

# **UK ZEV Mandate — a world-leading regulatory framework to drive supply and consumer confidence**

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## **Executive Summary**

While governments around the world have expressed ambitions to transition to zero emission vehicles (ZEVs), few governments have enacted enforceable regulatory frameworks to achieve these targets. Following extensive outreach with a a broad range of stakeholders, the UK has proposed a new regulatory framework centred around a ZEV mandate trading scheme, which will require that an increasing share of new cars and vans sold each year in the UK are zero emission. This framework would be the most ambitious legally binding, enforceable decarbonisation policy for cars and vans in the world and provide substantial climate and economic benefits. This paper discusses the development of this policy, summarises the main provisions, and highlights the forecasted climate and economic impacts for the UK.

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## **1 Background and motivation**

### **1.1 Climate contributions of cars and vans in the United Kingdom**

In 2019, the United Kingdom became the first major economy in the world to legislate its commitment to achieve net zero greenhouse gas emissions by 2050. This remains amongst the most ambitious targets globally and is aligned with a path to keep global warming to below 1.5°C above pre-industrial levels. Achieving this goal will require contributions from all sectors of the economy, but transport is a particularly critical area for action.

As shown in Figure 1, transport accounted for 26% of greenhouse gases emitted in the UK in 2021, more than any other sector; this share is similar to other years, despite a drop in absolute emissions in 2020 [1]. Within transport, cars and vans were responsible for 52% and 17% of greenhouse gas emissions respectively in 2021. Cars and vans emissions (dark green) have remained relatively high while other sectors, like energy supply and business, have fallen dramatically.

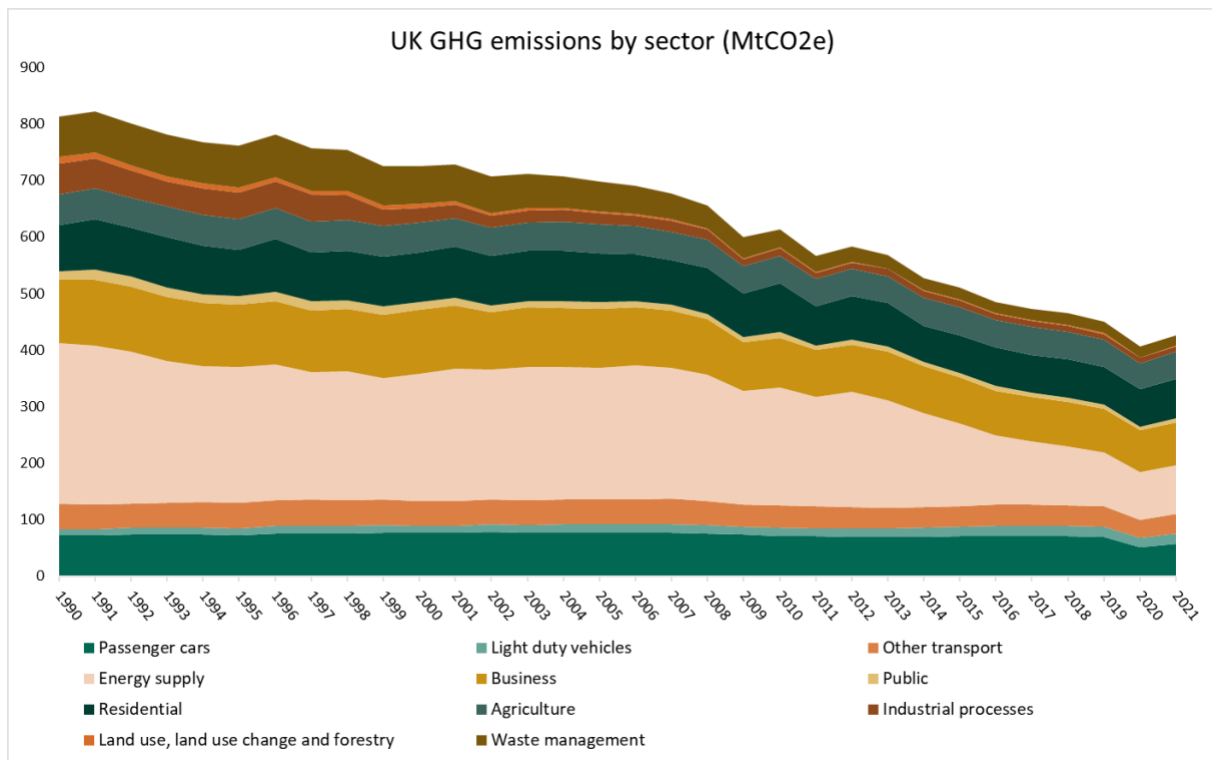


Figure 1: Contribution of different sectors to the UK's greenhouse gas emissions from 1990-2021 [1]

This trend, and the fact that vehicles remain on the roads for many years after their initial purchase, suggests that quickly reducing the emissions of cars and vans is critical for meeting the UK's climate targets. In November 2020, the UK committed "to end the sale of new petrol and diesel cars and vans by 2030, with all vehicles being required to have a significant zero emissions capability... from 2030 and be 100% zero emissions from 2035" [2].

## 1.2 Growth of ZEV sales in the United Kingdom to 2022

The market for zero emission cars and vans has grown dramatically in recent years, supported by reductions in vehicle prices and increased model availability as well as supportive policies from the UK government such as the plug-in car and van grants, investments in charging infrastructure, and consumer awareness programs. Figure 2 illustrates the share of new cars (in dark green) and light commercial vehicles (primarily vans, in light green) that were zero emission (including battery electric vehicles and fuel cell vehicles) from 2020 to 2022 [3]. To account for seasonal variation in ZEV sales share, the data is presented using a 12-month rolling average for each month. At the start of 2020, less than 2% of new cars and less than 1% of new vans were ZEVs. In under two years, these sales shares increased to almost 17% for cars and 6% for vans. By the end of 2022, over 1.5 million zero emission cars and vans have been sold in the UK. This progress illustrates that ZEV technology is mature and that there is consumer demand, but also indicates an opportunity for policy to ensure continued, predictable growth to meet climate targets.

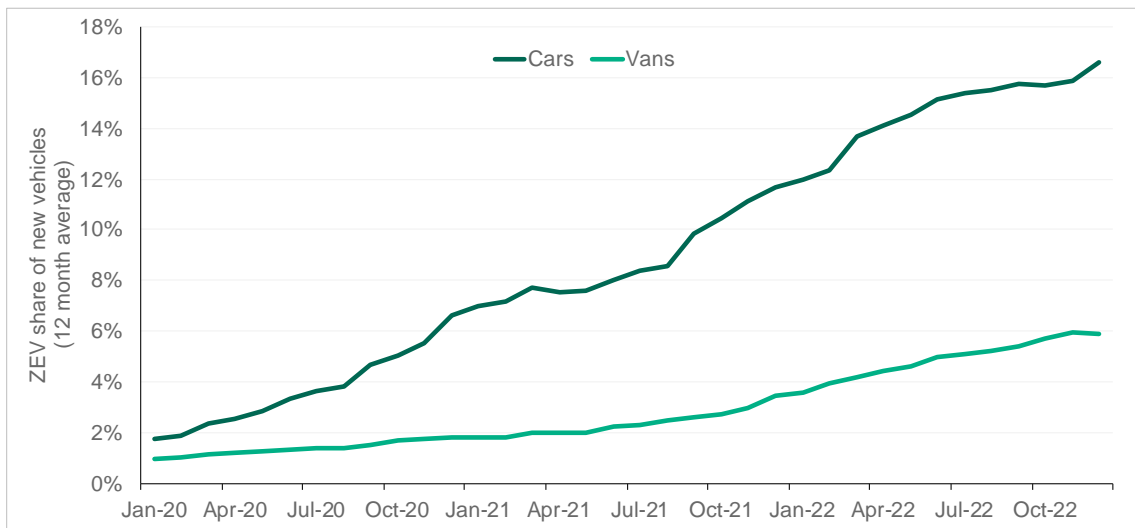


Figure 2: Zero emission share of new cars and vans sold in the UK, 2020–2022 [3]

### 1.3 History and shortcomings of existing car and van CO<sub>2</sub> regulations

Prior to 2020, when the UK was a member of the European Union (EU), car and van CO<sub>2</sub> emissions were regulated by the EU; these standards were initially applied to the car fleet in 2015 and to the van fleet in 2017. Manufacturer-specific targets are based on the fleet-wide average CO<sub>2</sub> emissions of new cars and vans using pre-determined lab-based CO<sub>2</sub> test procedures (formerly the New European Drive Cycle, or NEDC; now the Worldwide Harmonised Light Vehicle Test Procedure, or WLTP), adjusted for vehicle mass. Any manufacturer missing their target faced financial penalties — known as an ‘excess emissions premium’.

While these standards have been effective in incrementally reducing CO<sub>2</sub> emissions over the past decades, the regulations fell short in several areas. Firstly, because the targets are based on a fixed test procedure, manufacturers have largely focused on ensuring that their vehicles were as efficient as possible for the test, rather than for real-world use. Although the test procedure was changed from 2017 onwards to counter this issue, there continues to be a gap between real world CO<sub>2</sub> levels and levels set via the test procedure [4]. Secondly, because the EU targets worked on the basis of 5-year increments, rather than annual target changes, as soon as manufacturers hit their targets, they may effectively ‘plateau’ their emissions levels for the remainder of the target period, having no incentive for continued improvement. Thirdly, because the targets are adjusted based on vehicles’ mass, there has been an incentive for manufacturers to produce ever-larger (and therefore more polluting) vehicles and receive higher CO<sub>2</sub> targets [5].

### 1.4 Development of a new car and van emissions regulatory framework

When the UK left the EU in 2020, these CO<sub>2</sub> regulations were retained in UK law. However, outside the EU, the UK has the ability to design and implement a new regulatory framework to achieve its targets. The Department for Transport (DfT) published a Green Paper consultation in July 2021 to seek public views on the best framework to deliver the UK’s commitments. In particular, the consultation asked whether stakeholders preferred to strengthen the existing CO<sub>2</sub> regulation or to adopt a ZEV mandate-style framework, such as those utilised in California and the Canadian provinces of Québec and British Columbia. The consultation ran for three months and received 61 responses from companies (e.g., vehicle manufacturers, chargepoint operators, fleet operators), environmental non-governmental organisations (NGOs), and individuals [6]. Based on the views of the majority of respondents, as well as additional research by officials, the UK Government announced in October 2021 that it would develop a ZEV mandate framework, along with a CO<sub>2</sub> regulation for new non-zero emission vehicles, which would take effect in 2024.

Following this announcement, Government launched a second consultation on policy design features of a new car and van ZEV mandate in April 2022 [7]. This consultation, which ran for over 2 months, featured 16 questions on design features including ZEV uptake trajectories for new cars and vans, how a certificate

trading scheme might function, and the potential need for derogations and exemptions. In addition to receiving 76 written responses, government also conducted six stakeholder workshops for different sectors (e.g., vehicle manufacturers, energy/charge point operators, and environmental non-governmental organisations) and held bilateral meetings with many stakeholders, including manufacturers representing over 90% of the new car market and 97% of the new van market in the UK [8]. This stakeholder outreach process was critical in informing the design of the final proposal.

The third and final consultation for the ZEV mandate, containing the full details of the proposed new emissions framework, was launched on 30 March 2023 [9], alongside the government response to the previous technical consultation [8]. During this 8-week consultation period, government will again conduct workshops, bilateral meetings, and Minister-led workshops with key stakeholder groups in addition to soliciting feedback on 25 questions. As environmental policy is a devolved policy area in the UK, the consultation is being conducted jointly between the UK Department for Transport, the Scottish Government, the Welsh Government, and the Northern Ireland Department for Infrastructure.

## 2 Key features of the proposed ZEV mandate policy framework

The ZEV mandate is designed to balance many factors including, but not limited to: CO<sub>2</sub> reductions in line with the UK's legally binding carbon budgets, affordability for consumers, achievability for large and small vehicle manufacturers, and providing certainty for the chargepoint and electricity sectors. The key provisions are summarised in this section; full details can be found in the detailed proposals and accompanying Cost Benefit Analysis [9].

### 2.1 Trading scheme design

The proposed ZEV mandate would operate as a trading scheme under the powers of the Climate Change Act 2008 (CCA). The CCA permits the creation of trading schemes that operate by either limiting activities that contribute to greenhouse gas emissions, or encouraging activities that lead to a reduction in greenhouse gas emissions. This policy is based on limiting the sales of non-ZEV vehicles, and will have four components: the ZEV mandate for cars and for vans and the non-ZEV CO<sub>2</sub> standard for cars and for vans.

Trading schemes within the CCA operate through the requirement that a manufacturer's activity for each trading period (in this case, one year) be covered by a combination of allowances and credits. A manufacturer's activity in the ZEV mandate schemes is defined as the sale of new cars or vans (in the respective schemes) which are not zero emission. Therefore, compliance is defined as:

$$UK\ new\ non-ZEV\ sales\ activity - credits \leq allowances \quad (1)$$

Allowances are allocated each year for the allowable share of vehicles which may be non-ZEVs, or 100% minus the annual ZEV target, multiplied by the manufacturer's total new vehicle sales. For example, in a year in which the car target were 66%, for a manufacturer selling 100,000 cars, that manufacturer would receive  $(100\% - 66\%) \times 100,000 = 34,000$  allowances.

### 2.2 Annual ZEV trajectories

The core objective of the ZEV mandate is ensure that an increasing share of new car and van sales in the UK are ZEVs each year on the path toward being 100% ZEV in 2035. This initial regulation will set minimum targets out to and including 2030; initial proposals for targets in 2031-2035 are also included for consultation. Government intends for future tranche of legislation to implement binding targets at least as ambitious as those provided here.

Figure 3 shows the trajectories for cars (light green) and for vans (dark green). The solid lines from 2024–2030 indicate the extent of this regulation; the dashed lines indicate envisaged targets to be officially adopted in a later regulation. The annual targets for cars start at 22% in 2024 and reach 38% in 2027 and 80% in 2030. The targets for vans start at 10% in 2024 and increase to 34% in 2027 and 70% in 2030. The lower trajectory for vans recognises the lower zero emission sales share in 2022 and more limited market offerings, but rapid progress in the van transition is expected given the total cost of ownership savings.

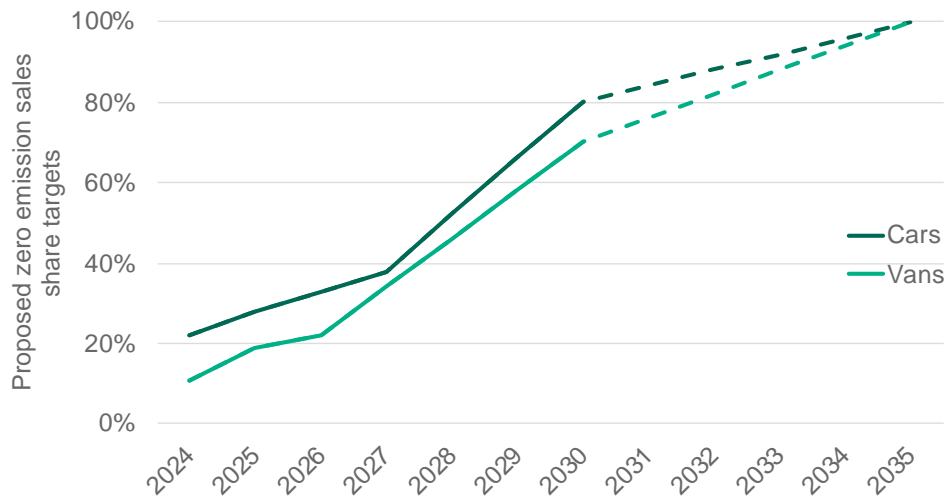


Figure 3: Proposed annual ZEV targets from 2024–2035 for cars and vans

### 2.2.1 Exemptions

Current UK and EU CO<sub>2</sub> emissions regulations exempt several categories of vehicles which perform a specific function and are typically modified from their original form with specialised equipment or body work, collectively referred to as special purpose vehicles (SPVs). Examples include wheelchair accessible vehicles, camper vans, hearses, and ambulances. In total, SPVs account for about 1–2% of the new cars and vans registered in the UK each year.

Because of the higher cost and more challenging requirements for making zero emission variants of these vehicles, this proposal would also exempt SPVs from the ZEV mandate, whilst also incentivising their development, i.e., producing an ICE version of an SPV would not use an allowance, nor would it be included in the registrations figures for calculating the number of allowances a manufacturer receives. If a manufacturer does sell a ZEV SPV in the UK, they may earn a credit in the appropriate scheme, which would offset one ICE vehicle sold in that scheme. These exemptions will be kept under review as the market and technology develops.

### 2.3 Minimum requirements for ZEVs

For a vehicle to qualify as a ZEV, the vehicle must meet a minimum set of requirements. These are intended to maximise the emissions reduction potential of this policy and ensure a positive user experience while also allowing ample opportunity for industry to innovate on product offerings to meet consumer preference. The proposed ZEV definition includes 3 factors: emissions limits, minimum range, and warranty requirements. These requirements apply to both cars and vans.

Firstly, a zero emission vehicle would be defined as a vehicle which emits no greenhouse gases from the exhaust. Specifically, the vehicle must have 0g CO<sub>2</sub>/km according to the Worldwide Harmonized Light Vehicles Test Procedure (WLTP) and also not emit any other greenhouse gases.

Secondly, the vehicle must have an operational range of at least 120 miles according to the WLTP test cycle. Consumers currently appear to prefer vehicles with a longer range, but there is a market for a lower-cost ZEVs with a shorter range and we expect consumer tastes to change over time as the UK's charging infrastructure develops. However, given potential for battery degradation over time, this requirement will contribute towards minimum viable ranges for the second-hand market.

Finally, manufacturers must provide a warranty for the vehicle to ensure that they will provide a positive experience for consumer. Traction batteries, hydrogen fuel cells, and hydrogen tanks must have a warranty for 8 years, with the batteries eligible for replacement if they fall below 70% capacity during that period. The

remainder of the vehicle must have a 3-year warranty. The battery warranty requirements align with proposals for battery durability requirements in the Euro 7 emissions standard for cars, and are more stringent than the proposed Euro 7 requirements for vans [10]. The vast majority of battery electric and hydrogen fuel cell vehicles sold in the UK in 2022 met the proposed minimum requirements on emissions, range, and warranty.

## **2.4 Bonus credits**

While the ZEV mandate is intended to transition all cars and vans to zero emission, there are some applications for which ZEVs have outsized environmental and social benefits. The proposal includes the opportunity to earn bonus credits for two such applications. Credits can cancel out a unit of activity, making them functionally similar to allowances; they may also be traded freely at any cost.

### **2.4.1 Car clubs**

There is strong evidence that car clubs, or car sharing programs, reduce reliance on car ownership, with a shared vehicle substituting between 3 and 20 private vehicles [11]. They can lead to lower overall vehicle miles travelled, further reducing emissions, and provide access to vehicles without high upfront cost. Car clubs have grown steadily in the UK, reaching over 5,800 vehicles and 784,000 members in 2021, but the rate of car club adoption lags far behind some other countries such as Germany and the Netherlands. About 12% of car club vehicles in the UK were zero emission as of the end of 2021, a much higher share than in the private car fleet [12].

To reflect these benefits, a manufacturer who sells a ZEV to a car club would earn 0.5 ZEV credits in the car or van scheme depending on the type of vehicle. These ZEVs must meet the same minimum requirements as presented above. To receive the credits, the car club purchasing a ZEV must meet certain criteria regarding availability and user experience, which will be published before the policy takes effect. A ZEV receiving credits under this scheme must be used in a car club scheme for at least 2 years to prevent ZEVs from earning extra credits under this scheme before being quickly resold on the secondary market.

### **2.4.2 Wheelchair accessible vehicles (WAVs)**

Traditional vehicles may not be accessible or usable by those with disabilities, such as individuals who use wheelchairs. To remedy this problem, vehicles (typically vans) may be modified to become wheelchair accessible vehicles (WAVs) with features such as ramps and customised safety designs. Because they are derived from vans, WAVs tend to have higher fuel consumption and therefore produce higher emissions than typical cars, indicating the importance of transitioning these vehicles to zero emissions. Converters may face some additional challenges in adapting ZEVs to be wheelchair accessible such as a limited selection of electric van models, limited availability of those models, and the need for new designs to accommodate batteries and other components.

To ensure that ZEVs and their benefits, including cleaner air and lower operating costs, are accessible to all, including people with disabilities, credits are also offered for zero emission WAVs. By default, WAVs (as a type of SPV) are exempted from the ZEV targets or the counting of activity. However, a zero emission WAV would earn 1.5 credits. This is intended to provide a financial incentive to provide ZEV stock to this sector and overcome the additional cost associated with converting a ZEV into a WAV.

## **2.5 Regulating emissions from new non-ZEV vehicles**

The ZEV mandate will be the primary tool to reduce fossil fuel consumption from new cars and vans out to 2035. However, new petrol and diesel cars and vans may still be sold in large volumes in the UK for many years. It is therefore important to ensure that an increase in CO<sub>2</sub> emissions from the conventional petrol and diesel fleet does not outweigh the carbon savings from transitioning to ZEVs. To that end, the new framework will include a CO<sub>2</sub> standard applying only to new non-ZEV cars and vans to ensure that these vehicles do not become less efficient and more polluting over time.

These standards for cars and vans will also be implemented as a trading scheme under the Climate Change Act. Each manufacturer will receive allowances according to their unique CO<sub>2</sub> performance target (in grams

of CO<sub>2</sub> per kilometre according to the WLTP standard) multiplied by the number of non-ZEV cars and vans sold in the relevant calendar year. The sum of the CO<sub>2</sub> ratings of all non-ZEV cars and vans sold in each year (the regulated activity) must not exceed allowances. Manufacturers may trade allowances freely at any price.

Manufacturers' non-ZEV CO<sub>2</sub> performance targets for the car and van schemes will be equivalent to the average CO<sub>2</sub> ratings of new non-ZEV cars and vans sold by that manufacturer in 2021. These targets would remain constant from 2024–2030 and would not be adjusted based on mass, powertrain mix, or other factors.

## **2.6 Flexibilities for annual ZEV targets**

Due to the novel nature of this regulation and the multi-year product planning cycles typical in the automotive industry, some manufacturers may face challenges in selling sufficient ZEVs to meet the targets in the initial years. To that end, the framework includes flexibilities designed to accommodate manufacturers' different starting points in the transition to ZEVs without compromising the carbon savings at the core of this policy.

### **2.6.1 Banking**

Manufacturers are awarded allowances each year according to the aforementioned annual ZEV targets. If manufacturers exceed these targets and do not use all of their allowances, those allowances may be banked for future use in the same component of the scheme. This flexibility acknowledges the benefits of early reductions in carbon emissions from deploying ZEVs onto UK roads more quickly.

There is no limit on the number of banked allowances from previous years which can be used to meet compliance in any given year, but banked allowances may only be used after a manufacturer's allowances from that year have been used. An allowance may be banked for 3 years after the year in which it is allocated. If the allowance has not been used by that point, it will expire and will have no value. For example, an allowance originally allocated for 2024, if not used in that year, may be banked for use to cover a non-ZEV sold in 2025, 2026 or 2027. Banked allowances may be traded but will retain the same expiration date.

### **2.6.2 Borrowing**

Manufacturers who cannot meet the targets in a trading period using allowances from either that trading period or previous periods, may choose to borrow allowances from a future trading period. In contrast to banking, borrowing allowances from future years presents a risk of reduced carbon savings. Given this, the proposal includes a cap on the number of allowances which can be borrowed in any trading period and an interest rate for borrowed allowances, and will only be permitted during the 2024–2026 scheme years; all deficits must be repaid in 2027.

The number of allowances that can be borrowed during any trading period is capped at 75% of the ZEV target in 2024, 50% in 2025, and 25% in 2026. This is equivalent to 16.5%, 14%, and 8.25% of a manufacturer's total car sales in 2024, 2025, and 2026 respectively, and 7.5%, 9%, and 5.5% of total van sales in the same years.

A manufacturer's allowance deficit is multiplied by 1.035 each year that it is not repaid, acting as a 3.5% compounding interest rate. 3.5% mirrors UK HM Treasury's social time preference rate — how much society prefers something today versus the next year. This is intended to reflect the lost environmental benefit to society of delaying the deployment of a ZEV in a given year. For example, if a manufacturer borrowed 10,000 car allowances to meet their requirements in 2024, they would have to surrender 10,350 allowances to cancel this deficit in 2025, or 10,712 if they wait until 2026 to cancel the deficit.

### **2.6.3 Transfer of ZEV mandate allowances to non-ZEV CO<sub>2</sub> standard**

The priority of this regulatory framework is to encourage a swift transition to ZEVs. Therefore, we propose that manufacturers who sell ZEVs above the minimum targets can use that overachievement to offset any CO<sub>2</sub> emissions from non-ZEVs, effectively reducing the stringency of their CO<sub>2</sub> emissions targets standard and incentivising them to sell more ZEVs earlier. If a manufacturer has met the ZEV target in a trading period, unused allowances in the ZEV mandate may be converted to become allowances in the CO<sub>2</sub> standard.

The proposed rate of conversion reflects the average CO<sub>2</sub> emissions of non-ZEV new cars and vans (in the respective schemes), according to the WLTP cycle, in 2021. Preliminary data suggests that new non-ZEV cars sold in the UK in 2021 had average CO<sub>2</sub> emissions of 135 g/km; if confirmed in final data, a ZEV mandate allowance earned in 2024 could be exchanged for allowances for 135 gCO<sub>2</sub>/km from their new non-ZEV cars sold in 2024. Transfers will also be permitted between the van ZEV and non-ZEV elements.

#### **2.6.4 Transfer of non-ZEV CO<sub>2</sub> allowances to ZEV mandate scheme**

While some manufacturers have deployed a significant share of ZEVs to meet CO<sub>2</sub> targets, others have met these targets through improvements in ICE efficiency, hybrid vehicles and plug-in hybrid vehicles. To acknowledge these strategies and the potential additional carbon savings that these investments may yield, the proposal offers a limited option to count ongoing improvements in non-ZEV emissions toward ZEV mandate targets. As with borrowing, this flexibility would be offered only to meet compliance in 2024–2026.

In these years, manufacturers whose average emissions from new non-ZEV CO<sub>2</sub> cars or vans are below their target may convert unused allowances in the non-ZEV CO<sub>2</sub> standard to credits in the ZEV mandate scheme. The proposed rate of conversion is 167 non-ZEV CO<sub>2</sub> allowances per 1 ZEV mandate credit in the car scheme and 216 non-ZEV CO<sub>2</sub> allowances per 1 ZEV mandate credit in the van scheme. These rates of exchange are based on the real-world difference in CO<sub>2</sub> emissions from an average non-ZEV car or van in the UK compared to a ZEV.

As a further safeguard for this provision, the number of credits that can be generated through this provision may not exceed 25% of the ZEV target in any respective year, separately for the car and van schemes. For example, for the car scheme, a manufacturer may earn credits equivalent to 5.5% of a manufacturer's car sales in 2024, 7% in 2025, and 8.25% in 2026.

## **2.7 Derogations**

Most new cars and vans sold in the UK are manufactured by large manufacturers: in 2019, over 90% of new cars sold in the UK were made by the 20 most popular manufacturers (some of which were part of larger manufacturing groups) [13]. The van market was even more concentrated, with 11 manufacturers representing 95% of sales. Many smaller manufacturers produce only one or a small number of models in small volumes for niche markets and typically have lower budgets for research and development and less flexibility to change their production plans, potentially making the transition to ZEVs more challenging.

Manufacturers selling fewer than 2,500 cars or vans per year, considered small volume manufacturers (SVMs), will not be subject to ZEV targets under this regulation for years 2024–2029. A manufacturer may have a small volume derogation under one scheme but be a major manufacturer with a ZEV target under the other scheme. To facilitate this, SVMs will receive allowances for each car or van sold (up to 2,499) each year which can each be used to cover the sale of a non-ZEV, effectively setting a ZEV target of 0%. If the SVM does sell ZEVs, they would have allowances remaining, which could then be traded to other manufacturers. The end of new petrol and diesel engine vehicle sales in 2030, and the requirement for all new cars and vans to be ZEVs in 2035, will still apply small-volume manufacturers.

In the non-ZEV CO<sub>2</sub> scheme, only manufacturers selling fewer than 1,000 cars or vans annually would be exempted. This lower threshold reflects that this scheme does not require additional emissions reductions but only that average emissions do not rise. Therefore, this exemption is proposed as a way to reduce administrative burden for government and for smaller companies alike.

## **2.8 Enforcement and penalties**

If the manufacturer is still unable to meet compliance for the trading period through in-year allowances, banked or borrowed allowances, credits earned for the sale of zero emission SPVs/WAVs or ZEVs sold to car clubs, and trading, they must make a payment to government proportionate to the amount of activity not covered by allowances or credits.

Payments within the ZEV mandate are priced to reflect at least three criteria: a) they must be greater than the additional cost to produce a ZEV compared to a comparable conventional ICE vehicle, in order to discourage



manufacturers from making payments rather than producing ZEVs; b) they must reflect the price of the excess carbon emissions that would result from selling an ICE vehicle rather than a ZEV; and c) they must be at least as high as the equivalent fines for non-compliance in other markets where there is significant automotive trade with the UK. ZEV mandate schemes in North America include penalties of £12,000–£17,000 and do not differentiate between cars or vans.

Accounting for these criteria, the framework includes payments of £15,000 per excess activity in the ZEV mandate car scheme and £18,000 per excess activity in the ZEV mandate van scheme. In practice, this also sets a ceiling on the price of trading for allowances or credits. Government anticipates that manufacturers will be able to purchase allowances through trading with other manufacturers at a lower cost.

In the non-ZEV CO<sub>2</sub> scheme, payments are proposed to be the same as under the existing CO<sub>2</sub> regulation: £86 per gram (or fraction of a gram) of CO<sub>2</sub> above the manufacturer’s target multiplied by the number of non-ZEV cars or vans sold. For example, suppose that Manufacturer X sells 50,000 non-ZEV cars in a year and has a target of 150 g CO<sub>2</sub>/km, but the non-ZEV cars sold by that manufacturer average 152 gCO<sub>2</sub>/km. In that case, if the manufacturer does not use surplus ZEV allowances or trade for additional CO<sub>2</sub> allowances to meet compliance, they would face a payment of:

$$2 \text{ gCO}_2/\text{km} \times £86 \times 50,000 \text{ non ZEV cars} = £8,600,000 \quad (1)$$

### 3 Climate and economic implications

The ZEV mandate framework was the largest carbon-saving measure identified in the UK’s Net Zero Strategy published in October 2021 and is central to meeting the UK’s interim carbon budgets. Detailed analysis was conducted to understand the climate and economic implications of the proposed policy; these impacts are described in the cost-benefit assessment (CBA) published alongside the consultation [14]. Because this initial regulation will only set legally binding targets out through 2030, the CBA’s analysis assumes that ZEV uptake remains flat after 2030. The move to 100% of new cars and vans being ZEV from 2035, which will be implemented in future legislation, will provide additional carbon savings and economic benefits.

#### 3.1 Energy and carbon savings

These proposals lead to a significant change in the fuel consumption of the UK car and van fleet, as ICE vehicles are increasingly replaced by ZEVs. Petrol and diesel fuel consumption falls and there is an increase in electricity consumption due to the greater number of ZEVs. In total, the overall energy demand from cars and vans falls due to the greater efficiency of electric vehicles. The change in total energy demand from different sources from 2020–2050 due to this policy is shown in Figure 4. The baseline (dashed line) in this figure is the business-as-usual scenario in which no new policy was passed.

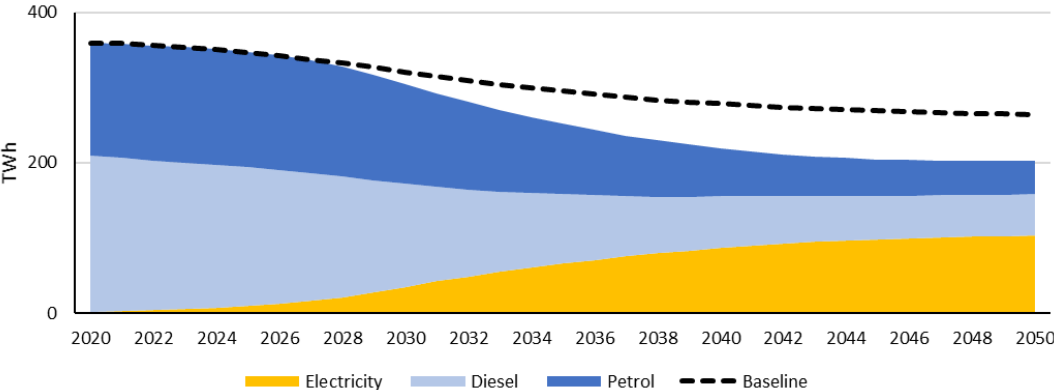


Figure 4: Energy demand from cars and vans as a result of the ZEV mandate policy from 2020–2050 compared to a baseline with no additional policy

Because of this reduction in fossil fuel use, combined with projections for continued reductions in the emissions intensity of the UK electricity grid, this policy is projected to save 31 megatonnes of CO<sub>2</sub>

equivalent (MtCO<sub>2</sub>e) in carbon budget (CB) 5 (2028–2032), 81 MtCO<sub>2</sub>e in CB6 (2033–2037), and 415 MtCO<sub>2</sub>e from 2020 – 2050, compared to the baseline. Again, these amounts do not consider additional savings from moving from the 2030 targets to 100% ZEV sales from 2035 and beyond, or the requirement that all non-ZEVs sold from 2030–2034 have significant zero emission capability.

### 3.2 Economic impacts

The ZEV mandate will have substantial economic impacts. The largest sources of economic benefits resulting from this proposed policy stem from the value of carbon savings, fuel savings, and reduced maintenance costs. On the other hand, the policy is expected to create additional costs from the increased upfront costs of zero emissions vehicles and the costs of installing and maintaining charging infrastructure. Additionally, because ZEVs have lower running costs than petrol or diesel vehicles, the cost benefit analysis includes the potential for induced demand, whereby drivers may drive more kilometres after switching to ZEVs. This could result in additional costs from congestion and accidents, which are partially counteracted by smaller benefits from new tax revenue and consumer surplus, reflecting the utility of these additional trips. That said, there is significant uncertainty regarding the magnitude of any potential induced demand.

Figure 5 summarises the net present value (NPV) of the costs and the benefits resulting from this policy from 2024–2071; all numbers are in millions of pounds. The costs are listed first on the left side of the axis; the benefits are listed below on the right side of the axis. Some impacts with values under £2 billion (e.g., air quality benefits, administrative costs, consumer surplus from rebound effect) are excluded from the figure. The total net present value is a net benefit of £44.2 billion. If the costs and benefits associated with the rebound effect were excluded, the policy would result in a net benefit of £96.2 billion over the same period.

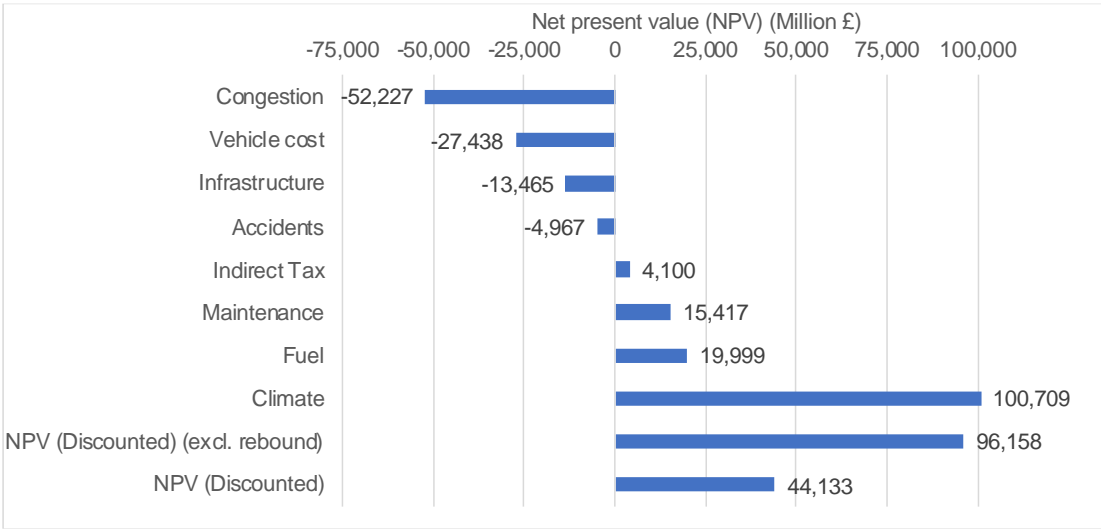


Figure 5: Net present value of costs and benefits of the ZEV mandate from 2024–2071

By comparing the net present value of the costs and benefits (excluding the value of carbon savings) of the policy to the amount of carbon savings, one can calculate the abatement cost, or the cost to avoid one tonne of CO<sub>2</sub> emissions. This is estimated to be £100/tonne of CO<sub>2</sub>-equivalent (tCO<sub>2</sub>e) when incorporating the rebound effect, or £12/tCO<sub>2</sub>e if the rebound effect is not included. Even when including rebound effects, this is anticipated to be lower than the central estimated cost of abating carbon in this profile across the broader economy (excluding sectors captured by the Emissions Trading Scheme) as a whole (£175/tCO<sub>2</sub>e).

## 4 Discussion

A number of countries have expressed ambitions to move fully to zero emissions vehicles, with alignment emerging around a 2035 target for 100% of new light-duty vehicles being ZEVs in leading markets [15]. However, there are very few jurisdictions which have created a legally binding regulatory framework to

achieve these targets, and no countries which have 100% ZEV targets sooner than 2035 (e.g., Norway, the Netherlands, Austria, or Singapore) have yet designed a legally binding framework to enforce these targets. This proposed ZEV mandate in the UK seeks to ensure that the government’s commitment for all new cars and vans to be zero emission by 2035, but also that strong interim targets be met.

Two of the strongest policies to shift light-duty vehicle sales toward ZEVs are California’s Advanced Clean Cars II (an extension of Advanced Clean Cars, the first regulation to include mandatory annual ZEV targets) and the EU’s CO<sub>2</sub> emission performance standards for cars and vans. Table 1 compares the recently adopted ZEV policy in California, the EU’s proposed CO<sub>2</sub> standards out to 2035 for cars, and this proposal in terms of the required ZEV share in 2030 and 2035 and/or the reduction in average CO<sub>2</sub> emissions intensity (grams of CO<sub>2</sub> emitted per kilometre) for all new cars in 2030 compared to 2021. For the UK and California policies, this latter metric is derived by assuming that ZEV targets are minimally met while the average emissions from the remainder of the new car fleet (including PHEVs) remains static. California’s ZEV shares are expressed as a range because up to 20% of the annual ZEV targets may be met through the sale of PHEVs with at least 70 miles of range, whereas PHEVs are not considered ZEVs within the UK’s regulation.

*Table 1: Comparison of ZEV targets and emissions reduction for new cars versus 2021 in 2030 and 2035 for proposed or adopted regulations in the UK, EU, and California*

	2030 ZEV share (cars)	2030 emissions reduction	2035 ZEV share (cars)	2035 emissions reduction
UK (proposal)	80%	77%	100%	100%
EU (proposal)	–	55%	100%	100%
California (adopted)	54.4%-68%*	At least 50%	80%-100%*	–

*\*California’s policy requires that an additional 13.6% of sales in 2030 and 20% of sales in 2035 be either ZEVs or plug-in hybrids with at least 70 miles of range*

The table illustrates that although the UK’s policy is essentially aligned with other leading jurisdictions like the EU and California in its 2035 ambition, this proposed policy is much more ambitious in its interim (e.g., 2030) targets, which will result in greater carbon savings over the course of the regulation. This is also true when comparing against other ZEV mandate-style policies like those in the Canadian provinces of Québec and British Columbia (which are similar to California’s) or the proposed Canada-wide ZEV mandate. Other legally binding regulatory frameworks like in China, Japan, and South Korea have not yet announced targets out to 2035.

Creating the world’s most ambitious legally binding decarbonisation policy for cars and vans was made possible through careful deliberation and extensive outreach from government. Over the 3 years since the ambition to reach 100% ZEV sales in 2035 was announced, the government has run 3 consultations to provide transparency to the public. Stakeholders including vehicle manufacturers, environmental advocates, and the chargepoint industry were proactively engaged in multiple formats at every step of the process. To address concerns from vehicle manufacturers and ensure that the regulation does not cause unintended economic harms, flexibilities were added in the early years. However, these flexibilities were carefully crafted to ensure that carbon savings and world-leading 2030 targets are not compromised. This policy framework and approach may be useful for other governments to follow as they embark on their own path along the zero emission vehicle transition.

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## Presenter Biography



James Vickery has worked in transport decarbonisation policy in the UK Government's Department for Transport since 2017. A Head of the ZEV Mandate and new car and van CO2 regulation in the UK, he leads the team responsible for delivering road vehicle carbon reduction regulation. This has included designing and developing the ZEV mandate, as well as delivering existing CO<sub>2</sub> legislation retained in the UK following the UK's exit from the EU. James attended the University of Birmingham where he earned a BA and MA in International Relations.