Local Plan 2040: Road transport options carbon emissions

Technical report on the evaluation of carbon emissions (greenhouse gas emissions) for Local Plan road transport infrastructure options based on traffic modelling outputs.

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Executive summary

Emissions from road transport are a major component of the greenhouse gas emissions in Canterbury district, producing around 40% of the emissions from energy, predominantly from the combustion of petrol and diesel fueled vehicles. Reducing emissions from road transport is a key component of reducing the causes of climate change in the UK Government plans and the Kent and Medway Energy and Low Emissions Strategy.

This report evaluates the projected carbon emissions from road transport from the five strategic transport options that were traffic modelled to provide evidence for the Local Plan 2040. It should be read in conjunction with the traffic modelling report (Stage 3 Report - May 2021).

The evaluation focuses on emissions from the fuel used to power the vehicles, national fleet projections and modelled road use. The evaluation shows that the growth in road transport use under all scenarios is significant and will result in an increase in carbon emissions based on fleet projections through to 2030.

The analysis also evaluates the potential to reduce the transport emissions by enabling an accelerated uptake of electric vehicles and finds that the most ambitious forecasts could reduce the annual road transport emissions by around 60% by 2040.

The report concludes that the selected option for the Local Plan 2040 includes a transport strategy will require an evidence-based plan to deliver changes to the transport system that includes:

- allocation of resources to fully mobilise the uptake of electric vehicles in order to aim for the high scenario in the Electric Vehicle and Charging Infrastructure Strategy
- a very strong focus on the parts of the transport options that deliver improvements that maximises non-car dependent transport in the three district urban areas

Contents

1. Introduction

The options for developing the Canterbury district road infrastructure within the Local Plan have been modelled byJacobs consultants in conjunction with Kent County Council and Canterbury City Council transport teams. For further details on the traffic modelling methodology and options, please refer to the local plan transport modelling report Stage 3 Report - May 2021

The purpose of this evaluation is to compare and contrast the projected greenhouse gas emissions, referred to as carbon emissions, from road transport between the five transport options.

2. Methodology

In order to understand the climate change impacts of developing the road network, the output from the transport model has been used to calculate the projected greenhouse gas emissions from the vehicles.

The road traffic model provides projections of the number of vehicles by type and the road speed at morning and evening peaks by portions of roads called links that join together at nodes.

The DEFRA Emissions Factor Toolkit is provided as a mechanism for calculating the emissions on sections of roads (links) based on the speed and number of vehicles by type. The model also includes projections of the emissions composition of vehicles based on the national forecasting.

The DEFRA Emissions Factor Toolkit provides an evaluation of the exhaust emissions from road transport for an individual section of road based on the length, road speed, mix of vehicles and a range of other factors. The emissions calculations do not include greenhouse gas emissions associated with production and distribution of the fuel, maintenance of the vehicles and roads or any supply chain emissions associated with the operation of road traffic such as vehicle insurance and financing. The direct emissions from operating fossil fuel powered vehicles accounts for around 40% of district emissions and the focus of this analysis is therefore the vehicle exhaust emissions.

The modelled output has been compared to the national statistics on Local Authority emissions from road transport to validate the calculations.

1.1. EFT output and conversion from link to total emissions

The Emissions Factor Toolkit (EFT) provides estimation of carbon dioxide, nitrogen oxides and particulate emissions from vehicle exhausts for sections of road. For this analysis the carbon dioxide emissions have been aggregated across all the sections of road (referred to as links in the model) and scaled up from the modelled morning and evening peak traffic flows in the traffic model to annual emissions using scaling factors provided by the modelling consultants, Jacobs.

In order to compare calculated tailpipe emissions to national data on district energy emissions which include emissions associated with extracting and distributing fuels from the source allocated at a district level, well-to-wheel and tank-to-wheel conversion factors have been used. See Appendix for more details.

There are road transport greenhouse gas emissions that are not included in this evaluation including emissions from manufacturing, maintaining and disposal of vehicles, road manufacture and maintenance and other supply chain activities associated with the operation of the road transport systems.

1.2. Calculation sequence

1. Traffic model outputs supplied from Jacobs as spreadsheet with AM and PM peak flows by system averages and link averages, vehicle type, link length and road speed
2. Spreadsheet transformation from model output to EFT input
3. Load data to EFT and run model for each AM and PM peak
    a. Summary level based on AM/PM Car/LGV/HGV aggregates
    b. Link level (~50,000 rows per model)
4. Download EFT output data

5. Combine AM and PM outputs and scale up to annual emissions

1.3. Scaling up emissions from peak to annual emissions

The following scaling factors were calculated by Jacobs and supplied to Canterbury City Council:

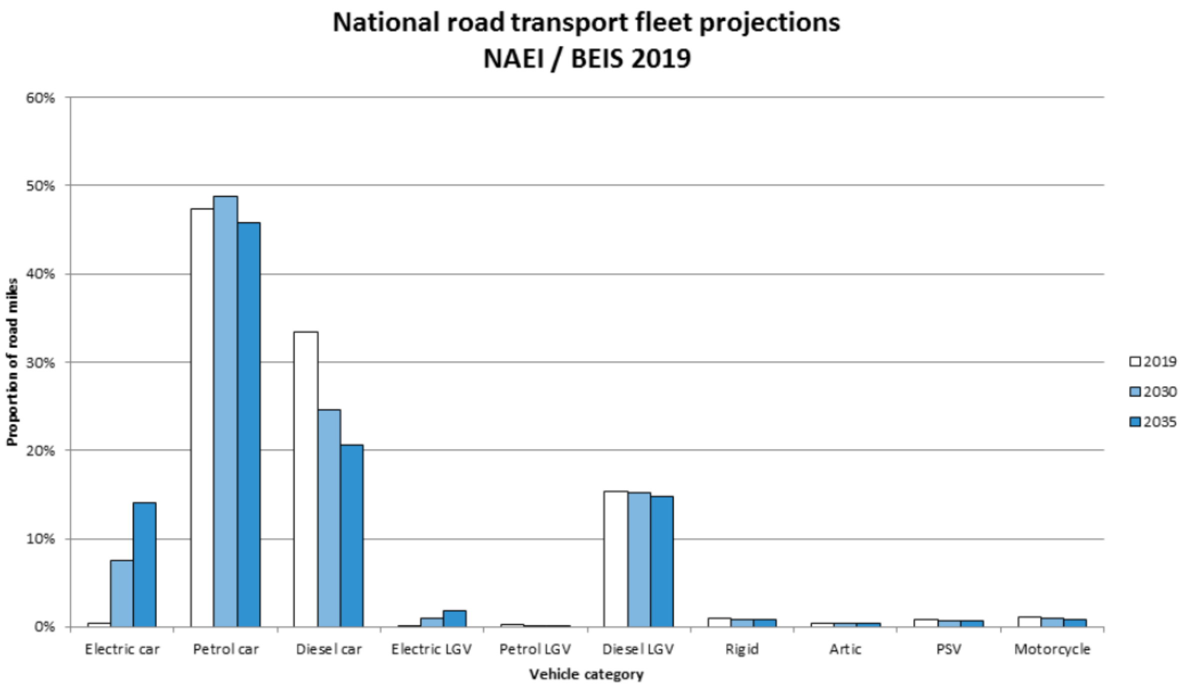
Factor Description	Factors	Comment
AM peak hour factor (1 hour peak hour to 3 hour peak period)	2.488	Based on Canterbury ATC database
PM peak hour factor (1 hour peak hour to 3 hour peak period)	2.756	
6h - 12h AAWT factor	1.832	
12h -24h AAWT factor	1.188	
24 AAWT to AADT (Motorway or high speed)	0.95	Based on wider Kent ATC database Note: The factor 0.92 was used for the summary level calculations which applies to >85% of the links and road length
24 AAWT to AADT (local/residential/rural roads)	0.92	

1.4. Assumptions

The following assumptions have been made:

1. The projected fleet distribution - the mix of vehicles by emissions types in 2030 for 'urban - not London' is as projected by DEFRA in the EFT v.10 model. These projections are based on NAEI/BEIS data. Canterbury City Council Electric Vehicle and Infrastructure Strategy aims to mobilise a higher level of electric vehicle usage in the district and the potential impacts of this strategy have been evaluated in this study. A more comprehensive discussion of fleet projections is contained in Appendix 2.

2. Fleet projections at 2030 have been used as projected within the Emissions Factor Toolkit v10 model based on National Air Emissions Inventory and Department for Business, Energy and Industrial Strategy data derived from National Transport Statistics from the Department for Transport. The projected distribution of vehicles by miles travelled in urban non-London areas is:



The NAEI/BEIS fleet projections 2019 project fleet changes to 2030 and 2035 low emissions vehicles that are too slow to deliver emissions reductions from the existing road transport systems, let alone contribute significantly to reductions in emissions from further development of the road transport system. Canterbury City Council Electric Vehicle and Infrastructure Strategy aims to enable a higher rate of uptake of electric vehicles in the district. However this work is in its early stages and can not yet be demonstrated as an alternative basis for emissions projections.

Although the UK Government has indicated that there will be an end to the sale of petrol and diesel fuelled vehicles, the policy is not yet agreed. The target date for the end of all petrol and diesel fuelled vehicles is currently for consultation as from 2035. Once in place, this may accelerate the uptake of electric vehicles, but it is relatively late in the plan period.

3. The Jacobs traffic model allows for differential vehicle speeds by type of vehicle on each link i.e. with some overtaking by smaller faster vehicles. This is most applicable on dual carriageway sections of road. The EFT v.10 model does not allow for this approach and assumes a uniform average speed on the link for all vehicles travelling on the link. Within the model data the speed differential between vehicle types is small. For the emissions model the higher of the traffic model output speeds has been used.

4. For the model scale up from AM and PM peak to average annual daily traffic and annual emissions, the scale up methodology assumes that the vehicle speed and therefore emissions characteristics are constant in the scale up approach. In reality, the average speed of vehicles outside of the peaks may be slightly higher and therefore the link emissions slightly lower than calculated. The emissions to speed curve is relatively flat at

higher speeds. If the overall emissions evaluation is very similar for options with very different road systems, this assumption may require revisiting.

5. The Jacobs transport model is based on road transport systems and does not model changes in travel behaviour including:
    a. Changes in the need to travel e.g. through increased homeworking
    b. Major modal shift where people choose to use walking, cycling and public transport instead of personal transport.

2. Modelling results

2.1. Baseline calibration

The road transport model developed by Jacobs is based on road traffic survey data and the modelled regional road network. To calibrate the methodology used in this evaluation, the baseline output (2019) has been compared to the national energy emissions data for the district transport network (2018).

The Emissions Factor Toolkit (EFT) calculation based on the average road speed for all road links, and the distance travelled during the morning and evening peaks, for the three vehicle group categories - cars, light goods vehicles and heaving goods vehicles gives total annual tailpipe emissions from the vehicles = 152 ktCO_2/y

EFT tailpipe emissions are from the vehicle exhausts and referred to as Tank to Wheel (TTW) and do not include any emissions from the production of the fuels or from the construction and maintenance of the fuels, vehicles or roads. National Statistics local authority emissions data are based on Well to Wheel (WTW) emissions factors and include the share of emissions from the processes to produce and refine the fuels used. Scaling the tailpipe emissions from the EFT evaluation to WTW emissions using the average factor for petrol and diesel of 134% gives total annual emissions 204 ktCO_2/y.

Comparison of district road transport emissions calculations	Tonnes carbon dioxide per year (ktCO_2/y)
Total road transport emissions Canterbury District (Source: UK local authority and regional carbon dioxide emissions national statistics 2018)	230
Traffic Model output Baseline 2019 (with 2018 fleet composition) EFT transport model network average output scaled to WTW	204

The road transport emissions from the average network approach (204 $ktCO_2/y$) are 11% lower than the national data (230 $ktCO_2/y$). Both figures are estimates using different methods and both will have ranges of uncertainty. There are multiple potential reasons for the differences:

- The Jacobs transport model does not take into account issues such as engine idling, small vehicle movements (such as within a car park) or acceleration and deceleration at traffic junctions.
- The calculations from the Emissions Factor Toolkit are based on average traffic speeds and a level gradient. Slow moving traffic and vehicle loading have a large impact on increasing vehicle emissions.

The range of uncertainty in the emissions evaluation is important to keep in consideration when comparing and contrasting model outputs. The comparison of the transport model exhaust emissions to the national energy emissions data shows that the approach provides a comparable evaluation that is suitable for comparing carbon emissions from different transport options.

2.2. Options comparison

The model output provides a comparison between the five transport options against the 2019 baseline transport emissions with a projected 2030 fleet composition.

Option	Annual emissions (EFT output - network average method) ktCO2/y	Annual emissions (EFT output - link method)[1] ktCO2/y
Baseline Year (2018)	152	168
Baseline forecast	164	191
Option 1: Existing Local Plan Strategy	176	208
Option 2: Coastal focussed development with improved public transport	171	*205*
Option 3: City focussed development with SWECO interventions plus	165	*198*
Option 4: City focussed development with SWECO interventions plus and relief roads	169	*203*
Option 5: City focussed development with active streets and relief roads*	174	210

[1] The links based approach is more thorough as it reflects the traffic composition, flow and speed on each link.

*Important note about Option 5: the traffic model for option 5 is not designed or able to reflect the significant modal shift from private cars to active and public models of transport that are facilitated by this option by design.

The evaluation shows that in all cases emissions are projected to increase from the baseline:

- The proposed options all generated additional road traffic beyond unplanned growth in development.
- The evaluation also shows that there are some marginal reductions in emissions from focussing development in Canterbury (options 3 and 4) which results in shorter journey lengths compared to options 1 and 2 which have more dispersed development
- Option 5 is evaluated to generate the highest emissions from road transport; this option is designed to restrict and divert traffic from the Canterbury ring road and from using residential streets as routes around Canterbury. The model does not reflect the shift to active travel away from using personal cars for short urban journeys that this option is designed to achieve. The transport model is therefore inadequate to accurately reflect this option.

Recommendations

This evaluation of emissions from the local plan road transport options shows that without other interventions, all the options are likely to increase the total carbon emissions from the district transport system. Moreover, in order to reach carbon reduction targets towards net zero emissions, significant alternative transport system changes and interventions will be needed.

The traffic flow data that underpins this evaluation is not adequate to quantify the potential emissions reduction from the active travel components of the transport options, and in particular option 5 which aims to enable significant modal shift in the Canterbury urban area. A much more detailed and comprehensive multimodal study is required to develop and evaluate option 5.

It will be necessary for the local plan and the future transport strategy to provide additional transport options and interventions to reduce transport carbon emissions. Based on the evidence, these are likely to include:

- Local plan policy and allocation of resources to fully mobilise the uptake of electric vehicles in order to aim for the high scenario in the Electric Vehicle and Charging Infrastructure Strategy
- A very strong focus on the parts of the transport options that deliver improvements that maximises non-car dependent transport in the three district urban areas

Glossary

AADT - Annual average daily traffic

AAWT - Average annual weekday traffic

Baseline

EFT (Emissions Factor Toolkit)

Greenhouse gas emissions

Appendix 1 - Emissions model input summaries

Example of traffic model output used as the emissions calculations input. The network average is compiled by aggregating the vehicle flows over all the road sections in the district. The traffic models simulate the 1 hour morning and evening peaks

2019 Baseline network average model output				
Vehicle class	Travel Time [h]	Travel Distance [km]	Median Speed [km/h]	Average Speed [km/h]
AM (1 hour peak traffic flows)				
Car	5701	282738	46.94	49.59
LGV	788	40862	47.68	51.86
HGV	253	15812	54.99	62.40
PM (1 hour peak traffic flows)				
Car	6074	302725	46.85	49.84
LGV	602	32136	48.52	53.36
HGV	149	9582	56.84	64.30

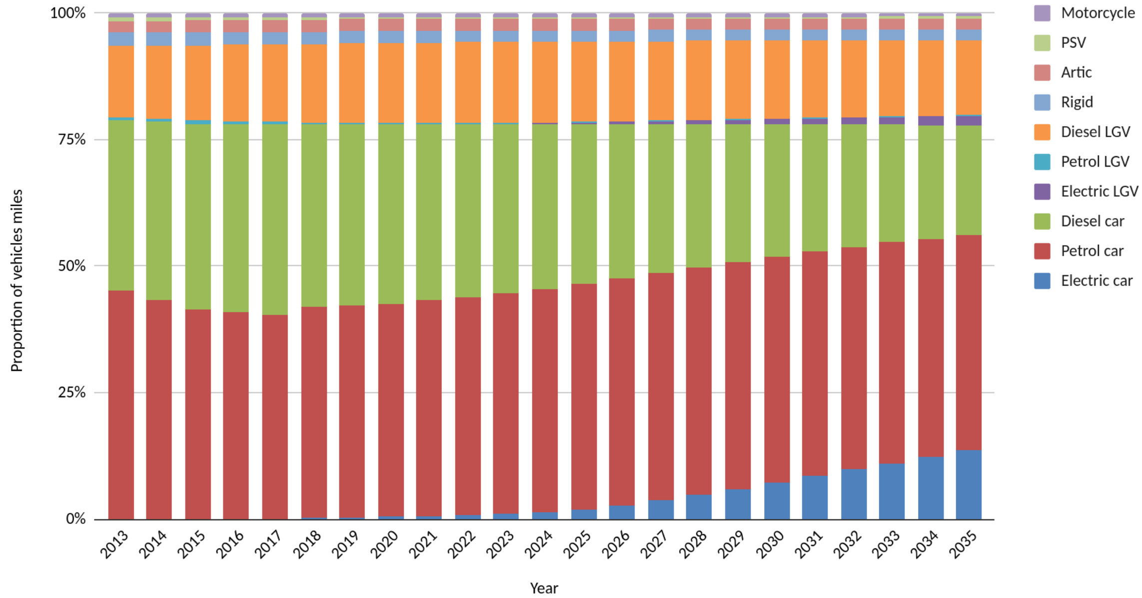
Each network summary is also accompanied by a full list of road sections (links) and the emissions calculations can be applied at the network or link level.

Appendix 2 - Road fleet distribution projections

The fleet projections used in the DEFRA Emissions Factor Toolkit forecast the proportion of road use by vehicle type and fuel through to 2035. The projections show steady increase in the take up of electric vehicles through to 2035 by which time slightly under 14% of the road usage by distance will be from electric cars and less than 2% electric vans.

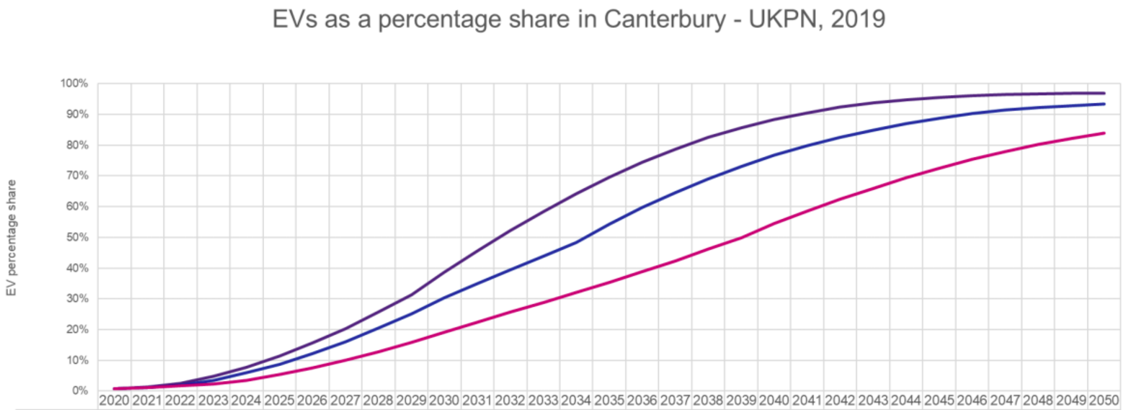
These projections are much lower than pathways to reduce emissions to net zero which are aligned to the Paris agreement. In order to reach net zero emissions targets, according to Anthesis SCATTER pathways, full electrification of private cars is necessary by 2035 along with significant modal shift in favour of active travel, public transport and a general reduction in the distance travelled per year per capita.

National Atmospheric Emissions Inventory vehicle fleet projection to 2035 (Rural England outside London)



Canterbury City Council Electric Vehicle and Infrastructure Strategy is based on enabling a higher level of electric vehicle take-up than the NAEI/BEIS projections, informed by UK Power Networks (UKPN) and Energy Savings Trust work. The UKPN projections aim for electric vehicles to comprise at least 55% of district cars by 2040:

Extract from UKPN Distribution Future Energy Scenarios



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
High	1%	1%	2%	5%	8%	11%	16%	20%	26%	31%	39%	46%	52%	58%	64%
Medium	1%	1%	2%	3%	6%	9%	12%	16%	20%	25%	30%	35%	39%	44%	48%
Low	1%	1%	2%	2%	3%	5%	8%	10%	13%	16%	19%	22%	26%	29%	32%

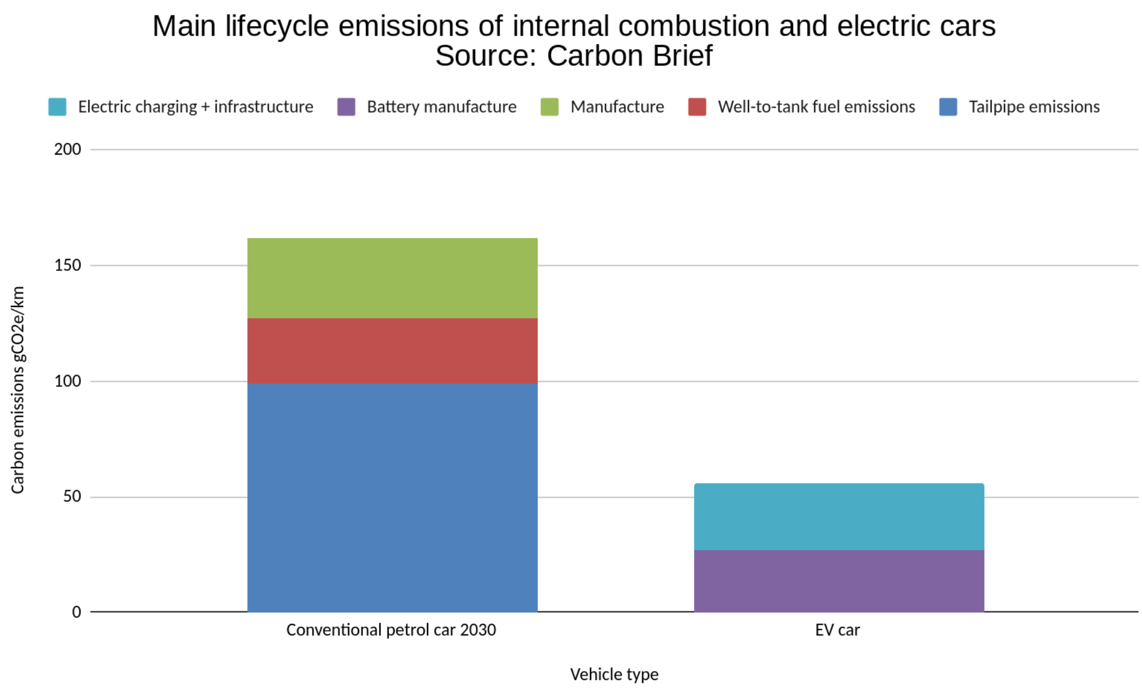
	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
High	70%	74%	79%	83%	86%	88%	91%	92%	94%	95%	96%	96%	96%	97%	97%	97%
Medium	54%	60%	65%	69%	73%	77%	80%	83%	85%	87%	89%	90%	91%	92%	93%	93%
Low	35%	39%	42%	46%	50%	55%	59%	62%	66%	69%	73%	75%	78%	80%	82%	84%

These projections are very dependent on the national policy on the end of sale of petrol and diesel fuelled cars, including hybrids, as well as local factors including the district electric charging network, parking and vehicle licencing and planning policies.

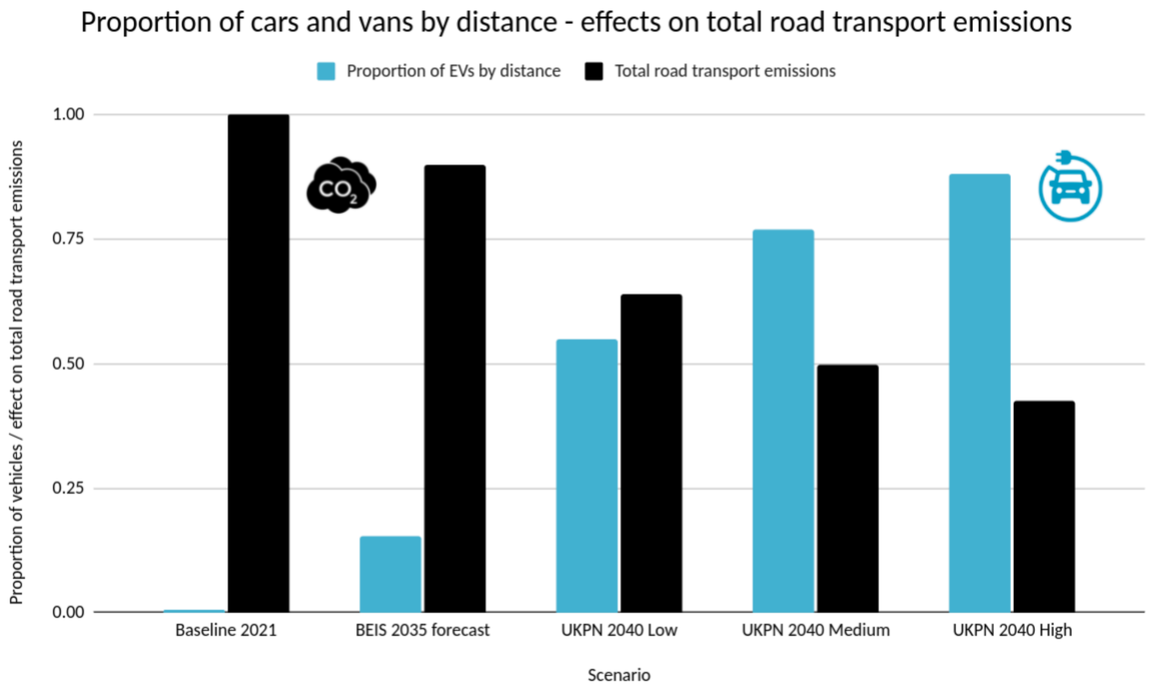
Appendix 3 -Impact of higher electric vehicle uptake on emissions

In order to evaluate the impact of an accelerated uptake of electric vehicles on the projected road transport emissions it is necessary to expand the scope of the emissions evaluation to include embodied emissions from manufacturing the vehicles (which are higher for electric vehicles) as well as the emissions from generating the electricity to power the electric vehicles. The DEFRA Emissions Factor Toolkit only evaluates tailpipe emissions.

Research to evaluate in detail the projected carbon emissions from electric vehicles is ongoing; there are many areas of uncertainty including improvements in battery technology and manufacture and evolution of the electricity generation and charging infrastructure. Based on current aggregated research, electric vehicles produce around 30% of the emissions of a conventional internal combustion powered car per km travelled over the vehicle lifetime.



By applying the 70% reduction in emissions from the electric vehicle component of projected fleet composition scenarios to the total road transport emissions, the range of possible emissions reductions is between 10% for the NAEI/BEIS forecast and nearly 60% under the most ambitious UKPN projection of high electric vehicle uptake. This estimation focuses on electric cars and light goods vehicles and does not include potential fuel changes to heavy goods vehicles such as hydrogen produced from renewable energy.



Appendix 3 - Exhaust emissions to total fuel emissions scaling factors

DEFRA Emissions Factor Toolkit evaluates emissions from vehicle exhaust systems. There are additional greenhouse gas emissions associated with the extraction, refining and distribution of fuels before they are used in the vehicles. The total fuel emissions from extraction to combustion are referred to as Well-To-Wheel emissions. The exhaust emissions can be referred to as Tank-To-Wheel and the ratio of Tank-To-Wheel to Well-To-Wheel can be used to compare exhaust emissions to total energy emissions using the following factors:

Fuel	Well to Wheel (WTW) kg CO2e/litre	Well to Tank (WTT) kg CO2e/litre	Tank to Wheel (TTW = (WTW-WTT)) kg CO2e/litre	WTW/TTW emissions factor
Diesel (average biofuel blend)	2.59	0.62	1.98	1.31
Petrol (average biofuel blend)	2.21	0.60	1.61	1.37

Source:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904213/conversion-factors-2019-full-set-v01-02.xls