LowCVP
Low Carbon Vehicle Partnership

LowCVP submission to

Ending the sale of new petrol, diesel and hybrid cars and vans – OLEV

Executive Summary

This paper provides an outline response from the LowCVP Secretariat to the open consultation "Ending the sale of new petrol, diesel and hybrid cars and vans" published by the Office for Low Emission Vehicles (OLEV) in February 2020.

The LowCVP, which was established in 2003, is a public-private partnership working to accelerate a sustainable shift to lower carbon vehicles and fuels within the road sector, and to create opportunities for UK business. Around 200 organisations are engaged from diverse backgrounds including automotive and fuel supply chains, vehicle users, academics, environment groups and others. The Partnership became a not-for-profit company limited by guarantee in April 2009 and receives roughly half its funding as a direct grant from the DfT, together with funding directly from Transport Scotland and all member companies.

In compiling this response, LowCVP has collated background research from previous LowCVP projects, partner activities and relevant publications. This included a review of transport and environmental policies implemented in countries outside of the UK, and the performing of Life Cycle Analysis (LCA) on selected scenarios. LowCVP also engaged it's membership for feedback and input to the consultation response, this being achieved with a series of dedicated workshops, one-to-one interviews and survey replies. As such, the views expressed within this submission are an amalgamation of opinions and do not represent the viewpoint of one single member organisation in isolation.

As a carbon focused organisation, the LowCVP has chosen to base the core of this consultation response on life cycle greenhouse gas emissions, supported where appropriate with commentary on associated factors. LowCVP has achieved this through the development of it's own simplified model of the car and van fleet, allowing it to compare the relative impact of the different policy approaches described below.

- Business as usual (BAU) – sales of new car and vans without any additional measures being applied to encourage the adoption of battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV)
- ICE Only – all new car and van sales are combustion engine vehicles, a worst case scenario if public uptake of BEV and PHEV was to stall completely
- BEV 2030 – all new car and van sales are BEV from 2030 onwards
- BEV 2035 – all new car and van sales are BEV from 2035 onwards
- BEV & PHEV 2030 – all new car and van sales consist of BEV and PHEV from 2030 onwards, with PHEV sales ceasing by 2040

Based on consultation feedback and work conducted to date, LowCVP recommend **bringing forward the end of sale date to 2030 based on the following**:

- **Cease the sale of new cars and vans that are powered solely by petrol or diesel combustion engines, including hybrid vehicles that are without a plug-in capability**
- **From 2030 onwards and for a period of 10 years, permit the sale of battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV) before transitioning to BEV only sales in 2040**
- **An increase in renewable, low carbon fuels available for use with the PHEV new car and van fleet**

LowCVP analysis indicates that such a proposal would result in a greater saving in cumulative greenhouse gas emissions up to 2050 compared with moving solely to BEV only sales in 2035. LowCVP also believes that it provides for an achievable ramp up and transition for vehicle manufacturers whilst placing a more realistic demand on the supply chain, particularly in the area of battery production.

Other observations drawn are:

1. The government proposal for ending the sale of new petrol and diesel cars and vans at 2035 is considered feasible within which it may be possible, but challenging, to include ending the sale of PHEVs
2. The introduction of a BEV only strategy for new car and van sales in 2030 is regarded as too disruptive and costly to be considered achievable and results in minimal additional saving in life cycle greenhouse gas emissions compared to the alternative proposed by LowCVP
3. A strategy based upon new car and van sales from 2030 onwards consisting of BEVs and PHEVs is 10% more effective at reducing cumulative greenhouse gas emissions than a strategy mandating solely BEV new car and van sales in 2035
    a. The increased use of renewable fuels in 2030 in conjunction with new PHEV cars and vans generates an additional cumulative greenhouse gas emission saving, as well as providing a means of decarbonising the existing car and van parc
4. Electrifying the UK's cities through the introduction of zero emission zones (ZEZ) potentially starting in 2025 will result in an immediate reduction in cumulative greenhouse gas emissions (estimated at 6.5MtCO_2e per annum in England), whilst accelerating the uptake of BEV and PHEV cars and vans
5. The manufacture and assembly of BEV and PHEV cars and vans in the UK provides a potential cumulative greenhouse gas emission saving per vehicle in 2035 compared to the import of vehicles from the EU and rest of world
6. A battery manufacturing capacity of approximately 120GWh will be required to support new car and van sales for a BEV only strategy in 2035. Such capacity is required 5 years later in 2040, if following a combined PHEV and BEV strategy. Conversely, a BEV only strategy introduced in 2030 requires the full capacity to be in place 5 years earlier in 2030
7. The adoption of smart charging and potentially vehicle-to-grid (V2G) technology will be required to minimise reinforcement and upgrade of the electricity grid network, in

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order to support the 200,000 public chargers estimated as necessary to serve the vehicle parc in 2050
8. Retention of grants and incentives will be required to ensure affordability of both new and used zero emission cars and vans
9. Targeted policy interventions (both carrot and stick) in specific sectors, locations and applications may accelerate the uptake of electric vehicles more rapidly and deliver greater greenhouse gas emission savings
10. In conjunction with a clear policy on new cars and vans, consideration of the adjoining sectors in PLVs (L Category) and light trucks (N2 category) is necessary to avoid unintended transfer of transport activity to combustion engines not captured in the new car and van policy

Detailed Consultation Response

Phase Out Date

LowCVP has received no indication in discussions to date to suggest that a phase out date of 2035 is not possible with the correct package of measures and policies in place, although the inclusion of PHEVs in the end of sale criteria is felt to make the task significantly more challenging.

Bringing the phase out date further forward from 2035 in combination with the pursuit of a BEV only strategy for new car and van sales is regarded as largely unachievable. LowCVP has a high level of confidence that the UK energy system can be ready in time for 2030 based on the Electric Vehicle Energy Taskforce report "Energising our Electric Vehicle Transition" [1]. Similarly, industry roadmaps confirm that electric vehicle technology will be sufficiently mature to provide the zero tail pipe emission solution required, with battery electric considered further ahead during this timeframe than hydrogen fuel cell in this regard. However, LowCVP believe that the level of battery manufacturing capacity required to support a BEV based new car and van fleet is highly unlikely to be available for 2030. In addition, battery and associated electric vehicle systems will be more costly to produce in 2030, affecting both manufacturer and consumer alike. Finally, LowCVP analysis will show that there is very little saving to be made in terms of life cycle greenhouse gas emissions by targeting a 2030 BEV only introduction in comparison to alternative proposals.

What Should Be Phased Out

All new cars and vans below 3.5t powered solely using a petrol or diesel combustion engine, plus the majority of new cars and vans utilising hybrid technology.

However, the LowCVP membership strongly believe that not all hybrids should be included in the end of new car and van sales. Specifically, PHEVs are felt to offer a means of rapidly electrifying miles in the short to medium term, generating an overall benefit. Full greenhouse gas lifecycle analysis performed by LowCVP, illustrated in Figure 1 below, indicates that significant savings in cumulative greenhouse gas emissions in the order of 10% are possible with a 2030 introduction date for PHEV and BEV new car and van sales compared to a 2035 date for BEV only new car and van sales.

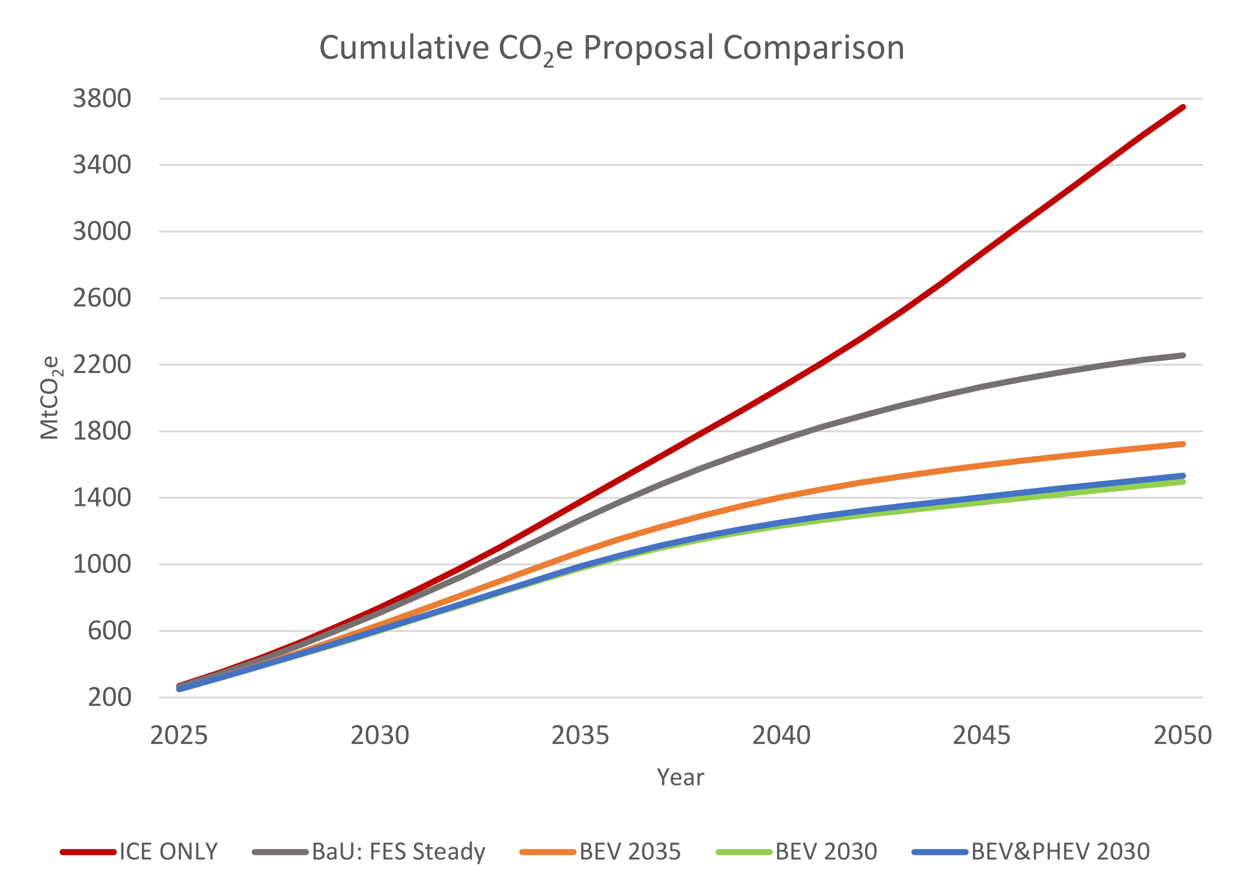

Figure 1: Cumulative greenhouse gas emissions by proposal

A 2030 date for BEV only new car and van sales is considered very difficult to achieve, particularly for hard to electrify sectors such as large vans and based on LowCVP analysis provides only a small additional saving in terms of cumulative greenhouse gas emissions over the 2030 introduction of a BEV and PHEV strategy. As shown in Figure 2, equivalence is all but achieved between the two strategies with the introduction of a renewable fuel blend such as E85 in 2030 for use with PHEV new cars and vans. Whilst not the focus of this consultation, renewable fuels in general will play an important part in the reduction of greenhouse gas emissions in the existing car and van parc.

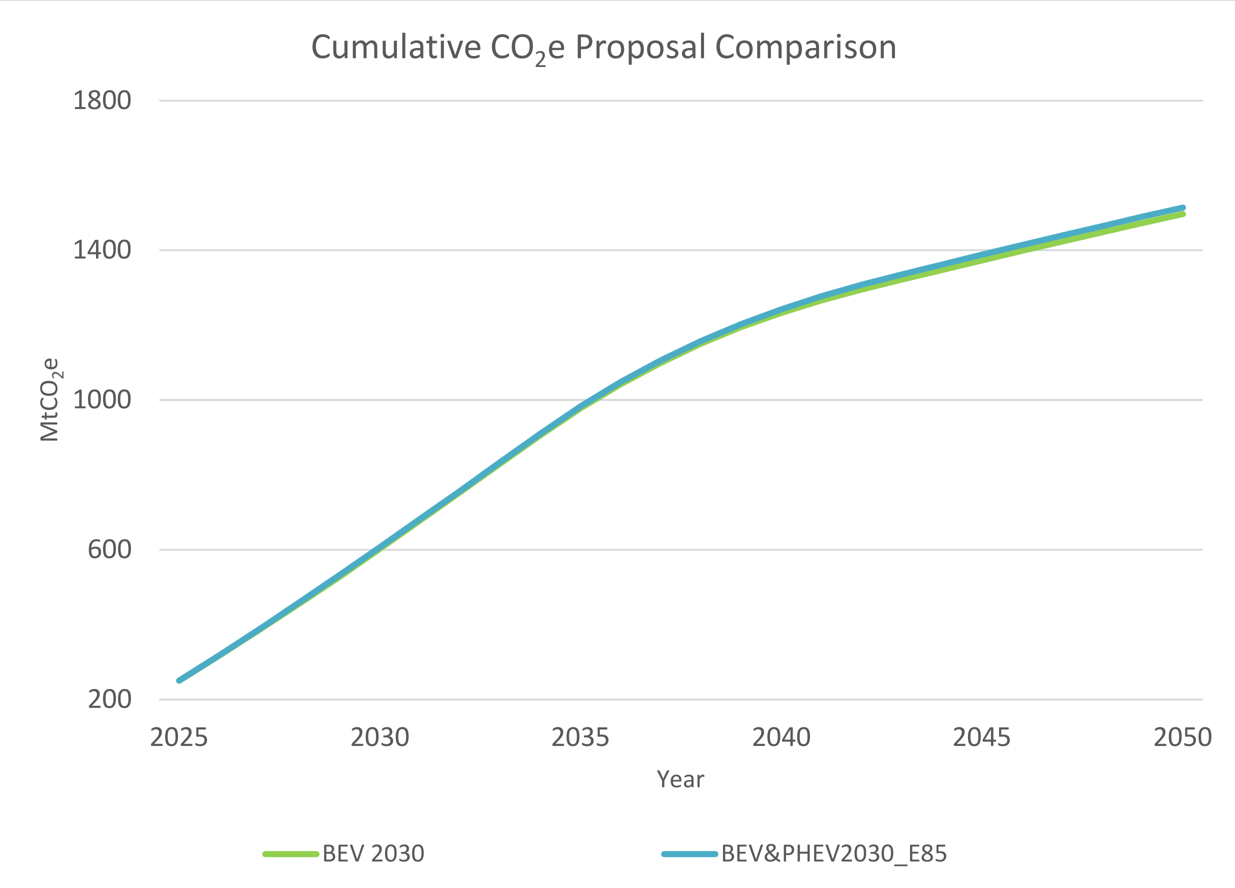

Figure 2: BEV 2030 in comparison with PHEV & BEV 2030 using E85

As PHEVs typically use smaller batteries, a PHEV based strategy also has the effect of reducing the raw material demand placed upon battery producers at a point when the supply chain begins the transition to high volume manufacture. Technology exists today, and should be leveraged, to ensure that such vehicles are operated in the most efficient and low emission manner possible, addressing concerns of users failing to plug in and charge their vehicle. The most obvious parallel in this area are the vehicle control strategies that have been developed to ensure use of AdBlue in diesel vehicles.

If the implementation of zero emission zones (ZEZ) in UK cities was targeted to begin in 2025, this would aid the uptake of BEV and PHEV cars and vans, with the technology forecast to be available at the time better suited to the shorter range journeys typically taking place in a city environment compared to a rural area. The roll out of ZEZs would also simultaneously provide a reduction in greenhouse gas emissions, estimated at 6.5$MtCO_2$ per annum in England alone.

Barriers To Achieving Phase Out

In the case of battery electric vehicles (BEV), barriers that exist to accelerated adoption include:

- A large battery pack is required to achieve a range comparable with a petrol or diesel vehicle ***or*** the consumer must accept a shorter vehicle range

    - LowCVP estimate 110-120kWh will provide a 500 mile range in 2035 for a medium sized passenger car
    - Based on driver polls [2], 250 miles is regarded as the minimal acceptable range for a BEV passenger car, roughly equivalent to a 60kWh battery pack
    - In the case of larger vans, LowCVP estimate achieving a 500 mile range in 2035 will require in excess of 180kWh reflecting the greater challenge facing the electrification of the N1 category
- A battery manufacturing capacity in the region of 120GWh will be required to support new car and van sales under the BEV 2035 proposal
    - Currently, the UK has a manufacturing capacity of approximately 2GWh [3]
    - If following a combined PHEV and BEV strategy introduced at 2030 then a capacity of 120GWh is required 5yrs later in 2040
    - If following a BEV only strategy introduced at 2030 then a capacity of 120GWh is required 5yrs earlier in 2030
- Approximately 200,000 public chargers will be required to serve the vehicle parc by 2050 [4]
    - Based on the latest Zap-Map data, at present there are an estimated 31,000 public charge points installed in the UK
    - To achieve the required roll out will require an average of 9,000 charger installations per annum until 2050
- The electrification of road transport has the potential to increase electricity consumption by up to 30% [1]
    - Equivalent to an estimated cost of £2.7bn to £6.5bn to reinforce the grid
- Purchase cost parity with a petrol or diesel vehicle
    - Whilst parity on total cost of ownership (TCO) can be achieved today for a BEV, initial purchase prices remain high by comparison even with the availability of the plug-in grant
    - Vans in particular suffer from a greater purchase price disparity and with lower volumes and increased range/load requirements compared to passenger cars, the van sector may require longer as an industry to achieve lower purchase prices

Whilst this document focuses on BEV and PHEV for new car and van adoption, primarily due to the greater level of information available upon which to assess cumulative greenhouse emissions through techniques such as life cycle analysis, it is recognised that fuel cell electric vehicles (FCEV) also offer a zero tail pipe emission capability. Barriers that exist to the accelerated adoption of FCEV include:

- Production readiness of fuel cell technology
    - Current global automotive fuel cell production is limited to a few thousand vehicles per annum. [5] Industry estimates range from 5 to 10 years for fuel cell production to scale to the low hundred thousands per annum [6]
- Hydrogen generation infrastructure and refuelling network
    - According to UKH2Mobility, 12 hydrogen refuelling stations exist in the UK at present with a further 4 planned, an increase of 7 from 2015. For no behavioural change on the part of the consumer, it is assumed equivalence with

    - the current petrol station network would be required (approximately 8,300 stations)
- Scale of hydrogen generation required to satisfy demand from the passenger vehicle and van market
    - LowCVP estimate that 260TWh would be required at the pump to service the passenger car and van sector in its entirety, this being 10x the current production capacity in the UK [7] and a significant proportion of the 2030 forecast for EU hydrogen produced from renewable sources [8]

Impact
Whilst a single cut off date provides a very clear focal point for both industry and consumer alike, LowCVP believe that there are sufficient past examples available to indicate that it is likely to result in an undesired "hockey stick" response from the market. Under such conditions, the sale of diesel and petrol vehicles continue at high levels and may even increase at the cut off point, prolonging the life of the combustion engine parc and representing a lost opportunity to minimise emissions in the intervening period. A phased approach with a suite of local and national measures leading up to the cut off date is likely to prove more effective in this area.

The implementation of a defined cut off date and policy measures such as ZEZs also carry the risk of consumers moving into adjacent vehicle categories, such as L2 and N2 which are served largely by combustion engines, as they seek to find the lowest cost option in order to continue to operate in their usual manner.

At present, the UK automotive industry produces a large number of combustion engines and associated systems. In combination with an end of sale cut off date, this creates a risk that automotive manufacturers may choose to cease further development of high efficiency combustion engines and hybrid systems in order to maximise their existing financial investment, resulting in additional greenhouse gas emissions that may otherwise have been saved.

Automotive manufacturers such as Volkswagen estimate that that the manufacture of a BEV is approximately 20% less labour intensive than a petrol or diesel vehicle [9], so the transition to a zero emission vehicle fleet is likely to be accompanied by a reduction in workforce in this sector.

Battery electric vehicles present an affordability challenge for lower income households and small scale van operators, particularly those that typically purchase outright in the new and used vehicle market. Similarly, the majority of vehicle producers report difficulties in achieving a profit margin on BEVs until economies of scale are achieved through high volume sales. In both manufacture and sale, the costs associated with the battery are a dominant factor.

With approximately a third of UK car owners without access to off street parking [10], the switch to a predominantly BEV form of transport will present a challenge from a charging perspective, placing additional emphasis on public and work place charging.

As the production of BEVs approaches mass volume levels, ethical sourcing and security of supply chain for elements such as batteries and electric machines become of increasing concern. Forecasts, such as that produced by Benchmark Mineral Intelligence [11], suggest that battery manufacture will be constrained by cathode availability in 2025 and raw material supply in 2030. Similarly, the geographical location of component and system manufacture can have a significant impact on the level of embedded carbon imported into the UK. LowCVP estimate that producing all required battery packs in the UK in 2035 rather than the EU represents a saving in cumulative greenhouse gas emissions of 2.7MtCO_2e per annum.

Additional challenges associated with bringing the transition date forward to 2030 from 2035 include:

- LowCVP estimate an additional £28bn loss in fuel duty revenue across the five year period assuming alternative measures are not introduced to compensate
- Key components within an electrified vehicle are forecast to be more expensive to manufacture in 2030 than 2035 due to the maturity of the technology and production processes. As an example, the manufacture of a 60kWh battery is estimated to cost 20% more in 2030 than in 2035. The greenhouse gas emissions associated with the manufacture of each battery will also potentially be higher in 2030 than 2035 due to a lower proportion of renewables being present in the energy system at that point

Measures Required To Achieve Phase Out

LowCVP believe that the following measures are required by industry and government to support an accelerated transition to zero tail pipe emission vehicles.

- Adopt a technology and use led approach to the phase out of petrol and diesel cars and vans to aid rapid transition and maximise greenhouse gas emission savings
- Establish a large scale battery manufacturing capability in the UK to support vehicle production demand and maximise greenhouse gas savings
- Aggressive roll out and implementation of a public charger network to serve public demand
- Application of smart charging and V2G technology and systems to minimise impact on the electricity grid network and largely reduce the need for grid reinforcement
- Retention of grants and incentives to ensure affordability of both new and used zero emission vehicles. These need to be clearly signalled and planned to phase with the desired rate of vehicle uptake

Supporting Evidence

Proposal Analysis - Cumulative Greenhouse Gas Emissions

LowCVP has performed a life cycle analysis (LCA) on a number of proposals using it's in-house vehicle fleet model to assess the effect on cumulative greenhouse gas emissions for the car and van parc. It should be noted that the purpose of the analysis is to allow comparisons to be made between the different proposals being considered. The figures generated are not intended for use for any other purpose nor should they be viewed in isolation as discrete and absolute numbers.

As mentioned earlier in this document, the proposals subjected to analysis were:

- Business as usual (BAU) – sales of new car and vans without any additional measures being applied to encourage the uptake of BEV and PHEV cars and vans. This is based on the Steady Progression model published by the National Grid Electricity System Operator in the 2019 Future Energy Scenarios document [12]
- ICE Only – all new car and van sales are combustion engine vehicles, a worst case scenario if public uptake of BEV and PHEV was to stall completely
- BEV 2030 – all new car and van sales are BEV from 2030 onwards
- BEV 2035 – all new car and van sales are BEV from 2035 onwards
- BEV & PHEV 2030 – all new car and van sales consist of BEV and PHEV from 2030 onwards, with PHEV sales ceasing by 2040

Assumptions made when running the LowCVP car and van fleet model include:

- 2 million new car and van sales per annum
- New cars are category M1
- New vans are category N1
- A vehicle fleet of 30 million cars and vans, split into the following segments, these having been selected as historically representing the majority of new car and van registrations [13]
    - Mini/supermini
    - Medium
    - SUV
    - Van – small
    - Van – large
- A 15 year life span for cars, 12 years for vans
- Use of BEIS emission factors for elements such as gasoline, diesel & electricity. These have been drawn from data tables issued by BEIS in March 2019 [14] and well-to-tank factors published by LowCVP. [15] For clarity, the relevant figures are replicated in Table 1 below
- 80% utilisation of electric drive for a PHEV

Energy Vector	Units	2020	2025	2030	2035	2040	2045	2050
Gasoline	[kgCO2e/L]	0.5977	0.5977	0.5980	0.5980	0.5980	0.5980	0.5980
Diesel	[kgCO2e/L]	0.6171	0.6171	0.5400	0.5400	0.5400	0.5400	0.5400
CNG	[kgCO2e/kg]	0.4880	0.4880	0.4880	0.4880	0.4880	0.4880	0.4880
Electricity - Grid Average								
Domestic Consumption	[kgCO2e/kWh]	0.1405	0.1053	0.0828	0.0409	0.0409	0.0342	0.0276
Commercial/Public Sector Consumption	[kgCO2e/kWh]	0.1380	0.1034	0.0813	0.0401	0.0401	0.0336	0.0271
Industrial Consumption	[kgCO2e/kWh]	0.1354	0.1015	0.0798	0.0394	0.0394	0.0330	0.0266
Generation	[kgCO2e/kWh]	0.1283	0.0962	0.0756	0.0373	0.0373	0.0313	0.0252

Table 1: Emission Factor Assumptions

Note: The BEIS emission factor figures do not achieve a net zero electricity grid in 2050

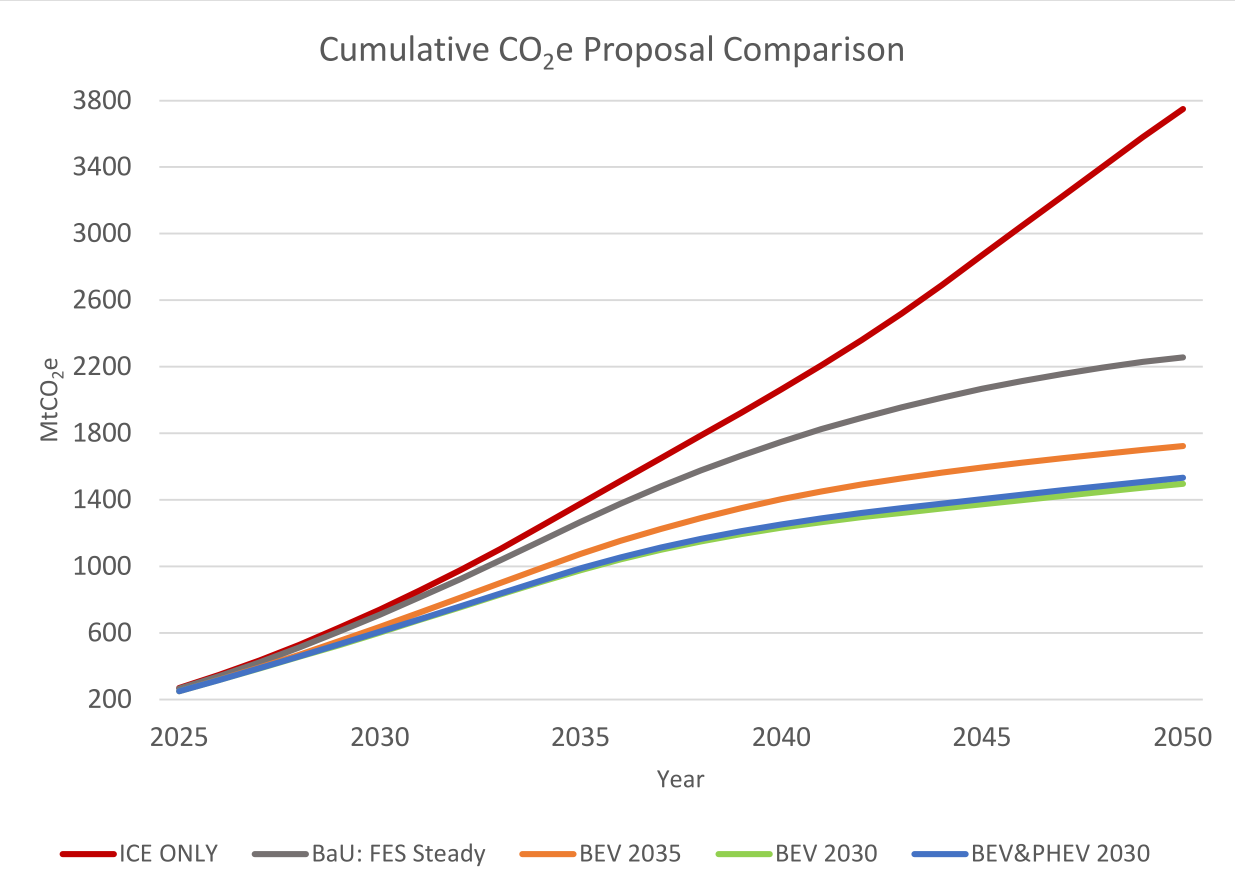

Figure 3: Cumulative greenhouse gas emission comparison

Figure 3 provides a summary of the output from the LCA model when applied to the different proposals. As might be expected, those proposals containing a high degree of electrification perform considerably better in reducing the level of cumulative greenhouse gas emissions from cars and vans than the worst case, ICE only solution. For example, ending the sale of new petrol, diesel and hybrid cars and vans in 2035 and 2030 results in a 54% and 60% reduction respectively against the ICE only proposal.

The combined PHEV and BEV strategy implemented in 2030 generates 720$MtCO_2$e less than the BAU proposal and 190$MtCO_2$e less than the 2035 BEV proposal. It also follows a similar profile to the 2030 BEV proposal, although producing an additional 35$MtCO_2$e than the latter by 2050.

Applying a combined BEV and PHEV strategy to new car and van sales, in conjunction with a 2030 introduction date, reduces cumulative greenhouse gas emissions by an additional 190$MtCO_2$e compared to a 2035 BEV only approach.

However, when used in combination with an increased level of renewable fuel, the delta in cumulative greenhouse gas emissions between the 2030 PHEV & BEV proposal and the 2030 BEV only proposal is all but eliminated. This is illustrated in Figure 4, where E85 fuel is introduced in 2030 for use in the PHEV new car and van fleet.

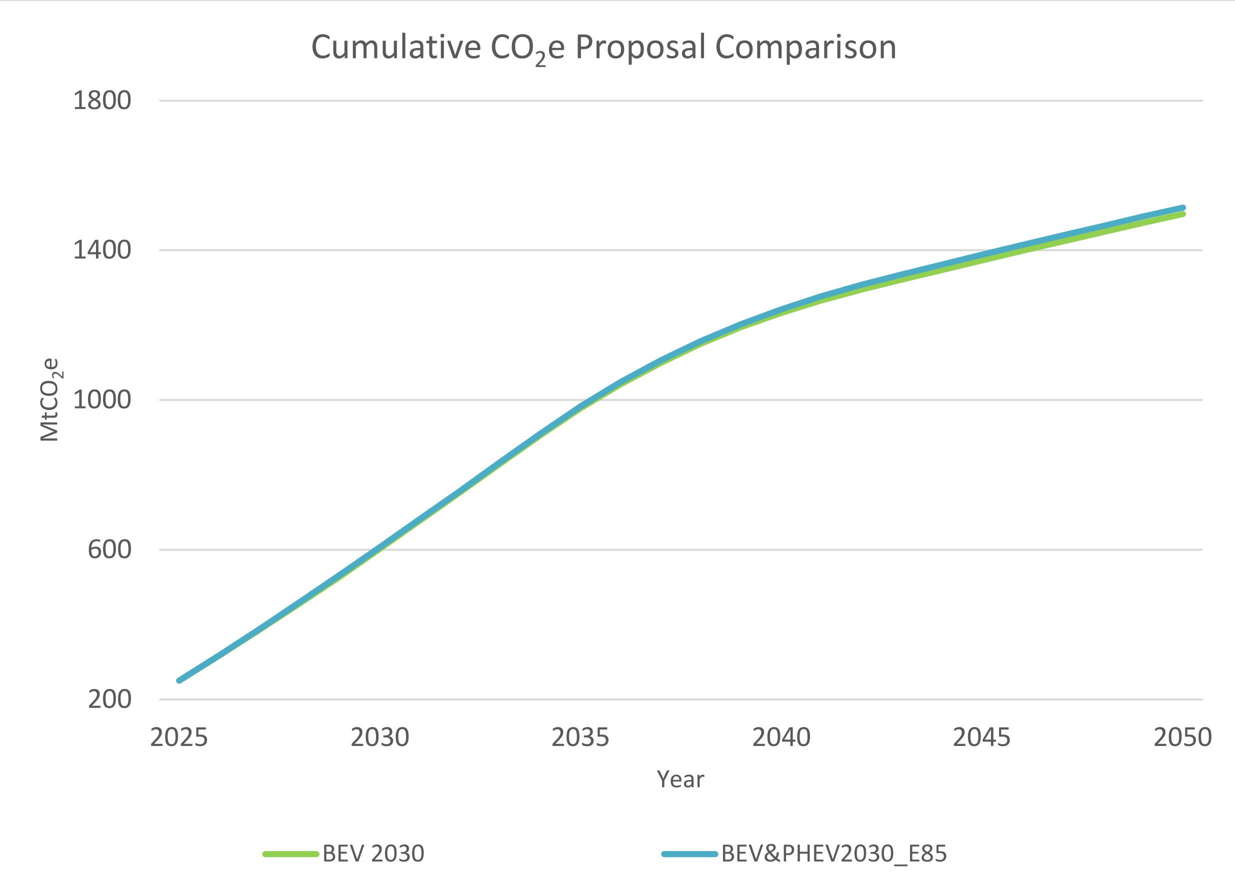

Figure 4: BEV 2030 in comparison with PHEV & BEV 2030 using E85

Combining E85 fuel with the 2030 BEV & PHEV proposal results in an equivalent cumulative greenhouse gas emission performance to the 2030 BEV only proposal.

Effect of Zero Emission Zones

Without data readily available to describe the number and type of vehicles entering cities in the UK and the associated journey lengths, LowCVP used the following information to estimate the impact of a large scale implementation of zero emission zones (ZEZ).

- The average number of miles travelled per person per year by car/van in urban conurbations taken from the 2018 National Travel Survey [16]
- The population in the urban conurbations taken from a 2014 DEFRA analysis [17]
- The average gCO_2/km for the passenger car fleet in the UK in 2016 [18]

This produced a figure of approximately $6.5MtCO_2$ per annum generated by approximately 12.8 million cars and vans driven by residents in the cities of England.

As people living in major conurbations typically travel on average shorter distances per trip by car and van compared to more rural areas [16], cities align well with the use of PHEVs and BEVs where the battery range available today and certainly in the future is more than adequate for such journeys. As a result, cities are considered to offer a quicker route to electrification than other areas of the UK and are therefore suitable for the application of ZEZs, as well as also having a need to urgently address air quality issues. A key consideration in achieving such a strategy will be the adequate provision of vehicle charging stations, particularly for households without access to off street parking.

A phased introduction of ZEZs in UK cities from 2025 onwards would act as an additional and effective lever in encouraging the early adoption of BEV and PHEV new cars and vans.

UK Manufacture

Figure 5 provides a greenhouse gas life cycle analysis (LCA) comparison for a medium sized passenger car, historically the most popular segment in new car registrations, for both 2020 and 2035.

The BEV in this instance is equipped with a 60kWh battery with a range of approximately 250 miles, typical of the latest market entrants in this sector in 2020. Components, including the battery are manufactured in Europe and the vehicle is assembled in the UK.

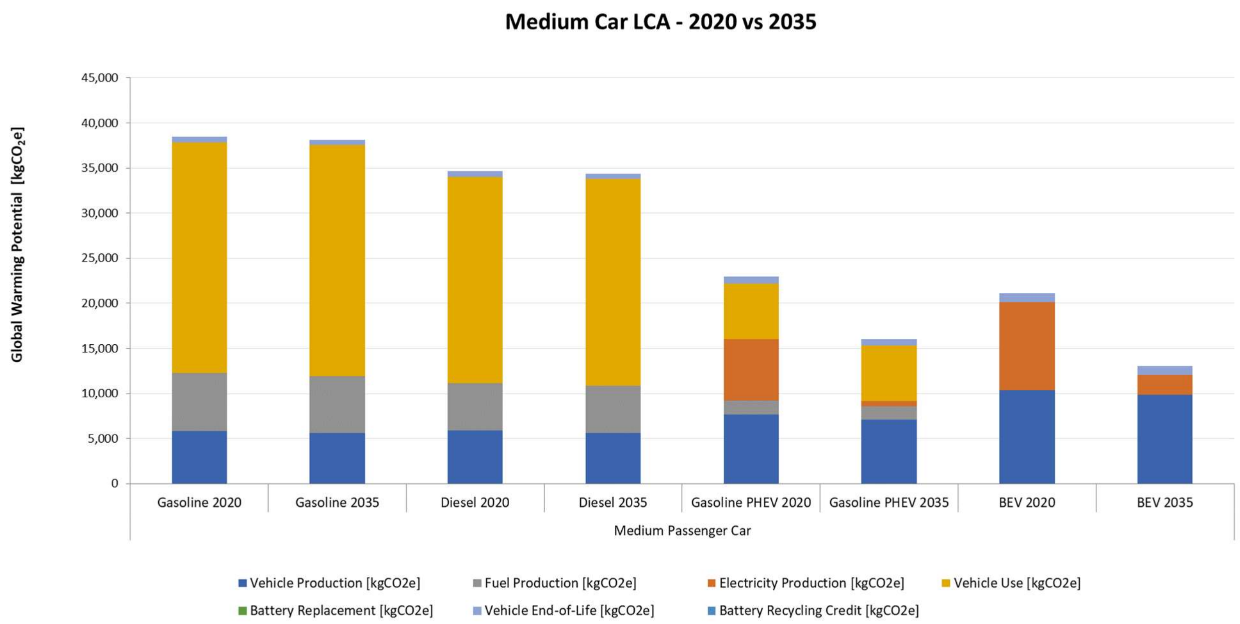

Figure 5: Medium car LCA comparison – 2020 & 2035

As expected, the BEV offers substantial greenhouse gas emission savings over its gasoline and diesel counterparts across the lifetime of the vehicle. This situation improves in 2035, primarily due to the increased use of renewable energy in UK and EU electricity generation. However, further greenhouse gas emission savings in the order of 1,350kgCO_2e per vehicle are available in this scenario if battery manufacture is moved to the UK, to take full advantage of the much lower forecast CO_2 intensity in the UK grid compared to the EU grid average. This is equivalent to reducing the total life cycle CO_2 emissions for the vehicle by 10%.

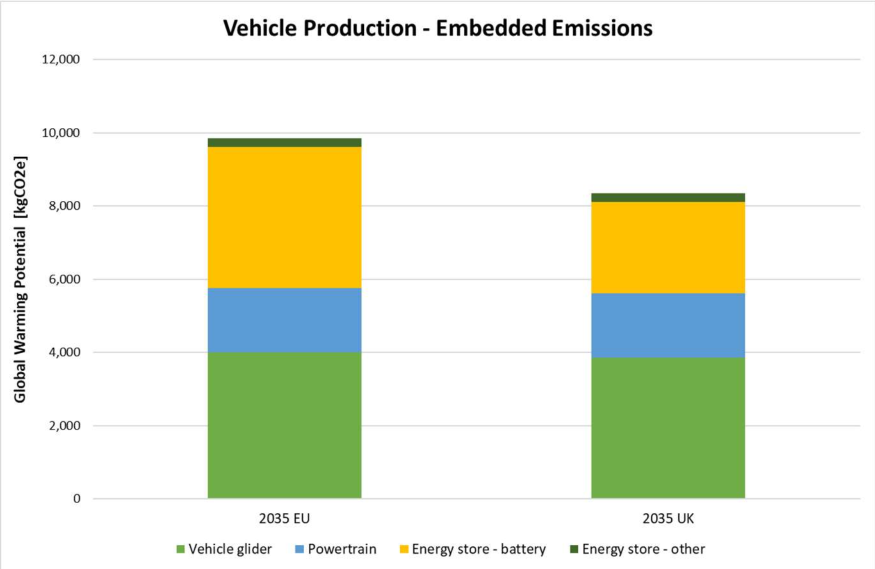

Figure 6: Medium car LCA breakdown – vehicle production

For a 2035 phase out date, locating battery manufacture in the UK has the potential to reduce the total life cycle CO_2 emissions for each new car and van BEV produced by 10%.

If a 60kWh pack was said to represent the average battery size across the entire new car and van fleet of 2 million vehicles per annum, then manufacturing all battery packs in the UK would represent a saving in cumulative greenhouse gas emissions of 2.7MtCO_2e per annum.

To achieve such savings would require the UK to put in place a battery manufacturing capability of 120GWh per annum, equivalent to 8 Gigafactories of 15GWh capacity each, at an estimated cost of £10bn.

For a 2035 phase out date, a battery manufacturing capacity in the region of 120GWh will be required to support UK market demand.

Take Up Rate

Figure 7 below provides an estimate of the new car and van take up rates required for the BEV element of the BEV 2030 and BEV & PHEV 2030 proposals.

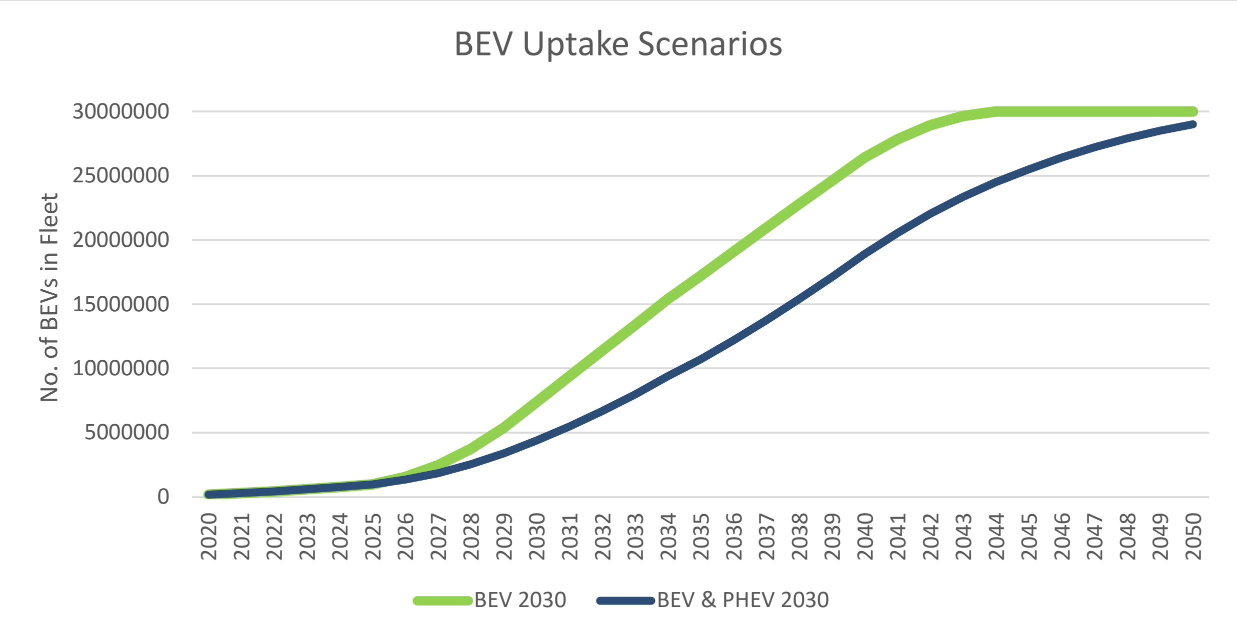

Figure 7: New car and van BEV take up rates

The proposal for all new car and van sales to consist of a split between BEV and PHEV from 2030 onwards, with PHEV sales ceasing by 2040, requires a less aggressive take up rate on BEVs compared to the alternative 2030 BEV only proposal. It should not be forgotten that such a proposal also requires the manufacture of 1 million PHEVs per annum for a period of 10 years from 2030 onwards. However, overall, LowCVP believes that the strategy of combined PHEV and BEV new car and van sales from 2030 provides for a softer and therefore more manageable transition for vehicle manufacturers and their supply chains.

By way of illustration and taking the battery as an example, by being smaller in size, a PHEV battery is lower cost, requires less raw material, produces lower greenhouse gas emissions during production and is quicker to manufacture than a BEV battery for an equivalent sized vehicle.

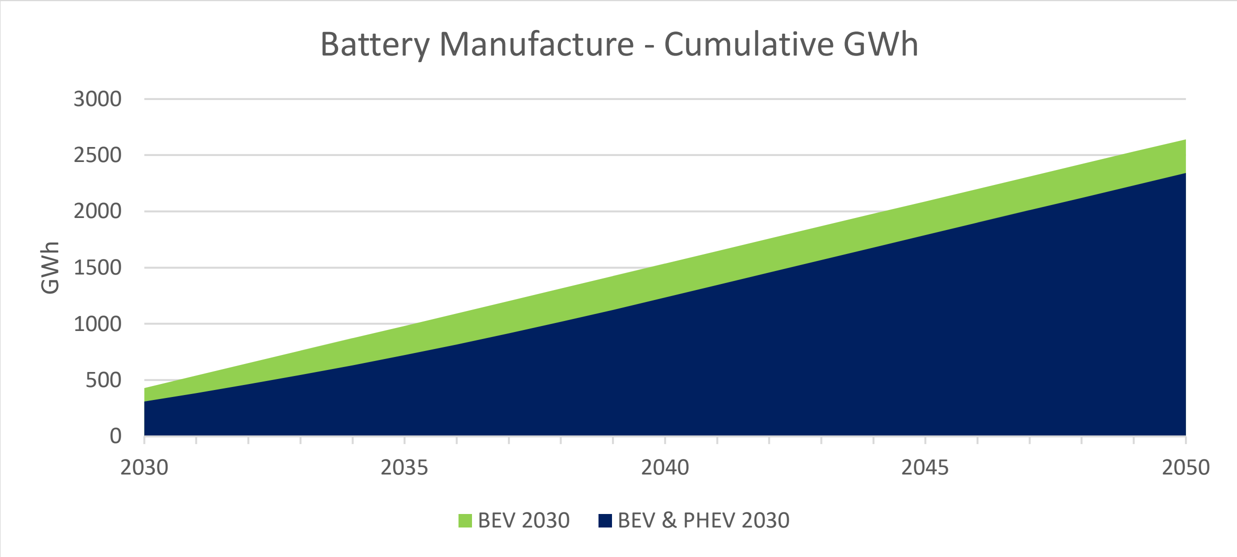

Figure 8 – Cumulative GWh battery manufacture

Over the 20 year period between 2030 and 2050, this equates to an approximate 10% reduction in total battery GWh manufacture for the 2030 BEV & PHEV proposal compared to the 2030 BEV only proposal.

Applying a combined BEV and PHEV strategy to new car and van sales, in conjunction with a 2030 introduction date, reduces the cumulative battery GWh manufacturing requirement to 2050 by approximately 10% compared to a 2030 BEV only approach.

As shown in Figure 9, the 2030 PHEV & BEV proposal also places lower annual demand on battery manufacturing capacity from 2025 through to 2040.

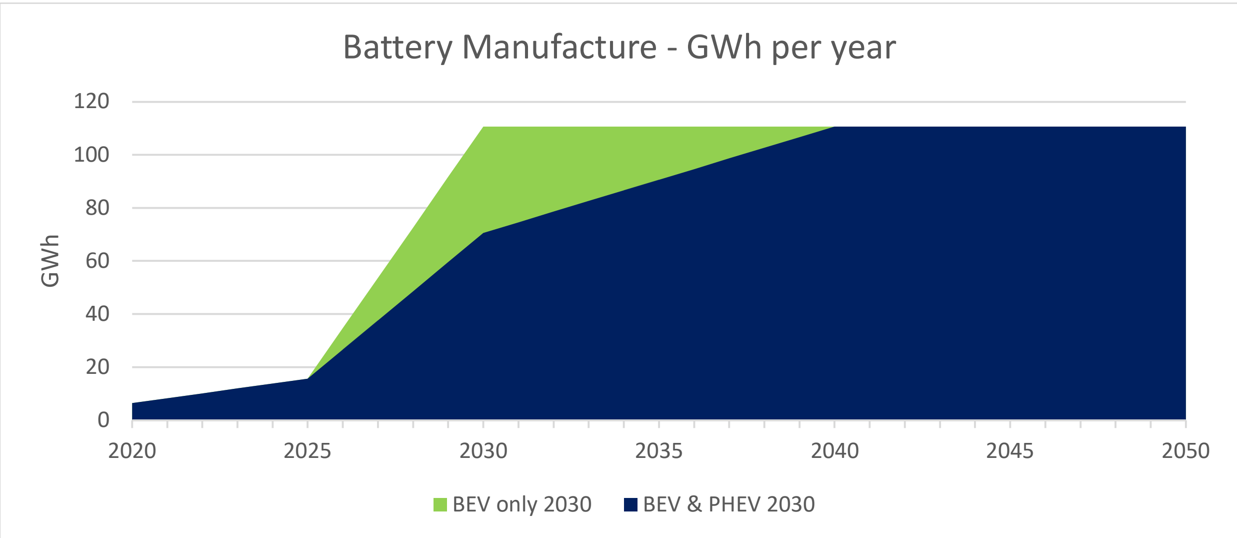

Figure 9 – Annual GWh battery manufacture

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