysis assumes all new zero emission buses would be electric buses.

Please outline your understanding, providing evidence if possible, of the future apportioning of the zero emission bus fleet between hydrogen fuel cell and battery electric buses.

77. The remaining buses purchases would be made up of a mixture of non-zero emission powertrains including EuroVI diesel buses, parallel and plug in hybrid buses, biogas buses, and any future development beyond a EuroVI diesel bus.

78. The majority of the current non zero emission buses are diesel buses, given uncertainty in the take up of alternative non zero emission powertrains in the absence of government intervention, the analysis assumes all non zero emission buses in the do-nothing scenarios would be diesel EuroVI buses.

Option 0 – Do Nothing

79. In the do nothing scenario, the Government would not end the sale of new zero emission buses. When purchasing a new vehicle, operators would continue to have free choice of any powertrain available in the market. Choices of powertrain are expected to be largely driven by the respective total cost of ownership, which includes the purchase cost of vehicles and on-going costs to operate services.

80. Some new zero emission buses are expected to be purchased under the do-nothing policy option. This is due to:
    - The Government's commitment in the National Bus Strategy to support the delivery of 4,000 new zero emission buses.
    - Transport for London's commitment to be operate a zero-emission bus fleet by 2030
    - An expected change in operators purchasing preferences, as zero emission buses become cheaper and technologies improve.

81. Given the Transport for London commitment an assumption has been used that all new London buses will be zero emission in the do-nothing scenario. This means no additional cost and benefits will be incurred in London in any of the do-something scenarios.

82. The number of additional zero emission buses purchased by operators outside of London has been calculated based on survey[21] evidence, seeking operators appetite for electric buses based on the payback time (number of years to breaking even) compared to a diesel bus. As the payback time falls operators indicated their probability of purchasing an electric bus will increase. Appetite for electric buses given this payback period is outlined in Figure 3 Probability of purchasing an electric bus.

[21] Zemo Partnership (formally LowCVP) "*Barriers and opportunities to expand the low carbon bus market in the UK.",* 2014

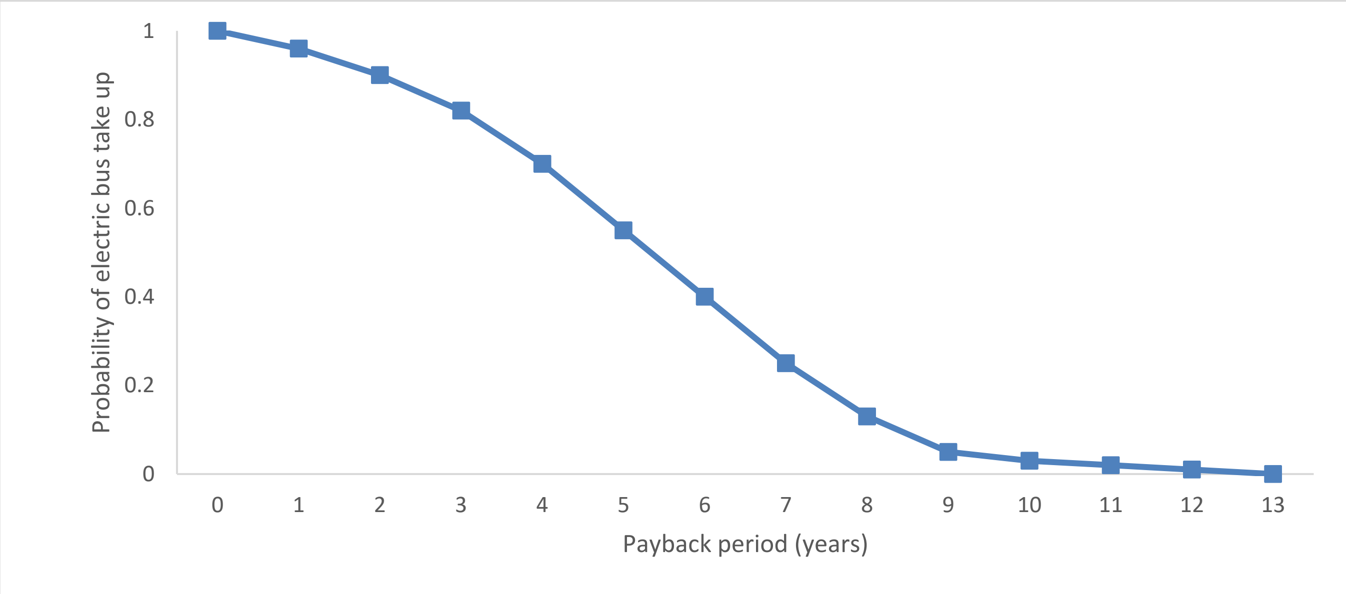

Figure 3 Probability of purchasing an electric bus

83. The payback time calculations consider the cumulative costs incurred from bus ownership accounting for the wider operating costs as well as the purchase cost. Given operating costs are lower for electric buses than diesel buses, the cumulative costs narrow overtime to reach cost parity. The payback period is the number of years it would take to reach cumulative cost parity, beyond this point the cumulative costs of an electric bus would be lower than a diesel bus.

84. To calculate the payback period, the annual cumulative cost of ownership has been estimated for both diesel buses and zero emission buses, by summing costs incurred from the year of purchase. the payback period is the number of years taken for cumulative costs of a zero emission bus to equal or fall below the cumulative cost of a diesel bus. Costs being accounted for are the capital cost to purchase a bus and associated infrastructure, annual operating cost, annual vehicle maintenance cost, annual infrastructure maintenance cost, mid-life battery replacement cost and annual Bus Service Operator Grant (BSOG) revenue. Methodologies of each can be found in the summary of costs and benefit methodology section below.

85. The payback time is expected to change overtime as the purchase cost of electric buses decreases, largely due to falling component prices[22]. The expected decrease has been forecasted using evidence estimating the fall in batteries for electric buses, the key component driving vehicle cost[23]. There is uncertainty in the extent the battery costs will fall, to account for this, three cost scenarios have been used to represent the low, best, and high estimates, details found in the vehicle capital cost section. Figure 4 , below, shows the estimated number of years for the cumulative cost an electric bus to break even against a EuroVI diesel bus, depending on the year of the bus purchase.

[22] Stern, *"The Economics of Climate Change: The Stern Review"*, 2006

[23] Element Energy, *"Analysis to provide costs, efficienceies and roll-out trajectories for zero emission HGVs, buses and coaches"*, 2020

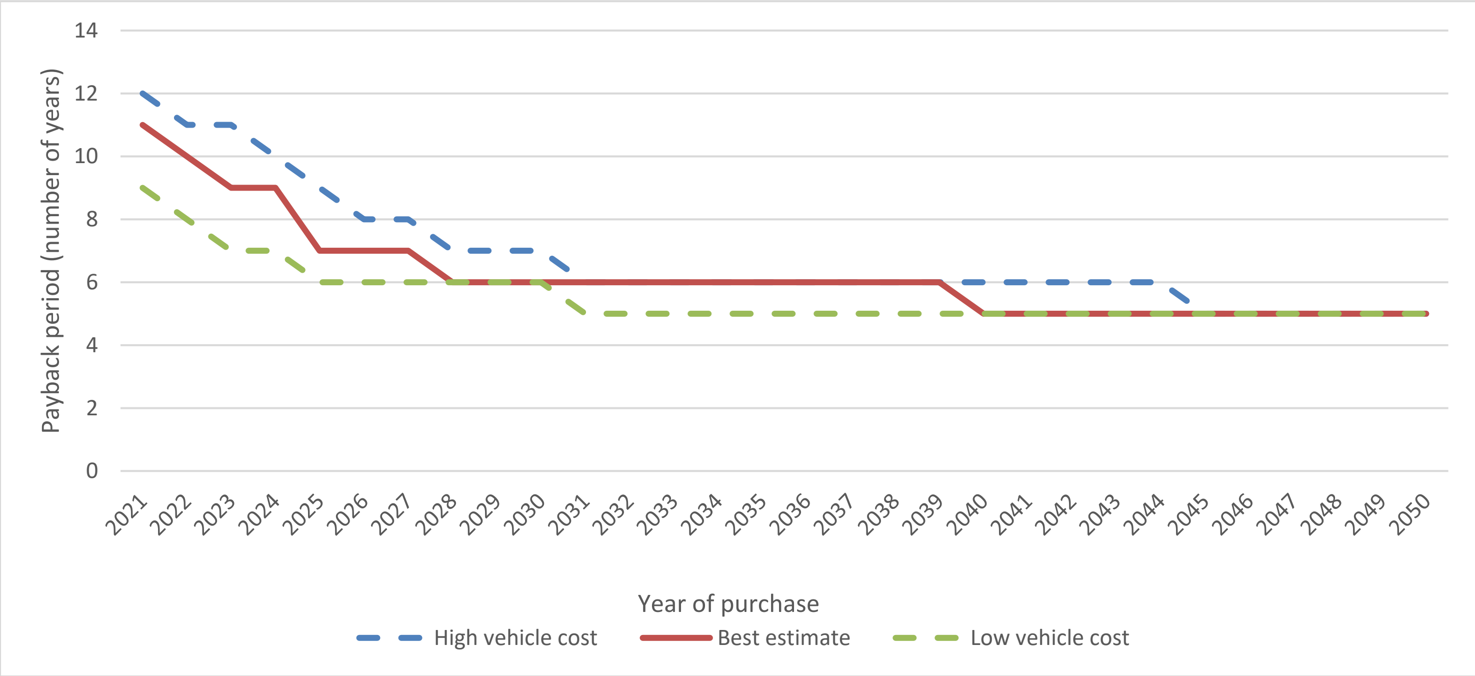

Figure 4 Payback period of an electric bus

86. In the best estimate scenario, this results in operators in England (excluding London) having a 2% probability of buying an electric bus in 2021 increasing to 55%, given the payback period is estimated to fall from 11 years for zero emission buses purchased in 2021 to 5 years, for purchases made between 2039 to 2050, in the absence of government intervention.

In the absence of any policy/regulation, what would you expect the uptake of zero emission buses to be over the period 2025-2032

87. Figure 5 Zero emission buses as a proportion of sales (do-nothing) – excluding buses delivered with government grants illustrates the estimated proportion of sales made up by zero emission buses, in England. This has been adjusted to assume all buses purchased in London, from 2021, are zero emission, but excludes the Government's commitment to 4,000 zero emission buses. Three scenarios, a best, high, and low estimate have been used to account for the uncertainty in change in vehicle costs, these can be found in figures 7, 12, and 13, of this section, respectively.

Figure 5 Zero emission buses as a proportion of sales (do-nothing) – excluding buses delivered with government grants

88. This expected uptake in zero emission buses will result in impacts such as a reduction in the carbon emissions produced by the bus fleet and a change in the cost incurred to operators, influencing bus fares. These are not additional costs and benefits and are not attributed the do-something options. A summary of the expected impacts under the do nothing option can be found in Figure 6 Summary of impacts under the do-nothing option below.

Impacts to the private sector	Description – no figures included because it is not proportionate or useful to decision making to monetise do nothing costs and benefits
Bus replacement costs	• Existing costs incurred by bus operators, and in some case supported by government, to replace vehicles that have reached the end of their operational life. • Buses are expected to have an operational life of between 15 and 20 years, after which bus replacement costs will be incurred. • Without intervention new vehicle purchases can continue to be non-zero emission buses including diesel buses. Some uptake in zero emission buses is expected • A new non zero emission bus currently has a lower purchase cost than an equivalent zero emission bus. • Components for Zero emission buses are expected to fall overtime, reducing the cost difference.
Charging and refuelling Infrastructure costs	• Existing costs incurred largely by operators, with some government funding, to install new charging and refuelling infrastructure for those zero emission buses that would be delivered in the do-nothing scenario
Fuel related operating costs	• Existing fuel costs incurred to bus operators to operate services • Given much of the fleet is expected to continue to be diesel buses, operators will incur a cost from consumption of diesel.

	• Only 2% of the current bus fleet in England is made up of zero emission vehicles but is expected to grow overtime. In these cases, operators will incur a change in operation costs from the use of electricity or hydrogen. • Fuel operating cost differ depending on the bus powertrain (such as Diesel, Battery electric or Hydrogen fuel cell). • Duty and VAT paid to run buses also differs by powertrain • Costs will change overtime as the structure of the bus fleet (by powertrain) changes.
Vehicle maintenance costs	• Existing costs to maintain vehicle fleet to an operational standard • Cost will differ depending on the bus powertrain (such as Diesel, Battery electric or Hydrogen fuel cell). • costs will change overtime as the structure of the bus fleet (by powertrain) changes.
Infrastructure maintenance cost	• Existing costs incurred to operators to maintain charging / refuelling infrastructure. • Cost to maintain infrastructure will differ depending on the bus powertrain (such as Diesel, Battery electric or Hydrogen fuel cell). • costs will change overtime as the structure of the bus fleet (by powertrain) changes.
Bus service operator grant payments (BSOG) Revenue	• Operators receive BSOG revenue from the Department to reduce the operating costs of buses, leading to lower fares for passengers. • The rate of BSOG differs depending on the bus powertrain and whether eligibility for incentives are met. • The revenue operators receive will change overtime as the structure of the bus fleet (by powertrain) changes.
Impacts to public sector	**Description**
Change in Bus service operator grant payments (BSOG) payments	• The government provides BSOG payment to operators to reduce the operating cost of bus leading to lower fares • The rate of BSOG differs depending on the bus powertrain and whether eligibility for certain incentives are met. • The revenue operators receive will change overtime as the structure of the bus fleet (by powertrain) changes.
Fuel Duty and VAT revenues	• The government receives revenues from operators from the fuel duty and the VAT on fuel and vehicles. • The rate of these revenues differ depending on the powertrains used
Grant funding to support 4,000 Zero emission buses	• The government has committed to support the delivery of 4,000 new Zero-Emission buses by the end of this Parliament.

	• Grant funding will be provided through programmes, such as the All Electric Bus Town and the Zero Emission Bus Regional Area (ZEBRA) funds.
Impacts on society	Description
Carbon, NOx, and PM savings	• Zero emission buses delivered in the do-nothing scenario will result in lower carbon, nitrogen oxide and particulate matter emissions, reducing the associated societal costs.

Figure 6 Summary of impacts under the do-nothing option

Do-Something Options 1 to 11 - Ending the sale of non-zero emission buses in years ranging from 2025 to 2035.

Summary

89. Eight policy options have been considered for ending the sale of new non-zero emission buses, with an additional three options presented for information only. Each option represents a single end year ranging from 2025 to 2035. New buses purchased beyond this point would be required to be zero emission at the tailpipe. Operators would still be able to buy non-zero emission buses in the second-hand market.

90. Given there will be some expected uptake in zero emission buses in the do-nothing scenarios, the do-something scenarios only account for the additional costs and benefits, attributed to the difference between the do-nothing and do-something scenarios. Cost and benefits are created when the do-something scenario results in a purchase of zero emission bus that would have otherwise been a purchase of a non zero emission bus, in the do-nothing scenario. There are no additional cost and benefits created for purchases of zero emission buses occurring in both the do nothing and do something scenarios.

91. Additional zero emission buses delivered in each year following a end of sale date, is calculated by subtracting the annual forecasted number of zero emission buses in the Do-nothing scenario, from the forecasted annual total number of new bus purchases, given all new buses zero emission in the do something scenario. See the “Option 0 - Do nothing” section and the “Number of new buses purchases per year” section for further detail on how these forecasts are derived. Bus operators purchasing decisions are assumed to be the same as the do-nothing scenario until the point the end of sale is implemented.

92. The scale of the costs and benefits are dependent on the when the end of sale is introduced. Figure 7provides a summary of present value impacts for each policy options under the best estimate scenario. See the sensitivity analysis section for present value impacts under the low vehicle cost and high vehicle cost scenarios.

Greener bus model

93. The Department’s Greener bus model has been used to determine the impacts generated by each of the policy options. The impacts being captured by the model reflect the change to the England bus fleet as a result of the policy options. Impacts cover the key

monietised costs and benefits to businesses, government and society. These are the reduction in carbon dioxide, nitrogen oxides (NOx) and particulate matter (PM2.5) emissions, additional capital costs to purchase new zero emission buses, capital cost incurred for battery replacements, incremental maintenance cost of the bus fleet, capital costs associated with supporting infrastructure, maintenance costs associated with supporting infrastructure, incremental operating costs from fuel and electricity used, changes in Bus Service Operators Grant (BSOG) payment and changes in fuel duty revenue/costs.

94. For each of the above impacts the model calculates the annual cost or benefit generated, in each year from the first year the end of sale policy is implemented, which varies depending on the policy option, up until 2066. This accounts for impacts generated from expected differences in bus purchases, compared to the do nothing scenario, made between the first year of each respective end of sale policy option and 2050. Given each bus is assumed to have an operational life of 17 year, the appraisal period extends to 2066 to include all costs and benefits that would occur from the additional zero emission buses delivered by 2050. Each additional zero emission bus will only generate costs and benefits during the assumed 17-year operational life.

95. An overview of the methodology for each monitised cost and benefit is outlined in the below methodology summary sections. This includes details of the key assumptions and parameters used. These parameters and assumptions often vary over time to account for external factors. Costs and benefit for each year will depend on the parameters and assumptions used in a given year and the estimated difference in the bus fleet, or changes to the buses, between the do-nothing and do something options.

	End of sale of all new, non zero tailpipe emission buses by										
Impact on Operators (£m)	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Additional vehicle capital costs	-£1,470	-£1,364	-£1,264	-£1,194	-£1,154	-£1,117	-£1,026	-£940	-£858	-£780	-£706
New charging and refuelling infrastructure costs	-£588	-£553	-£520	-£495	-£481	-£467	-£433	-£400	-£367	-£336	-£306
Net savings in maintenance cost	£952	£896	£843	£803	£780	£757	£702	£648	£596	£546	£497
Infrastructure maintenance cost	-£385	-£363	-£341	-£325	-£316	-£307	-£284	-£262	-£241	-£221	-£201
Net savings in operating costs (includes duty and BSOG)	£2,914	£2,753	£2,596	£2,481	£2,412	£2,346	£2,180	£2,018	£1,862	£1,710	£1,562
Total	£1,423	£1,370	£1,314	£1,269	£1,241	£1,212	£1,138	£1,064	£991	£918	£846
Impacts on Government (£m)											
Change in fuel duty revenues (transfer)	-£2,503	-£2,366	-£2,233	-£2,134	-£2,076	-£2,019	-£1,878	-£1,740	-£1,606	-£1,476	-£1,350
Change in government expenditure on Bus Service Operators Grant payments (transfer)	-£44	-£41	-£38	-£36	-£34	-£33	-£30	-£28	-£25	-£23	-£20
Total	-£2,548	-£2,407	-£2,270	-£2,170	-£2,110	-£2,052	-£1,908	-£1,768	-£1,631	-£1,499	-£1,370
Environmental and Societal impacts (£m)											
Reduction in carbon emissions	£2,893	£2,749	£2,608	£2,504	£2,441	£2,380	£2,225	£2,074	£1,925	£1,779	£1,636
Reduction in Nitrogen Oxide	£35	£33	£31	£30	£29	£28	£26	£24	£22	£20	£18
Reduction in Particulate Matter	£8	£7	£7	£7	£7	£6	£6	£5	£5	£5	£4
Total	£2,936	£2,790	£2,647	£2,540	£2,477	£2,414	£2,257	£2,103	£1,952	£1,804	£1,658
Net Present Value	£1,811	£1,753	£1,690	£1,640	£1,608	£1,574	£1,487	£1,400	£1,311	£1,223	£1,134

Figure 7 Monetised impacts of policy options – best estimate (price base 2020 and discounted to 2020)

96. The bullet points below summarise the monetised and unmonetised cost, benefits and changes in transfers resulting from a do something scenario. In the absence of an appropriate method to include as monetised impact, available evidence has been used to provide a sense of scale of the unmonetized impacts.

Monetised Costs

97. **Additional vehicle capital costs** (Direct) – Additional costs incurred to purchase a zero-emission bus compared to an equivalent non-zero emission bus. Includes mid-life cost such as battery replacements

98. **New charging and refuelling infrastructure costs** (Direct) – New zero-emission buses will require charging & refuelling infrastructure. Includes cost incurred to connect to the grid and substation upgrades.

99. **Infrastructure maintenance cost** (Direct) – Charging and refuelling infrastructure will need maintenance to keep in operation, cost of maintenance expected to be higher than infrastructure used for non zero emission buses.

Unmonetised Costs

100. **Short-run vehicle capability constraints** (Direct) – In the short-term technology constraints may mean a zero emission bus cannot cover the same distance per day as a non zero emission bus, for instance due to limited battery capacity. In these cases, a higher number of zero emission buses would be needed to cover the same level of service as the current non zero emission fleet being used. Stakeholder advice indicated operators could need 10% to 20% more zero emission buses to run same level of service being delivered with non zero emission buses with todays technology.

    - Improving technologies are expected to overcome these constraints in the medium term, however the timing is uncertain. Additionally, it is expected that in the short term operators will look to avoid cases where additional zero emission buses are needed by using new zero emission buses on services technically feasible with the zero emission buses available. Evidence will be tested at consultation.

Do you have any evidence to indicate the extent to which additional zero emission buses might be needed on a given route, given current and expected technological developments?

101. **Additional Depots space** (Direct) – Upgrading depots to accommodate the infrastructure required to refuel and recharge new zero-emission buses, reducing the space to park buses when not in use. This could result in operators needing to increase the size of depots to keep the same bus capacity. Evidence will be sought at consultation.

Monetised Benefits

102. **Net savings in operating costs** (Direct). - Zero emission buses can have a lower per km operating cost than non-zero emission buses. The cost of electricity per km for electric buses is lower than cost of diesel per km for diesel buses. This includes change in VAT, Duty, and the Bus Service Operator Grant (BSOG).

103. **Net savings in maintenance cost** (Direct) - Zero emission buses can have lower maintenance costs, due to fewer mechanical components relative to non-zero emission alternatives[24] .

104. **Reduction in carbon emissions** (Direct) Zero emission buses emit fewer greenhouse gases than non-zero emission buses.

105. **Reduction in Nitrogen Oxides emissions** (Direct) – use of zero emission buses in place of non-zero emission buses reduce the Nitrogen Oxides (NOx) emissions.

106. **Reduction in Particulate Matter** (Direct) – Replacing non zero emission buses with zero emission buses eliminates particulate Matter (PM2.5) that would have occurred by using diesel.

Unmonetised Benefits

107. **Reduction in upstream carbon emissions** (Direct) - Monetised carbon emissions savings captures the reduction in emissions created directly from the use of diesel to operate a non zero emission buses. Carbon emissions are also produced in the extraction of oil, oil refining to produce diesel and distribution of diesel prior to use. These carbon emissions can be associated with the consumption of diesel, reduced demand of diesel due to the greater uptake of zero emission buses could reduce some of these associated carbon emissions.

108. **Improved journey quality** (Direct) – Zero-emission buses vibrate less and are quieter than non-zero emission buses. This could be associated with an improvement in journey quality for passengers.

109. **Reduction in noise pollution** (Direct) - ZEBs run more quietly than diesel buses. As a result, there may be additional benefits generated associated with reduced traffic noise. Reduced traffic noise has been associated with increased health and wellbeing. The benefit generated will depend on whether the road in question is busy or not. Benefits are unlikely to be significant on very busy roads. Nonetheless, they could deliver material benefits for roads with low traffic flows. In all cases, the proposed changes are highly likely to be audible leading to an increased quality and acceptability of soundscape and consequently an associated increase in well-being. Increases to wellbeing are hard to monetise, so have not been included in our model for the purposes of making an initial assessment on this policy.

---

[24] Adheesh, Vasisht, & Ramasesha, *"Air pollution and economics: diesel bus versus electric bus"*, 2016

Changes in government transfers

110. **Change in Bus service operator grant (BSOG) payments** (Direct) – Zero emission and non zero emission buses receive different BSOG rates. The Department is increasing the rate of BSOG payments for zero emission buses. The basic rate for diesel buses is 34.57p per litre of diesel used, with additional uplifts of 6p per km for eligible Low carbon emission buses (LCEB), EuroIV or above, and an uplift of 2% and 8% of the basic rate for auto vehicle location (AVL) and smartcard incentives. Zero emission buses currently receive 6p per km, however will increase to 22p.

111. **Change in fuel duty payments** (Direct) – Reduction in fuel duty paid due to reduced diesel consumption, battery electric or, and hydrogen fuel cell vehicles do not incur fuel duty.

Summary of Costs Methodologies

The paragraphs below summarise the methodologies and assumptions used to determine the additional costs created from intervention.

Vehicle capital costs:

112. Vehicle capital costs differ by powertrain due to the differing component and manufacturing requirements. With equivalent specifications, zero emission buses currently have a higher purchase cost than a non-zero emission bus.

113. Powertrains considered as non zero emission buses include diesel, hybrids (parallel or plug in) and biofuel buses, whereas powertrains considered as zero emission include battery electric and hydrogen buses. For the purposes of this analysis all non-zero emission buses are assumed to Euro VI diesel buses and all zero-emission buses are assumed to be battery electric.

114. The purchase cost of both types of powertrains will vary on a case by case basis. The analysis uses evidence on the typical purchase cost. Evidence has suggested the typical cost for:
    - A Euro VI diesel bus is on average £180,000 for a single deck bus and £220,000 for a double deck bus (in 2019 prices). Given the assumption the split between single and double deck buses will be 50/50, the average cost used is £200,000 (2019 prices). This is assumed to stay static over the period considered.
    - A pure electric bus is on average £320,000 for single deck bus, and £400,000 for a double deck bus (in 2019 prices), giving an average cost of £360,000 per bus assuming a 50/50 double and single deck split. Given the expected reduction in costs of components (particularly batteries) and economics of scale of production, it has been assumed the cost of an electric vehicle will fall over time.

115. The analysis assumes the cost of vehicles will fall in line with the expected change in battery costs for electric buses. Figure 8 Forecast battery costs (£/kwh)below outlines

evidence used to inform this change. This is based on research[25] published by the Climate Change Commission (CCC). A linear change between each of the data points has been assumed to form a data series to cover the appraisal period. This evidence will be tested at consultation, a related question has been included in the consultation document.

Scenario	2020	2025	2030	2035	2040	2045	2050
High cost	£481	£246	£159	£131	£114	£97	£84
Best estimate	£370	£190	£122	£101	£88	£75	£65
Low cost	£287	£116	£72	£48	£45	£43	£41

Figure 8 Forecast battery costs (£/kwh)

116. There is currently a high degree of uncertainty around the current and future cost of batteries. The forecasts of the change in costs per kWh have been based on bottom up analysis of battery component costs in the light duty sector, where there is greater evidence available, with adjustment to account for batteries in the heavy duty sector (including buses) given prices are significantly higher. A summary of the scenarios is outlined below, further detail can be found in the published report.

- **Best estimate –** Bottom up analysis of battery component costs in the light duty sector adjusted to reflect the expected higher costs for battery used in heavy duty vehicles. 2020 cost based on cost of batteries used in current large-scale production battery electric buses, based on discussions with battery manufactures.
- **Low cost –** Assumed cost reductions achieved for electric car batteries are directly applied to costs for bus batteries. The cost curve is assumed to be 5 years behind the electric car battery forecast.
- **High cost –** Adds a permanent 30% price premium to the best estimate scenario to reflect range in current battery prices. Estimate assumes batteries for buses will never be able to benefit fully from the cost down curve expected for light duty vehicle batteries

117. Stakeholder advice indicated a typical battery for an electric bus should have a capacity between 200 and 350 kWh. The average, of 275kWh, has been used to convert the cost per kWh of capacity into an estimated cost of a battery, this has been applied to adjust the vehicle cost overtime. Assumption to be tested at consultation.

118. Battery costs have been estimated by multiplying the forecasted cost per Kwh of battery capacity, in a given year, by the assumed average electric bus battery size of 275Kwh. Vehicle costs, in a given year, are calculated by determining the difference in battery cost compared to 2021 and subtracting from the vehicle cost in 2021. The 2021 vehicle cost in the best estimate scenario is equal to the assumed average cost (£360,000), whilst the 2021 vehicle costs in the low cost and high cost scenarios are calculated by adjusting the average cost for the difference in 2021 battery costs compared to the best estimate. Estimated battery electric vehicle costs are below in Figure 9 Forecasted average electric bus cost

[25] Analysis to provide costs, efficiencies and roll-out trajectories for zero-emission HGVs, buses and coaches, available here

119. Additional capital cost is only incurred for bus purchases that without government intervention would otherwise be non zero emission bus purchases, further details on the estimated number of bus purchase impacted is outlined in the in the Do-nothing section. The capital cost that would have been incurred from the purchase of diesel buses has been subtracted from the capital cost of zero emission buses to derive the additional capital cost generated from a policy option.

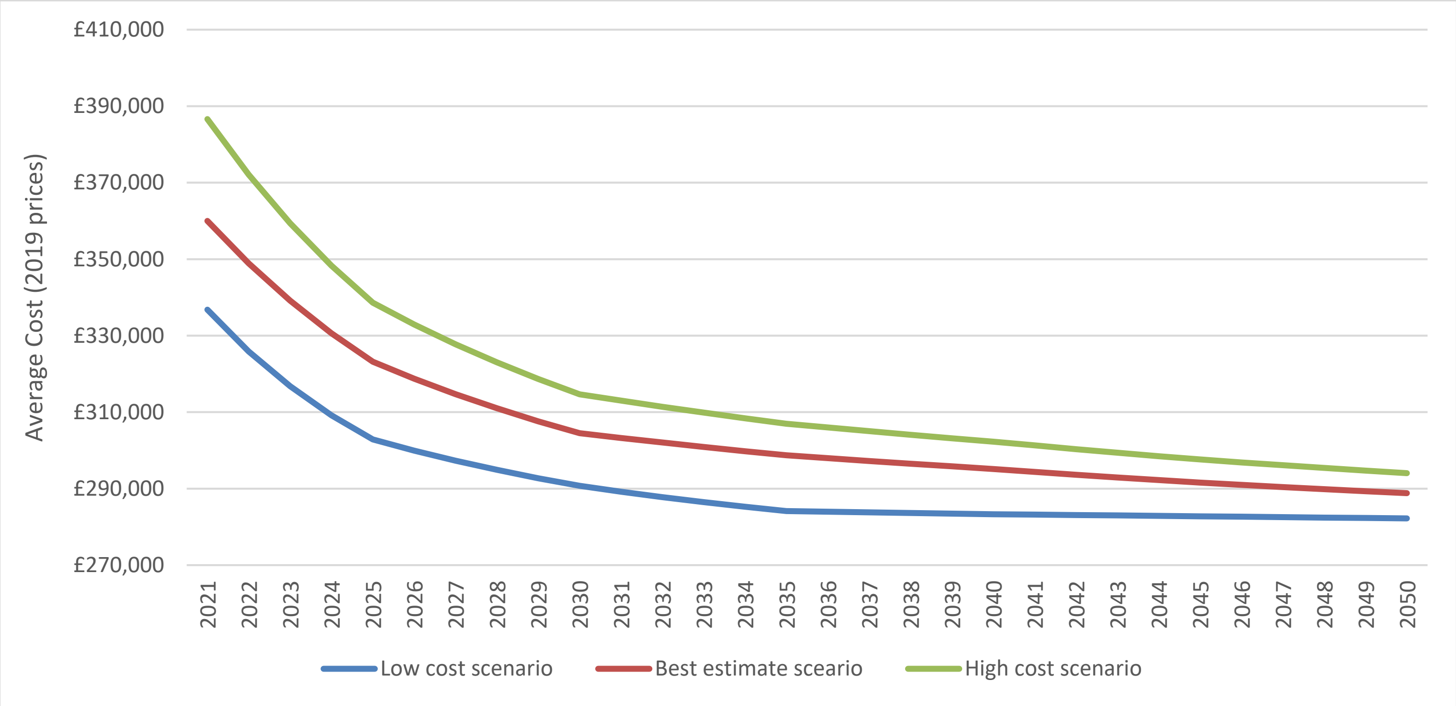

Figure 9 Forecasted average electric bus cost

How do you expect the upfront cost of:

- **a) Battery electric buses**
- **b) Hydrogen fuel cell buses**
- **c) Battery replacements**
- **d) Fuel cell replacements**
- **e) Electric powertrains**

to change over the period 2025 to 2032? Please provide or cite any evidence you may have, or which informed your understanding.

120. In addition to the purchase cost electric buses are expected to require a battery replacement during the operational life, this has been included in the vehicle capital cost. Stakeholder advice indicated batteries replacement would be required after 7 to 10 years. For the purposes of the analysis the battery replacement assumed to be in year 9 for each bus, resulting in one battery replacement over the assumed 17 year operational life of an electric bus. This assumption will be tested at consultation. The cost incurred for the battery replacement considers the forecasted fall in prices set out above and is assumed replacement batteries will also have a 275kWh capacity.

Please outline your understanding of the need, and costs relating to mid-life component replacements for battery electric and hydrogen fuel cell buses.

New charging and refuelling infrastructure costs

121. Additional zero-emission buses will require installation of new infrastructure to refuel hydrogen buses or recharge battery electric buses. Battery electric buses will require charging points, additional cables and substation in the depots. Depending on location they may also require reinforcement to the grid to support high power chargers, additional grid connection and upgrades to a primary substation. Hydrogen buses will require equipment to compress, store and dispense hydrogen gas, at high pressure.

122. Cost incurred for new infrastructure will vary on a case by case basis, depending on location and technology used and size of fleet, the analysis of cost incurred uses an estimate on the typical infrastructure cost per battery electric bus. This cost is assumed to occur for every bus purchased over the appraisal period. Stakeholder advice has indicated that infrastructure needed for battery electric buses is typically around £50,000 per bus, given estimates that a 40-bus depot would require an investment of £2m to incorporate the technology required to recharge battery electric buses. This assumption will be tested at consultation.

123. However, uncertainty remains, infrastructure costs could be higher for hydrogen refuelling infrastructure, in rural areas where the need for grid reinforcement is more likely or where opportunity charging infrastructure is being used. Costs could also be lower where there is existing zero emission infrastructure and grid connections to depots.

Please explain your understanding, providing evidence where appropriate, of the costs and barriers relating to the provision of infrastructure for zero emission buses (both hydrogen and battery electric).

124. The additional cost incurred by operators is calculated by multiplying the number of additional zero emission buses in the do-something scenario by the estimated infrastructure cost per bus (£50,000). Without government intervention it is expected operators would otherwise purchase diesel buses, given the established diesel refuelling infrastructure, it is assumed there would be no infrastructure cost associated with these purchases.

Infrastructure maintenance cost

125. New infrastructure installed to support the additional zero emission buses in do something scenarios will require maintenance in order to keep in operational use, creating additional costs incurred by operators. Limited evidence is available to estimate these costs, the analysis uses an assumption that the annual maintenance rate of 5% the capital cost of infrastructure (equating to £2,500 per year).

126. Annual additional cost is equal to the 5% the cumulative capital cost of additional infrastructure since the implementation of a policy option. Without government

intervention it is expected operators would otherwise purchase diesel buses, given the established diesel refuelling infrastructure it is assumed there would be no additional infrastructure maintenance. These assumptions will be tested at consultation.

Summary of change in government transfers

The paragraphs below summarise the methodologies and assumptions used to calculate the changes in transfers to or from government created from intervention.

Lower fuel duty revenue

127. Additional zero emission buses will result in lower fuel duty revenues to government, given fuel duty is paid when operators purchase diesel for diesel buses but no duty is paid when oporators purchase of electricity for battery electric buses. The annual reduction in duty revenues per additional zero emission is equal to the annual litres of diesel that would have otherwise been used, assuming diesel bus fuel consumption of 40 litres per 100km and an annual average vehicle distance of 56,531km, multiplied by the fuel duty per litre in the year under consideration, full data series of duty paid per litre of diesel can be found in the Departments Transport Analysis Guidance (TAG) Databook[26]. The benefit to oporators from lower duty paid is included in the lower operating cost.

Higher BSOG Payments

128. Additional zero emission buses is estimated to result in an increase in BSOG payments from the goverenment. The estimated BSOG rate per km for diesel buses is expected to be lower than the rate for zero emission buses. As outlined in figure 10, further details on the BSOG rate for diesel and electric buses are outlined in the lower operating cost section.

	Basic BSOG rate	LCEB Incentive	Smartcard and AVL uplifts	Total BSOG payment per km
Diesel Bus	34.57p/l	6p/km	8% and 2%, respectively	21.2p/km[27]
Zero Emission Bus (ZEB)	22p/km	-	-	22p/km

Figure 10 - BSOG payment per km

Summary of Benefits Methodologies

The paragraphs below summarise the methodologies and assumptions used to determine the additional benefits created from intervention

Lower operating costs:

129. Non zero emission buses and zero emission buses use different fuels, and these fuels have different unit costs per km. The costs vary in terms of the resource cost, duty paid, and bus service operator grant (BSOG) payment received. Analysis focuses on electric

---

[26] Department for Transport, "Transport analysis guidance databook A1.3.7", 2021

[27] BSOG payment per km for diesel buses will depend on individual fuel consumption per km, analysis assumes an average 40 litres per 100km

and diesel buses; operating costs will differ with other powertrains (such as hybrids and hydrogen buses). Resource and duty (where applicable) costs per litre of diesel and kWh of electricity can be found in the Department's Transport Analysis Guidance Databook28.

130. The BSOG basic rate for diesel buses is 34.57p per litre of diesel, with additional uplifts of 6p per km for eligible Low carbon emission buses (LCEB), and 8% and 2% uplifts on the basic rate for smartcard and auto vehicle location (AVL) respectively[29]. All uplifts are applied to calculate operating costs in the do nothing scenario, given all new non zero emission buses would likely be eligible, for the LCEB, smartcard and AVL incentives.

131. From April 2022 the BSOG rate for zero emission buses will be 22p per km, as announced in the Government's Transport Decarbonisation Plan (TDP)[30]. BSOG rates are subject to change as a result of a committed full BSOG reform.

132. Evidence from stakeholders has indicated the average consumption for a diesel bus is 40 litres of diesel per 100km and the average electric buses consumes 100kWh per 100km. As shown in Figure 11 Cost differences between ZEBs and Diesel buses below, this results in electric buses being cheaper to run per km than their diesel equivalent. The benefit to operators is the difference between the fuel and electricity consumption.

133. Total fuel related operating cost are calculated assuming the average vehicle distance is remains constant at average as of 2019/20 calculated to be 56,531km per bus per year. Annual distance estimated based on the Department's annual bus statistics (tables BUS0206 and BUS0602).

	Resource cost per km[31]	**Duty Paid**	**BSOG payment per km**	**Total Cost**
Diesel Bus	22.0p/km	30.1p/km	21.2p/km[32]	30.9p/km
Zero Emission Bus (ZEB)	18.4p/km	0p/km	22.0p/km	-3.6p/km

Figure 11 Cost differences between ZEBs and Diesel buses

134. Annual operating costs per diesel and electric bus are calculated by multiplying the estimated total cost per km outlined in figure 11 by estimated annual average vehicle distance outlined above. The benefit generated for the additional zero emission buses has been calculated by subtracting the estimated total operating cost of additional zero emission buses from the total operating cost that would be incurred if these are otherwise diesel buses.

[29] Department for Transport, Bus Service Operators Grant: guidance for commercial transport operators, available here

[30] Department for Transport, (2021), *Decarbonising Transport*, available here

[31] Based on estimated average diesel and electricity cost between 2025 and 2050, using unit resources costs presented in the Department's *Transport analysis guidance databook*, available here

[32] payment per km for diesel buses will depend on fuel consumption per km, analysis assumes an average 40 litres per 100km.

Lower maintenance cost of vehicles

135. Both zero emission and non zero emission buses will require maintenance in order to keep vehicles operational. Electric vehicles have fewer moving parts compared to diesel buses and are expected to have lower maintenance cost than diesel vehicles.

136. Evidence from engagement with operators indicates maintenance cost for diesel buses and electric buses is equivalent to £0.25 per km and 0.15km per km respectively (2020 prices). Annual maintenance costs for both diesel and electric buses has been calculated by multiplying the estimated maintenance cost per km by the estimated annual average vehicle distance of 56,531km, based on DfT statistics as outlined above. The benefit generated is calculated by subtracting the total maintenance cost from additional electric buses from the total maintenance cost if they were otherwise diesel buses.

Reduction in carbon emissions:

137. Non zero emission buses emit carbon dioxide at the tailpipe contributing to climate change. Changing the powertrain of new buses from non zero emission to zero emission, will reduce the carbon dioxide emissions of the bus fleet and the associated costs.

138. Diesel buses are estimated to emit 2.4kg of CO2 per litre of diesel burnt[33], annual carbon emissions per bus is calculated assuming fuel consumption of 40 litres per 100km[34] and an annual distance of 56,531km[35].

139. Zero emission buses do not emit carbon dioxide at the tailpipe, yet production of electricity or hydrogen used by zero emission buses can result in carbon dioxide emissions. Emissions will differ by the fuel type and production method used. The analysis assumes all zero emission buses are electric buses and electricity would be derived from the grid. The analysis uses the BEIS road electricity forecast[36] for CO2 emissions per kWh of electricity. In 2021 it is estimated 0.28 kg of CO2 are produced per kWh of electricity, this follows a downward trend to 0.03 kg in 2050 to reflect greater use of renewable electricity. Annual carbon dioxide emissions per bus were calculated assuming electricity consumption of 100kWh per 100km and an annual vehicle distance of 56,531km.

140. The benefit created is the total carbon savings resulting from the do something scenario. CO_2 emissions reduced from diesel buses are monetised using the Government published central non-traded carbon values, summarised in Figure 12 Non-Traded Cost of Carbon values (2020 prices), from TAG databook for BEIS. The impact of new carbon values, and how these should be reflected in relation to traded carbon is still being considered, however for the purposes of this IA, given electricity is in the traded carbon sector, the carbon impact of electricity used for new zero emission buses are included in the price per kWh of electricity, and is accounted for as part of the change in operating costs.

---

[33] CO_2 per litre of diesel burnt found in the Departments Transport Analysis Guidance (TAG) databook

[34] Low Carbon Vehicle Partnership, *Economics of bus drivelines*, 2005

[35] Department for Transport, *Local bus vehicle distance travelled,* 2020

[36] Forecast can be found in the Department Transport Analysis Guidance (TAG) databook

Carbon value scenario	2020	2025	2030	2035	2040	2045	2050
Low	£120	£130	£140	£151	£163	£176	£189
Central	£241	£260	£280	£302	£326	£351	£378
High	£361	£390	£420	£453	£489	£527	£568

Figure 12 Non-Traded Cost of Carbon values (2020 prices), from BEIS

Reduction in Particulate Matter (PM) emissions:

141. Particulate matter (PM) is microscopic particles of solid or liquid matter suspended in the air, which are emitted as you burn diesel fuel. They create air pollution and are associated with adverse health conditions.

142. Shifting from diesel to electric buses would reduce the overall emissions and the health costs associated with emissions. A diesel bus is estimated to produce 0.01kg[37] of PM2.5 per km from engine emissions. Given an electric bus is not expected to produce PM2.5 emissions via the electric powertrain, the benefit is derived from the resulting reduction in PM emissions. Annual PM2.5 emission savings per additional electric bus have been calculated by multiplying the PM2.5 emission per km by the estimated average annual vehicle distance estimate of 56,531km.

143. The reduction in these emissions have been monetised by multiplying the PM2.5 savings by the central road transport PM damage costs found in the Departments Transport Analysis Guidance (TAG) Databook.

Reduction in Nitrogen Oxide (NOx) emissions:

144. Non zero emission buses produce nitrogen oxide (NOx) emission from the use of diesel, which has a negative impact of local air quality, creating health costs. per km an average diesel bus is estimated to produce 0.4 grams of NOx. Given zero emission buses do not produce NOx at the tailpipe the benefit is reduction in the NOx emissions and associated health costs. The annual NOx emissions savings per additional zero emission bus has been calculated by multiplying the grams of Nox emitted per km by the average annual milage of 56,531km. the reduction in health costs is calculated using the central road transport Nox damage costs found in the Department's Transport Analysis Guidance Databook.

Sensitivity Analysis

145. The main uncertainties to the analysis are:
    - The extent to which the purchase cost of zero emission buses changes overtime. The additional cost of vehicles is the largest cost faced by bus operators. Zero emission technologies for buses are still evolving and the costs are expected to fall overtime as components improve and economies of scale are realised. However limited data and evidence is available to forecast the extent of change.

[37] ZEMO partnership, *Low emission performance report,* 2018

- The take up in zero emission buses without intervention – This determines the scale of the change in purchasing behaviour resulting from an intervention. There is evidence to indicate operator's appetite to purchasing zero emission buses, including a survey used in this analysis and commitments from bus operators. However, take up of zero emission buses is dependent on the extent to which they become cost competitive with a diesel equivalent.

146. Sensitivity analysis has been used to test the impact of three forecasts for vehicle costs outlined in Figure 9. This change the number of zero emission buses expected in the do nothing scenario and the cost incurred to operators per bus in the do something scenarios.

High vehicle cost estimate

147. The high cost scenario assumes the cost per kWh of battery capacity would fall from £481 in 2020 to £84 in 2050. Assuming an average 275kWh-capacity battery, the change in battery cost would translate into a drop in the cost of the vehicle, the cost of an average electric bus would fall from £386,622 in 2021, in 2019 prices, to £294,048 in 2050.

148. As costs are higher than the best estimate scenario, the probability of operators purchasing zero-emission buses in the do nothing scenario would be lower, see Figure 13. Given lower take up compared to the best estimate a larger change in purchasing behaviour would be needed to end the sale of non zero emission buses.

149. Figure 13, below, shows the impact for each policy option under the high vehicle cost scenario, broken down group affected.

	End of sale of all new, non zero tailpipe emission buses by										
Impact on Operators	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Additional vehicle capital costs (including VAT)	-£1,898	-£1,727	-£1,586	-£1,481	-£1,406	-£1,337	-£1,209	-£1,112	-£1,020	-£933	-£850
New charging and refuelling infrastructure costs	-£672	-£624	-£583	-£551	-£527	-£504	-£461	-£428	-£396	-£365	-£335
Net savings in maintenance cost	£1,089	£1,011	£944	£893	£854	£818	£748	£694	£642	£592	£543
Infrastructure maintenance cost	-£441	-£409	-£382	-£361	-£346	-£331	-£303	-£281	-£260	-£239	-£220
Net savings in operating costs (includes changes in VAT, duty and BSOG)	£3,325	£3,100	£2,907	£2,755	£2,642	£2,533	£2,325	£2,164	£2,008	£1,856	£1,708
Total	£1,402	£1,351	£1,300	£1,254	£1,217	£1,178	£1,100	£1,037	£974	£910	£847
Impacts on Government											
Change in fuel duty revenues (transfer)	-£2,856	-£2,664	-£2,499	-£2,369	-£2,274	-£2,181	-£2,004	-£1,866	-£1,732	-£1,602	-£1,476
Change in government expenditure on Bus Service Operators Grant payments (transfer)	-£51	-£47	-£43	-£40	-£38	-£36	-£32	-£29	-£27	-£24	-£22
Total	-£2,907	-£2,710	-£2,541	-£2,409	-£2,311	-£2,216	-£2,036	-£1,895	-£1,759	-£1,627	-£1,498
Environment Impacts											
Reduction in carbon emissions	£3,287	£3,087	£2,913	£2,775	£2,673	£2,572	£2,379	£2,227	£2,078	£1,932	£1,789
Reduction in Nitrogen Oxide	£41	£38	£35	£33	£32	£30	£28	£26	£24	£22	£20
Reduction in Particulate Matter	£9	£8	£8	£7	£7	£7	£6	£6	£5	£5	£5
Total	£3,337	£3,133	£2,956	£2,816	£2,712	£2,609	£2,413	£2,259	£2,107	£1,959	£1,814
Net Present Value	£1,832	£1,774	£1,714	£1,661	£1,617	£1,571	£1,477	£1,400	£1,322	£1,243	£1,163

Figure 13 High vehicle cost scenario (2020 prices and discounted to 2020)

Low vehicle cost estimate

150. The low cost scenario assumes the cost per kWh of battery capacity would fall from £287 in 2020 to £41 in 2050, in line with the battery price forecasts outlined in figure 8. Assuming an average 275kWh-capacity battery and the change in battery cost would translate into a drop in the cost of the vehicle. The cost of an average electric bus would fall from £336,794 in 2021 to £282,223 in 2050 (2019 prices), per figure 14 .

151. As cost are lower than the best estimate scenario, the probability of operators purchasing zero-emission buses in the do nothing scenario would be higher than the best estimate scenario. Given lower up take a larger change in purchasing behaviour would be needed.

152. Figure 14, below, shows the impact for each policy option under the low vehicle cost scenario, broken down by group affected.

	End of sale of all new, non zero tailpipe emission buses by										
Impact on Operators	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Additional vehicle capital costs (including VAT)	-£1,007	-£948	-£893	-£859	-£827	-£797	-£724	-£672	-£622	-£575	-£530
New charging and refuelling infrastructure costs	-£493	-£468	-£445	-£430	-£416	-£402	-£367	-£342	-£318	-£295	-£272
Net savings in maintenance cost	£798	£759	£721	£697	£674	£651	£596	£555	£516	£479	£442
Infrastructure maintenance cost	-£323	-£307	-£292	-£282	-£273	-£264	-£241	-£225	-£209	-£194	-£179
Net savings in operating costs (includes changes in VAT, duty and BSOG)	£2,451	£2,338	£2,228	£2,158	£2,089	£2,023	£1,857	£1,736	£1,618	£1,504	£1,394
Total	£1,427	£1,374	£1,329	£1,284	£1,247	£1,211	£1,120	£1,052	£985	£919	£855
Impacts on Government											
Change in fuel duty revenues (transfer)	-£2,108	-£2,011	-£1,917	-£1,857	-£1,799	-£1,742	-£1,601	-£1,497	-£1,397	-£1,300	-£1,205
Change in government expenditure on Bus Service Operators Grant payments (transfer)	-£37	-£34	-£32	-£31	-£29	-£28	-£25	-£23	-£21	-£19	-£18
Total	-£2,144	-£2,045	-£1,949	-£1,888	-£1,828	-£1,770	-£1,626	-£1,521	-£1,418	-£1,319	-£1,223
Environment Impacts											
Reduction in carbon emissions	£2,451	£2,350	£2,251	£2,188	£2,125	£2,064	£1,909	£1,795	£1,684	£1,574	£1,467
Reduction in Nitrogen Oxide	£30	£28	£27	£26	£25	£24	£22	£21	£19	£18	£16
Reduction in Particulate Matter	£7	£6	£6	£6	£6	£5	£5	£5	£4	£4	£4
Total	£2,488	£2,385	£2,284	£2,219	£2,156	£2,093	£1,936	£1,821	£1,707	£1,596	£1,487
Net Present Value	£1,771	£1,714	£1,665	£1,615	£1,575	£1,535	£1,430	£1,352	£1,274	£1,197	£1,119

Figure 14 Low vehicle cost scenario (2020 prices and discounted to 2020)

Summary

153. Figure 15 Net present value, high vehicle cost, low vehicle cost, and best estimate scenariosshows the net present value (NPV) of options to end the sale of new non zero emission buses under the low, best estimate and high scenario.

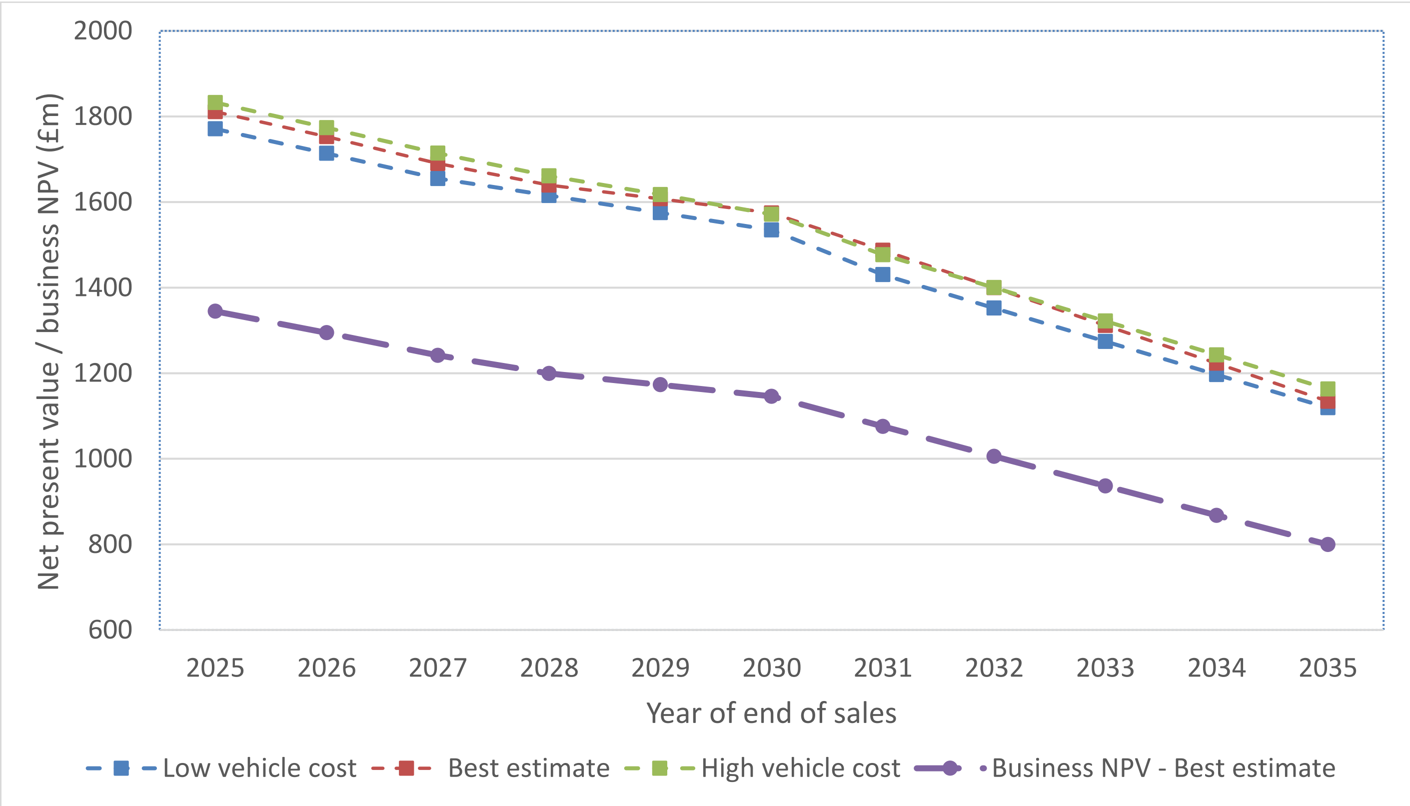

Figure 15 Net present value, high vehicle cost, low vehicle cost, and best estimate scenarios (2020 prices and discounted to 2020)

3.0 Risks and unintended consequences

154. There are multiple options that may achieve carbon reductions close to the goal of net zero by 2050, but all with different trade-offs and risks.

155. In general, the earlier we bring the end of sales date, the greater the carbon savings, but the higher the risk that there might be adverse risks to the bus sector and additional costs to consumers and to the energy sector.

156. At a global level, in setting an earlier date for a phase-out, there is a risk that the UK will simply displace carbon emissions savings of ZEBs which would otherwise be sold elsewhere, rather than providing any new additional emissions savings in the absence of the proposed policy. This risk will only be realised if manufacturers, globally, do not accelerate zero emission vehicle production to meet demand.

157. There is a risk that bringing forward the end of sales date could result in further negative impacts. These may include a smaller range of vehicle models to choose from (although we expect a vastly expanded range of ZEB models to be available on the market in subsequent years), higher upfront costs, and potentially fewer new buses available in the market altogether due to supply constraints. This could lead to fleet turnover slowing down,

as operators may turn to the secondhand market for older ICE vehicles rather than purchasing new ZEBs.

158. We anticipate that this policy will generate the required behaviour, however there is a risk that manufacturers may adopt different pricing strategies around an end of sales date to maximise profits, and thus operators may retain internal combustion engine buses for longer than they currently do, both of which would slow carbon reduction and could lead to an increase in carbon emissions ahead of a phase-out. Enforcement regulation is therefore also required and planned in parallel with an end of sales date.

159. Bringing forward the end of sales date may increase electricity system costs as greater numbers of vehicles switch to electricity or hydrogen to power their vehicles.

160. Removing ICEs from the market after their end of sales dates could increase the upfront cost of ZEVs as it removes the ability for manufacturers to cross-subsidise ZEVs by increasing the price of ICEs within markets. Manufacturers could cross-subsidise across international markets, but this is at their discretion and often not attractive because of currency differences, so vehicle cost impacts are uncertain and unclear.

161. An earlier end of sales date (in all scenarios) is likely to have a positive effect on residual values for ICEs. With supply of these types of vehicles limited, some may turn to the second-hand market, bolstering demand.

162. In the longer term there are likely to be impacts on those who will continue to use conventional fuels, in terms of higher maintenance costs and potential difficulty ensuring security of supply at competitive rates as such fuels become less prevalent in the UK.

163. Two core zero-emission drivetrain options are considered as an alternative to internal combustion engine propulsion: pure Battery Electric (BEV), and Hydrogen Fuel Cell (FCEV). Conventional powertrains, relative to BEV/FCEV powertrains, are smaller, both in terms of size and weight. The greatest benefit of fossil fuels, like diesel, relative to alternative fuels, are higher energy and gravimetric density – allowing buses and other heavy vehicles to easily carry large stores of energy in limited spaces, with minimal need for complex and new refuelling infrastructure.

164. Introducing zero-emission powertrains to buses may reduce the number of passengers that can be carried. This will impact the business case for some operators, as it means more vehicles are needed to move the same number of passengers leading to higher costs (however many operators will not need to utilise the entire carrying capacity, and may be willing to accept some loss from zero-emission powertrains).

165. There is currently limited evidence as to the effect of zero emission buses on patronage and in relation to passenger behaviour more broadly, we will look to use this consultation and further engagement to grow the evidence base.

166. Longer range models are significantly more expensive, on top of the existing price premium for zero emission vehicles, due to the need for substantially increased onboard energy storage.

167. With upfront price parity yet to be reached, a policy-only approach to secure our desired uptake of ZEBs would likely result in operators holding onto existing buses, shrinking the new market. A smaller new bus market would have negative impacts environmentally and for the economy. To avoid this, policy needs to be accompanied by incentives for ZEBs, e.g. the existing ZEBRA scheme and BSOG reform. Such incentives, alongside policy will give long-term signals to the market. There are options around how far such measures should aim for fiscal neutrality.

168. As, in the main, departmental statistics refer to buses used on local bus services, these have provided the underpinning data for the analysis in this IA. There may be a slight risk that this does not fully capture the impact on private bus services, such as airport shuttles.

169. As the preferred option would be to implement on this through the post-EU CO_2 regulations proposed in the recent green paper, this would ameolirate the majority of risks of non compliance. Any implementation related risks will be covered in the IA for the necessary legislation.

170. As such, we do not expect any risk to heavily disrupt the effectiveness of this policy, in relation to the aims and objectives.

4.0 Wider impacts

Rural proofing

171. The policy is only focused on ending the sale of new non zero emission buses, existing buses will still be able to operate, as will the second-hand market. The direct impact of the policy on rural areas is that, from the end of sale date, rural operators (as with all others) would no longer be able to procure new non- zero emission buses. Currently, zero emission buses have a higher upfront capital cost than conventionally fuelled alternatives, although they have lower operating costs.

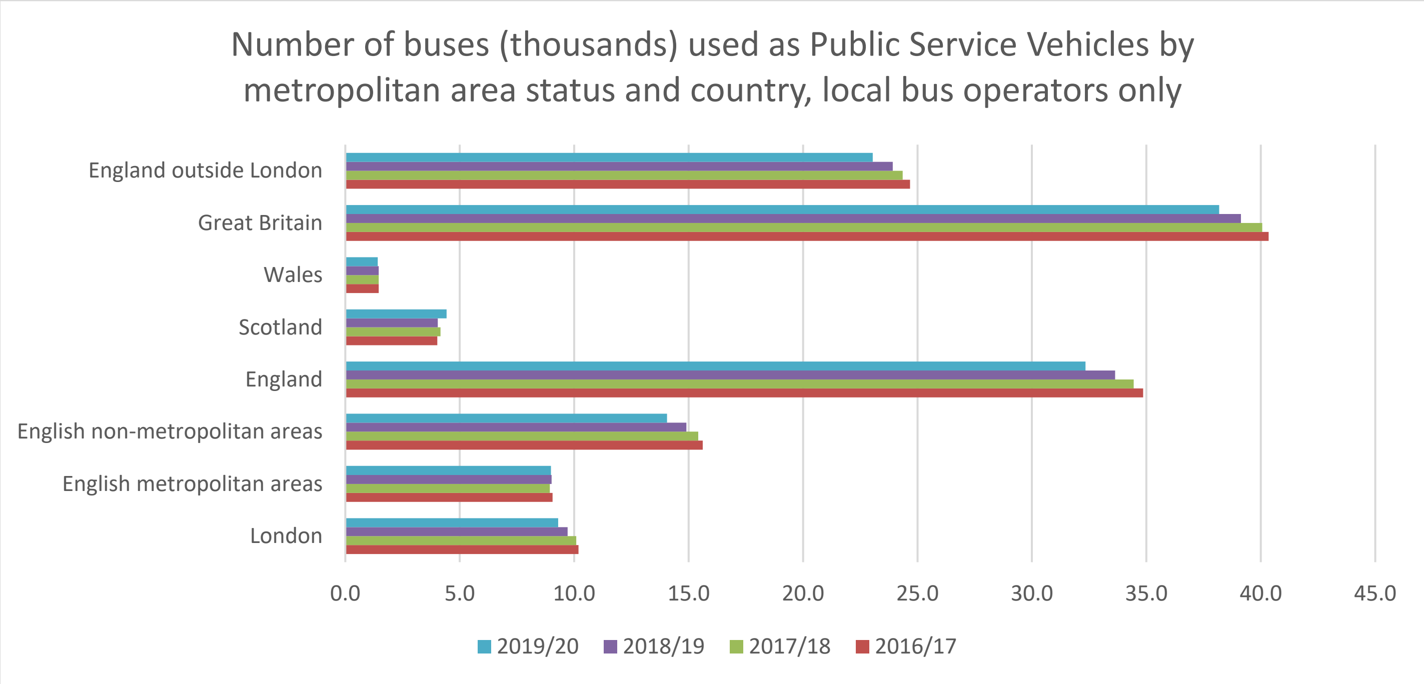

Figure 16 No. of buses by geography[38]

172. Per the graph above, Figure 16 No. of buses by geography, there were under 15,000 buses used as public service vehicles in non-metropolitan areas of England in 2019/20.

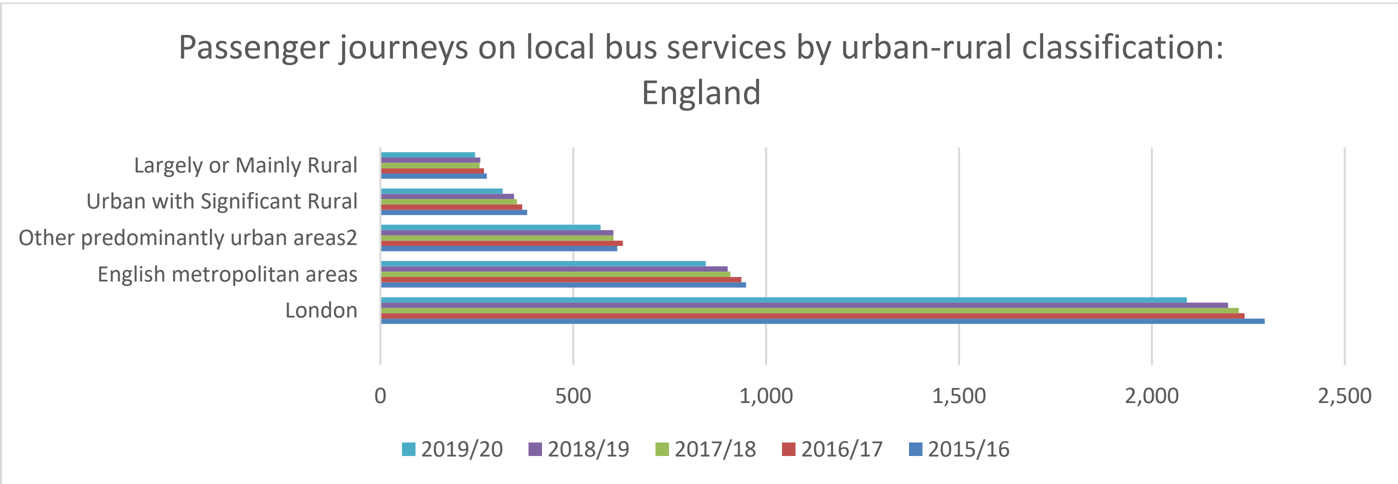

Figure 17 Passenger journeys by geography[39]

173. As shown by the graph above, Figure 17 Passenger journeys by geography, there has been a general decline in bus passenger journeys across England, with rural areas having the smallest amount. This may reflect the specific transport dynamics of rural areas, with generally lower populations and population densities.

174. Notably, the rate of decline in rural areas is lower than that for urban areas, though this may reflect the lower starting point, in terms of absolute values.

[38] Department for Transport, *Vehicles operated by local bus operators*, 2020

[39] Department for Transport, *Local bus passenger journeys*, 2021

175. Indirectly, the policy will benefit rural areas, providing positive environmental benefits, most notably decreased greenhouse gas emissions and improved air quality. There may be some increased impact on the built environment, with the potential need for civil works to upgrade bus depots and stations to deploy appropriate charging/refuelling infrastructure.

176. Per the graph below, Figure 18 Average age of bus fleet by geography, buses used in English non-metropolitan areas tend to be the oldest amongst the GB fleet. Hence, the emissions' profile of the rural fleet is likely to be higher, across both GHG and AQ emissions. Therefore, there is likely to be a greater environmental benefit

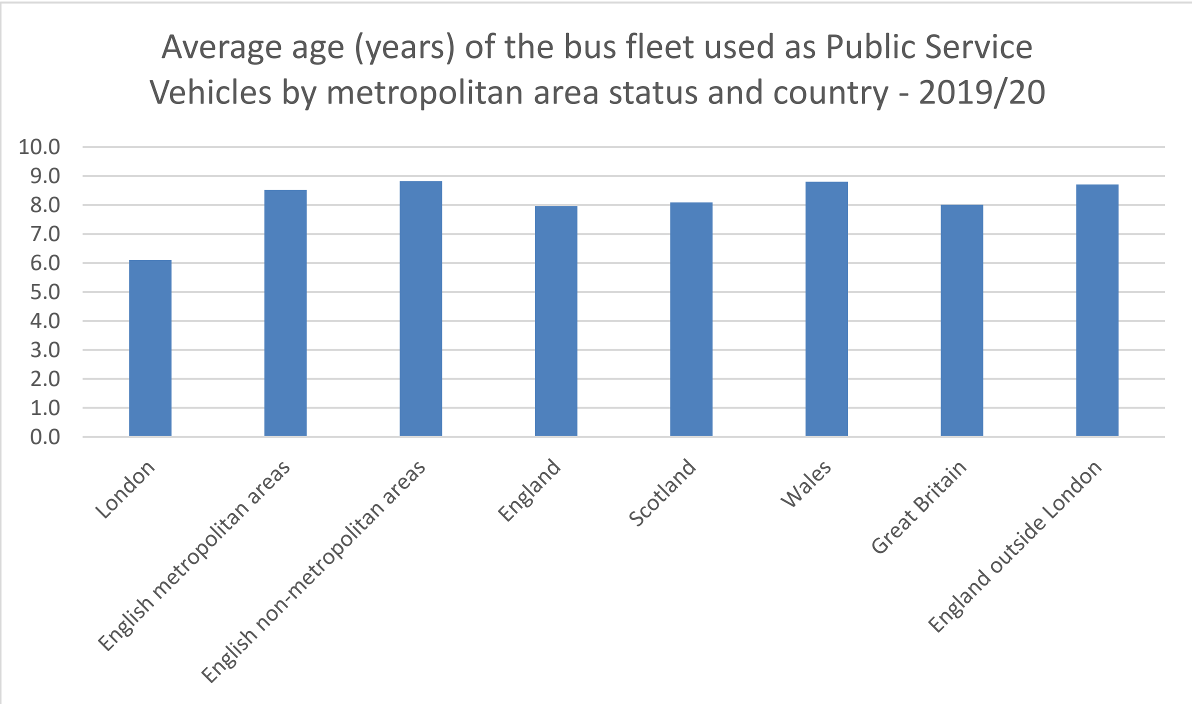

Figure 18 Average age of bus fleet by geography[40]

177. With new technologies, there will be a need for new skills and associated jobs. For example, the need for further innovation in the automotive sector will provide high quality jobs in research and development, the need for additional infrastructure investment will also be reflected in associated engineering and construction jobs, etc. We expect that these jobs will be proportionally generated in geographies where ZEBs operate, hence a positive benefit for rural areas.

178. As flagged in the risks and unintended consequences section, there are space and weight challenges related to shifting to zero emissions technology. The, current, lack of energy density for batteries, and space requirements may reduce the carrying capacity, and thus number of passengers.

[40] Department for Transport, *Vehicles operated by local bus operators*, 2020

179. However, as per Figure 19 Bus occupancy by geography, below, bus occupancy for rural routes is below that for all other English areas, and below the GB average, suggesting that this is less of a concern for such routes.

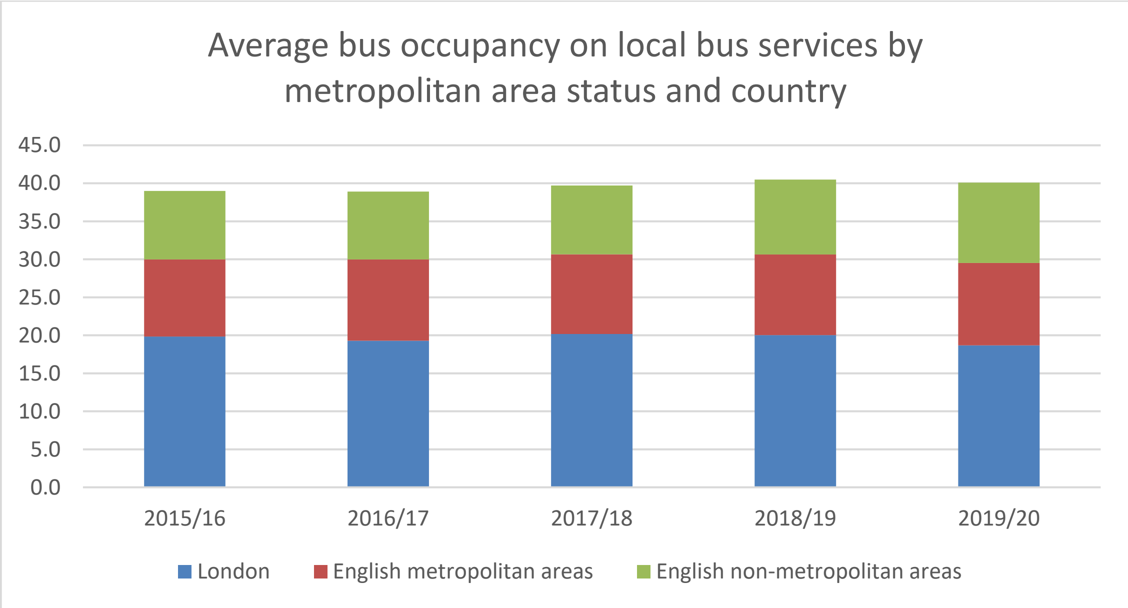

Figure 19 Bus occupancy by geography[41]

180. As a result, rural areas tend to use smaller vehicles. This smaller part of the sector may, in fact, be harder to decarbonise than heavier buses. Due to their higher fuel consumption, large buses benefit from the lower cost of zero emission fuels compared to fossil fuels. As a result, while the absolute cost to support each larger vehicle is higher than for smaller vehicles, because they are larger and more expensive vehicles, the cost of supporting their deployment is proportionally less than small vehicles.

181. Though, as per figures 21 and 22, below, passengers on rural routes tend to travel further than those in urban areas (excl. London).

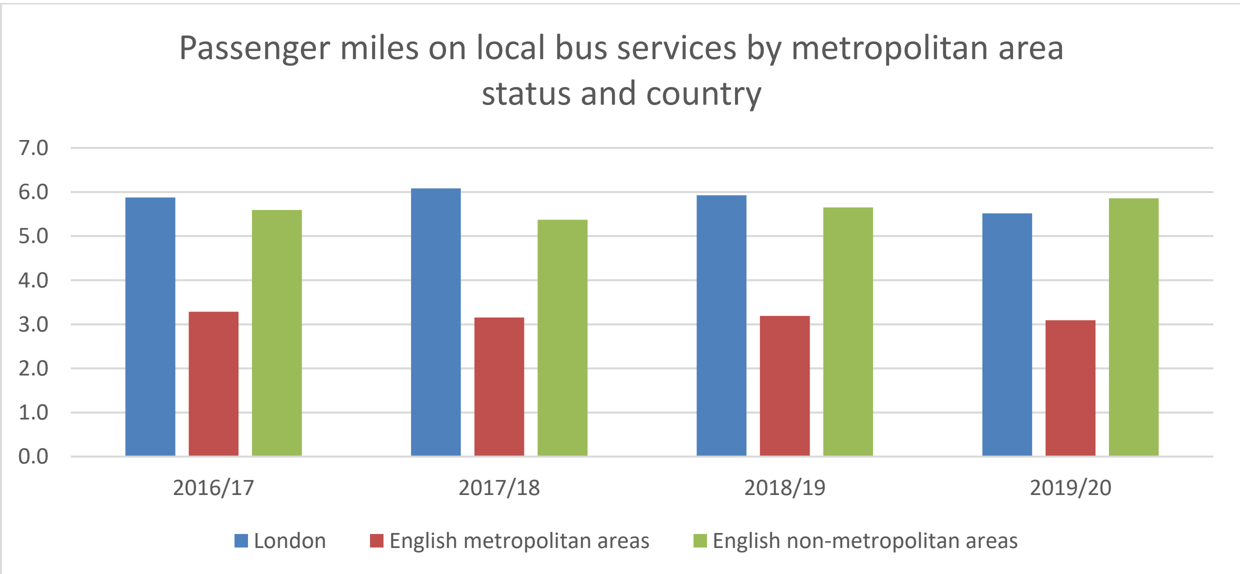

Figure 20 Bus passenger miles by geography[42]

[41] Department for Transport, *Costs, fares and revenue,* 2021
[42] Department for Transport, *Local bus passenger journeys*, 2021

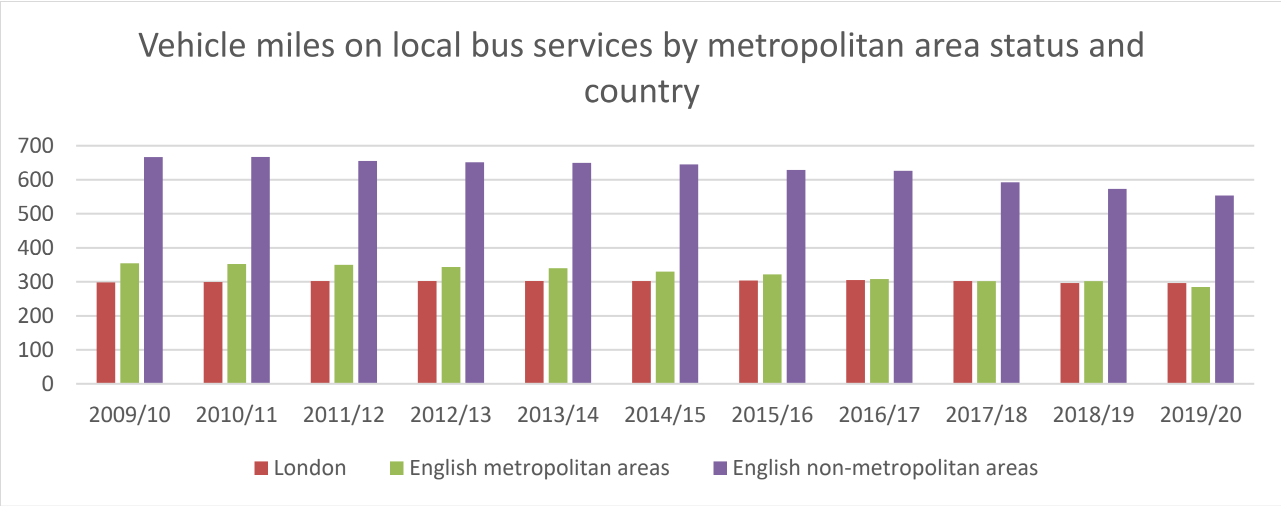

Figure 21 Bus vehicle miles by geography[43]

182. Longer range models are significantly more expensive, on top of the existing price premium for zero emission vehicles, due to the need for substantially increased onboard energy storage but can take advantage of cheaper in-depot refuelling/charging.

183. Rural bus routes tend to be the most marginal, with low levels of patronage. Thus, larger firms tend to leave this aspect of the sector to other operators or community transport providers (see competition test for further analysis on this aspect).

184. Buses, today, are typically depot-based, returning after each shift, and typically only needing to refuel once a day, meaning operators are highly unlikely to shift to refuelling/charging in public. This is due both to the operational complexity this would entail including health and safety challenges of refuelling high volumes of buses at public locations, but also because their operational profiles may provide opportunities to accommodate additional depot refuelling. As a result, zero-emission buses may well have different refuelling infrastructure requirements to other vehicle segments, with the majority of refuelling likely to continue to take place in-depot – limiting the impact on the rural natural and built environment to areas with existing development.

185. For operators who do not consider depot refuelling/charging feasible for zero emission vehicles, particularly for longer rural routes, there is the option of public fuelling/charging. Whilst for the other vehicle segments, 'public' recharging/refuelling refers to public access infrastructure, for buses this would in practice likely mean infrastructure at bus stops (flash charging) or at bus stations/the end of routes (opportunity charging).

186. Per the graph below, Figure 22 Operating cost, pence, per mile by geography, though the operating cost has been generally increasing across the board over the past decade, both the rate of increase for non-metropolitan English areas, as well as the absolute level, has been lower than that for urban areas of England.

[43] Department for Transport, *Local bus vehicle distance travelled*, 2020

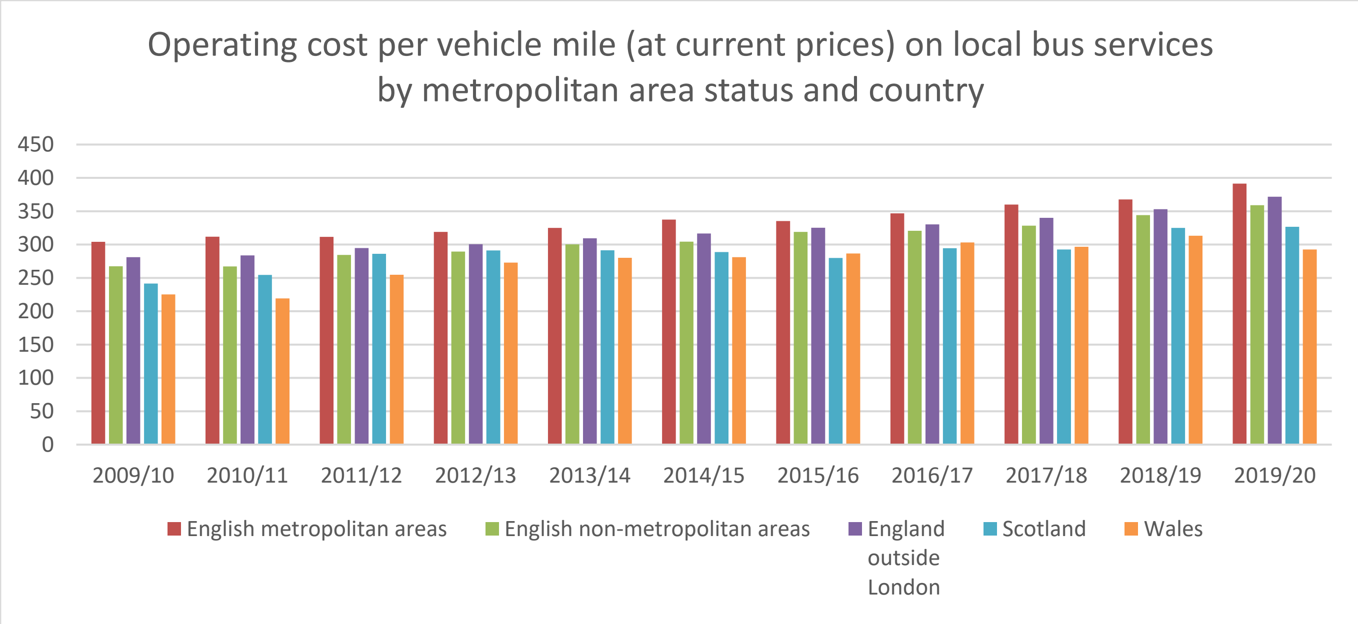

Figure 22 Operating cost, pence, per mile by geography[44]

187. This illustrates that, though there is less scope for operating cost decreases as in urban areas, in the long-term rural areas will also benefit from reduced operating costs that ZEBs benefit from.

What is the scale of these expected impacts?

188. In the immediate short-term we recognise that the upfront capital cost of zero emission buses is significantly higher, and that vehicle performance may not suit all rural routes. However, Bloomberg New Energy Finance predicts that parity for total cost of ownership will be reached for some vehicle segments by the mid-2020s, in Europe. We are confident that, as technology improves and upfront costs fall, the proposition of zero emission buses will look increasingly attractive from a total cost of ownership perspective.

189. In England, rural areas tend to have the highest proportion of older, more polluting buses (see Figure 23, below). There is, depending on the date set, the potential that for the end of sales to lead to newer ICE vehicle stock being cascaded to rural areas. As urban areas often have a greater impetus to shift to zero emission vehicles, due to increasing concerns around acute air quality problems meaning stricter tailpipe standards, there is a potential risk that end of sales may lead to a cascade of newer Euro VI diesel and hybrid buses to rural areas.

190. Regardless, we can expect an improvement in local air quality, as NOx and particulate emissions from buses are proportionally high. A reduction in further local environmental damage, for example through fuel spillage, can also be expected.

[44] Department for Transport, *Costs, fares and revenue*, 2021

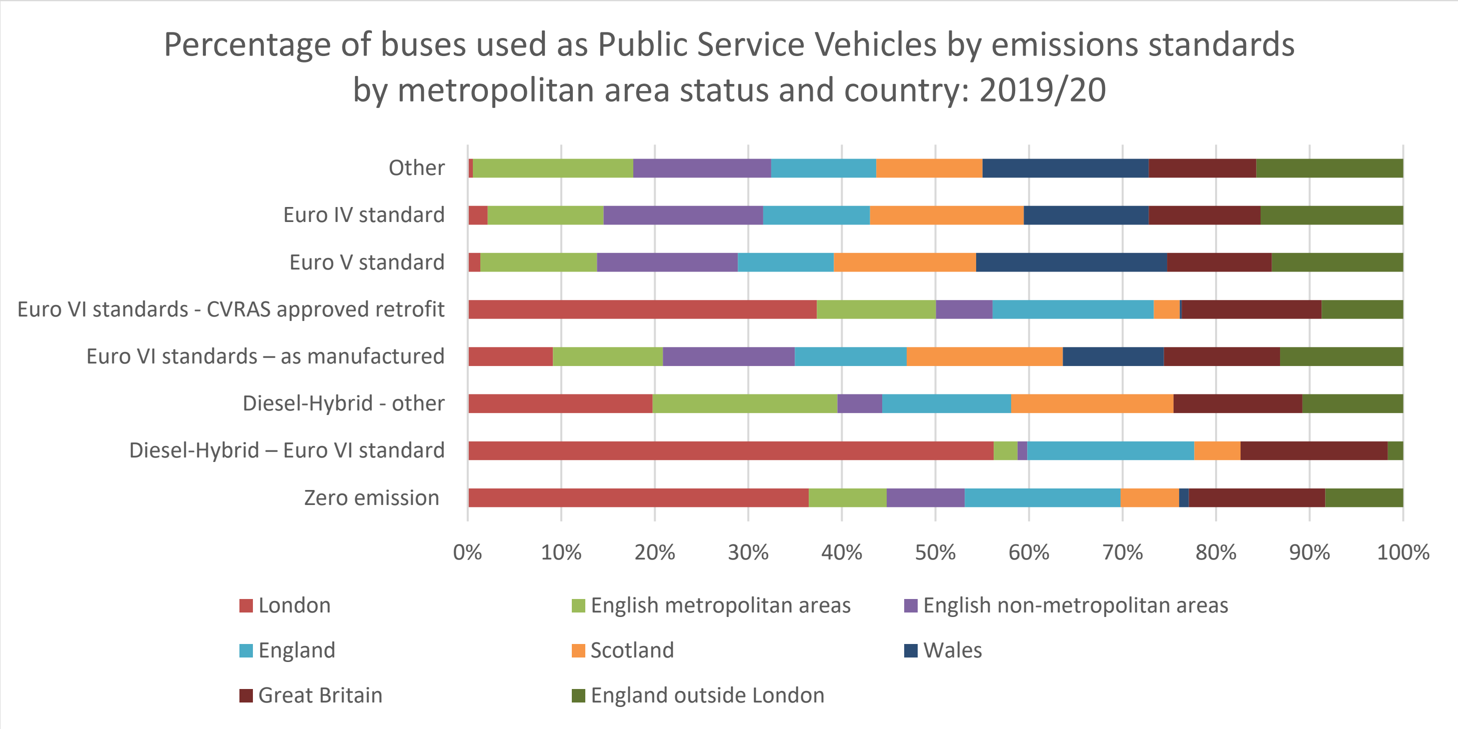

Figure 23 Emissions standards of buses by geography[45]

191. The scale of any infrastructure related impacts will be highly contextual to the local environment. For example, the suitability of the existing electrical infrastructure will vary across the country – in some cases it will require reinforcement or additional capacity to allow for the installation of sufficient high-powered charging infrastructure, concentrated in bus depots, in others a lighter touch might be appropriate.

192. Though some rural areas will have sufficient existing grid capacity, others will not. We recognise high upgrade costs required for infrastructure may have a disproportionate impact on rural bus operators, especially as they are more likely to be SMEs, with limited and/or remote garage/depot space.

What actions can you take to tailor your policy to work best rural areas?

193. As part of the National Bus Strategy (where this intention to consult was flagged), local transport authorities are producing Bus Service Improvement Plans (BSIP), which will include actions for working to transform the local bus fleet to zero emission. This will ensure that local context is considered with respect to uptake of ZEBs, alongside targets for journey times and reliability improvements and bus priority measures to drive improvements for passengers.

194. BSIPs also require LTAs to consider the differing needs of any parts of their area (e.g. urban and rural elements). Furthermore, also as part of the National Bus Strategy, government has committed to support new forms of provision, such as demand responsive travel in smaller vehicles, in rural areas. Such vehicles are typically easier to immediately decarbonise.

[45] Department for Transport, *Vehicles operated by local bus operators*, 2020

195. Government is actively supporting industry-led work into what skills and qualifications may be required currently, and in the future, to ensure a thriving ZEV skills base in all areas of the UK. As part of this effort, the Government is reviewing whether current regulations are sufficient to protect mechanics working on ZEVs. We are working with the Institute of the Motor Industry (IMI) to ensure the UK's workforce of mechanics are well trained and have the skills they need to repair and maintain ZEBs.

196. We note that the development of energy storage and smart charging technologies can mitigate the need for expensive grid connections, both in rural and urban areas. The Zero Emission Bus Regional Areas (ZEBRA) scheme encourages bids to consider such energy solutions, ensuring that areas, including rural, with poor connectivity are still able to benefit without the need for prohibitively expensive grid reinforcement. In addition to the accompanying consultation we will look to learn from ZEBRA bids covering rural areas.

197. Ofgem are reviewing the electricity network price control regulatory framework, with the next iteration due to take effect from 2023 – this will ensure that there is sufficient investment in electricity networks to enable the transition to zero emissions transport more broadly.

198. Ofgem have also concluded a consultation considering how the costs of new and upgraded connections are recovered from connecting customers and electricity bill payers more generally through socialising some of these costs.

199. With vehicle to grid technology, battery electric buses have the potential to perform as energy aggregators, acting as virtual power plants in rural areas, helping to balance the local distribution network, and cultivating new sources of revenue. Bus depots with hydrogen refuelling infrastructure can provide co-benefits, helping to decarbonise other modes of heavy transport such as tractors, HGVs, and special purpose vehicles.

200. We intend to use responses and evidence to the consultation, published alongside this impact assessment, to test our understanding of the effect of the policy on rural areas, and determine if specific support is required.

201. Government is working to leverage sources of finance to support uptake of zero emission buses, to ensure all parts of the country can benefit. As part of the 2020 Autumn Statement, the Chancellor announced that the government would launch a national infrastructure bank (UK Infrastructure Bank or UKIB) in 2021. This was formally launched on 17 June.

202. UKIB's remit, which will prioritise investment in projects that help tackle climate change, helping the UK to meet its net zero target by 2050, and level up the country by supporting regional and local economic growth, also aligns with aims to decarbonise rural transport.

203. There are also increasingly flexible offers in terms of financing and leasing buses, which may be of particular interest for rural and smaller operators.

204. As part of the Better Deal for Bus Users, government has invested £20 million through the Rural Mobility Fund to trial demand responsive bus services in 17 rural and suburban areas

across England. Some of these will use zero emission vehicles, and as these schemes deliver we will seek to learn from this to broaden our evidence base.

205. Government has taken a holistic approach to the bus sector, with decarbonisation forming one pillar of the broader strategy set out in Bus back better. Thus, this proposed policy must be viewed through the lens of the national bus strategy.

Small and Micro Business Assessment

How much of the policy objective is sacrificed by applying a full exemption for SMBs?

206. Small businesses are defined in the better regulation framework guidance as those employing between 10 and 49 full-time equivalent (FTE) employees. Micro businesses are those employing between 1 and 9 employees.

207. Small and Micro Businesses (SMBs) make up 99 per cent of UK businesses and account for around 48 per cent employment and 33 per cent of turnover. SMBs often cite regulation as one of the key barriers to growth, and regulation can affect them disproportionately. The default position is to exempt SMBs from the requirements of new regulatory measures.

208. It can be argued that the implementation of the policy being proposed would place barriers to entry on the industry.

209. However, it may not be appropriate to provide exemptions to SMBs from any final regulation, due to the need to mitigate the environmental, legal and international relations risks outlined in the problem under consideration. If we exclude SMBs we might fail to achieve the policy objectives. The objective is to end the sale of new non zero emission buses, relating to wider government aims of achieving net zero greenhouse gas (GHG) emissions.

210. An extensive range of options were reviewed and refined throughout the policy development process. The proposed policy is designed to enable the market to develop, whilst ensuring international and domestic climate targets are met.

211. The "big 5" operators (Stagecoach, FirstGroup, Arriva, Go-Ahead, and National Express) make up around ~80% of the English bus market, outside of London[46]. The remaining 20% consists of, typically, smaller operators – however very few, if any, would be considered micro businesses. While most bus operating companies are private, some are operated as community based or not for profit entities, or as local authority arms-length bodies.

212. Rather than a full public service vehicle operator's (PSV 'O') licence, organisations which provide transport on a not for profit basis can apply for permits under Section 19 and Section 22 of the Transport Act 1985. These operators are far more likely to be SMB than full PSV operators.

---

[46] Department for Transport, *Operator market share of weekly bus vehicle trips by local authority,* 2017

213. Data held by Traffic Commissioners allows us to examine the make-up of bodies operating under section 19 and 22 permits. Section 19 permits can be standard (up to 16 passengers or less) or large (17 passengers or more). The data contains basic information about operators who have applied for one of the three types of Transport Act 1985 permits – section 19, section 19 large and section 22. This data shows that there are approximately 6,300 operators who hold valid permits.

214. The vast majority of these operators (around 94%) hold section 19 permits while others hold either section 19 large (1%), section 22 (4%) or multiple permits (1%). The types of permit held by operators are displayed in Figure 24, below. The manually entered fields that make up the data could contain a substantial number of entry errors, so all results derived from using this data should therefore be treated with caution.

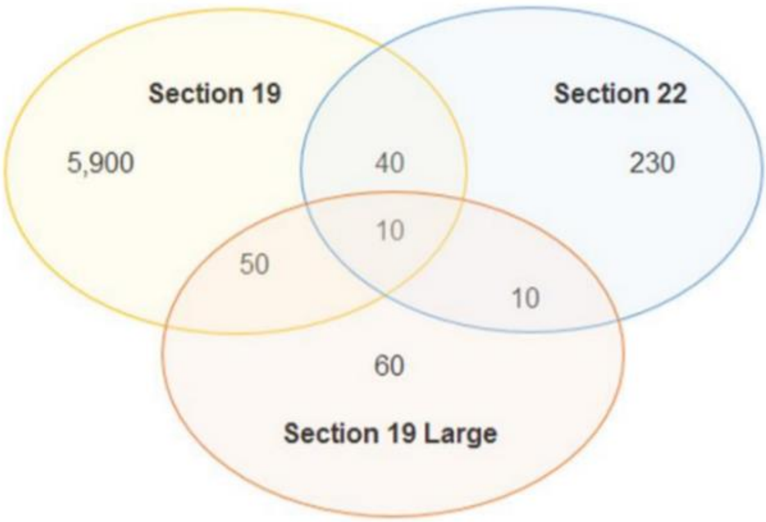

Figure 24 S19, S19L and S22 operators

215. The permit data also suggests that around half of bodies operating using permits are educational institutions such as schools and universities. This has been estimated using a keyword sift of the names of operators (e.g. those operators with the words ‘school’, ‘college’ or ‘university’ in their name have been classified as being educational institutions). These figures should therefore be treated with caution but do provide some indication of the types of organisations which make up the sector.

Type of operator	**Number**
Educational institution	3,000
Place of worship	150
Local authority	200
Other	2,950

Figure 25 SMB operators by type

216. The relative amount of sectoral GHG emissions generated from SMBs is small, though it may be disproportionately large, relative to their market share. This is due to reliance on cascaded, older vehicles. As a result, SMB operators are likely to have higher average, per vehicle CO2 emissions, relative to larger operators who are more easily able to purchase newer buses. Thus, the proposed policies focus only on new sales will mitigate some of the direct effects on SMBs.

217. None of the existing manufacturers in the UK are SMB, and, as noted, neither are the vast majority of operators. As the policy does not propose ending the use or second-hand sale of existing non zero emission buses, those who rely on cascaded or existing vehicles will be able to continue using existing operational models until the end of their useful life. As shown above, we expect the price of these vehicles to fall over time, and we can expect that to be reflected in the second-hand market also.

218. Unlike other segments of the automotive manufacturing market, for example cars and light duty vans, bus manufacturing tends to be more labour intensive, with relatively less automation in bus manufacturing. Sunk and fixed costs for manufacture can be lower, and thus enable greater participation from SMBs.

219. Another means to exempting a large proportion of SMBs would be to target the policy to apply only to operators holding a Public Service Vehicle (PSV) licence rather than the Section 19 and 22 permits which community transport organisations operate under.

220. How these users are treated will be an important question for the future regulatory regime for any of the proposed end of sales dates. We will be guided by responses to the accompanying consultation. If any derogations are needed, this would ultimately be addressed through regulation.

221. However, it is important to kep in mind that SMEs will be disproportionately affected by climate change[47]. Thus the implications, relating to SMEs, of any action taken to mitigate climate change must be viewed through this lens.

How much of the overall cost burden to business is expected to fall on SMBs with no exemption?

222. As set out above, due to the existing market structure, the burden will mainly be borne by larger operators, who represent the overwhelming majority of new bus purchases. Many already have voluntary or local-led commitments relating to decarbonisation.

223. In all scenarios, there will be some agents for whom the effect of an earlier end of sales date might be disproportionately negative, and for whom specific exemptions might need to be considered.

224. We would not expect costs to be disproportionally weighted toward SMBs, given their reliance on the second-hand market for vehicles. Therefore, there are unlikely to be direct effects, but, holding all other things equal, the restriction on the supply of further ICE buses may raise prices on the second-hand market, at least in the short term.

225. We would expect the larger fleets, who represent a high proportion of new vehicle purchases, to continue to turnover vehicles and ensure a steady flow of vehicles to the second-hand market, over time.

[47] Hendrichs & Busch, *“Carbon management as a strategic challenge for SMEs”*,

226. We intend to use responses and evidence to the consultation published alongside this impact assessment to firm up our understanding of the effect of the policy on SMBs and determine if an exemption might be necessary.

Trade Impact

227. The potential impacts of the policy on UK trade and investment must be given against the counterfactual.

228. Option 0: Do nothing (the counterfactual) represents a continuation of the status quo. There will be no additional policies to enable the end of sale of non zero emission buses. As a result, the resulting uneven development of the UK zero emission bus industry will likely impact on UK trade and investment. This is evidenced by the fact that, currently, manufacturers still must balance the production of zero emission models alongside conventional internal combustion engine models, we expect this to continue without this policy.

229. In this counterfactual some small trade and investment effects may be seen:

- **Expenditure effects** – There are some expenditure effects without the proposed policy, as grant funding has already been disbursed, with further rounds already underway, including across the devolved administrations, which has incentivised domestic investment and foreign direct investment (FDI). The inward FDI flow resulting from expenditure effect is likely negligible compared to total UK annual inward FDI flows. The effects on goods and services imports and exports resulting from expenditure effects may be reasonably assumed to be negligible.

230. We believe there is an opportunity for the UK to grow its automotive and supporting technologies sector significantly. Such a major disruptive technology transition presents an opportunity for the UK's successful automotive sector to be at the forefront of new technologies. Any accelerated ambition should place us in a good position to capture part of this growing global market.

231. Options 1-5, may cause additional trade impacts not realised in the counterfactual scenario:

- **Leveraged effects** – Policy would provide certainty to the market and focus research and development efforts away from non-zero emission-based powertrains toward zero emission alternatives. In this case, we could expect domestic manufacturing to capture a growing portion of the international market. This could result in an increase in UK exports of zero emission buses, alongside increased exports of UK services, in the form of transport and energy consultancy services which count as mode 2 services exports, consumption abroad. The existence of a thriving UK market implies that infrastructure, specialist finance firms, consultants and other service providers, vehicle manufacturers and operators tied to the UK operate, these agents may import specialist components and machinery as part of their capital expenditure. This may also attract additional inward Foreign Direct Investment (FDI) to the UK.
- The expected increase in the UK export of services would likely have a marginal positive impact on total UK goods and services exports, which stood at £562.8bn

in 2020[48]; likewise, the expected flow of inward FDI to the UK resulting would likely have a marginal positive impact on the UK's inward FDI stock, £1573.6bn in 2018[49].

- Ning and Wang[50] suggest that FDI relating to environmental projects tends to increase overall positive environmental knowledge externalities in a region, and also spill overs to nearby regions, attenuating the absorption and diffusion of a variety of cross-sectoral knowledge
- **Growth effects** – it is expected additional growth will be stimulated in the UK downstream automotive and advanced manufacturing and services segments as a result of the policy. It is likely the imports and exports and inward and outward FDI flows in this segment will experience additional growth.

232. The competition assessment section outlines the domestic bus manufacturing market. New entrants to the market, e.g. Oxfordshire-based Arrival, could also offer further opportunities in the development of the UK's zero emission bus market.

233. Unlike the cars and vans market, which relies on large volumes and production automation to provide competitively priced products, the bus market is relatively low volume and relies far more on manual construction and finishing. These lower barriers to entry mean that it is possible for small-scale companies to potentially produce a price competitive product in the bus market. This presents trade and export opportunities for UK SMEs.

234. There are already a number of countries who have announced end of new sales dates, which will help in focussing manufacturer strategies on non-zero emission technologies.

235. The Technical Barriers to Trade (TBT) Agreement defines measures prohibiting the manufacture, importation, marketing or use of products as technical barriers. Any potential regulation may create non-tariff barriers, however the degree to which this is true is subject to final approach and policy design.

236. As the proposed policy assessed in this IA would simply be an announced end date for the end of sales, rather than a regulatory action, at this point, this policy would not constitute a technical barrier to trade. Any impact as a result of regulation would be captured by the IA for any enforcement regulation. This proposed policy may have indirect impacts on commercial behaviours, summarised below.

237. The value of new internal combustion engine buses (imported to the UK) will likely greatly diminish as there will be no means to register and operate any new vehicle without zero tailpipe emissions.

238. However, this policy also opens opportunities for greater investment and trade than currently exists. The three largest UK bus manufacturers all make zero emission models, so there is existing potential to scale up, creating more jobs, alongside developing domestic industry's ability to export globally.

---

48 Department for International Trade, "*Core statistics book for trade, investment and the economy",* 2021

49 ibid

50 Lutao Ning & Fan Wang, "*Does FDI bring environmental knowledge spill overs",* 2018

239. Government strategies recognise that manufacturing ultra-low and zero emission buses in the UK will have a positive multiplier effect, supporting UK jobs and growth and new export opportunities.

240. The zero-emission bus sector is still globally nascent. However, the overwhelming majority of the existing global fleet (~90%[51]) is based in China. Despite this, there are still enormous opportunities for UK manufacturing and services.

241. Already, UK bus manufacturers are already exporting, including zero emission buses, around the world. Examples include Alexander Dennis double deckers operating in Mexico City, Optare buses in New Zealand, and Wrightbus vehicles in Japan.

242. In order to continue attracting international investments and anchor high value manufacturing to the UK, government has committed to increase the productivity and competitiveness of the UK zero emission supply chain. There are still gaps in the UK supply chain meaning automotive manufacturers import components.

243. The Automotive Sector Deal announced a commitment for industry to increase the percentage of UK content in the supply chain to 50% by 2022. Development of, for example, domestic traction motor and power electronics technologies and capabilities could also deliver significant export potential.

244. The Advanced Propulsion Centre predicts that optimised future electrified supply chains will be localised to ensure they are cost effective and competitive. It estimates that there are £24bn worth of opportunities for UK suppliers in batteries, electric machines, and power electronics in the next 5 years.

245. The UK also has considerable expertise in the design and manufacture of electric chargepoints. Ambitions and policies across modes mean the UK is in a strong position to attract investment in infrastructure. We can also lead development of emerging new chargepoint and energy business models, particularly through government supported work on smart charging and energy storage options.

246. The All Electric Bus Town or City, ZEBRA and other schemes and initiatives are expected to stimulate the ZEB UK manufacturing sector, driving down the prices of buses, supporting infrastructure, and associated services such as consultancies.

247. Approx. 80% of new bus registrations in 2020 were domestically manufactured, with the remainder vehicles which were imported from other countries. Specifically, for zero emission buses the split was 77% domestic and 23% imports.

248. The measure does not specifically seek to affect trade or investment, rather it is a consequence of achieving our stated objective. This will likely impact imports of conventionally powered buses into the UK, though less than 27% are purchased from non

[51] Electric Buses in Cities (2018) Bloomberg New Energy Finance

domestic manufacturers. The measure will not restrict the ability of domestic manufacturers to produce vehicles and components for export.

249. There is a well-established supply chain for the production and operation of conventional buses in the UK, with specialised firms producing diesel and alternative fuel engines, and related components. These technologies will retain use cases in other sectors, for example non-road mobile machinery and for export.

250. In the short term, there is a risk of reliance on imports of both components for, and fully finished, electric and hydrogen buses. By providing a clear direction of travel to the market, i.e. through the end of sales, we expect firms to adapt and invest appropriately to meet the challenge. Early conversations with manufacturers support this view. Broader Government initiatives, like the Automotive Transformation Fund, Faraday Institute, Advanced Propulsion Centre, and others, are providing support for zero carbon propulsion technologies.

251. It is also important to consider investment in earlier stage component production infrastructure, for example for batteries. This would encompass cathode and anode production and precursor chemicals production facilities. This would reduce dependence on foreign suppliers.

252. Energy storage onto a bus is very challenging as most of the space is required for passengers. The challenge for buses varies significantly between different bus designs (double decker buses are more challenging as the energy storage cannot increase the height of the vehicle) but all buses face the challenge of ensuring the chassis is strong enough to hold the weight of the energy storage, 'a challenge which is less of a concern for other vehicle types. Given UK expertise in double deck design and manufacturing, this could present further export opportunities.

253. The lifetime of batteries and fuel cells used in buses is currently uncertain. This means that vehicle operators could face a potential additional cost burden for mid-life battery or fuel cell replacements. This uncertainty may well remain in the short term until a generation of zero emission buses have performed in real-world operation.

254. However, as flagged in the risks and unintended consequences section, manufacturers may cross-subsidise ZEVs by increasing the price of ICEs within markets. With the intention to restrict this ability domestically, manufacturers could cross-subsidise across international markets, but this is at their discretion and often not attractive because of currency differences, so vehicle cost impacts are uncertain and unclear.

255. The proposed measure will not include different requirements for domestic and foreign business. Both imported and domestically produced buses will be treated equally under the proposed measure, and there are no proposals to treat any particular countries differently to any other.

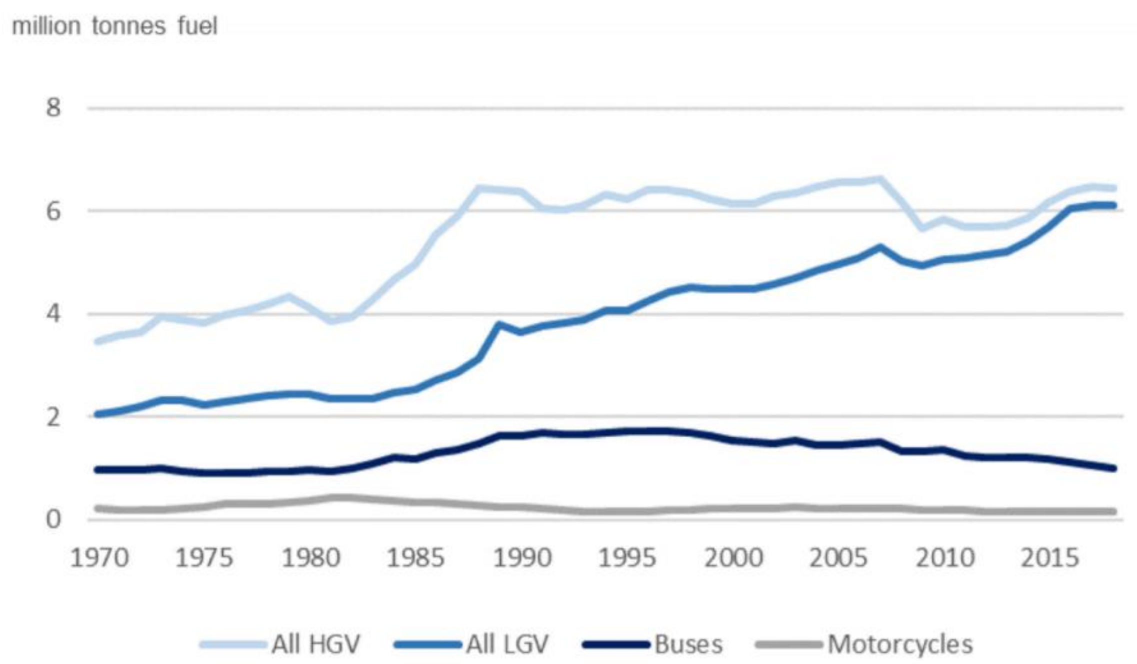

Figure 26 UK diesel consumption by vehicle type

256. Per Figure 26[52], above, buses share of diesel consumption has been declining since the mid-1990s, reflecting efficiency gains from EURO engine standards. This trend will likely accelerate as a result of this policy. Per Figure 27[53], below, most UK petroleum products were imported.

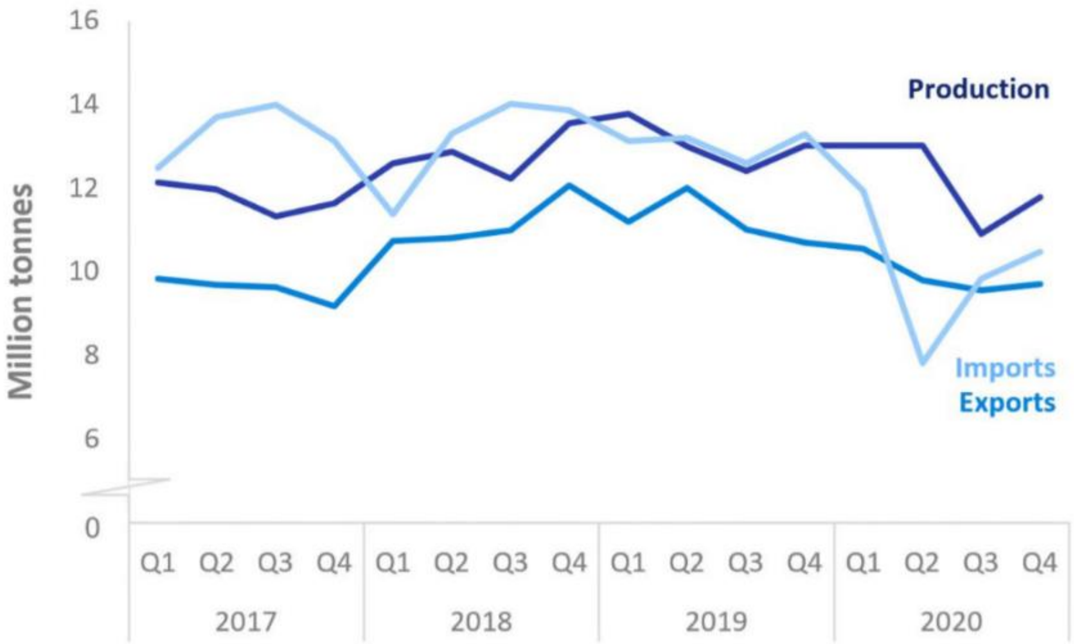

Figure 27 UK balance of payments for petroleum products

257. We can extrapolate and subsequently use the analysed impact on petroleum/diesel products as a corollary for other sectors in the bus value chain, such as gearboxes, fossil fuel heaters, etc.

52 Energy Consumption in the UK 2020

53 Energy Trends March 2021

258. We intend to use this second consultation to further understand trade implications of this policy and ensure they are fully assessed in the final IA and any further assessment of regulation to implement the policy.

Competition Assessment

Will the measure directly or indirectly limit the range of suppliers?

259. This proposed policy may act as a barrier to entry, as businesses will only enter the market if they think it is commercially viable given any additional cost this proposal might impose in the short term. There is a trade-off here between government intervention and ensuring healthy market competition.

260. This assessment concludes that the proposed policy is unlikely to have a negative impact on the level of competition in the UK launch market, given the "outcomes" based approach that has been taken when developing the policy. This prescribes the outcomes which government expects to see, rather than how to achieve them.

261. The measure, as proposed, will inevitably have impacts on the bus market. The intention is to end the sale of new diesel/non-zero emission buses, which may have unintended consequences (some of which are flagged in the risks section) which directly or indirectly could limit the number or range of suppliers, their ability to compete and the choices to end users. However, all existing manufacturers and operators have plans to move to zero emission technology in the coming years and all manufacturers are being treated equally through the policy's objectives.

262. The economic intuition behind SMBs being disproportionately affected by regulation is that some costs resulting from complying with regulation are fixed, i.e. they do not depend on the output of the business. Since larger businesses operate on a greater scale, such fixed costs are likely to be a smaller proportion of their overall costs. An identical increase in fixed costs in absolute terms will, therefore, translate into a larger relative increase in costs for SMBs.

263. The indirect impacts on competition may be more apparent than any direct impact, at least in the short term. Currently zero emission buses, whether electric or hydrogen fuel cell, tend to be more expensive than those propelled by combustion powertrains. This is partly the result of high component costs, such as batteries and fuel cell stacks. These tend to be produced internationally, and their high cost may:
   - significantly raise the costs of production for incumbent firms, causing them to exit the market;
   - significantly raise the costs for new suppliers (including small businesses) relative to existing suppliers; and,
   - raise the costs of some existing suppliers relative to other existing suppliers.

264. There may be fixed costs with the need to retool manufacturing facilities and upskill workers to process high voltage electrical components and pressurised hydrogen gas, for example. There are large fixed costs associated with constructing a bus manufacturing

facility, regardless of any additional regulatory requirements. This is also the case for vehicle operators, who face high costs in terms of the development and building of depots, procurement of vehicles, and other associated infrastructure necessary to enable vehicle operation. However, these cost elements are largely independent of the proposed policy, which may vary certain component elements of the total cost.

265. In the Prime Minister's 10-point plan for a green industrial revolution, Government committed to supporting the development of "gigafactories" in the UK, to support the market through domestic battery manufacturing. The Automotive Transformation Fund (ATF) is a new programme that aims to establish a competitive and sustainable UK supply chain. It offers a share of up to £1 billion of funding for capital and associated industrial research projects. These measures will support the industrialisation of a high value, electrified automotive supply at scale in the UK, and mitigate some of the effects.

266. Existing bus manufacturers in the UK already produce zero emission models, these manufacturers may enjoy incumbency advantages, such as access to information, pre-qualification, and support for transition costs.

267. 80% of urban buses operating domestically are made in the UK, with manufacturing based across the UK with Alexander Dennis based in Falkirk, Scotland; Wrightbus, based in Ballymena, Northern Ireland; and Optare/Switch Mobility, based in North Yorkshire, England.

268. Delivery of the Prime Minister's commitment for 4,000 zero emission buses will provide a considerable boost to industry . The 4,000 ZEB investment would help position British bus manufacturing sector as a centre of high-tech manufacturing, with benefits for jobs and trade.

269. For component suppliers of manufacturers, specifically those involved in powertrains, the proposed policy will likely have an impact. Though, as the proposed measure does not halt the export of such vehicles (or related components), manufacturers and their supply chain will still be able to sell their products in geographies where it is appropriate to do so.

270. It is important to note that the measure as proposed will not affect the manufacture, or export of such vehicles, nor sale on the second-hand market.

271. The manner of the policy may, inadvertently, favour some suppliers over others. For example, those who have already integrated power electronics, batteries and fuel cells into manufacturing processes may have a competitive advantage relative to those who need to retool and reskill their manufacturing base and staff to a greater extent.

Will the measure limit the ability of suppliers to compete?

272. Inherently, the proposed measure will influence the characteristics of new buses which may be placed on the market in the UK. However, despite this, the proposed policy will not directly:

- limit the sales channels a supplier can use, or the geographic area a supplier may supply in; or
- substantially restrict the ability of suppliers to advertise their products; or
- limit the suppliers' freedom to organise their own production processes or their choice of organisational form.

273. The specification of certain standards, i.e. for zero tailpipe operation, may also increase suppliers' costs. Higher costs incurred by businesses could therefore translate into higher fares prices, and a reduction in the variety of services available. Given, on average, the cost of an average battery or fuel cell stack far exceeds that for a combustion engine there is a likelihood of higher costs in the short term, however zero emission buses have far lower operating costs meaning that zero emission buses can often be more cost efficient when compared from a total cost of ownership perspective.

274. A major part of the decision to purchase a commercial vehicle depends on the expected total cost of ownership over the vehicle's lifetime. This includes: the capex cost of the vehicle including taxes and incentives, the cost of borrowing the capital to make the purchase, the residual value it is likely to retain for resale on the second hand market, and the cost of refuelling and maintenance. TCO calculations will remain the key component of vehicle purchasing decisions for zero-emission buses (as for ICE) and the competitiveness of the market (relative to ICE buses), on this basis, may ultimately determine the rate of uptake.

275. Government remains technology neutral, but we are not outcome neutral – to achieve legally binding carbon and air quality targets and reduce our contribution to climate change the bus sector must ultimately transition to zero emissions. This approach is less likely to harm innovation, since suppliers are able to tailor their products to the standard, compete over efficient modes and methods of production, and ultimately provide more choice for end users.

276. The proposed policy will not restrict the ability of suppliers to compete with each other by differentiating their products. Regardless of powertrain there are numerous other characteristics which bus manufacturers do and will continue to compete on.

277. In terms of fuel, although the current range of blended petroleum products and other combustible fuels will no longer be appropriate for zero emission buses, we anticipate competitive electricity tariffs and sources of hydrogen will be new arenas for price competition and product differentiation.

Will the measure limit suppliers' incentives to compete vigorously?

278. Policy or regulation can create a scenario where it is in suppliers' commercial interests to coordinate their activities in an anti-competitive manner, as flagged above. The move to zero emissions for the bus market will not eliminate the ability for suppliers and manufacturers to compete.

279. In fact, the move to full zero emissions may increase the competitiveness of the market – with a new, and potentially greater, array of choice for end users, for example on battery size, vehicle capability, design etc. There is still significant scope for product differentiation

in the bus market, irrespective of any policy relating to powertrains. Separate from price, characteristics such as handling, ride etc. will remain important for operators, and a venue where manufacturers and suppliers will remain competitive.

280. The characteristics of the bus market, namely the current market condition as well as methods employed in manufacturing, mean that it would be unlikely that suppliers would lack an incentive to compete, particularly on price. This is as bus manufacturing is particularly labour intensive, especially relative to other automotive manufacturing sectors, such as for cars and vans, which tend to have a greater degree of automation.

281. The need for such significant change across the sector may also diminish any inherent advantage incumbent firms have, lowering the barriers to entry to the market and allowing for greater competition, and thus price decreases.

Will the measure limit the choices or information available to consumers?

282. The measure, once implemented, is directly intended to totally restrict the availability of new diesel/non-zero emission buses.

283. We would expect operators to be able to access information relating to battery chemistry and other key technical information relating to zero emission vehicles as a matter of course in making the commercial decision to procure buses from any given manufacturer.

284. As buses are road vehicles, there is a baseline level of information that is publicly available through the DVLA's Vehicle Enquiry Service, in addition to the logbook. Fundamentally, the information that would be available to a purchaser now, will also be available, at least, as a result of the proposed policy.

285. In December 2020, Government laid an SI before Parliament enabling the display of green number plates for zero emission vehicles, including buses. Green number plates provide a UK-wide mechanism which will enable people to spot and differentiate vehicles based on their environmental impact, help inform road-users and normalise the idea of clean vehicles on our roads. This all plays an important part in supporting the transition to zero emission vehicles, and easily enables passengers to understand the relative environmental impact of different bus services.

Next steps

286. The consultation published alongside this impact assessment asks specific questions to enable a more in depth understanding of the market dynamics in the bus sector, for a more complete assessment of the effect of the proposed policy on competition in the final IA.

Innovation Test

287. The emerging nature of the zero-emission bus market means that it is inherently innovative for the UK, and the proposed policy is designed to focus market development in bus manufacturing, and related sectors, to help achieve climate change commitments. In the absence of such policy, there is a risk that firms in other countries will benefit from this

innovation to the detriment of those in the UK. Creating a prohibitive environment in the UK would therefore not achieve the policy objectives.

288. Overly prescriptive policies can negatively impact innovation by ‘pigeonholing’ the industry into a limited number of pathways that shut out other avenues of discovery. The preferred option has been drafted in an “outcome” based approach, prescribing what government expects the outcomes to be rather than how to achieve them.

289. This approach has been chosen to ensure the greatest flexibility and minimise other burdens for industry, whilst still ensuring there are sufficient precautions in place to mitigate any risks. By keeping the prescriptiveness to a minimum, the policy aims to not stifle innovation and potentially innovative changes to organisational methods and processes.

290. Officials have considered the potential impacts, with relation to innovation, throughout policy development, and have ensured the policy is:
   - designed and reviewed with a clear understanding of how it can maximise the potential benefits of innovation; and
   - is supported by robust evidence and analysis

291. This has been supported by use of futures tools and techniques, to gather intelligence and explore the different dynamics of change.

292. In the driver mapping exercise, the following factors were considered key to shaping the future business environment:

Levelling up and building back better

293. Government wants the UK at the forefront of the design and manufacturing of zero emission vehicles. The size of the global opportunity is huge: McKinsey estimates the global market for zero emission vehicles could be worth £1.5 trillion per year by 2030.

294. The UK is well placed to seize these new opportunities as home to the manufacture of a range of zero emission buses, across England, Scotland and Northern Ireland, one of the fastest selling electric vehicle markets in Europe, all supported by a world-class R&D ecosystem and supply chain.

Improving air quality

295. Over recent decades, UK air quality has significantly improved thanks to action at all levels. Between 1990 and 2018, UK estimated emissions of nitrogen oxides have fallen by 73%, UK estimated emissions of PM10 particulate matter have fallen by 53% and UK estimated emissions of PM2.5 particulate matter have fallen by 54%[54].

296. Despite this, poor air quality remains the largest environmental risk to public health. Public Health England found that the health and social care costs of air pollution (PM2.5 and NO2) in England could reach £5.3 billion by 2035.

[54] Department for Business, Energy and Industrial Strategy, *National Atmospheric Emissions Inventory,* 2020

297. Road transport is a major source of air pollutants, including 34% of NOX (contributing to 80% of concentrations at the roadside), 12% of PM2.5 and 4% of non-methane volatile organic compounds (NMVOCs). Investing in clean air and taking action to tackle poor air quality are key priorities.

Improving energy security

298. Since 2013/14, the UK has become a net importer of oil. Imports of road transport fuels have also increased over the last decade, in particular to, meet the growth in demand for diesel. In 2019 the UK remained a net importer of petroleum products by 13 million tonnes[55]. As with crude oil, imports are critically important to meet UK domestic demand.

299. Zero emission vehicles can help reduce the UK's reliance on oil, and exposure to the volatility of global markets. The transition to zero emission vehicles could partly replace our reliance on imported oil with largely UK generated energy sources, helping to improve the UK's long-term energy security.

300. This will also likely stimulate the domestic energy services, e.g. frequency response, and flexibility services, and energy storage industries, in addition to generation and distribution.

Lowering costs for operators and users

301. Today zero emission vehicles, like battery electric buses, already have substantially lower fuel and maintenance costs compared to conventional vehicles. More energy efficient vehicles and operations can significantly drive down the costs of operating bus services.

302. This can also enable greater services, including on routes which were assessed as uneconomical under conventionally fuelled operations.

303. Additionally, the Energy Saving Trust estimate that efficient driving alone could save drivers up to 5-10% of their annual fuel bill - for heavier vehicles, like buses, improving the overall efficiency of operations can have significant costs savings as well as overall emissions reduction benefits.

Policy pressure

304. As previously mentioned, there is a global impetus to move to zero emissions, across all sectors and segments of society. The UNFCCC provides the international strategic framework.

305. We have a series of legally binding carbon budgets that track progress against our long-term ambition to reduce economy-wide emissions to net zero by 2050. Today, transport is the largest GHG emitting sector in the UK, accounting for 27% of GHG emissions. Road transport accounts for 91% of this.

[55] Department for Business, Energy and Industrial Strategy, *Digest of UK Energy Statistics (DUKES)*, 2020

306. Given the broad, often global nature of the drivers outlined above, it is almost inevitable that the market will shift towards zero emissions technologies, as a result of numerous interventions by both state and non-state actors.

307. As outlined, this policy intends to ensure that this happens in a manner that is compliant with the UK's carbon emissions reductions targets, and consistent with the UK's Nationally Determined Contribution to the UNFCCC. It also aims to ensure that the transition to zero emission buses is delivered in a cohesive manner, to support the green transformation of the bus sector and to build back better post COVID-19; as well as ensure value for money for the taxpayer.

308. Officials also examined critical uncertainties – drivers which are more important for the policy area, but which have an uncertain outcome, to understand whether implementing a policy in a certain way could 'lock' the government or wider sector 'in' or 'out' of certain pathways.

309. A common insight that emerged from initial consultation is the considerable uncertainty industry has around the vision and policy direction for ZEBs nationally in the UK. The proposed policy will provide a clear steer to industry as to government's intention.

310. Also mentioned elsewhere in this IA is uncertainty relating to technology change and fears of obsolescence for first movers.

311. The proposed policy will not remove all incentives toward further innovation on internal combustion engines, as, through retrofitting and the second-hand market, opportunities will remain. Though, it will incentivise a move toward fully zero emissions solutions, providing opportunities for growth in this segment of the sector. A more comprehensive examination of the potential market impacts can be found in the competition assessment.

312. Government retains a technology neutral approach; however, we are not outcome neutral. By providing an end of sales date, we will provide assurance and a clear direction of travel, not only for the bus sector but also for related industries which are critical for the transition, such as the infrastructure and energy sectors. This would allow manufacturers to adjust product planning and assembly lines by a set date, in turn improving efficiencies and reducing costs, as well as building confidence for lenders and financiers.

313. This certainty will also encourage innovation toward overcoming some barriers that exist in the zero-emission bus space, for example further development of battery light weighting, more efficient motors, etc.

314. Government is supporting innovation across the sector, for example in vehicle-to-grid technologies, where battery electric vehicles may be used to supply electricity back to the grid at times of high energy demand, to glean wider energy system benefits. There may be opportunities to licence and export this technology around the world.

315. Key requirements of bus operations are range (can the vehicle travel far enough in one day), refuelling time (if a refuelling stop is required in the middle of the day whether this can be incorporated into existing rest breaks), carrying capacity (whether the vehicle can carry

the same number of passengers). Range is a major challenge across many classes of zero-emission vehicles, and, as buses may cover hundreds of kilometres in a single day, there is room for further innovation.

316. Providing batteries with sufficient capacity or hydrogen onto a vehicle to cover this range is very challenging, as outlined. Zero emission powertrains are also more expensive than diesel, so zero emission vehicles with equivalent range to ICE alternatives will be far more expensive, requiring further innovation to achieve cost parity.

317. We anticipate significant improvements in technical specifications, components and materials, software in the product, user friendliness and other functional characteristics, as a result of the proposed intervention.

5.0 Post implementation review

1. **Review status:** Please classify with an ‘x’ and provide any explanations below.

	Sunset clause		Other review clause		Political commitment		Other reason	X	No plan to review

Regulations to be reviewed every five years to ensure continued suitability.

2. **Rationale for not conducting a PIR:**

As there is no regulation presented there is no post implementation review. The enforcing legislation will come with its own impact assessment, including its own post implementation review.