Phasing out sales of new cars with engines

A UK approach:

July 2020

Summary

This paper responds to the UK government consultation on the policies and regulations needed to phase out sales of new cars and vans with engines by 2035 or earlier. It illustrates the target is feasible, and an earlier date is possible, but will require a very strong suite of policies to deliver such a rapid market transformation.

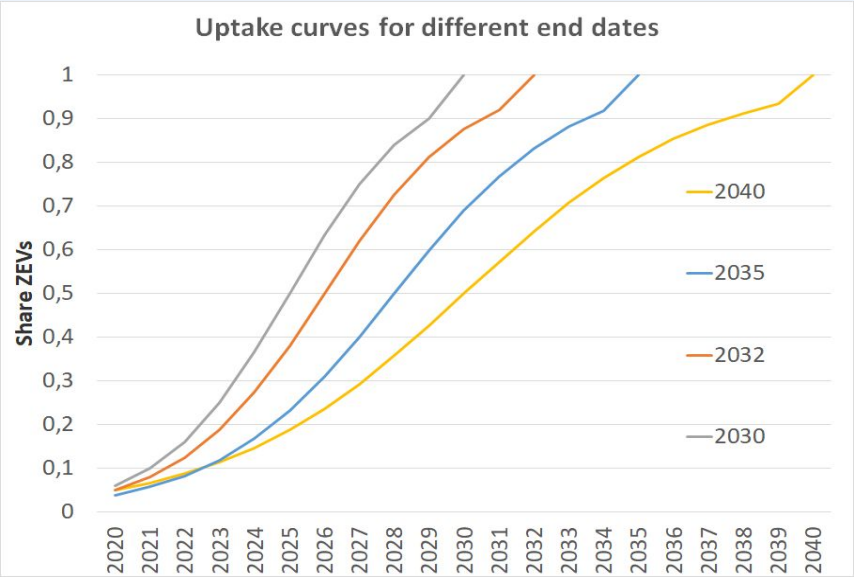
Transport is the UK's biggest single source of CO2 and emissions have flatlined since 1990. To achieve the UK goal of achieving net zero emissions by 2050 a shift to zero emission vehicles is required. Whilst several countries have announced plans to end sales of cars with engines as part of decarbonisation strategies, many of these are part of the EU single market (including Norway) and cannot currently legally do so (although this may change as part of upcoming EU Green Deal proposals). If enacted the proposed UK ban is therefore one of the most ambitious policies of this type in the world.

To deliver the required change car and van makers must be regulated to require them to progressively increase their market share of sales of zero emission vehicles (ZEVs - battery electric and hydrogen fuel cell vehicles) in the form of a ZEV Mandate, a system that has been successfully operated in California and many other US States. Sales of plug-in hybrid and hybrid models should not count towards the target as these are transitional solutions and detract from the goal of ensuring vehicles emit no tailpipe CO2. Policy must focus on increasing the supply of ZEVs and charging infrastructure and progressively increasing the proportion of car buyers choosing zero emission solutions. To achieve a 2035 phase out date manufacturers must achieve about a quarter of sales as ZEV by 2025 and over two-thirds by 2030. Early phase out dates require even more ambitious interim milestones; a 2030 phase out date would require half of new car and van sales in 2025 to be zero emission compared to an estimated 3-4% in 2020. All brands selling either cars or vans should be required to meet the same targets, excluding brands with very small market share (less than 0.5%) which would be exempted from regulations until 2030. Brands should be allowed to trade credits between one another to create flexibility in the market. To be effective the regulation must include dissuasive penalties for failing to meet annual interim targets. In addition, to ensure CO2 emissions from cars and vans with engines did not rise

after 2020 these should be progressively lowered by 1%pa with penalties for brands that fail to reach this benchmark in future years. The ZEV Mandate could commence in 2024, but from the end of 2020 the UK will need to put in place transitional arrangements as it plans to leave the existing EU car CO2 regulation. This will cause the supply of electric cars into the UK market to dry up unless there is a regulatory incentive to continue to sell low and zero emission vehicles in the UK from 2020 until a new mandate is in place.

Analysis indicates there will be no supply shortage for cars with a 2035 phase out trajectory in the next few years (until 2025) based upon manufacturers existing production plans for Europe (including the UK). A phase out date before 2035 will require additional manufacturing capacity to be installed to meet increased demand from UK and EU regulations and this creates opportunities for new UK production of battery electric cars. At present only BMW plans to significantly increase BEV production of cars in the UK to 2025. Toyota and Vauxhall do not current plan to build any BEVs in the UK until at least 2028 and Nissan and Jaguar Landrover do not plan to significantly increase BEV production beyond that planned for this year. For vans, a 2035 phase out trajectory creates supply constraints and the opportunity for the UK to attract additional BEV van production.

To be successful in driving the transition to ZEVs, the regulation of the auto-industry must be complemented by other policies to stimulate demand, including tax breaks and grants that should be funded by progressively raising 1st Year VED registration taxes. Ensuring the expansion of charging infrastructure matches the growth in BEV sales is also essential. Over time, fleets such as taxis should also be quickly switched to become ZEVs. The paper shows for a 2035 phase out date the rate of installation of public charging connectors would need to more than double from current rates throughout the period 2020-5.



The proposals detailed in this paper will make a sizable contribution to meeting future carbon budgets but would need to be complemented by other policies to reduce car use, such as raising fuel duty, improving facilities for walking and cycling and improving public transport, notably schemes to separate buses from congested traffic.

1. Introduction

This briefing responds to the UK government consultation on bringing forward the end to the sale of new petrol and diesel cars and vans from 2040 to 2035, or earlier if a faster transition is feasible. Specifically the paper identifies the policies and regulations that will be needed to shift the market to zero emission vehicles and the required trajectory to meet alternative end dates.

Transport is the UK's biggest single source of CO2 and emissions have been virtually flat since 1990. Cars and taxis account for over half of transport CO2 emissions (excluding international aviation and shipping). To achieve the UK goal of achieving net zero emissions by 2050 road transport will need to be fully decarbonised. A shift to battery electric cars is likely to be the principal means to achieve this with a small share of hydrogen fuel cell vehicles. There will never be sufficient biofuels to fully replace petrol and diesel without causing extensive land use change which would offset most or all of the benefits. Manufacturing synthetic fuels would require unfeasibly large quantities of renewable electricity and both solutions are needed to decarbonise aviation for which other options are unavailable. The UK proposal to focus on an early transition from cars with engines to zero emission vehicles (ZEVs), particularly battery electric vehicles (BEVs) is therefore the right strategy but needs to be complemented by actions to reduce vehicle use to help neet carbon budgets and ensure emissions from new cars with engines do not rise as their sales decline.

Several countries have now announced they plan to ban sales of cars with engines as illustrated in Figure 1. However, recent research shows those countries that are part of the EU single market (including Norway) cannot at present ban sales on cars with engines under current type approval and single market rules. The UK proposal to ban sales by 2035, and possibly earlier, is therefore more ambitious than it appears at first sight as only Iceland currently have a stronger deliverable target.

Achieving a phase out of cars with engines requires a suite of policies that:

1. Drive supply and sale of ZEVs;
2. Encourage purchase; and
3. Facilitate the ease of use, particularly charging.

Sections 2 and 3 of this paper focuses on the regulation of carmakers that is essential to increase availability of ZEVs and draws lessons from EU regulations. Section 4 Measures to increase demand from car buyers to choose zero emission models, including tax and purchase incentives and charging requirements. Reform of vehicle purchase taxes is considered in a more detailed briefing paper.

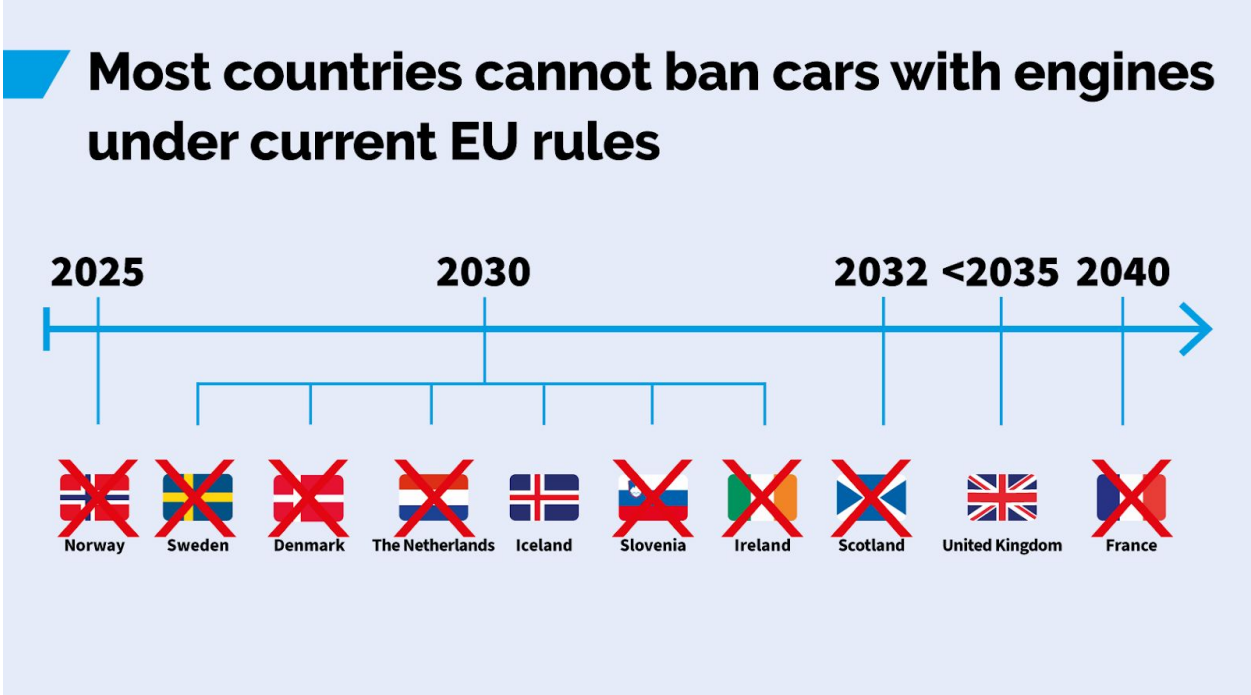


Figure 1: Countries planning to phase out ICE cars - and legally able to.

Establishing an appropriate balance between policies to increase both supply and demand is essential. Just providing carrots for consumers will be very expensive and ultimately unsuccessful as it is unlikely to be matched by a sufficiently fast increase in supply of ZEVs leading to shortages of vehicles and higher prices. Just regulating the car industry to achieve high sales of ZEVs without providing an attractive package of incentives and charging for buyers is a recipe for failure and fines not progress. This paper provides guidance that strikes an appropriate balance between policies to require supply and sales and attract sufficient demand.

2. Regulating emissions from new cars: lessons from the EU

Historically regulations to reduce new car CO2 emissions have been largely ineffective, getting the design and ambition of regulations right is therefore essential. The 1998 voluntary agreement between the car industry and European Commission broke down after a few years. The first EU regulatory target for 2015 (140g/km) was undermined by test manipulation that resulted in more than half of the measured improvement only being delivered in the laboratory test rather than on the road. The 5 year cycle of targets the EU has adopted has also enabled emissions to rise since 2015, largely as a result of increasing sales of SUVs. In 2018, UK emissions from new cars averaged 124.5 g CO2/km substantially more than the target of 95 g CO2/km,[1] that applies from 2020. However, the strong penalties that are part of the regulation are now driving a rapid reduction in CO2 emissions from new cars with most companies choosing to comply by increasing sales of

[1] Measured using the now obsolete NEDC laboratory test

electric vehicles (both battery electric and plug-in hybrid models) to meet their targets. Figure 2 illustrates the surge in EV sales in major European markets, including the UK, at the start of 2020.

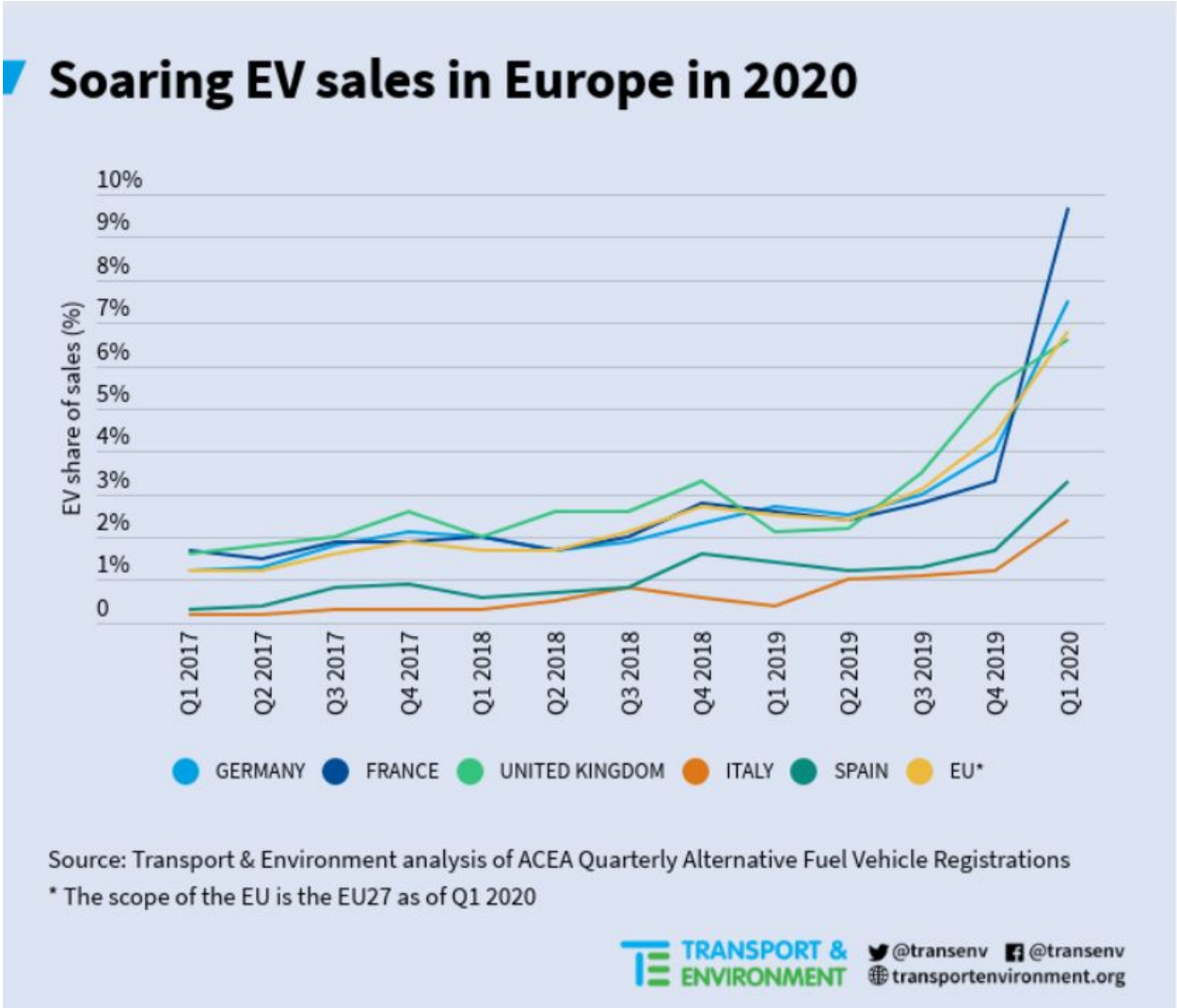


Figure 2: EV shares from new cars in France (T&E, 2020)

For vans, EU regulations are significantly weaker than for cars. The 2020 target is 147g CO2/km whereas a target equivalent to that for cars would be 118g CO2/km. The future targets requiring a 15% reduction from 2020 levels by 2025 and 31% by 2030 are also less ambitious for vans than cars. As a result, vanmakers have not needed to supply electric vans to achieve 2020 targets and will only need to supply around 7% to meet 2025 targets, about half the market share required for cars. The supply of electric vans is therefore much more modest than for cars and will remain so. There are several lessons that can be drawn from the EU approach:

1. Ambitious but realistic targets are essential to drive the industry - weak targets (such as for cars in 2015 and vans in 2020) do not increase ZEV supply or choice
2. The regulation must be accompanied by strong penalties if the industry is to comply - the voluntary approach fails
3. Carmakers delay reducing new car CO2 emissions to the last possible moment - so regular intermediate targets are essential
4. The more complex the regulation the more loopholes will be introduced and weaker the impact will be - simplicity is essential
5. Real world checks on CO2 emissions are needed to prevent lab tests being manipulated
6. The UK needs a regulation that applies from the start of 2021 - if nothing is in place the supply of electric cars into the UK market is likely to dry up putting at significant risk the long term goal.

The following section applies these key learnings to outline the design of an appropriate UK scheme.

Key message: effective regulation of the car industry is the only way to guarantee adequate supply of ZEVs at competitive prices.

3. Driving ZEV supply

3.1 ZEV mandate or CO2 regulation?

The current EU new car CO2 regulation and future targets are based upon the average CO2 emissions of cars sold by companies. This approach is now beginning to drive electric cars into the market as most carmakers have chosen this as their principal means to comply with the regulations. For vans the CO2 approach has not yet been effective as the targets are not sufficiently ambitious. An alternative approach is to specify an increasing number of ZEVs car and van makers must sell in a given year (so called ZEV mandate). Figure 3 illustrates the differences between a CO2 based regulation and ZEV mandate.

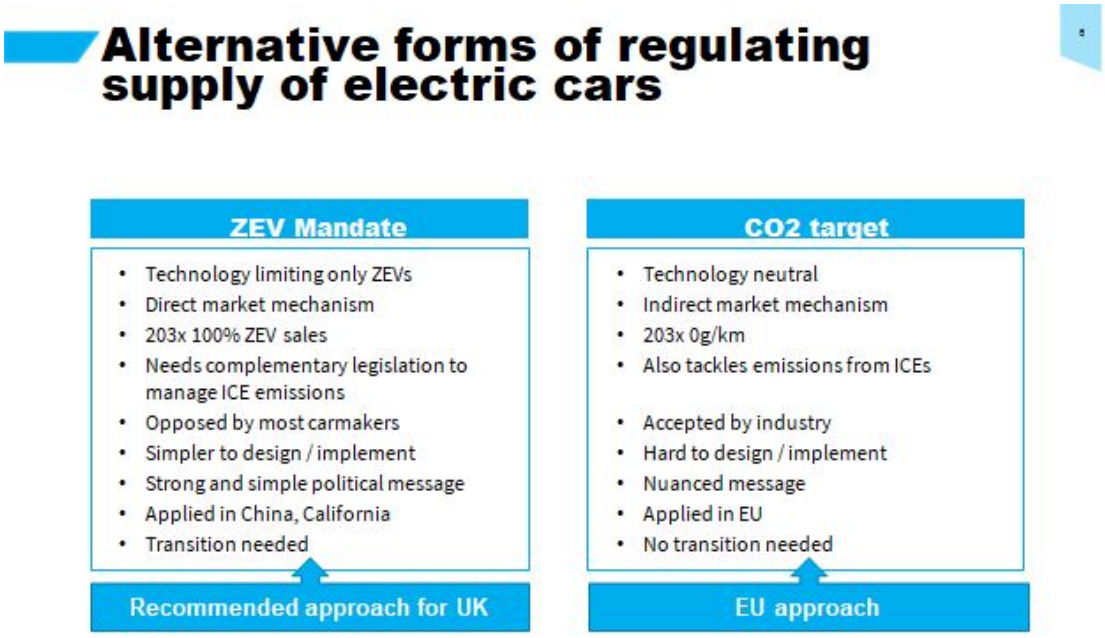


Figure 3: comparison of ZEV mandate and CO2 regulatory approaches

Either approach could be effective in a UK context but since the UK has a specific goal to achieve a complete shift to ZEVs, a ZEV Mandate is more direct and importantly is significantly simpler to implement and more likely to succeed as there can be fewer loopholes. It also links clearly to public messaging to consider purchasing a ZEV rather than the CO2 based target that encourages lower CO2 vehicles in general including mild hybrids, full hybrids, PHEVs as well as BEVs.

The DfT is currently consulting on proposals to translate the current EU regulation into UK law (T&E's response is here.) These proposals will help to ensure the supply of BEVs to the UK after we leave the EU regulation but are entirely inadequate to achieve the goal to phase out sales of new cars with engines by 2035 at the latest. The UK regulation will require only about 29% sales of BEVs in 2030 to meet the regulation whereas the to achieve a phase out sales will need to be more than double this level (see section 3.2).

Key message: a ZEV Mandate is the most effective form of future regulation for the UK.

3.2 Compliance date and trajectory

To achieve a phase out of new cars with engines it will be essential for the regulation to propose a trajectory based upon a standard S-uptake curve for new technology. Such curves have slow growth in sales at the beginning and as the target is neared and it will therefore be necessary to rapidly phase out ICEs once sales of ZEVs reach over 90% of sales. S-curves for different end dates are shown in Figure 4 with the relevant market shares tabulated in Table 1.

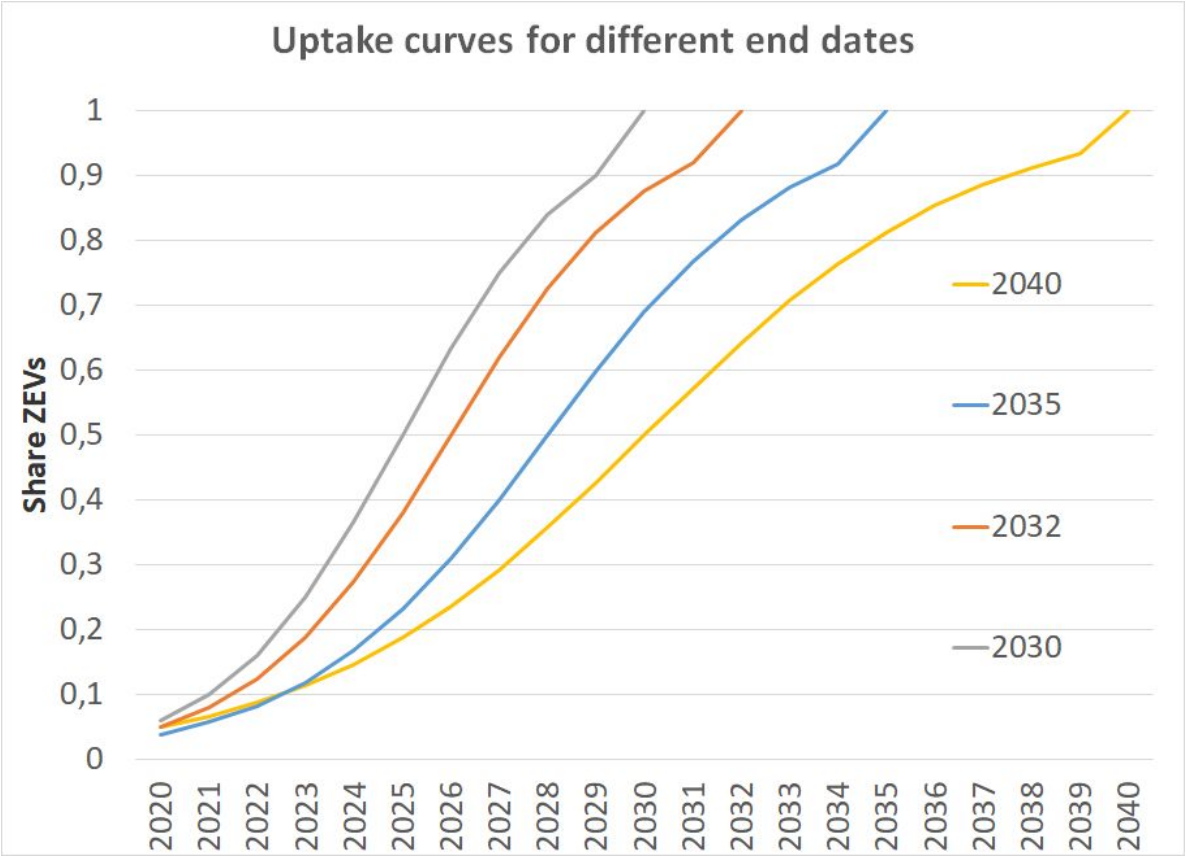


Figure 3: Proposed uptake scenarios

Milestone	EU Cars estimated BEV share	Phase-out year			
		2030	**2032**	**2035**	**2040**
2025	c10%	50%	38%	23%	19%
2030	c33%	100%	88%	69%	50%
2035	?	100%	100%	100%	81%

Table 1: Proposed share of ZEVs in 2025, 2030 and 2035 for different phase out years

In 2019, the market share of ZEVs in the UK was 1.3%. In 2020, T&E estimates it will more than double to over 4% and double again in 2021 to about 8% (assuming the UK remains part of the EU CO2 regulation or introduces its own equivalent regulation). The proposed trajectories for all end years

will require sales to be significantly higher than the estimates for average EU sales and will match most leading national markets such as the Netherlands (excluding Norway where sales are already over 50%).

Whether 2035 is the most appropriate phase out date, or an earlier date is feasible, depends upon the complementary policies the government is willing and able to implement alongside the phase out date and regulation and is considered in detail in Section 6.

Key message: achieving a phase out by 2035, or earlier, requires a rapid increase in sales from 2020 to 2025 and beyond - it cannot be delivered through a sudden increase in sales after 2030

3.3 Intermediate targets

The experience of EU regulations shows that manufacturers wait until the last possible moment before implementing environmental regulations. This is clearly illustrated for CO2 where in 2019 average CO2 emissions in the EU are expected to be over 30g CO2/km above the 95g CO2/km target just a year before it comes into force. This is despite the target being first agreed in 2009 and reconfirmed in 2014. If the UK retains a phase out date without intermediate targets it will have no impact on the short to medium-term supply of vehicles even if a very early 2030 phase out date is proposed - the target will be symbolic only.

The EU has set a 5 yearly sequence of targets (2015, 2020,[2] 2025 and 2030). But 5 years gaps lead to stepped progress that results in fewer cars coming onto the road overall compared to a smooth trajectory. By 2035, (for a 2035 phase-out date) cumulative ZEV sales are estimated to be 19 million vehicles with annual increases in sales;[3] with 3 yearly targets 17 million vehicles would be sold; and for 5 year targets less than 15 million vehicles would be sold due to industry delaying the increase in sales to the last possible moment.

Maximising cumulative sales requires annual increases in targets. However, annual targets pose a challenge for carmakers in terms of having to sell a set proportion of vehicles each year which does not fit with production plans. This could be addressed through allowing banking and borrowing of sales between years but this adds complexity for little value in terms of additional cumulative sales achieved. On balance it is recommended the UK adopts 3 yearly targets with the first target commencing in 2024, 1 year before the next step in EU regulations. This strikes a reasonable balance between driving the uptake of ZEVs quickly and providing flexibility to manufacturers. With 3 year targets banking and borrowing requirements are unnecessary.

[2] 2020 is phased in - the target applies fully in 2021 as a political compromise
[3] Assumes total car sales of 2.5 million pa following the trajectory shown in Figure 3?.

Key message: new targets should commence in 2024 and be increased every 3 years

Intermediate targets	Phase out year		
	2030	**2032**	**2035**
2024-26	37%	27%	17%
2027-29	85%	62%	40%
2030-33	100%	88% (2030 & 2031)	69%
2032	-	100%	-
2033	-	-	89%
2035	-	-	100%

Table 2: Proposed intermediate targets

Adopting a 2024 start date provides time for legislation to be finalised, passed, and for the car industry to adapt to the different regulations in the UK (a ZEV mandate) compared to the EU (CO2 target).

Key message: the regulation should commence in 2024 with targets rising every 3 years.

3.5 Applying the target and trading credits

The EU regulation has an excessively complex system in which the target applies to brands but companies can also form groups. Different targets also apply to different companies. The UK can simplify this approach by only applying the target to brands and setting the same target for all brands (with a significant market share). All market sectors are moving in the same direction and there is no reason for some companies to have higher or lower targets.

In order to allow for flexibility, brands would also be able to trade credits (ZEV sales) between one another in a single year (but not between cars and vans that would be regulated separately to avoid market distortion as not all companies operate in both markets). Trading credits enables companies wishing to go faster than the Mandate target to earn a benefit from doing so whilst companies could buy credits from other companies to make up any shortfall in a specific year. Companies supplying only ZEVs (like Tesla) would therefore be able to sell their sales. Such a mechanism means the targets are likely to be met rather than exceeded overall but so long as intermediate targets are ambitious (as proposed) this is not a weakness but provides flexibility.

The DfT would need to establish a monitoring system that enabled companies to inform them when a transfer of credits had been agreed ensuring there could be no double counting.

All sales of zero emission vehicles should be treated equally, there should be no additional credit for supplying longer range cars. Longer range is largely possible through larger battery packs on higher cost vehicles. Allowing more credits for longer range vehicles would create a market distortion in favour of premium manufacturers and there is no evidence the utility of short range electric cars is significantly diminished as very few short range models are now sold. The regulation should only apply to M and N-class vehicles (cars and vans) to prevent the targets being met through sales of smaller quadricycles with less utility.

Key message: all major brands should have the same target with the flexibility to trade credits. The regulation should only apply to M and N-class vehicles (cars and vans) separately. There should be no credit for PHEVs.

3.6 Fines and derogations

To be effective, the regulation must include strong penalties in the form of fines. The EU regulation applies a fine of €95 for each g/km the target is missed for each vehicle sold. The UK should apply a similar levy of £100 for each 1% the mandate is missed for each vehicle sold (both ZEVs and vehicles with engines). This level of penalty provides a considerable incentive to meet milestones.

For companies with a very low market share the Mandate would present a significant barrier to business as they may only sell a small number of models in the UK market. SMMT data lists sales by brand in the UK and applying a derogation for companies with a UK market share of less than 0.5% would only exclude 13 of the 41 brands listed representing just 1.6% of all UK vehicle sales (based upon 2020 year to date sales for the first quarter). The most significant brands to receive a derogation would be Porsche and DS. Companies with a derogation should not be permitted to sell credits (if they do sell ZEVs as both these companies do) unless they chose to waive the derogation and participate in the Mandate in which case targets should apply in full. It is proposed that the derogation for companies with a market share below 0.5% would apply until 2030 after which the requirements of the mandate would apply.

Key message: brands with a market share below 0.5% would be exempted from the regulation until 2030 after which all brands would need to comply with the requirements of the ZEV mandate.

4. Complementary policies

The complementary policies put in place to incentivise the purchase of ZEVs and ease their use are as important as the regulation of the automotive industry to ensure it supplies sufficient vehicles at competitive prices. At present the niche market for electric cars is made up of buyers that embrace new technology and/or have strong green principles and are willing to tolerate the relatively high prices of the new technology and incomplete UK charging network. But if the UK wishes to sell 17% ZEVs by 2024 (the requirement for a 2035 phase-out date) then many of these buyers will not be willing to choose a BEV if the costs of ownership are higher and charging is inconvenient. Government must ensure that complementary policies match its ambition for the phase out date.

The earlier the phase-out date the quicker the ZEV uptake and this is illustrated in Table 2 which shows the cumulative sales of ZEVs for each phase-out year for 5 yearly milestones (2025, 2030, 2025 and 2040).[4] By 2035, there are estimated to be 26 million ZEVs on the road with a 2030 phase out date and 19 million for a 2035 phase out. There are presently 36 million cars and vans on the UK's roads and this is rising. The quicker BEVs enter the vehicle fleet the quicker they filter down into the second hand market benefiting less affluent 2nd and 3rd hand car buyers.

[4] Assumes total sales of cars and vans of 2.5 million per year and an increase in sales of BEVs in line with Figure 1 for each phase-out date.

Milestone	Phase-out year, Millions			
	2030	2032	2035	2040
2025	3.6	2.7	1.7	1.6
2030	14	12	8.0	6.2
2035	26	24	19	15

Table 2: Cumulative sales of ZEVs for different phase-out dates

4.1 Charging

The more rapid the increase in BEVs the faster that public charging connectors must be installed. Table 3 illustrates the average number of new connectors needed per month in each 5 year period).[5] By way of comparison, the UK (before the lockdown) was deploying about 800 connectors a month.

Milestone	Phase-out year, Thousands per month			
	2030	2032	2035	2040
2020-25	4.0	3.0	1.9	1.8
2025-30	11	9.9	7.0	5.1
2030-35	14	14	12	9.7
2035-40	14	14	14	13

Table 3: New charging connectors required per month[6]

[5] The assessment assumes 1 connector is needed for every 15 electric vehicles which as the market matures is likely to be realistic - at present a ratio of 1 to 10 is widely used.

[6] Assumes 1 public charger for every 15 BEV and direct replacement of ICE sales by BEVs

A 2035 compliance date would require about 2000 new connectors to be deployed every month in the period 2020-5. After 2025 the required rate of deployment of new public connectors grows quickly. It should not be necessary for the public sector to fund the rollout of charging points, but where grid upgrades are required these costs can be prohibitive and some of these costs may need to be met centrally. There may, however, be non-commerical locations where the government needs to intervene to ensure there is national coverage.

Key message: bringing forward the phase out date, even to 2035 will require deployment of charging connectors to more than double from current rate in the period 2020-5. Earlier dates would require a 3 to 4 times acceleration in connectors deployed.

4.2 Incentivising sales

The purchase price for BEVs is currently significantly more than an equivalent new car with an engine. A typical new small car with an engine is priced on the road between £12,000 - £17,000 with BEV equivalents around double this (£25,000 - £30,000). A medium sized engined car is £22,000 - £36,000 and a similar BEV generally £30,000 - £40,000. The average SUV is £23,000 - £28,000 and a large BEV £60,000 - £70,000. Leasing prices for an electric car are typically 20% more at present. But the electric car will typically be much cheaper to run both in terms of fuel and maintenance costs and for many drivers the total costs of ownership will already be lower.

The price of BEVs is continuing to fall due to cheaper batteries, mass production, learning rates and more competition in the market driven by regulation. The average price of battery packs has fallen from $373/kWh 5 years ago to around $154/kWh today. Pack prices are forecast to be below $100/kWh by 2024 at which point the manufacturing cost of a BEV will be similar to a car with an engine. In contrast the costs of cars with engines will rise due to the need to include more technology to reduce emissions.

However, manufacturing cost does not equate to the sellers asking price. Vehicle manufacturers have a vested interest to continue to sell cars with engines to recover past investments and on which they are keen to make a return. The last 5 years has seen minimal investment in new electric models and marketing constraining supply of electric cars. EU car CO2 regulations are now forcing the industry to increase supply and prices are expected to fall with increased competition for sales to ensure targets are met. This will only continue with UK specific legislation once we leave the car CO2 regulation.

A technology uptake curve (Figure 4) highlights two key lessons to drive the phase-out of cars with engines. Firstly, there is a recognised “Chasm” in building sales amongst early adopters. For BEVs this has not yet been reached and for this reason it is imperative that incentives are maintained and not phased out too early. Secondly, there are a group of “Laggards” that will

need considerable “encouragement” to stop buying new cars with engines. This is likely to require an increasing amount of “Stick” such as restricting the use of cars with engines to outside of cities for air pollution reasons and high purchase taxes.

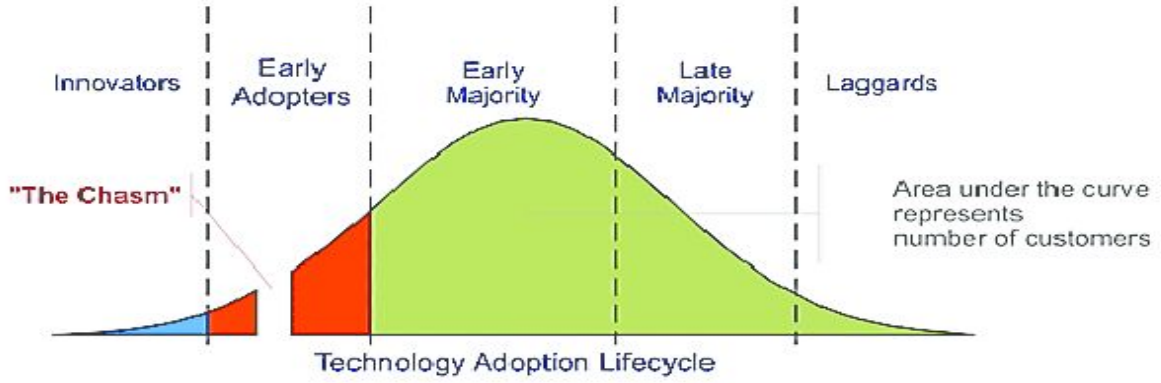


Figure 4: Technology adoption lifecycle[7]

The current government package of incentives for BEVs is comprehensive including grants of £3,000 for the purchase of ZEVs below £50,000; grants of £7,000 for vans and very attractive benefit in kind rates for company car drivers plus a range of other tax incentives. The purchase grant has recently been extended to 2022/3 but reduced by £500 and is likely to be lowered further in coming years. Using general tax receipts to fund electric car purchases cannot be a long term solution as the costs quickly escalate as sales grow, nor is it equitable to use public funds to support large numbers of car purchases for wealthy buyers. T&E has proposed the government raise the cost of 1st year VED for cars with engines to fund grants and the Treasury is currently consulting on reform of VED including 1st year VED rates. A steady phase out of the plug-in grant is inevitable, but using revenues raised from higher 1st year VED charges the transition can be managed in part by increasing the cost of buying ICE vehicles to help build sales through the “The chasm.”

Key message: progressively raising 1st year VED rates for cars with engines and using revenues to support grants for BEVs is the most equitable way to incentivise the purchase of ZEVs in coming years. This can be complemented by tax breaks for company cars and businesses.

4.3 Ending use of all cars with engines by 2050

The purpose of bringing forward the end date for sales of cars with engines is both to: reduce cumulative emissions of CO2 from transport (outlined in Section 6) and to ensure by 2050 there are no

7 https://www.researchgate.net/figure/Technology-Adoption-Lifecycle-The-Chasm-Moore-1991_fig2_281060763

further cars on the road with engines (excluding heritage models). This section considers whether this second objective can be achieved for different end dates.

Vehicle registration statistics show in 2018 that 18% of cars were over 13 years old and this percentage has been rising steeply in recent years as each car has been driven less on average and has become more durable. The average vehicle in the UK is typically scrapped 18 years after first registration. A 2040 phase-out date is therefore far too late and a third to a half of cars on the road in 2050 would still have engines - far short of what is needed to achieve net-zero emissions. A 2035 date would also result in around 15% of cars still using fossil fuels in 2050. Even with a 2032 phase out there would be a small fleet of engined cars (although if sales ended in 2030 this share is likely to be tiny).

Tackling the legacy fleet can be addressed by placing a maximum lifetime on the car. For example, if the phase out date for new cars having engines was 2035 there could be a maximum lifetime for that vehicle of 15 years specified in the vehicle Type Approval at point of sale. In this way even a 2035 phase out date could ensure cars with engines cease to be used by 2050.

Key message: to ensure cars with engines (excluding heritage models) are not driven after 2049 an age limit should be placed on the vehicle type approval.

4.3 Emissions from cars with engines

One limitation of a ZEV Mandate is that CO_2 emissions of cars with engines are not regulated. This could lead to higher emissions from new cars with engines as carmakers seek to maximise profits by selling cars with high emissions at higher margins; and, removing technology fitted to new vehicles to lower the CO_2 emissions (like mild-hybrid systems). It may also undermine sales of PHEVs that help to lower emissions.

To address this limitation it is proposed that carmakers are required to ensure that average emissions from cars and vans decline by 1%pa after 2021. This would be achieved calculating the average emissions of all cars sold in the UK with an engine including hybrid, and plug-in hybrid models in 2021. This value would become a benchmark for future years to ensure that the future sales of these vehicles (as they decline) do not exceed this CO_2 value. Companies failing to achieve their benchmark level would be fined as for the current EU regulation using a sterling equivalent cost equal to €95 for each g/km CO_2 above the benchmark level for each vehicle sold. This will place a minimal challenges on car and van makers to reduce emissions from conventional technology vehicles after 2020 and focus their attention on increasing sales of ZEVS.

Key message: car and van makers should be required to ensure average emissions from diesel, petrol, hybrid and plug-in hybrid cars decline by 1% pa from 2021.

5. Supply of ZEVs

An important consideration is whether the supply of BEVs will be sufficient to achieve more ambitious targets, particularly in the early years to 2025. Most European manufacturers have plans to grow production of battery electric cars to around 13% of EU production by 2025 which amounts to around about 2.5 million units, plus imports. Production of fuel cell vehicles is expected to be very low with just 14 models in 2025 compared to 172 BEV models.

T&E has analysed the extent to which different phase out dates will be impacted by limited supply of cars and vans and the results illustrated in Figure 5. The data is based upon planned European production statistics provided by IHS Markitt.

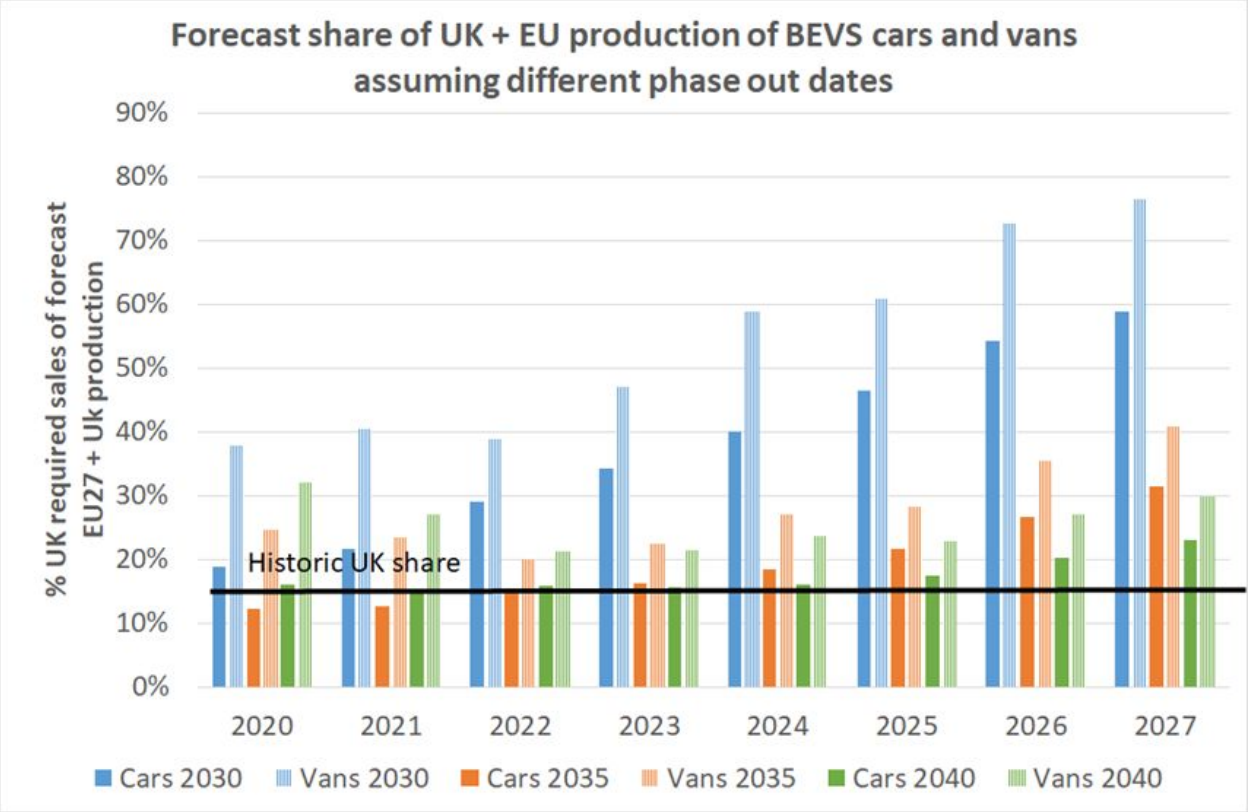


Figure 4: Comparison of required UK new BEV sales with total BEV production in Europe and the UK

The analysis compares the % of UK BEV sales with total EU BEV production (including the UK). Historically UK sales of new cars and vans represented about 17% of total European production of cars and vans. If the demand for new UK BEVs therefore rises significantly above 17% it begins to put pressure on the availability of BEVs to sell across the EU and UK (most carmakers aim to broadly balance supply and demand regionally although it does vary between companies). The chart shows

earlier phase out dates do create supply challenges in the next few few years. However, this also creates opportunities for new BEV production to be installed which could be in the UK. The results are summarised in Table 4.

	% UK BEV sales of European (including UK) BEV production in 2025	Deficit compared to historic proportion of sales (17%)
Cars		
2030 phase out	46%	800k
2035 phase out	22%	123k
2040 phase out	17%	12k
Vans		
2030 phase out	61%	126k
2035 phase out	28%	32k
2040 phase out	23%	17k

Table 4: Deficit of European and UK BEV production in 2025 as a result of different phase out trajectories

In 2025, if the UK adopted a 2030 phase-out year in 2025 UK sales would need to be just over 1 million BEVs. Alongside average EU sales (of around 10% BEVs) total demand for BEVs in Europe would be around 2.5 million, matching planned production but providing no export volumes. It is therefore likely that as a result of the UK Mandate manufacturers would establish additional production capacity for BEVs in Europe which could be located in the UK. A slower timetable phase-out timetable with a 2035 end date would create total EU plus UK demand for BEVs of 2 million vehicles less than forecast European production and may not drive an increase in production by 2025.

UK production of BEVs cars by 2025 is forecast to be 190,000,[8] 21% of UK production. This includes: Mini; Jaguar Land Rover and Nissan Leafs. There is no planned BEV production by Toyota or Vauxhall. Only BMW plan to significantly increase BEV production in the UK to 207. The UK production is not sufficient to match demand and basing a Mandate on production (as has operated in China) would severely restrict market choice. Imports will therefore make up a sizable proportion of the market.

[8] T&E analysis based upon IHS date https://www.transportenvironment.org/sites/te/files/publications/2019_07_TE_electric_cars_report_final.pdf

For vans, the much lower levels of planned BEV production create greater supply challenges. Detailed figures are not available but it is estimated in 2025 about 10% of total light commercial vehicle production will be BEVs, around 200 thousand vehicles. The lower production is a result of the less demanding CO2 targets. There will be an estimated 24,000 BEV vans manufactured at Vauxhall. UK vans sales in 2019 were 366,000 vehicles and for a 2030 phase out this would require half of these (183,000 vehicles) to be BEVs. The UK demand would therefore consume most of the European production. For a 2035 phase out date, UK demand would still be 90,000 vehicles just under half of the estimated total European production. The considerable UK demand would require manufacturers to establish additional manufacturing capacity to supply the larger UK plus EU market creating opportunities for additional UK-based production, a notable benefit of such a policy.

Key message: for cars, production of BEVs in the UK plus the EU would be sufficient to supply the required number of cars in 2025, except for the most ambitious 2030 phase-out date. For vans supply constraints would exist due to planned lower production and this creates an opportunity for additional UK manufacturing.

6. Conclusions

This briefing details the policies and regulations needed to deliver the goal of phasing out sales of new cars with engines by 2035 at the latest. Whilst there is understandable focus on the proposed end-date, the suite of policies and regulations needed to ensure the goal is delivered remains the most important consideration. This must include regulation of vehicle manufactures so that they are required to sell an increasing share of ZEVs until sales of new cars and vans with engines are entirely phased out. Such a regulation must include dissuasive penalties for failing to meet annual interim targets.

The regulation of car sales must be complemented by other policies to stimulate demand including tax breaks and grants that should be funded by progressively raising 1st Year VED registration taxes. Ensuring the expansion of charging infrastructure matches the growth in BEV sales is also essential. The date by which cars and vans with engines can be phased depends upon the effectiveness of complementary policies, the earlier the end date the quicker sales of BEVs must grow in the period 2020-25 and 2025-30. Specifically:

- A 2035 end date will require nearly a quarter of sales to be fully electric by 2025 and over two-thirds by 2030
- A 2032 end date requires nearly 4 in 10 sales to be ZEV by 2025 and nearly 9 in 10 by 2030
- A 2030 end date requires 50% sales by 2025 and 100% by 2030.

A phase out date as early as 2030 is possible but will require a massive and rapid transformation in the car and van market and build up of charging points. Dates between 2032 and 2035 become

increasingly manageable - the choice is political depending upon the willingness of the government to put in place the necessary infrastructure and the purchase incentives to support the transition.

The earlier the phase out date the quicker the fleet of ZEVs grows and the greater the CO2 savings. T&E has estimated[9] the CO2 emissions from new ICE vehicles over the period 2020 - 2040 against a default of no regulation. CO2 savings take account of additional electricity demand for charging. Table 5 illustrates by 2040, cumulative CO2 savings from new cars approach over 60% for a 2030 phase out; over 50% for a 2032 phase out; and over 40% for a 2035 phase out.

Milestone	**Phase-out year, % reduction in cumulative new car CO2 (compared to no regulation)**			
	2030	**2032**	**2035**	**2040**
2025	-18%	-11%	-5%	-4%
2030	-38%	-30%	-18%	-11%
2035	-52%	-45%	-33%	-22%
2040	-58%	-53%	-43%	-32%

Table 5: percentage reduction in cumulative new car and van CO2 emissions compared to no regulation

To deliver these CO2 savings an effective design of the regulation requiring car and van makers to progressively increase sales of ZEVs is essential. Lessons learned from EU show the best form of regulation is:

1. A ZEV Mandate, commencing in 2024 with targets increasing every 3 years (2027, 2030, 2033) and in the phase-out year
2. To set the same target for all brands and treat all zero emission vehicles equally (no additional credits for longer range models)
3. Apply separate targets for cars (M-class vehicles) and vans (N-class vehicles) but with the same ambition in each year for each class of vehicle (no trading between systems)

[9] ICE emissions average 140g/km on the road for 12,000km per year. EV emissions from charging assumes 0.2KWh/km, 12,000km (as for ICE), carbon intensity from grid average https://www.carbonbrief.org/analysis-half-uks-electricity-to-be-renewable-by-2025. The no regulation scenario assumes BEV sales grow to about 10% (2025), 20% (2030), 33% (2035), 50% (2040)

4. Apply fines of £100 for each 1% the ZEV Mandate target is missed for each vehicle sold
5. Allow companies with a small market share (less than 0.5%) to be excluded from the mandate until 2030
6. Ensuring average emissions from cars and vans with engines do not rise after 2020.

Transitional arrangements for the years 2021-4 need to be put in place to ensure continued supply of ZEVs into the UK market. A system to prevent emissions from conventional new cars rising after 2020 is also needed.

Irrespective of the phase out date policies should also be put in place to reduce car use and lower CO2 emissions in order that the UK does not just achieve net-zero in 2050 but that the overall carbon budget for the UK to limit warning to 1.5 to 2 degrees is met. The later the phase out date the more additional measures are required.

Further information

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