Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the UK

Consultation response

September 2021

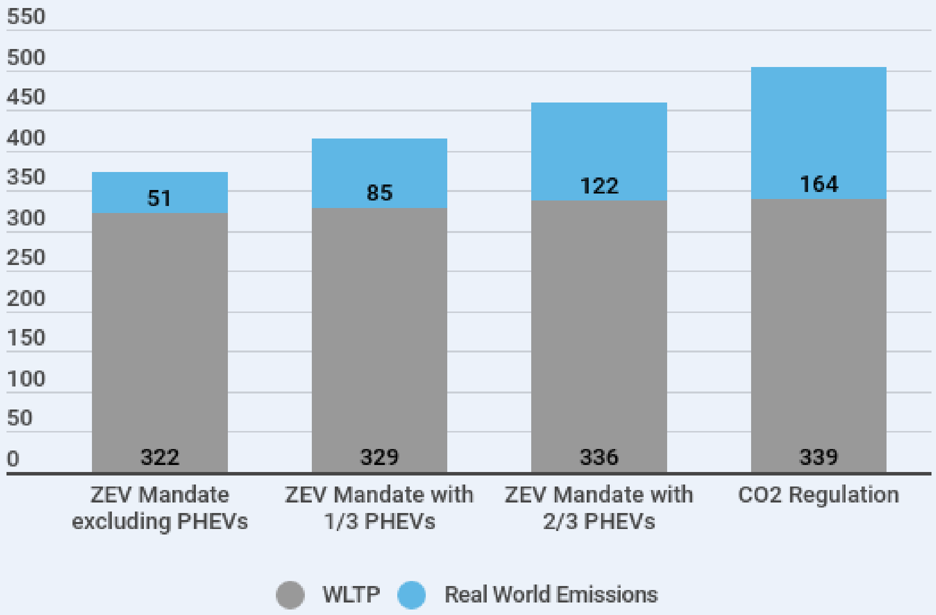
Policy is on the right track but risks remain particularly driving supply and sales of PHEVs and hybrids not zero emission vehicles

Government proposals for a Zero Emissions Vehicle (ZEV) Mandate detailed in its Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the UK are on the right track. But there are risks that the policy will fail to deliver the intended shift to zero emission vehicles and lead to much higher CO2 emissions if details in the policy design encourage the widespread adoption of hybrid and plug-in hybrid vehicles in place of genuine zero emission battery electric models.

Contrary to industry claims PHEVs are not a transition technology but **compete** for market share with BEVs and a high market share of PHEVs will result in a lower uptake of BEVs. Due to the elevated real world emissions of PHEVs, hybrids and conventional cars compared to their test emissions, any increase in their sales at the cost of lower BEV sales leads to higher CO2 emissions reducing the benefits of the policy and making it more difficult to achieve 6th Carbon Budget targets. To manage this risk T&E has a number of key messages:

- The regulation should be a ZEV Mandate NOT CO2 regulation. The figure overpage illustrates the cumulative new car CO2 emissions of a well designed ZEV Mandate are about 25% lower than an equivalent CO2 regulatory approach.
- The Mandate should allocate 1 credit for each ZEV sold with no credits for PHEVs (or hybrids) and no super-credits for longer range BEVs. This will prevent oversupply of credits and maximise the overall CO2 savings.
- Any complementary CO2 regulation to limit CO2 emissions from conventional cars should NOT require a large reduction in emissions as this will encourage sales of PHEVs and HEVs which cannibalize the market for ZEVs leading to higher overall CO2 emissions. A 0-1%pa CO2 emissions reduction is proposed.
- That PHEVs sold after 2030 must have: a minimum equivalent all electric range of 80 miles, have the capacity to fast charge, have an electric motor with a power output no smaller than

the engine; can operate in zero emission mode irrespective of any equipment that is switched on; and, the charge sustaining CO2 emissions should be no more than three times the WLTP value. By adopting these criteria, T&E estimates it will be possible to nearly double the share of miles driven electrically by PHEVs using this design specification from 31% today to 67%.



Cumulative emissions of new cars sold between 2020 and 2035

- That the ZEV Mandate should commence in 2024 with the share of ZEVs sold increasing in 3 yearly steps:
  - 2024-26 18%
  - 2027-29 40%
  - 2030-32 69%
  - 2033-34 89%
  - 2035 100%
- Government should legislate in 2022 and review targets in 2027 to consider if these can be revised upward from 2030.
- That there should be separate regulations for cars and vans and in the future trucks and L-category vehicles following a ZEV Mandate approach. Interim targets for cars and vans should be the same.
- Companies should be freely permitted to buy and sell credits in order to meet targets. The capacity to trade means all brands should be included in the regulation.
- Fines for failing to meet targets should be set at a level higher than in equivalent EU regulations in order to ensure adequate supply of ZEVs into the UK to meet targets.
- Regulation must be complemented by effective tax incentives for car buyers, the roll out of a world class charging network; and EV production incentives for manufacturers.

1. Introduction

This paper has been prepared by Transport and Environment (T&E) UK in response to the Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the UK from the Department for Transport (DfT).

T&E is Europe's foremost sustainable transport NGO, a federation of almost 60 national organisations campaigning for greener transport. T&E has been closely involved in developing the EU car and van CO2 regulation and defining the WLTP test and has a detailed understanding of policies to reduce vehicle CO2 emissions including EU regulation that this paper draws lessons from.

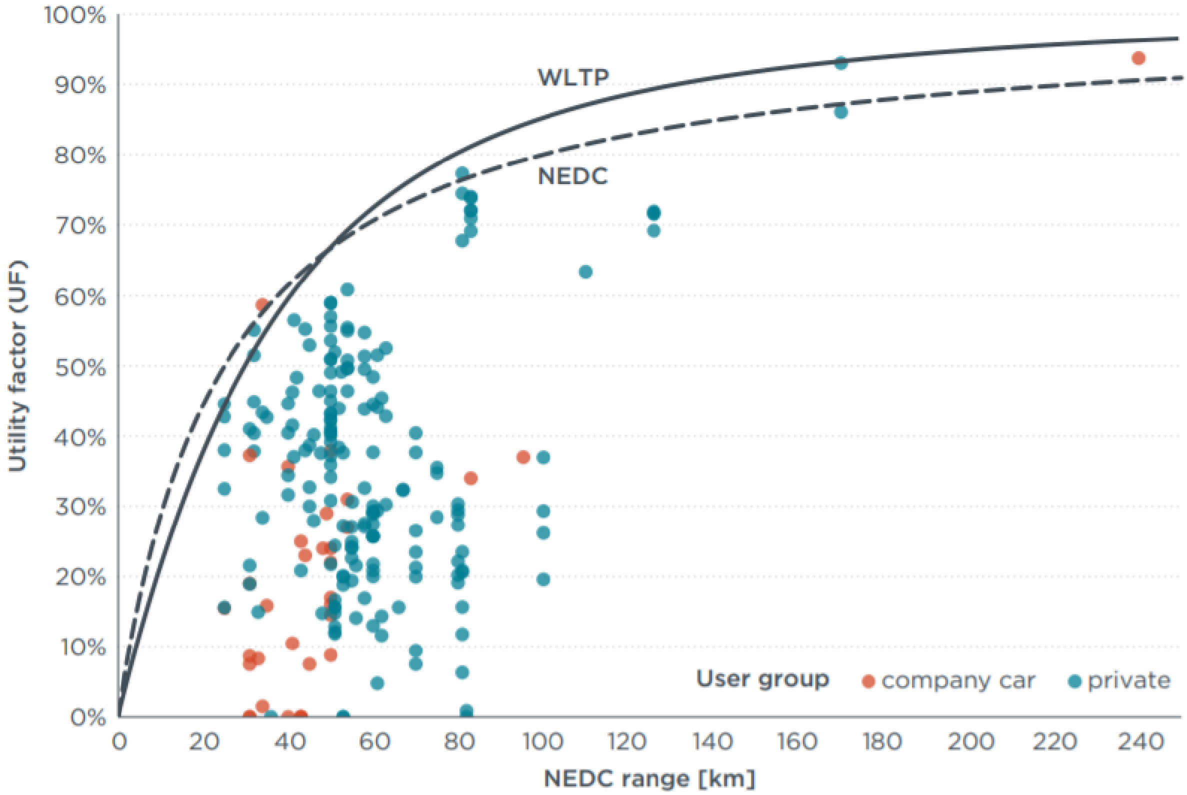
T&E is pleased with many of the proposals within the Green Paper which we believe provide a pathway to achieving the shift to electric vehicles by 2035 as planned. Regulation does need to be complemented by attractive incentives for buyers that should be based upon tax breaks rather than persisting with expensive grants. Our proposals for reform of vehicle vehicles are provided here. A smooth transport to battery electric vehicles also requires a comprehensive, high quality charging network and T&E proposals on this are provided here. However, it will be regulation that ensures adequate supply of electric cars at attractive prices and our response focuses on the questions in the Green Paper.

2. Defining significant zero emission capability

2.1. Metrics of significant zero emission capability (Question 1)

T&E favours using the continuous all electric range measured using the WLTP test as the metric to set eligibility criteria for a significant zero emission capability (SZEC) to apply after 2030. Whilst the WLTP test does inflate the typical electric range compared to real world performance, it provides a basis for fairly comparing different battery electric (BEV) and plug-in hybrid (PHEV models). Hybrid models (HEVs) do not have equivalent all electric range, because they are not zero emission vehicles and T&E strongly opposes allowing HEVs to be sold after 2030. We disagree with the green paper claim that *full hybrids can accommodate substantial driving time and even mileage in zero emissions mode.* This is highly questionable and at best only true in highly congested stop-start urban driving in which fewer cars, not more hybrids, would be most beneficial.

T&E opposes using the official CO2 emissions as an appropriate metric for PHEVs. The CO2 emissions measured for a PHEV are based upon the equivalent all electric range which is converted into a CO2 equivalent value using a formula that grossly exaggerates the utility function of the vehicle (extent to which the PHEV is driven using the battery) compared to real world experience. The figure below illustrates the relationship between the assumed utility factor and equivalent all electric range of PHEVs. The chart, reproduced from a study by the ICCT shows the range measured in the NEDC but the WLTP range will be closely correlated with this but typically about 75% of the range distance. The ICCT compiled data on the real world performance of more than 100,000 PHEV globally including 14,000 in Europe. The chart shows that no vehicle used in the real world exceeds the utility function predicted by WLTP for a given range and most significantly underperform the assumed performance. Using a CO2 metric will therefore bias the market in favour of PHEVs that will typically have a much lower CO2 value than achieved in real world driving.



Average utility factors (UFs) of all PHEVs in the sample versus all-electric range. The all-electric range is given as approximate WLTP range where the WLTP range is assumed to be three-quarters of the NEDC range. Shown also are the WLTP UFs (solid line) and NEDC UFs (dashed line).

2.2 Criteria of a significant zero emission capability (Question 2)

T&E suggests PHEVs whether cars or vans should have a minimum equivalent all electric range of 120km (80 miles) in order to be eligible for sale after 2030. This relatively long range is needed since a high proportion of the CO2 emissions from vehicles results from longer journeys. For example, based upon national trip statistics:[1]

- Only 4% of trips are 25 - 50 miles but account for 17% of emissions
- Only 1% of trips are 50 - 100 miles but account for 11% of emissions

T&E has undertaken a comparison of the electric mile share from three alternative specifications of PHEVs:

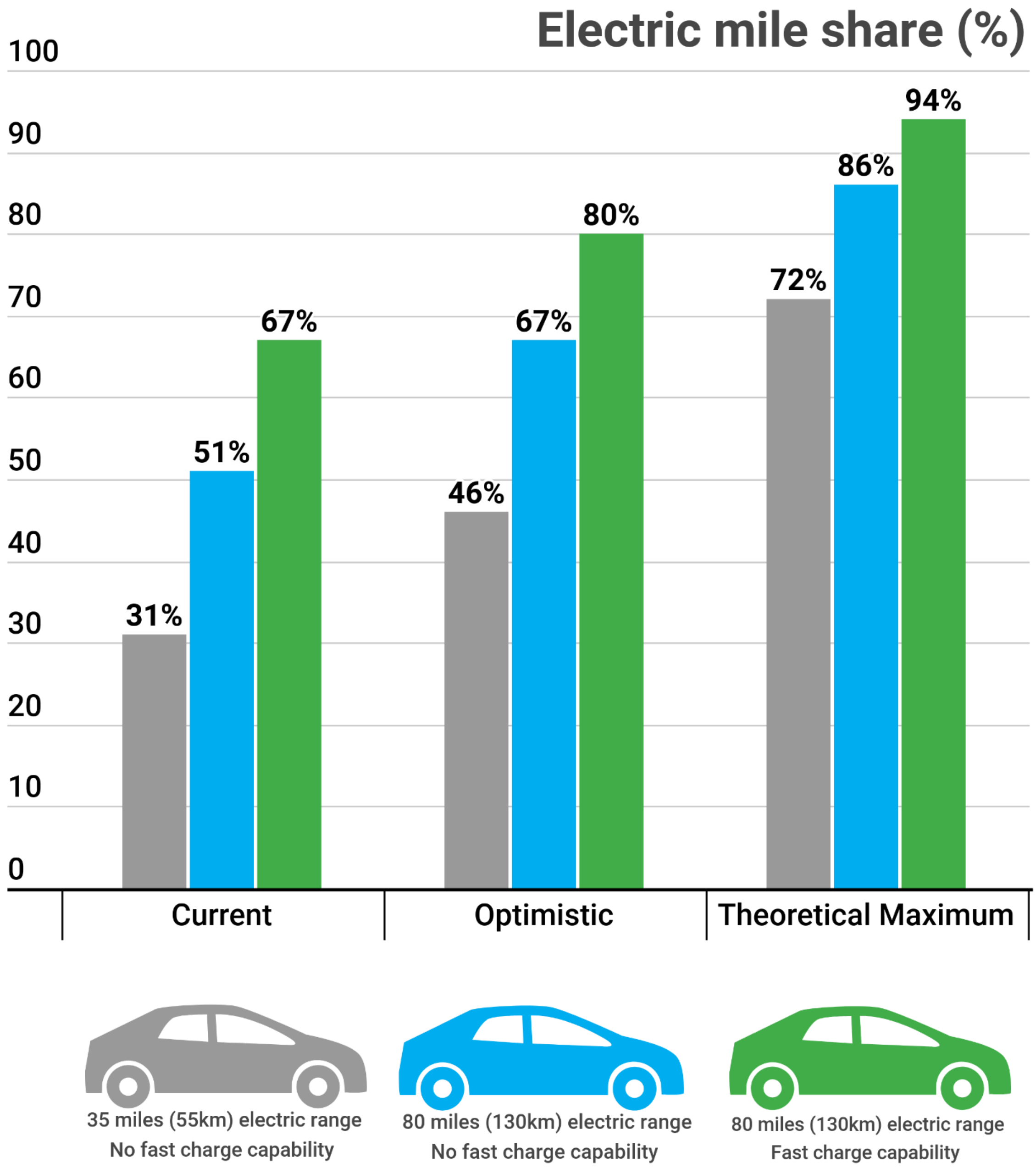
- 35 mile EAER (Equivalent all Electric Range) no fast charging capacity - typical of the PHEVs on the road today
- 80 mile EAER without fast charging capacity

[1] NTS0308, DfT (2020). Retrieved from: https://www.gov.uk/government/statistics/national-travel-survey-2019

- 80 mile EAER with fast charging capacity - our proposed specification for PHEVs to be sold after 2030.

For each vehicle specification we have assessed:

- The *current* electric mile share, based upon current PHEV charging frequency assessed by the ICCT - grey bar
- An *optimistic* electric mile share, that assumes with more charging infrastructure PHEVs are charged more frequently in the future - blue bar
- The *theoretical maximum* electric miles share, assuming the vehicle is charged before it begins each journey - green bar



Details of the assumptions underpinning the analysis are provided in the Annex. It should be noted the chart represents a best case, because:

- Many PHEVs regularly use the engine when accelerating and when auxiliary systems are switched on (see response to Question 3)
- On longer trips are likely to be driven at higher speeds so the real range of the PHEV will be less than the WLTP range for these models.

Based upon current PHEV charging frequency just a third (31%) of the miles driven by a current typical PHEV are electric, rising to 67% using the T&E proposed 80 mile range with fast charging capacity. This is still not an overwhelming proportion of the total miles driven and demonstrates why T&E's preference would be no PHEVs sold after 2030. If PHEV charging frequency improves then a current PHEV still only completes less than half (46%) of miles electrically compared to 80% with a 80 mile range model with fast charging capacity. Even the theoretical maximum electric mile share is less than three-quarters (72%) in a current PHEV. However with T&E's proposal it is 94% (it is not 100% as we do not assume the car is fast charged after 80 miles but completes its trip before recharging).

There is no reason to apply different criteria for cars and vans. There is minimal experience of recharging frequency for PHEV vans compared to that for cars and studies that have been compiled have been undertaken in controlled fleet trials that are not representative of the use of vans in the wider vehicle parc. It remains to be demonstrated whether there is greater charging of PHEV vans than is typical for cars and cost savings of charging a PHEV outweigh the business need for the van to be continuously available and not plugged in charging.

2.3 Additional significant zero emission capability criteria (Question 3)

There are **four other important criteria that should be introduced to maximise the zero emission capability of PHEVs** and ensure these operate in zero emission mode as much as possible:

1. The PHEV should be capable of fast charging at a minimum of 50kWh
2. The power of the electric motor should be equivalent to the power of the engine
3. The vehicle should be able to operate in zero emissions mode irrespective of the power demands of any auxiliary equipment.
4. That the charge sustaining CO2 should be no more than 3 times higher than their WLTP CO2.

These data are readily available from the vehicle manufacturer and could be a requirement of selling a PHEV after 2030.

2.3.1 Fast charging capability

The fast charging capability is essential to enable PHEVs to be able to make longer return journeys in electric mode. Without this capability PHEVs will only be able to make half of trips made in a single day in electric mode. This makes a difference to the total CO2 emissions as seen below.

2.3.2 Electric power requirements

Ensuring the power of the electric motor is at least as large as that of the combustion engine powertrain is intended to ensure that the PHEV can operate in electric mode irrespective of the driving style. It will prevent the engine constantly switching on during more dynamic driving because undersized motors and batteries cannot achieve the necessary accelerations.

T&E tested 3 current PHEV models in real world driving conditions a BMW X5, Volvo XC6 and Mitsubishi Outlander. Each car was tested in:

- EV predominant test mode (in which the battery was fully charged at the start of the test)
- ICE mode test (with a fully depleted battery at the start of the test)
- Charging mode test (commencing with a fully depleted battery and the driver selected the battery charging mode)
- Maximum load test (in which the car started with a fully charged battery - as per the EV mode test - but the load placed in the car was increased to the maximum load allowed for each car.

The largest decrease in EV-only range occurred when driving more dynamically (with sharper accelerations) and with greater altitude gain than allowed by the RDE regulation. The X5 observed the largest fall in emissions, cutting the EV-only range by 76% to only 17.6km. For the XC60 the decrease was of a similar magnitude of 71%, achieving only 10.7km. The Outlander performed slightly better achieving 33km of EV-only range, a reduction of 32%. While on this test the energy consumption during EV-only operation (compared to the EV-predominant test) increased by 57% to 413 Wh/km for the X5, by 49% to 180 Wh/km for the Outlander, for the XC60 the EV consumption decreased on this test to by 21% to 155 Wh/km .

Such a large drop in the EV-only range for the X5 and XC60 cannot be explained by differences in EV consumption alone. On this test, the engine of the X5 and XC60 come on much sooner, after the battery was only depleted by 26% (6.31kWh) for the X5 and 14% (1.43kWh) compared to 69% and 52% on the EV-predominant test. This suggests that the power from the electric motor and battery, as fitted, is insufficient to solely power these two cars when driven with sharp accelerations and greater altitude gain or that the power of the battery at this state of charge is already too low to provide full power to the electric motor. This is essentially a technology design limitation on the EV-only performance and operation of the two cars. In comparison, the Outlander shows no such performance limit. Its EV-only range was also reduced, but the engine only came on once the battery was depleted to a similar level (4.93kWh vs.4.83kWh) as in the EV-predominant test, most likely made feasible by the more powerful electric motor fitted to the Outlander.

2.3.3 Zero emission capability

T&E is particularly concerned about **unreliable claims from manufacturers that PHEV can operate as BEVs in geofenced areas such as city centres**. Most, if not all PHEVs cannot operate auxiliary equipment such as the air conditioning or heater in zero emission mode. This is because the equipment operates from the lead-acid battery that requires the engine to be on to retain charge. PHEVs sold after 2030 should have the capability to operate in zero emission mode irrespective of the demands of auxiliary equipment.

For example; the Kia Niro PHEV claims to operate with a 'battery only, zero emission mode' but switches on the engine (in this mode) when the windscreen demister is turned on. Kia claims the Niro PHEV has an electric range of 55km (34 miles). A Kia owner has informed T&E that despite selecting the Eco+ zero emissions mode, in which the car should only use its battery, the car continued to operate with its engine on. During short trips with the battery fully charged and in zero emissions mode the car recorded a fuel economy of 28 - 52mpg (234 -126 g(CO2)/km). This means the car is also using a substantial amount of fuel increasing its operating cost as well as causing emissions. The car has been checked by a Kia engineer who confirmed it was operating correctly. In correspondence obtained by T&E, Kia explains that, "When the coolant temperature is lower than 14 °C, and you turn the climate control on for heating, the vehicle will automatically switch to HEV mode as the engine is required to provide heat for the passengers. Conversely when the coolant temperature is higher than 14 °C, or you turn the climate control Off, the vehicle will automatically return to EV mode."

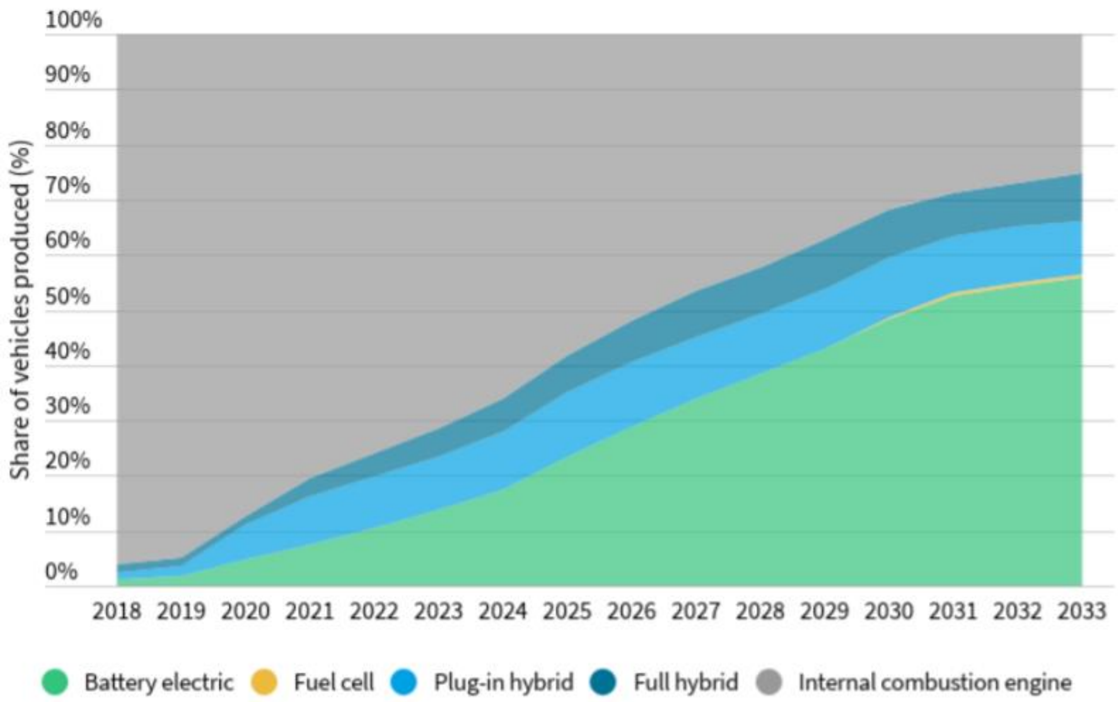
The UK's ten top selling PHEVs all behave in a similar way. This includes cold external temperatures triggering the engine to switch on in the Volvo's XC90 SUV, the Mercedes-Benz E Class executive car, as well as the Kia Niro. The Mitsubishi Outlander SUV has an "EV" button but the engine switches on with the adaptive cruise control or with high or low external temperatures. Jaguar Land Rover's Range Rover and Range Rover Sport plug-ins will start their internal combustion engines if more power is required than the electric engine can provide alone, as will Porsche's Cayenne. The Mini Countryman switches on the engine if you drive faster than the electric mode allows as do BMW's PHEVs. Manufacturers of PHEVs advertise the range of the car driven on the battery only and advertise the car as being capable of zero emissions in urban driving. The reality is it is almost impossible for the car to drive in zero emission mode even for short distances on a regular basis. A requirement for genuine zero emission capability is an important requirement for PHEVs sold after 2030.

2.4 Impacts of a significant zero emission capability (Question 4)

T&E is strongly supportive of the intention to only permit the sales to zero emission vehicles by 2035. It has compiled a range of evidence that illustrates that the real world emissions from PHEVs are typically two and a half times those of the former official (NEDC test) and more than twice that of the new WLTP test. T&E estimate over its lifetime (excluding emissions in production) PHEVs will typical release 28 tonnes CO2 - considerably more than a BEV (4 tonnes). PHEV emissions are marginally less than a HEV (33 tonnes) and better than a traditional diesel car (39 tonnes) or petrol (41 tonnes).

Auto industry claims that PHEVs represent a transition technology are not supported by the evidence. BEVs currently outsell PHEVs in the UK - year to date (end of June 2021) sales of BEVs were 74,000 vehicles compared to 58,000 PHEVs and 73,000 HEVs. PHEVs and HEVs compete with BEV sales - they do not accelerate the transition.

One of the key benefits of establishing a robust SZEC is that is provides a clear signal to the car industry that the current PHEV models available are not fit for purpose and provides long notice to carmakers if they wish to continue to sell PHEVs in the UK after 2030 these need to have a SZEC. PHEVs would probably have never come to market had it not been for the EU car CO2 regulation and were developed as a compliance strategy by OEMs to help meet CO2 targets. They are an expensive solution that is not expected to have a significant market share as illustrated in the figure below that shows planned production of cars in Europe to 2033. T&E analysis of European car production data from IHS Markit shows compared to all plug-in cars (both BEVs and PHEVs), the share of PHEV is expected to decrease from 57% of plug-in cars produced in 2020 to 34% in 2025 and only 18% in 2030. In absolute terms the number of PHEVs produced in Europe is expected to grow from 750,000 units in 2020 (6%) to a peak at 1.7 million units in 2025 (12%) and slowly declining after this. A ZEV mandate that does not include PHEVs (T&E's preferred approach) would send a clear signal to OEMs they should shift to supplying ZEVs not these fake EVs.



Source: IHS Markit, Automotive, European Light Vehicle Production based Powertrain Forecast, April 2021

EU27 + UK car production share per type

Source T&E 2021

The chart similarly shows a small increase in production of HEVs but that these remain a niche product with less than a 10% market share. It should be noted that these forecasts predate the European Commission proposals to shift to only sales of new ZEVs for cars and vans by 2035 - although prior to becoming law must complete the co-decision process with the European Parliament and Member States.

3. New Regulation for cars and vans

3.1 CO2 regulation (Question 5)

Strengthening the existing regulatory framework of CO2 emissions targets for manufacturers is an inferior regulatory approach to the proposed ZEV Mandate. The primary weaknesses of a CO2-based approach is that it will result in fewer zero emissions vehicles on the road by 2030 and 2035 and higher emissions. Given the government's extremely ambitious carbon reduction goals for the Sixth Carbon Budget, maximising the number of zero emission vehicles on the road is a clear priority. Unless around 90% of the car market in 2030 are BEVs it is likely there will need to be significant reductions in miles driven to meet 6th carbon budget targets. Given the government reluctance to reduce car use, adopting a ZEV mandate is therefore essential.

Whilst it will not be possible to reduce emissions to 0g/km by 2035, except by selling 100% zero emission vehicles; other approaches to reducing emissions can be used to achieve interim targets before 2035 in a CO2 based regulation and **this will increase transport and overall emissions compared to using ZEVs and adopting a ZEV Mandate**. This is because a CO2-based approach will result in selling fewer ZEVs until 2035 and there is a significant gap between the real world CO2 emissions and test values which will result in higher overall CO2 emissions - as illustrated below.

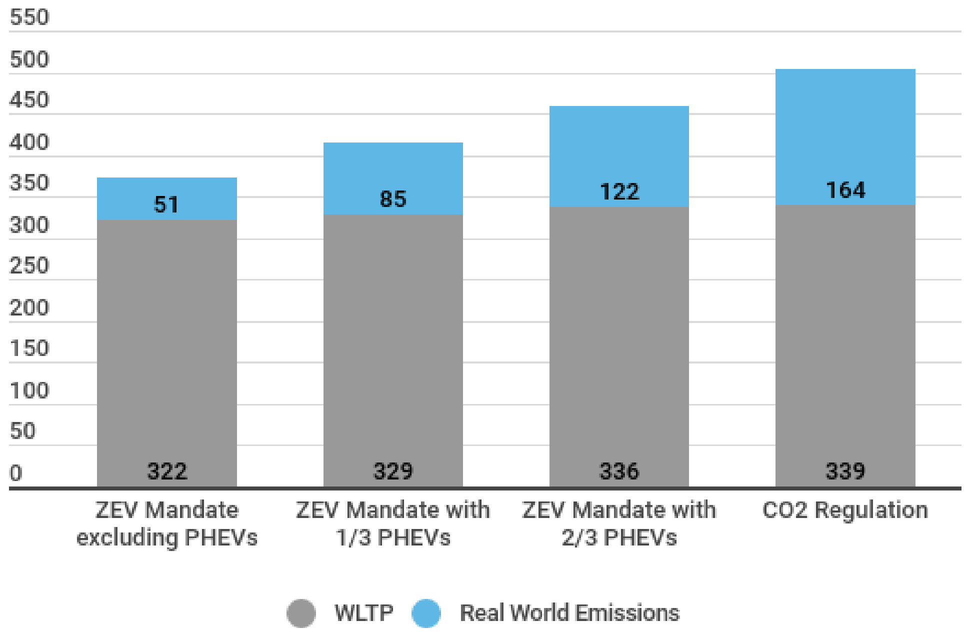
Powertrain	Average g/km eNEDC 2020[2]	Average g/km WLTP 2020	Average g/km real world 2020[3]	Average g/km WTW[4]	Increase WLTP to TTW	Increase WLTP to WTW
Petrol	125	149	174	214	25	65
Diesel	135	166	188	236	22	70
HEV	100	126	148	182	22	56
PHEV	42	45	111	137	66	92
BEV	0	0	0	23[5]	0	23

[2]eNEDC in this case refers to equivalent NEDC; DfT, 2020. Vehicle Licensing Statistics, Table 0156. Retrieved from: https://www.gov.uk/government/collections/vehicles-statistics
[3] Based on quoted eNEDC values and uplift factors obtained from the ICCT's 2018 Lab to Road study . Retrieved from: https://theicct.org/sites/default/files/publications/Lab_to_Road_2018_corrected-jul2021.pdf
[4] Diesel WTT increase of 26%% and petrol of 23%.. Retrieved from: Prussi, M., Yugo, M., De Prada, L., Padella, M. and Edwards, R., JEC Well-To-Wheels report v5, EUR 30284 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-20109-0, doi:10.2760/100379, JRC121213.
[5] 2020 figure based on 2020 UK grid carbon intensity of 155g/kWh and typical BEV ranges and battery capacities. As the UK grid is rapidly decarbonising, this number will decrease. National Grid, 'Future Energy

The table shows that new car CO2 emissions reductions achieved by improving the efficiency of ICE vehicles or selling more HEVs or PHEVs are much less effective overall at reducing emissions than selling BEVS because of the gap between test and real world performance. Even when taking into account upstream well to wheel emissions (WTW) that account for the electricity generation and fuel production emissions the benefit of reducing emissions through a shift to BEVs is much greater.

To illustrate the effect T&E has compared the impact of differently designed ZEV mandates with a CO2 regulation. For both this and the ZEV mandate we have assumed that the average fleet emission levels follow a linear reduction to zero by 2035, with EV sales in line with this.
We have also developed 2 options in which PHEVs count as one-third and two-thirds of a BEV respectively to illustrate the effect of allowing PHEVs to count. The method applied is detailed in the Box attached. The results illustrated below show:

- Imposing a ZEV Mandate in addition to a CO2 regulation ("Option 2") lowers real world emissions by 130 Mt relative to an average fleet target alone
- Allowing PHEVs to count one-third of a BEV in the ZEV mandate results in an additional 42Mt of CO2 between 2020 and 2035 counting PHEVs as two-thirds a ZEV increases emissions by 85 Mt - nearly a quarter.



Cumulative emissions of new cars sold between 2020 and 2035

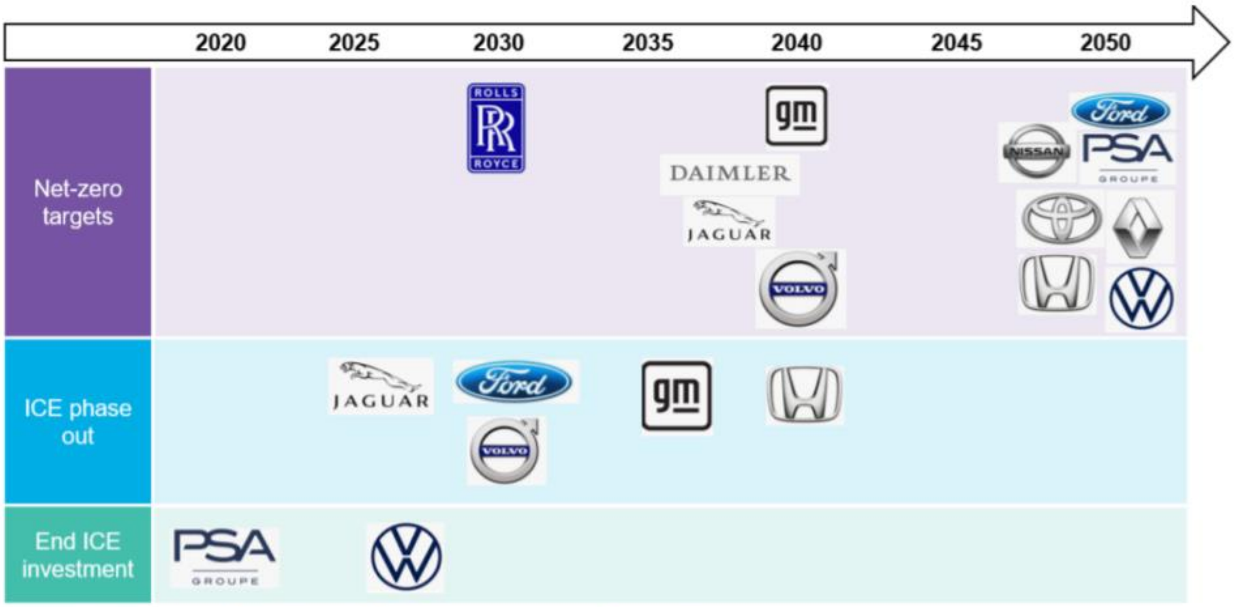
Scenarios in five minutes', 'Key Statistics' table page 12. Retrieved from: https://www.nationalgrideso.com/document/199926/download

A CO2 based regulation has other disadvantages:

1. There is much less certainty of future BEV sales, this presents challenges for a wide range of organisations from the Treasury (that will be less able to predict the impact on tax revenues); charge point operators and local authorities (that will be unable to predict demand for charging) etc.
2. By enabling a range of options to achieve a CO2 target carmakers are less focused on achieving a shift to ZEVs - the government's objective. This may include further delaying investment in new UK manufacturing of ZEVs that is acutely needed to secure the future of the automotive industry.

3.2 ZEV mandate (Questions 6 to 10)

A ZEV mandate is T&E UK's preferred approach to regulating CO2 emissions. It has several advantages, most notably it provides a clear trajectory towards the phase out providing certainty how many BEVs are likely to be on the road in coming years enabling much better planning and preparation for the shift. It also focuses manufacturer attention on delivering the shift to ZEVs rather than pursuing multiple strategies to decarbonise cars and vans. It is now clear, as illustrated below, that the overwhelming majority of car makers recognise the future is electric as illustrated by recent announcements. Increasing numbers of OEMS are already planning to end sales of ICE cars and a ZEV mandate simply regulates this. **A Mandate therefore complements many OEM strategies**.



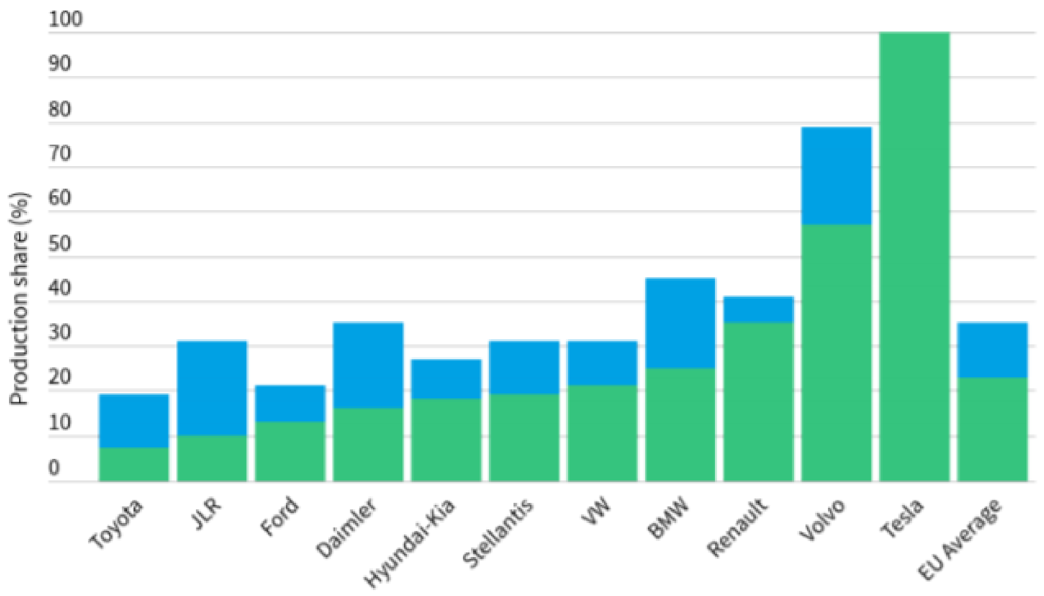
Source: BloombergNEF. Note: Ford ICE phase-out target is for Europe only.

[Source: T&E 2021]

The design of the ZEV Mandate will determine its success and T&E UK makes the following recommendations.

- There must be a series of interim targets - optimally **beginning in 2024 and rising every 3 years** to reach 100% in 2035. This strikes a balance between the need to increase the number of BEVs on the road rapidly and providing the flexibility for OEMs with different new model launch and upgrade cycles. The EU's 5 year cycle of targets has resulted in step increases in cuts to CO2 every 5 years, not the smooth trajectory that was hoped for when the regulation was designed. The proposed regulatory steps are:
    - 2024-26 18%
    - 2027-29 40%
    - 2030-32 69%
    - 2033-34 89%
    - 2035 100%
- **Only sales of BEVs should count towards the targets**. Each BEV should count once - with no multiplier (supercredits) for higher range models. The regulation should NOT encourage longer range BEVs that have larger batteries and higher embedded emissions. Neither should it encourage smaller batteries. There is strong evidence of EV range growing and no evidence of the development of a market of low range BEVs with limited utility.
- **HEVs should NOT count towards targets and neither should PHEVs.**
- Fines should be set at a level **slightly higher than the equivalent to the current UK car CO2 regulation.** This will in turn be higher than the EU fines and guarantees OEMs will prioritise meeting UK limits, T&E has no objection to the proposal to only fine OEMs for sales of BEVs below the OEMs target.
- **Trading should be an intrinsic part of the regulation** and will be important, particularly in the early years, to enable some carmakers to avoid fines by purchasing credits from others. It is NOT recommended to follow the excessively complex EU system of pooling and trading. Instead, car brands should be the regulated entities and the government create a platform through which OEMs can transfer credits between brands or one another. The market should be limited to OEMs not traders.
- **The trading system creates a level playing field for all companies and eliminates the need to exempt smaller companies**. A trading system will enable companies with a very low market share, for whom a Mandate would present a significant barrier to business, with a mechanism through which to meet targets.

T&E has analysed the forecast production of EVs in Europe in 2025 by which time there will be around 170 models. Notably this includes around 10 models from Toyota that is the least prepared of the large OEMs transitioning to BEVs. Toyota will nevertheless be manufacturing about 8% BEVs in 2025 and a further 10% PHEVs. It also has the capacity to import EVs into the UK from Japan and could also purchase credits from other carmakers having previously participated in the EU trading system providing credits to Mazda.



EU production may not reflect some OEMs' sales announcements (import/export not accounted or outdated production plans)
Source: IHS Markit, Automotive, European Light Vehicle Production based Powertrain Forecast, April 2021

BEV and PHEV share in 2025 forecasted production in Europe

Source T&E 2021

3.3 Combining targets (Questions 11-12)

T&E UK is in favour of focusing on driving the supply of zero emission vehicles not simply reducing emissions from new cars. **Accordingly, we are NOT in favour of significantly strengthened CO2 reduction targets.** Strong CO2 targets will lead to higher sales of PHEVs and HEVs and consequently lower sales of BEVs. Our preference is that the regulation only requires a small incremental reduction in CO2 emissions from conventional vehicles in order not to encourage manufacturers to achieve more ambitious targets through increasing PHEVs and HEV sales. This would also focus manufacturer attention on selling ZEVs.

In order to achieve this we propose that complementary CO2 regulation would establish a baseline emission of the average CO2 emissions from new cars sold in 2021 **excluding BEV sales** (only sales of conventional ICE, hybrid and PHEV vehicles would count towards the CO2 target). There would be a requirement on vehicle manufacturers to reduce this by 0-1% per year. Such a low target effectively eliminates the concern that manufacturers will be required to meet two separate targets and the additional burden and cost of compliance - the aim is primarily to avoid emissions from conventional vehicles rising.

There are several examples that illustrate that PHEV sales to some degree cannibalize BEV sales:

- After the UK and Netherlands scrapped purchase grants for PHEVs there was subsequently a strong growth in BEV sales
- In the Nordic countries (Sweden, Finland and Denmark) there are particularly strong market shares for PHEVs but sales of BEVs are much more modest in comparison.
- There is only 1 country with both a high share of PHEV sales and BEV sales in the whole of Europe (Iceland) although Norway has a very high share of BEVs and a strong PHEV market also.

The market for PHEV and HEVs does not need to be incentivised and in designing the new regulation the government is advised to avoid this to focus on accelerating the shift to BEVs.

3.4 Driving supply and supporting investment in the UK (Question 13)

The most effective way to ensure there is sufficient supply of vehicles to meet the mandate targets is to set fines at a high level and maintain strong tax incentives for ZEVs. There is adequate production capacity and availability of electric cars and vans to meet any UK demand. A high level of fines will ensure manufacturers prioritise selling these vehicles in the UK rather than the EU. A good level of consumer demand can be achieved by maintaining strong tax differentials with ICE cars which can be achieved by raising 1st year VED and BiK rates for conventional cars whilst ZEV retain a low tax rate. There is no need for a continuation of the increasingly expensive plug-in car grant once vehicle taxes have been reformed in line with Treasury proposals. The UK does not need to match the excessively generous grants for electric cars available in Germany - it can use penalties for not achieving ZEV Mandate targets and taxes on ICE cars to achieve the same influence on the market.

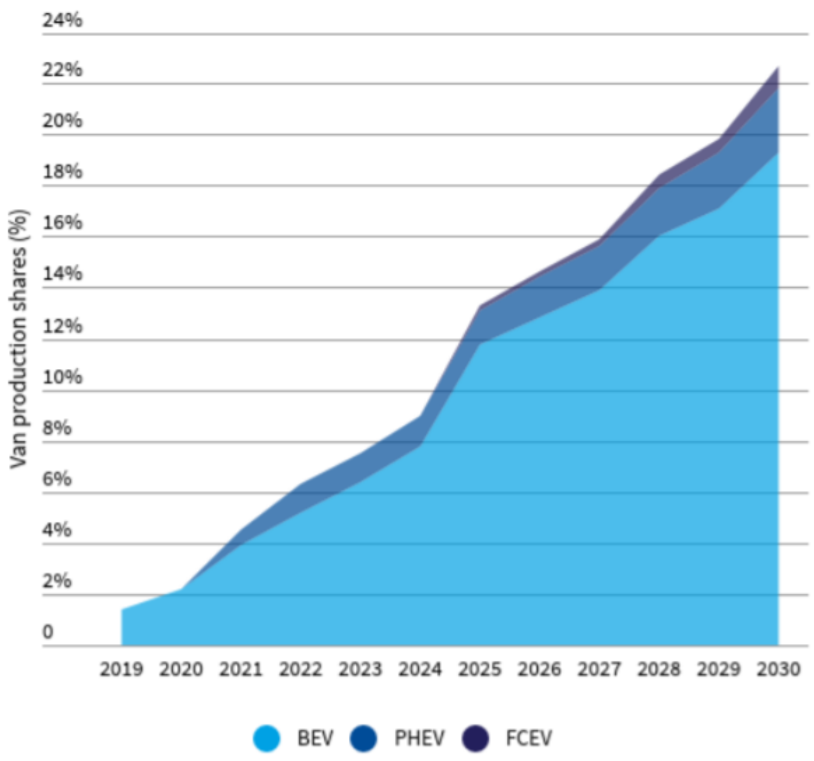
3.4.1 Cars

T&E analysis of car production forecasts by IHS Markit shows around a quarter of cars produced in the EU by 2025 will be battery electric rising to a half by 2030. Since this data was published additional production has also been announced including in the UK. Pre-pandemic (2019) 14 million cars were manufactured in the EU (then including the UK) so this will amount to around 3.5 million BEVs in 2025 and 7 million in 2030. UK car sales are typically less than 2.5 million per year - so there is adequate supply of EV manufactured in the UK plus EU that can be complemented by imports from the rest of the world to meet the planned 2030 end date for sales of conventional cars.

3.4.2 Vans

Availability of battery electric vans in Europe is less than cars but supply is still sufficient to achieve targets to meet a phase out. T&E analysis illustrated below indicates 12% of vans manufactured in the EU and UK will be electric by 2025 and 22% in 2030. 2.1 million vans were manufactured in total in 2019 so future availability of battery electric vans is forecast to be about 250,000 in 2025 and 460,000 in 2030. In 2019, 366,000 new vans were sold in the UK but sales are rising fast and could reach 400,000 in coming years. A ZEV mandate requiring a quarter of vans to be battery electric in 2025 would therefore require sales of 100,000 BEV vans. This level of BEV vans sales is achievable but would require the UK to be the market for 40% of the electric vans manufactured in Europe. Such a strong supply could only be achieved by levying a penalty through the ZEV mandate higher than the equivalent EU target.   For the UK to achieve an end to diesel van sales by 2030 there will need to be significant additional BEV van production in Europe.

The weak supply of electric vans in Europe arises from the weak van CO2 regulations that did not require van manufacturers to sell electric vans to meet the 2020 van CO2 target of 148g CO2/km. But a ZEV mandate for vans presents an opportunity for the UK to attract additional BEV van manufacturing in the UK. Stellantis recently announced that it plans to build electric vans at Ellesmere Port. Stellantis also manufactures vans in Luton and a strong UK regulation and market will encourage the company to consider electric vans production at this plant. As importantly LEVC manufacture vans and new start up Arrival will also and is establishing new manufacturing in the UK. Aligning van mandate targets with those for cars will support UK manufacturers on electric vans potentially enabling them to sell credits to other manufacturers choosing to export diesel vans into the UK market.



Source: T&E analysis, data from IHS Markit light duty vehicle production forecast, January 2021 update

Production shares of battery-electric, plug-in hybrid and fuel-cell electric vans in 2030 (EU27+UK+NO)

3.5 Exemptions (Question 14)

If the regulation includes a trading element there is no need to exempt specialist vehicles or niche manufacturers. Specialist vehicles represent a very small share of the overall market and manufacturers can purchase credits to meet targets for these vehicles. Similarly niche manufacturers only supply a tiny number of typically luxury vehicles and can buy credits to meet their obligations under a ZEV mandate.

If the Government did decide to exempt brands with a very low market share a possible criteria could be companies with a UK market share of less than 0.5%. SMMT data lists sales by brand in the UK and applying a derogation 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. Any derogation for companies with a market share below 0.5% should only apply until 2030 after which the requirements of the mandate would apply.

3.6 Credits for vehicles meeting a SZEC (Question 15 & 16)

T&E is not in favour of awarding credits for either hybrid or plug-in hybrid vehicles so these count towards the ZEV Mandate target. HEVs and PHEVs are NOT zero emission vehicles. If DfT decides to allow PHEVs sales to awarded credits **each PHEV should only count as one-third of a BEV** (credit of 0.33) reflecting the average current real world usage. This factor could be revised in the future either upward or downward in the future as evidence of real world use emergences. If credits are adopted for HEVs these should be less than 0.2 of a BEV.

There is insufficient evidence to justify adjusting the credits awarded to PHEVs based upon their range. There is no robust evidence PHEVs with a longer range have a higher utility function (proportion of kms driven using the battery) which depends upon driver behaviour.

3.7 Credit banking and trading (Questions 17 - 20)

T&E is not in favour of allowing banking of credits or any allowable debits as part of a ZEV mandate. In schemes where banking of credits is allowed there is extreme pressure to include weak targets in the early years to enable surplus credits to be used in later years. This is contrary to what is needed if the UK is to achieve its challenging 6th Carbon Budget targets that require ZEV sales to be as high as possible as early as possible.

Rather than allowing banking T&E is in favour of setting 3 yearly interim targets instead of annual targets. The experience of EU regulations is 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. The 2020 target was met by virtually every manufacturer that only took action to reduce emissions at the last possible moment. This is despite the target being first agreed in 2009 and reconfirmed in 2014.

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he EU (duplicated by the UK in its own CO_2 regulation) has set a 5 yearly sequence of targets (2015, 2020, 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. For example, assuming a 2035 phase-out date) cumulative ZEV sales are estimated to be:

- 19 million vehicles with annual increases in sales
- 17 million, with 3 yearly targets
- 15 million, with 5 yearly 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. 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.

T&E sees no reason to restrict the number of certificates that can be bought and sold. The trading system enables all manufacturers to achieve their targets irrespective of their strategy to decarbonise.

T&E is in favour of having separate mandates for cars, vans and heavy commercial vehicles (trucks). Not all car manufacturers also sell vans and very few sell trucks. To maintain a level playing field between companies there should be separate mandates for the three types of vehicles.

3.8 Fines (Question 21)

The level of fines being set should be **at a higher level than proposed for the EU car CO_2 regulation**. In this way manufacturers will prioritise supplying electric vehicles to the UK market over that of the EU in the event there are insufficient vehicles to meet both targets. This way ensures the UK will be the preferred destination for electric vehicles and there should be no supply constraints.

3.9 Target setting process (Question 22)

T&E is in favour of the Government setting a legally binding trajectory that increases the proportion of zero emission vehicles sold in each market segment. Targets should be set later this year, be legislated for in 2022 and become legally binding in 2024. The proposed targets for cars and vans are:

- 2024 -2026 17%
- 2027 - 2029 40%

- 2030 - 2032 69%
- 2033 - 2034 88%
- 2035 100%

This trajectory follows the pattern of targets rising every 3 years. A review could be held after 5 years (2027) to consider whether a faster trajectory is possible for 2030 onwards.

Whilst it is theoretically possible to account for real world emissions in a new UK regulatory system T&E only considers this necessary if the government does NOT adopt the proposed ZEV Mandate approach and instead proposes only a CO2 based regulatory framework. With a ZEV mandate and minimal CO2 regulation it is not necessary to include an adjustment for real world emissions. With only a CO2 based system monitoring and adjusting for real world emissions becomes necessary to avoid test-beating methods.

4. Heavy Duty vehicles (Questions 23 to 25)

One of the clear benefits of a ZEV Mandate for trucks over a CO2 regulation is that the UK Government is not dependent upon the development of the VECTO tool and can establish regulations for vehicle segments not currently covered by the tool. For a CO2 based regulation the UK will be dependent upon the EU-tool whilst having no influence over its development.

The unintended consequences of establishing a ZEV Mandate for certain vehicle sub-categories before a CO_2-based regulation are positive. Truck manufacturers will be encouraged to supply zero emission models in market segments not yet included within VECTO earlier as these sales will count towards the ZEV Mandate - that the UK will be the early market for these vehicles may encourage manufacturers to establish manufacturing here.

5. L category vehicles(Question 26)

There is no reason why L-category vehicles cannot be regulated in a similar way using a ZEV Mandate. Indeed there are significant benefits of A Mandate over a CO2 regulation as not all L-category vehicles are tested and have a type approval CO2 measurement.

Further information

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Appendix

Methodology 1: Electric mile share calculation

The share of miles driven electrically (also referred to as the utility factor or utility function) was calculated from the distribution of trip frequency by trip length in the 2019 National Travel Survey (NTS0308).

The average distance of a trip within each distance bin was based on the total distance travelled annually on trips in this category and the number of such trips. In keeping with the NTS data, half of the trips were assumed to be from home to a destination and half a return to home, which was taken to be the main charging location. For PHEVs without fast charge capability, it was assumed charging only occured at home; fast charge capable PHEVs began each trip (whether from or returning to home) with a full battery. All trips starting at home were assumed to begin with either a full battery, as in the theoretical maximum scenario, or with an average state of charge corresponding to the frequency with which the PHEV is charged before a trip begins.

Firstly, the share of electric miles on an average trip from the different length categories was calculated. For outbound trips, the electric mile share is the range of the PHEV divided by the average trip distance in each category. It was assumed that trips occured in pairs of equal distance, and therefore if a PHEV lacked fast charging capacity the electric mile share on the return trip was any remaining range after the outward leg divided by the average trip length. The range was assumed to be linearly proportional to the theoretical maximum and the average state of charge.

Secondly, the share of electric miles for each length category is the share of miles driven on trips within that category multiplied by the share of an average trip in that category that is electric. The overall electric mile share is the sum of these category electric mile shares for all categories.

Methodology 2: Cumulative CO2e emissions of cars sold between 2020 and 2035 over the same period

T&E assumed a CO2 regulation would decline linearly from a current fleet average of 135 g/km (WLTP) to zero in line with the government's ambitious 2035 phase out date. Average g/km values for different powertrains were taken from the 2020 WLTP averages (according to EEA data) and uplifted to real world values according to the ICCT's Lab to Road Study[6] . These were taken as constant through to 2035, as was the share of sales of HEVs (10%), average annual mileage (12,000km) and yearly new car sales (2.3 million per year).

[6] Based on eNEDC values from the EEA and uplift factors obtained from the ICCT's 2018 Lab to Road study . Retrieved from: https://theicct.org/sites/default/files/publications/Lab_to_Road_2018_corrected-jul2021.pdf

Three different forms of ZEV Mandate were assumed. The first was a maximum scenario where as many PHEVs were sold as was possible whilst keeping to the regulated average emissions levels over the whole fleet. The second was a minimum where no PHEVs were sold and the average emissions targets were met through increased sales of BEVs alone. The third scenario assumed a more realistic share of 33% of EVs as PHEVs.

The EV share needed to meet fleet average targets in line with the CO2 regulation was then calculated, with the above shares of PHEVs for each scenario, and from the resulting mixture of vehicles an average fleet emission level was estimated based on real world g/km values.